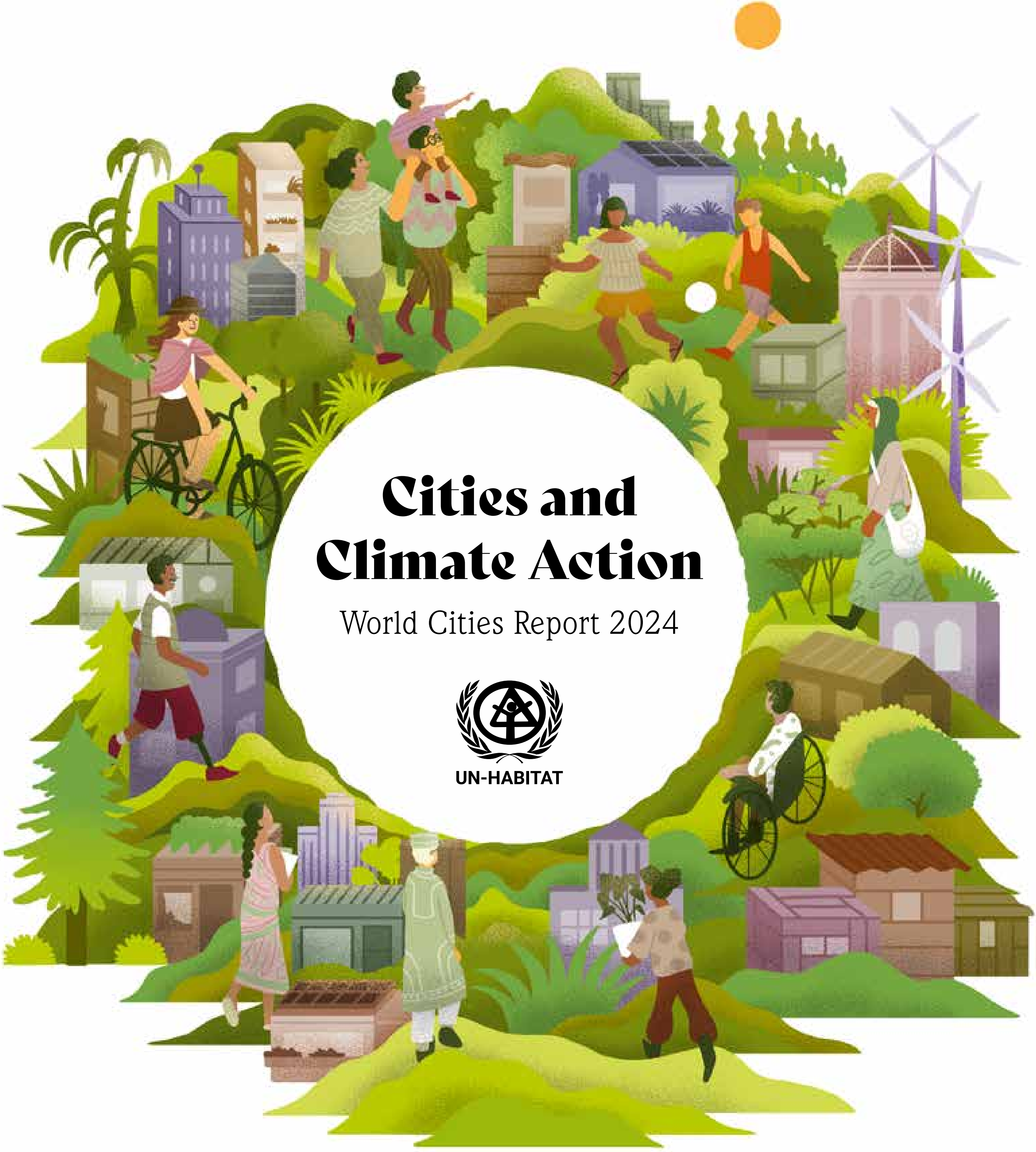

Cities and Climate Action

World Cities Report 2024

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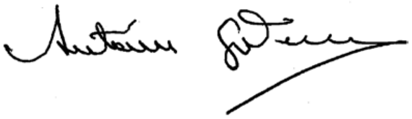
Secretary General's Foreword

António Guterres
Secretary-General of the United Nations



The fight against climate change and the struggle to achieve more sustainable and equitable urbanization are two sides of the same coin.

When buildings, homes and vital infrastructure like water and transportation systems are poorly planned, built and managed, they are no match for climate-fueled disasters like rising seas, heatwaves, and other extreme weather impacts. This challenge disproportionately affects the poorest and most vulnerable people.

But as this report shows, with bold investments and good planning and design, cities offer immense opportunities to slash greenhouse gas emissions, adapt to the effects of climate change, and sustainably support urban populations.

Hundreds of cities around the world are leading the way by expanding inclusive green spaces, reducing emissions through smart planning and building, and investing in renewable energy to power civic services like transportation networks.

This report highlights strategies for local and regional governments and other partners to collectively forge solutions, drive innovation and craft budgets and policies that support sustainable urbanization for people and planet alike.

City and local leaders must also continue to be at the forefront of the fight against climate change. In many cases, cities are going further and faster than national governments in limiting global temperature rise to 1.5 degrees Celsius. The success or failure of new national climate plans will be realized at the community level, and local leaders must be involved every step of the way.

The recently adopted Pact for the Future highlighted the importance of all levels of government working together to plan, design and build safe, healthy, resilient and sustainable cities for all people.

As we accelerate our efforts to reach the Sustainable Development Goals by 2030, let's work to ensure that cities, everywhere, contribute to this goal.

Executive Director's Introduction

Anacláudia Rossbach
Under-Secretary-General and Executive Director
United Nations Human Settlements Programme
(UN-Habitat)

UN-Habitat has been sounding the alarm on the threat facing cities from climate change for decades. The publication of the *Global Report on Human Settlements 2011: Cities and Climate Change* was a landmark, but our work on the complex and fast-moving intersection between the twin challenges of the climate crisis and rapid urbanization long precede this. With every year, however, the message has become more urgent as the impact of climate change worsens while concrete action to address it lags far behind. From rising sea levels to urban heatwaves, the human, economic and environmental costs are becoming too high—and are only set to increase in future. This report shows that almost no urban resident will be unaffected, with billions of people subjected to hotter temperatures or exposed to the risks of flooding and other threats.

Yet, climate change impacts are unevenly distributed within urban areas. Those most at risk from climate change are also those already facing persistent and chronic structural inequalities. Informal settlements and slums—typically situated in environmentally sensitive areas and lacking in protective infrastructure—often bear the brunt of climate-related disasters or extreme events. At the same time, the less visible effects of power imbalances, hierarchies and discrimination are compounding the vulnerability of the most marginalized individuals and communities. Women, children, people with disabilities, older people, migrants, minorities and Indigenous Peoples, among others, are not only more exposed to risk in the first place, but also less likely to receive support once a shock does occur. Accelerated transformation of slums and informal settlements, as well as addressing the needs of the most vulnerable territories in cities is thus a priority.

Of course, while the danger cities face from climate change is considerable, their dominant role in generating emissions must also be addressed. Cities have been routinely blamed, with some justification, for perpetrating the climate crisis due to the carbon-heavy patterns of consumption and production that urban areas can create. This, however, is only part of the picture. As this report shows, cities are already proving that it is possible to urbanize in a way that benefits, not harms, the planet. From electrified transport networks to energy-efficient buildings, ecosystem restoration to recycling, there are a range of paths we can pursue that will help curb the negative effects of urbanization while offering safer, healthier and more liveable cities for those living in them. Local and regional governments are already leading the way through action for climate adaptation and mitigation.

Caution is needed in accelerating climate adaptation and mitigation efforts in cities to avert unintended and exclusionary consequences. When protective disaster infrastructure is constructed in cities, poor households, and those living in informal settlements and slums may find themselves evicted or more exposed if such communities are not factored into the design

It is especially urgent to put in place the right urban policies, legislation and finance to leverage housing and basic services as key instruments through which climate action is enabled. Promoting energy-efficient and durable housing and construction has tremendous potential to advance climate action. Investing in basic services especially energy, water and sanitation and transport with a view to mitigate and adapt to climate is essential. It is equally critical to ensure that urban land is used to maximize its social, economic and ecological functions for more compact growth that improves energy consumption, affordability, economic value and accessibility in cities. These vast opportunities that cities offer to achieve broader global goals for climate change are too often overlooked and untapped. It is time to unlock this potential.

At the same time, caution is needed in accelerating climate adaptation and mitigation efforts in cities to avert unintended and exclusionary consequences. When protective disaster infrastructure is constructed in cities, poor households, and those living in informal settlements and slums may find themselves evicted or more exposed if such communities are not factored into the design. Further, sustainable buildings and construction measures may be expensive and compromise affordability. The phenomenon of "green gentrification" and the exclusionary effects of rising house prices that it can bring in its wake is one such case. This is why the planning and implementation of both adaptation and mitigation measures must be locally-led, with those traditionally sidelined from decision-making given centre stage. While climate action requires urgent global solidarity, it must also involve critical stakeholders at the local level. Developing improved mechanisms for dialogue and identification of solutions with civil society and grassroots organizations is key. Ultimately, a people-centred approach is key, placing social aspects and inclusion at the centre of climate action in cities and beyond.

In this regard, while much of the contents of this edition of the *World Cities Report* is sobering, there is also cause for optimism. It offers a comprehensive overview of what needs to be done at the international, national and local level to achieve the change needed to respond adequately to the climate crisis. While the work required is wide-ranging, from revitalized, multi-stakeholder governance frameworks to a significant increase in both the quantity and quality of finance available to fund city-led climate action, the benefits this will bring could be truly transformative. Indeed, the push to achieve climate resilience cannot be separated from the agenda of sustainable cities and human settlements as envisioned in the New Urban Agenda and Sustainable Development Goal 11.

What is clear is that climate change is already upon us. For those city dwellers caught on the frontline of the various catastrophes playing out in cities—houses destroyed by cyclones, roads melted by extreme heat, entire settlements inundated in flood water—denial or delay is not an option. We already have the solutions to act, should we so wish. As documented in this report, with the right will and resources, cities and communities are already proving their ability to deliver innovative, inclusive and scalable approaches to climate resilience that point the way forward to a thriving urban future. We do not need to wait for a silver bullet to be invented: instead, drawing on the prescriptions in these pages, and together through stronger coalitions, we can and we must have the courage to take action today for the sake of present and future generations.

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Acronyms and Abbreviations

100RC	100 Resilient Cities
ACCCRN	Asian Cities Climate Change Resilience Network
AI	Artificial intelligence
ASP	Adaptive social protection
BGI	Blue-green infrastructure
BRT	Bus rapid transit
C40	Cities Climate Leadership Group
CAP	Climate action plan
CBD	Convention on Biological Diversity
CBD	Convention on Biological Diversity
CCAP	Climate Change Action Plan
CCCI	Cities and Climate Change Initiative
CCFLA	Cities Climate Finance Leadership Alliance
CDP	Carbon Disclosure Project
CEMS	Copernicus Emergency Management Service
CNG	Compressed natural gas
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
COLGEI	Coalition of Local Governments for Environmental Initiative
COP	Conference of the Parties
COVID-19	Coronavirus disease
CRDP	Climate-resilient development pathway
CSN	Climate Shelter Network
DFI	Development finance institutions
DRR	Disaster risk reduction
EbA	Ecosystem-based adaptation
EM-DAT	International Disaster Database
EPR	Extended producer responsibility
ESSC	Environmental Science for Social Change
EU	European Union
EV	Electric vehicle
GAP	Gender action plan
GCA	Global Commission on Adaptation
GCF	Green Climate Fund
GCoM	Global Covenant of Mayors for Climate and Energy
GDP	Gross domestic product
GHG	Greenhouse gas
GHSL	Global Human Settlement Layer
GHS-UCDB	Global Human Settlement Urban Centre Database
GIS	Geographic information systems
GLA	Greater London Authority
GNDR	Global Network of Civil Society Organizations for Disaster Reduction
GSSS	Green, social, sustainability and sustainability
GST	Global stocktake
Gt	Gigaton
GTF	Global Task Force
HLPF	High-level Political Forum on Sustainable Development
HPFPI	Homeless People's Federation of the Philippines
HVAC	Heating, ventilation, and air conditioning
ICLEI	Local Governments for Sustainability
ICT	Information and communications technology
IEA	International Energy Agency
iNDC	Intended nationally determined contributions
IOM	International Organization for Migration
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

IPCC	Intergovernmental Panel on Climate Change
ISWM	Integrated solid waste management
ITS	Intelligent transportation systems
IWRM	Integrated water resource management
JMC	Jinja Municipal Council
KCCA	Kampala Capital City Authority
L&D	Loss & Damage
LECZ	Low elevated coastal zones
LEED	Leadership in Energy Efficiency and Design
LGMA	Local Governments and Municipal Authorities Constituency
LiDAR	Light detection and ranging
LUCHACOS	Lubaga Charcoal Briquettes Cooperative Society Limited
MDB	Multilateral development bank
MDF	Municipal development forum
MPGCA	Marrakech Partnership for Global Climate Action
MRTS	Mass rapid transit system
NAP	National Adaptation Plan
NbS	Nature-based solutions
NCQG	New Collective Quantified Goal
NDCs	Nationally determined contributions
NGO	Non-governmental organization
NMT	Non-motorized transport
NRG4SD	Global Network of Regional Governments for Sustainable Development
NUA	New Urban Agenda
NUP	National urban policy
ODA	Official development assistance
OECD	Organisation for Economic Cooperation and Development
PPF	Project preparation facility
PPP	Public-private partnerships
R&D	Research and development
RCPs	Representative concentration pathways
RISE UP	Resilient Settlements for the Urban Poor
SAFSC	South African Food Sovereignty Campaign
SDG	Sustainable Development Goals
SDI	Shack/Slum Dwellers International
SDSN	Sustainable Development Solutions Network
SEWA	Self Employed Women's Association
SIDS	Small Island Developing States
Sq. km	Square kilometre
SSP	Shared socioeconomic pathway
SURGe	Sustainable Urban Resilience for the Next Generation
TAMPEI	Technical Assistance Movement for People and Environment, Inc.
TFURP	Temasek Foundation Urban Resilience Program
TNCs	Transnational city networks
TSUPU	Transforming the Settlements of the Urban Poor in Uganda
UCLG	United Cities and Local Governments
UHI	Urban heat island
UK	United Kingdom
UNDP	United Nations Development Programme
UNDRR	United Nations Disaster Risk Reduction
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	United Nations High Commission for Refugees
UNICEF	United Nations International Children's Emergency Fund
US	United States of America
US$	United States Dollar
VLRs	Voluntary Local Reviews
VNRs	Voluntary National Reviews
WEF	World Economic Forum
WHO	World Health Organization

Key Findings and Messages

Chapter 1

Cities as Hubs for Climate Action

Cities are both victims of climate change and among its worst perpetrators: not only are they disproportionately exposed to its impacts, but they are also responsible for generating a large share of global emissions. This means there is not only a moral imperative to take urgent action at the local level to promote low-carbon, sustainable urbanization, but also a compelling logic. Cities, in fact, are highly conducive to the implementation of adaptation and mitigation programmes that deliver a range of co-benefits to communities in terms of poverty reduction, employment, service provision and quality of life. Already, some of the most exciting and progressive solutions are emerging from cities and communities who in many cases are taking action, in the absence of national and international support, to strengthen their collective resilience. In addition, cities across the world are demonstrating that it is possible to decouple urban development from increasing emissions. Increasingly, then, urban areas are being seen not just as part of the problem, but part of the solution too—even if their full potential has yet to be realized.

Key Findings

Though urbanization continues to be a major source of greenhouse gas emissions, in many contexts urban emissions per capita are now lower than national averages. The last 30 years have witnessed a gradual weakening of the link between cities and emissions globally. While in lower-income and developing countries urban per capita emissions are often still higher than those in rural areas, the opposite characterizes developed countries, where urbanization, greenhouse gas emissions and welfare are increasingly delinked. These changes are not solely accounted for by levels of urbanization, but also determined by consumption and production patterns, lifestyle choices, behavioural change and policy decisions around energy, housing, transportation and other key sectors.

Rather than regarding them as problems, cities should be seen as key to achieving global climate goals. Indeed, compact cities with well integrated transportation systems and energy-efficient buildings can be significantly more sustainable than suburban or rural areas. Vilifying cities as producers of greenhouse gas emissions is to fundamentally misunderstand their potential to deliver a more sustainable future for our planet. Contrary to the perception of cities as polluting, countries are not condemned to face rising emissions while urbanizing: net zero or low-carbon pathways can be achieved through appropriate climate-responsive planning choices.

Even countries with low levels of urbanization can plan and commit to ambitious climate action targets in their cities. Analysis of the implied conditional 2030 targets within different National Determined Contributions, found no relationship between each country's level of urbanization and their level of climate commitments. This implies that the level of urbanization is not a determining factor, positive or negative, in a country's ambition in setting climate goals. On the one hand, some countries at a relatively early stage of urbanization have shown themselves willing to commit to significant climate action. On the other hand, many cities and local governments have set ambitious climate goals that far exceed the pledges of their respective national governments.

Countries that have a higher share of informal housing and employment are more vulnerable to climate change. People living in informal settlements and engaged in informal employment face a double climate injustice: though contributing only limited emissions, they are typically the most vulnerable to the immediate consequences of climate change due to their disproportionate exposure to environmental hazards and loss of livelihoods. While informality is often overlooked in urban planning processes, including climate action, supporting residents and workers in this sector represents one of the best investments a city can make to strengthen its overall resilience.

Key Messages

Climate action, as currently implemented in urban areas, does not reflect the urgency of the threat posed by climate change. The severity of climate change impacts for urban communities, infrastructure and ecosystems should be driving climate action, but this is not the case in many contexts. Bold investment decisions, stringent emission reduction and ambitious adaptation plans will be required to prevent catastrophic loss and damage, especially for the most vulnerable groups who are the most exposed to extreme weather events and the least able to recover from their effects.

People must be at the centre of any meaningful climate action in cities and human settlements. Climate action must be inclusive and respond to the needs of the most vulnerable, especially children, women, older persons, people living with disabilities, Indigenous Peoples, slum dwellers, refugees and displaced populations. These groups are disproportionally affected by the effects of climate change events due to their limited access to coping mechanisms and the absence of social protection. From inclusive planning to targeted welfare support, cities should develop a comprehensive and participatory approach to resilience building.

Cities are at the forefront of addressing the challenge of climate change, both in terms of direct mitigation and adaptation efforts and resilience building. Cities, by concentrating people, businesses and institutions, represent not only places of enhanced and clustered vulnerability to climate change, but also places of unique opportunity.

Cities are where climate action can be effectively leveraged, thanks to a wide range of co-benefits, along with a variety of specifically urban low-carbon solutions (such as integrated public transit) that are possible due to their compact land use and economies of scale. Furthermore, as centres of buoyant innovation and advocacy, cities are ideally suited to the creative problem-solving that climate change demands.

Aligning climate change adaptation with poverty reduction and disaster risk reduction through community-led settlement upgrading can help build resilience to climate shocks. Many informal practices already embody principles that are aligned with low-carbon pathways and which inclusive climate action should actively foster. Social inclusion and human rights principles should be mainstreamed into their climate adaptation and mitigation frameworks, as a tool to ensure equitable outcomes and prevent forced eviction in the name of climate action. Adaptation in a context of urban informality needs to achieve tangible and rapid impacts in improving people's livelihoods, in ways that incrementally accumulate to larger-scale, longer-term transformation.

Chapter 2:

Climate Change and International Development: What Have We Achieved Since the Adoption of the Paris Agreement?

There has been increasing attention focused on the challenge of climate change in recent years, reflected in the passage of the landmark Paris Agreement in 2015 and an array of other development frameworks such as the 2030 Agenda for Sustainable Development and the New Urban Agenda that include specific components addressing its threats. However, the reality on the ground is that the world remains firmly on course to break the agreed ceiling of a 1.5 degree Celsius increase from pre-industrial levels. In part, this failure is the result of continued barriers to action at the local level: cities are still largely excluded from national and international decision-making around resilience building, and lack access to adequate levels of finance to take meaningful action themselves. However, there is evidence that this is beginning to change as awareness grows of the pivotal role cities can play in mounting a unified response to the climate crisis. Recent years have also seen debates on climate justice shift from the global to the local level, with cities beginning to mainstream climate equity considerations into their programmes. Consequently, the various global agendas set in place in recent years offer an important framework to guide and coordinate climate action across a multitude of scales and in different urban contexts.

Key Findings

Climate change has emerged as a critical factor shaping international development policy, with widespread implications. Despite notable progress, the world is not on track to remain within the 1.5 degree Celsius ceiling for global warming set by the Paris Agreement. Much more action is urgently required, with many challenges to overcome to achieve transformative climate commitments across cities. Encouragingly, however, climate change is increasingly being mainstreamed as a critical dimension across a range of different development and human rights agendas. At the same time, social justice and inclusion agendas are having an increasing influence on climate discourse and action on the ground, with youth and Indigenous Peoples playing key advocacy roles.

Historically, global climate negotiations and outcomes have not adequately addressed cities and other subnational entities, but this has begun to shift, with considerable implications for policy development. Since the Paris Agreement, advocacy by city networks has supported the development of stronger multi-level governance, as well as the increasing prominence of cities and subnational governments in COP negotiations and other international fora addressing climate change. However, cities and subnational authorities are still marginalized in formal negotiation processes. More supportive enabling environments and enhanced support are urgently required, particularly in small- and medium-sized cities and informal settlements to ensure achievement of the Paris Agreement.

Though there have been several significant societal and technological developments since the Paris Agreement, the impacts have been unevenly distributed. From increased electrification to artificial intelligence, these forces have intensified over the past decade, with widespread implications for international development policy and climate action. However, at both the global and local levels, many are still excluded from these benefits. Integrated approaches that bridge the various divides at play—between urban and rural areas, formal and informal neighbourhoods, developed and developing countries and regions—are critical to ensure that climate action and sustainable development are delivered equitably.

The private sector is a critical source of expertise, innovation and resources for supporting urban climate action. Though private sector interventions remain largely mitigation-orientated, the engagement of companies and investors in green sectors such as low-carbon technologies and electrified transport demonstrates their catalyzing potential. More attention needs to be paid to the continued shortfalls in adaptation funding, however, as well as the potential conflicts of interest and maladaptation risks that private sector-led climate action could bring without appropriate oversight in place.

Key Messages

The journey towards low-carbon futures is a shared responsibility, requiring collaborative policy and interventions across all scales. Countries are showing progress in their recent pledges as evidenced by enhanced, higher-quality climate commitments. Nonetheless, the aggregate effect on global emissions remains highly inadequate and requires urgent action across all quarters, particularly at the city level. Much more needs to be known about the contribution and role of urban governments in shaping and supporting the formulation and implementation of national climate commitments and linked climate policy developments.

Far-reaching, large-scale action is urgently required in a climate-changed world: an essential pathway to achieve this is through the development of inclusive, locally-led urban transformation. To achieve the level of change necessary to keep global warming within relatively safe planetary boundaries, national and local governments need to move beyond piecemeal and incremental reforms. Climate change considerations should be mainstreamed across the breadth of relevant urban development sectors, from housing and transportation to water, sanitation and waste management, to ensure that different global development priorities are aligned with the overarching aim of building socially inclusive climate resilience.

Unifying global frameworks is key to achieving global climate and development goals. Global governments across scales are guided by a unifying framework for achieving urban climate resilience laid out in the Sustainable Development Goals, the New Urban Agenda, the Sendai Framework for Disaster Risk Reduction, the Addis Ababa Action Agenda and the Paris Agreement on Climate Change. In combination these frameworks recognize the centrality of multi-level action and emphasize the role of subnational entities, particularly local governments, in building climate resilience. This requires acting consistently and collaboratively across administrative and political boundaries at all scales, not least in relation to climate action.

Closing the climate finance gap is a pressing priority. Mobilization of additional finance and restructuring of financial architecture is urgently required at all scales to ensure that climate adaptation, mitigation and loss and damage receive new and additional funding. It is also important that local governments and communities have direct and equitable access to allocated funds. Justice-based approaches are central to merging and mainstreaming urban climate finance mechanisms to avoid the creation or reproduction of existing inequalities.

Addressing equity considerations in climate action remains an urgent global priority. People-centred, equity-based urban design and planning are central to achieving the transformative commitments of the Paris Agreement and other global agendas, including the Loss and Damage mechanism. While there has been considerable progress through community-led collaborations to reduce disparities within cities, critical barriers remain. To remove these obstacles, issues of cultural diversity, gender, age and other dimensions of intersectionality must be effectively integrated into the design of national and local policies. Upscaling and mainstreaming is urgently required, with a focus on locally-led, people-centred and collaborative climate interventions.

Chapter 3:

Exposure to Climate-related Hazards: Current and Future Trends

This chapter provides a detailed overview of the current and projected exposure facing cities from a variety of climate change impacts: from temperature increase to sea-level rise and riverine flooding. It demonstrates how, even in moderate scenarios, billions of city dwellers could be directly affected as the crisis deepens and widens in the near future. Through adopting a geospatial approach that uses the *Degree of Urbanisation* methodology for defining different urban and rural areas, this chapter shows that virtually no urban inhabitant is unexposed to climate change, even though the impacts will be differentially felt. Importantly, modelling shows that the extent of these challenges will be greatly dependent on the pathways we choose today: the true human and environmental cost will depend to a large extent on whether or not dedicated and proportionate action is taken now. An important first step in making this happen is to develop detailed, multi-dimensional assessments in cities and communities, particularly developing countries and informal settlements where investment in data collection and analysis has often been limited. In this way, cities can develop a clearer picture of current patterns of vulnerability in their territories and tailor their responses accordingly to ensure the most exposed areas are prioritized for protection.

Key Findings

The increasing concentration of people in hazard-prone urban areas means the impact of climate change is increasingly urbanized. The exposure of cities to climate hazards, including heatwaves, sea-level rise and riverine flooding, has grown disproportionally faster than exposure of people living in rural areas. Cities are indeed at the forefront of the impact of climate change, a situation that is likely to intensify in the coming decades as urbanization continues, particularly in a high-emission climate scenario.

Cities are projected to become hotter in future, with almost no inhabitant unaffected in a carbon-intensive scenario. Assuming the world continues to follow a high-emission pathway, more than 2 billion people currently living in cities could be exposed to an additional temperature increase of at least 0.5 degrees Celsius by 2040. In addition, temperature changes of 0.5 degrees Celsius and above would affect over half of cities and their populations worldwide. In this scenario, as much

as 36 per cent of the global population in cities could experience mean annual temperatures of 29 degrees Celsius or above. Just 1 per cent of the population in cities globally would be spared temperature increases.

A significant proportion of cities will transition to more arid or humid conditions—the magnitude will depend on different policy choices and emission scenarios. The proportion of cities expected to change climate type between 2025 and 2040 varies from a minimum of 14 per cent in a low-emission context to 26 per cent in the worst-case projection. At least 600 cities across the world could be transitioning to drier climates by 2040, exposing more than 180 million additional people to various impacts, in particular water scarcity. At least 900 cities could be transitioning to more humid climates by 2040, affecting an additional 250 million people compared to current exposure: of these, most are projected to transition to a tropical climate, where increased humidity makes it more challenging to manage extreme temperatures.

Sea-level rise poses a profound threat to many coastal cities worldwide, creating even greater exposure in areas already vulnerable to flooding. By 2040, more than 2,000 cities will be located in low elevated coastal zones of less than 5 metres above sea level, rising to 2,620 cities for less than 10 metres above sea level. These cities will face heightened risks from sea-level rise and storm surges. The current population in these exposed cities is already 1.4 billion and expected to increase further by 2040. Multi-hazard early warning systems are essential to protect cities in low elevated coastal zones, but many are still not covered.

Riverine flooding, while less publicized as an issue than sea-level rise, nevertheless represents a major hazard in many cities. Currently, areas prone to riverine flood events with 100-year return periods host about 1 billion people: of these, half are based in cities, 39 per cent in towns or semi-dense areas, and the remaining 11 per cent in rural areas. By 2030, at least 517 million people living in cities will be exposed to riverine flooding with a 100-year return period, which is 14 per cent of the global population living in cities. Since 1975, exposure to flooding in cities has grown 3.5 times more than exposure to flooding in rural areas.

Key Messages

Though the projected impacts of climate change on cities appear bleak, better policy choices and effective climate action now have the potential to significantly limit future exposure. Alongside a more sustained global commitment to mitigation to remain within a moderate emission scenario, various measures can lead to substantially lower levels of urban climate exposure in the future. In particular, an integrated and adaptive approach to planning that is guided by current and projected environmental risks could result in significantly more resilient outcomes for cities.

The urbanization of climate exposure means that strategies to reduce vulnerability must be conceived through an urban lens, placing cities at the centre of climate action. Cities should adopt comprehensive, proactive approaches that address the collective needs of their populations, rather than isolated actions that may unintentionally increase risk elsewhere. By focusing on urban-specific adaptation and mitigation, cities can enhance their resilience to climate change and safeguard the lives and livelihoods of their inhabitants. Early warning systems for urban areas are particularly critical, as they provide timely alerts that can save lives and reduce economic losses. By integrating these systems into a broader resilience framework, cities can ensure that they are better equipped to handle the challenges posed by a changing climate.

Closing the urban exposure and vulnerability data gap is critical for cities to effectively prepare for and respond to climate risks. A comprehensive understanding of disaster risk is key to these aspirations, and it can only be built by integrating data and knowledge across scales and thematic areas. International frameworks such as the New Urban Agenda, Sustainable Development Goals and the Sendai Framework for Disaster Risk Reduction rely on data that are globally consistent and locally relevant. An assessable, readily comparable evidence base is essential to build cities that are not only sustainable, but also equipped to withstand and adapt to climate-related challenges.

There is a need to move beyond measuring exposure to determining vulnerability through detailed, localized assessments. Understanding vulnerability is critical for implementing effective action. By focusing on vulnerability, policymakers can prioritize interventions that address the root causes of risk and target resources to where they are most needed. This requires a granular analysis of the social, economic and physical factors that influence a community's ability to anticipate, cope with, respond to and recover from the impacts of extreme weather events. Localized exposure and vulnerability assessments are essential to capture the specific conditions and needs of urban populations and infrastructure.

Chapter 4:

Climate Action and Vulnerable Urban Groups

Though almost all urban residents will be affected to some degree by climate change, its impacts are not distributed evenly. The climate crisis is already interacting with existing patterns of inequality and exclusion, meaning the most marginalized populations—including women, children, migrants, people with disabilities, ethnic minorities and Indigenous Peoples—are disproportionately affected. Currently, urban climate interventions are failing to adequately recognize the specific challenges these groups face. Consequently, millions of urban residents (especially those living in informal settlements) are being excluded from adaptation plans and even negatively impacted by climate interventions that overlook their needs. Cities must therefore ensure they address the social dimensions of vulnerability by promoting community-led interventions, targeted in particular at the most neglected neighbourhoods and incorporating a variety of pro-poor elements such as inclusive service provision and welfare support.

Key Findings

The impacts of the climate crisis are being unleashed in an unprecedented manner on many inter-connected urban systems, including economic, social, ecological and urban infrastructure systems. Globally, cities are bearing the catastrophic impacts of the climate crisis due to persistent flooding, scorching heatwaves, looming water stress and storm surges, among other risks. Coastal flooding will trigger a huge economic cost for cities in both developed and developing regions. Assuming moderate levels of sea-rise, without additional investment in adaptation and risk management, 136 of the largest coastal cities could incur annual losses exceeding $1 trillion by 2050. Climate-induced extreme heat is far deadlier than other natural disasters, killing on average more than twice as many people each year as hurricanes and tornadoes combined. In the summer of 2024, temperatures in some parts of the world soared to almost 50 degrees Celsius in one of the longest heatwave spells recorded.

Urban informality by its nature is a key driver of vulnerability, with slums and informal settlements among the most exposed to disasters and other impacts. Besides often being situated in low-lying, flood-prone or precarious locations, official hostility and social stigma towards informal settlements frequently means they are denied basic services and excluded from protective infrastructure. Furthermore, their lack of legal recognition or secure land tenure means that residents are unable to invest in upgrading improvements due to the fear of eviction. Informal livelihoods are also highly exposed to climate change: the absence of social welfare and already precarious conditions mean that informal workers are more likely to be disrupted by extreme weather and other shocks.

The climate crisis is profoundly discriminatory, intersecting with and reinforcing pre-existing vulnerabilities among certain groups. Climate change is disproportionately affecting already marginalized urban groups, including women, children, residents of informal settlements and minority communities, among others. The situation is particularly dire for people living with disabilities, who are often invisible in climate change policies and programmes: as a result, they are up to four times more likely to die in the event of a climate-related disaster compared to other groups. Migrant and displaced populations in urban areas, including many whose decision to move to the city was driven in part by environmental stress or instability, are especially at risk of being uprooted again due to the impacts of climate change.

In many cases, current urban adaptation and mitigation efforts are failing to protect the most vulnerable populations from climate change—and even making their situation worse. When national and local governments overlook broader injustices, including gender-based inequalities and racial discrimination, there is a danger that climate actions will fail to address underlying drivers of vulnerability and overlook the specific needs of certain groups. For example, nature-based investments such as the development of parks can potentially displace low-income groups or trigger "green gentrification" if efforts are not made to ensure inclusive and accessible outcomes from these interventions. The development of climate-resilient infrastructure can exacerbate exposure in other areas if they prioritize affluent neighbourhoods at the expense of communities elsewhere.

Existing patterns of urbanization create differential vulnerabilities to climate change. The way cities grow, develop, expand and are planned creates unequal conditions for resilience, leaving some areas more vulnerable to climate risks than others. These disparities arise from differences in the quality of infrastructure, access to services, housing conditions and socioeconomic status, which are shaped by urbanization processes. Many cities across the world are marked by long-standing patterns of segregation where marginalized groups are concentrated in neighbourhoods suffering from decades of underinvestment. In some contexts, the rapid expansion of unplanned settlements is also associated with higher exposure to climate risks, particularly when communities are forced to settle in environmentally vulnerable or underserviced areas.

Key Messages

Adaptation plans that are co-created with diverse urban groups are more likely to result in inclusive, effective solutions that build the resilience of the most vulnerable to climate shocks. A transformative people-centred approach to climate action depends on the ability of governments and other stakeholders to create opportunities and platforms for diverse voices, especially those at the frontline of the climate crisis. Vulnerable populations should therefore be treated as partners in the planning and implementation of urban climate action plans. This is critical because grassroots knowledge systems, if complemented with scientific information and innovations, can inform and enhance adaptation planning.

Municipal governments should support locally-led climate adaptation to address vulnerability, boost resilience and enhance city-wide climate action. Supporting bottom-up climate adaptation efforts is essential for effectively tackling vulnerabilities and building resilience within cities. When municipalities back grassroots initiatives and community-driven projects, they empower residents to take charge of their own climate solutions, leading to more targeted and effective adaptation that reflects the unique needs and strengths of their communities. Locally-led adaptation projects often leverage local knowledge and resources, making them more sustainable. This approach not only helps communities better prepare for and respond to climate-related challenges, but also fosters greater community engagement in climate initiatives.

Cities should prioritize investing in resilient infrastructure in underserved communities as a basis for building their resilience to climate-induced shocks. As the impacts of climate change intensify, vulnerable and underserved neighbourhoods often bear the brunt of environmental disasters and infrastructure failures. By directing resources towards the development of resilient infrastructure in these areas, cities will not only enhance the well-being of their residents but fortify their long-term ability to withstand and recover from climate-related challenges. This involves upgrading critical infrastructure, sustainable transportation networks, energy-efficient housing and green spaces to mitigate urban heat islands. Focusing on marginalized communities ensures that the benefits of resilience extend equitably to all residents, addressing social disparities while fostering a more inclusive urban future.

Strengthening social protection programmes that address climate shocks is critical for building the resilience of vulnerable urban groups. Integrating social protection into climate action has the potential to avert, minimize and address loss and damage as well as contributing towards greater resilience. Governments can link social protection with public works programmes that focus on climate adaptation, such as constructing flood defences, improving water management systems or planting trees to reduce the urban heat island effect. This not only provides income for poor urban households, but also enhances community resilience to climate risks. Migrant and displaced populations—including both those driven to the city due to environmental stress, and those uprooted again by climate impacts such as flooding—should also be provided with comprehensive emergency and welfare assistance to support their integration and recovery.

Chapter 5:

Mapping the Solution Space for Climate Action: The Role of Urban Planning and Design

Urban planning and design offer an arsenal of highly effective strategies to improve resilience, yet so far, much of their potential remains untapped. This is despite the many opportunities now available—from the Nationally Determined Contributions and National Urban Policies that have emerged from recent global development agendas, to building codes, zoning and other instruments that can be leveraged at the local level—to promote sustainable, low-carbon development. From renewable energy systems and resource-efficient construction to integrated transport and nature-based solutions, cities have a variety of tools at their disposal to improve resilience and reduce emissions. However, various technical, financial and institutional barriers currently prevent many of these solutions from being enacted. With the right political will at both the national and local level, including adequate funding and expertise to support the development of solutions, cities can work with communities, businesses and other stakeholders to promote compact, integrated and equitable urban fabrics that benefit residents while strengthening resilience.

Key Findings

The last 30 years have witnessed a decline in green spaces in urban areas around the world, a trend that needs to be reversed given its implications for climate. On average, the share of green spaces in urban areas globally decreased from 19.5 per cent in 1990 to 13.9 per cent in 2020. Besides its effects on the environment—through climate change and biodiversity loss—the decline of green spaces has implications for human health and social impacts. This trend was by no means universal: though most cities have seen a reduction due to urban expansion or poor planning, some have managed to increase their share of green space through targeted policies such as mangrove restoration and revegetation.

Climate action plans remain absent in many countries and, where they do exist, typically prioritize mitigation over adaptation. There has been limited investment in adaptation, even in contexts where climate-induced impacts hit hardest While leading the charge in urbanization, national urban policies and climate action plans remain either underdeveloped or completely absent in cities in developing countries, leaving the most marginalized populations—including minorities, Indigenous Peoples, the urban poor and residents of informal settlements—disproportionately exposed to climatic hazards.

Inadequate capacity within local governments and institutional barriers pose obstacles for the development and effective implementation of climate-resilient plans. While planning offers an array of tools that local governments can leverage, at present these opportunities are not adequately exploited. Insufficient knowledge, skills and expertise within local planning agencies hinder the formulation and execution of effective climate action plans. Furthermore, institutional barriers undermine the ability of cities to implement timely climate actions. Rigid planning approaches also struggle to keep pace with rapidly changing climate scenarios, leading to loss and damage that could have been mitigated with more proactive measures.

Climate-resilient planning aligns with the broader principles of inclusive, sustainable urban development. While effective climate action requires a strong level of coordination and sectoral integration, this is also a requirement for sound city planning in general. Some of the most progressive urban paradigms—such as transit-oriented development or the "15-minute city", with its compact, accessible, mixed-use design—are implicitly resilience-building. Similarly, well designed climate interventions will have positive outcomes for public health, well-being and access to green space. Consequently, in many cases climate-resilience planning can be implemented without requiring painful trade-offs when it overlaps with other local development priorities.

Key Messages

Integrating climate action into urban planning and design frameworks is essential for a sustainable future. Urban planning and design play a vital role in efforts to reduce emissions and adapt to climate change. Today, as cities are confronted with increasingly severe impacts, climate considerations should be embedded within urban policies and plans. Where they exist, climate action plans are instrumental in mainstreaming resilience efforts at the local level. It is also imperative for cities to adopt more nimble, well-coordinated, flexible and responsive urban planning mechanisms that facilitate swift adjustments to emerging climate risks. Cities should also engage urban communities directly to ensure their active participation in the design of climate responsive urban forms.

National urban policies should urgently address mitigation and adaptation. These policies should be aligned with the emission reduction targets in Nationally Determined Contributions and must in turn inform climate action plans. Climate action plans should leverage international agreements and urban policy frameworks to integrate sectoral policies (including housing, land use, transportation and energy) and mainstream climate action. Importantly, climate action plans need to address differentiated vulnerabilities among the urban population and the varying adaptive capacity between communities. With this in mind, planning interventions should incorporate social policies that address underlying risk drivers of vulnerability.

Urban planning and design should promote localized, context-specific climate solutions. Though there is value in replicating a successful project in other settings, the very different socioeconomic and environmental conditions in different cities mean that any initiative should be tailored around these. In this regard, while large-scale mega-projects often attract the most publicity, in many urban areas the most appropriate interventions are likely to be small-scale and community-led. In particular, climate planning should, wherever possible, draw on traditional and Indigenous approaches to construction—for example, the use of vernacular architecture and locally available materials.

Cities should invest in equitably distributed, nature-based solutions. These provide low-cost mitigation and adaptation solutions along with a slew of co-benefits, from carbon sequestration, improved air quality and protection from coastal erosion to lower temperatures, increased biodiversity and rainwater harvesting. Nature-based solutions also provide communities with much needed recreational spaces and promote active lifestyles, improved mental health and the restoration of essential ecosystems. They should be integrated into the design of both buildings (for example, through green roofs and living walls) and urban spaces (as networks of blue-green infrastructure). It is also important that nature-based solutions are distributed equitably throughout the urban landscape to ensure an inclusive and just distribution of their benefits: otherwise, cities may have a large share of green space but still have a significant proportion of the population unable to access it themselves.

Chapter 6:

Resilient Infrastructure as an Accelerator of Transformative Climate Action in Cities

Urban infrastructure is not only a fundamental element in prosperity and well-being in cities, but also a key determinant of risk and vulnerability. Urban areas and communities with inadequate infrastructure are likely to be the most affected by extreme weather events associated with climate change. Without sustained, socially inclusive investments in infrastructure, these infrastructural deficits will widen, in the process exposing many more urban residents to potentially catastrophic climate-induced hazards. The fact that much of the infrastructure needed has yet to be built is both a problem and an opportunity: while the scale of action required is daunting, there is also the possibility for cities to correct course and channel resources towards infrastructure that builds resilience. But even more than that, infrastructure can play a transformative role in reshaping the relationships between urban residents and their surroundings in ways that contribute to lasting and climate-resilient development. By embracing innovative and justice-based approaches to infrastructure, including the promotion of green and blue infrastructure alongside conventional “grey” or engineered infrastructure, cities will not only improve the resilience of their infrastructure but also use it as a tool for societal and environmental transformation.

Key Findings

Resilient infrastructure is a critical element of urban climate action to achieve the Sustainable Development Goals, the Paris Agreement, the Sendai Framework and the New Urban Agenda. Infrastructure is responsible for 79 per cent of total greenhouse gas emissions, making it central to any effective urban sustainability response. Infrastructure also influences the attainment of the Sustainable Development Goals, including 72 per cent of the targets. The New Urban Agenda identifies quality infrastructure as essential for strengthening the resilience of cities and communities. The global infrastructure deficit affects millions of people in rapidly expanding cities, particularly in low- and middle-income countries, and is a key factor undermining development and human rights. In many informal settlements, residents lack access to basic infrastructure such as energy, water and sanitation, waste management and transportation.

Infrastructure around the world is already being affected by climate change, and the costs associated with damaged assets, expensive repairs, service disruptions and loss of life are expected to increase. The development of further infrastructure, while much needed, could leave cities even more exposed to costly climate change impacts if resilience is not a key priority in its design and construction. Investing in the construction, operation and maintenance of resilient infrastructure can generate long-term financial benefits for cities and national economies. While additional up-front funding will be required to achieve this, the returns on this investment are expected to be beneficial. Investment in low-carbon infrastructure can generate significant savings due to a range of efficiencies.

A large share of the urban infrastructure needed to achieve resilience has yet to be built, posing significant challenges but also offering the possibility to build it more sustainably and inclusively. While most infrastructure is currently located in the developed world, 90 per cent of all population growth is taking place in the cities of the developing world: this trend will intensify in the coming decades and will be accompanied by rapid expansion of infrastructure. This represents a significant opportunity to ensure that future infrastructure is built with resilience in mind. While buildings are becoming more energy-efficient, these efficiencies are dwarfed by the sheer extent of construction: infrastructure in other sectors (such as transportation) needs to be planned in ways that lead to significant decarbonization.

Infrastructure should be designed not only to be resistant to the effects of climate change, but also address the underlying social and environmental factors that contribute to vulnerability. Achieving more resilient cities requires infrastructure that is planned, designed, constructed and managed in ways that deliberately build the resilience of citizens and communities, better enabling them to respond to the impacts of climate change. In this way, infrastructure should aim to be truly transformative—addressing the drivers of both climate change and vulnerability, thereby contributing to broader and positive societal change in the longterm.

Key Messages

Residents should be involved in the planning, design and delivery of low-carbon and resilient infrastructure. Inclusive approaches to land use planning are an essential prerequisite for the development of transformative infrastructure. Encouraging community-led service provision models and other forms of participation in the development of low-carbon service models empowers communities to shape their own urban environments and adapt to the challenges of climate change. By meaningfully involving all relevant stakeholder groups in decision-making processes, cities can leverage local knowledge and expertise to develop innovative solutions that address the specific needs of diverse populations. Local governments should be comfortable to accommodate dissent and contestation within these discussions: these processes offer an important means to identify potential misalignment between planned infrastructure and local needs.

To ensure infrastructure is climate-resistant, but also builds resilience, it is vital to establish systems to fully access the wide range of benefits it will bring. This will require ongoing monitoring and evaluation of infrastructure performance over time. In terms of balancing the short- and long-term environmental implications, it is necessary to assess the immediate emissions created by its construction against the reductions achieved over its lifespan. It is also important to ensure that any cost-benefit analysis factors in the wide range of indirect societal benefits that it will likely bring: while the financial costs are relatively straightforward to enumerate, the benefits in areas such as health or well-being are harder to compute and can easily be overlooked.

Incorporating informality into infrastructure planning and implementation can contribute to equity and resilience in cities. By recognizing and incorporating the diverse economic activities of informal workers into the broader urban fabric, cities can harness their potential to contribute to sustainability goals while enhancing their own resilience. Traditional and informal forms of housing are often low-carbon and adaptive to prevailing climatic conditions in ways that are climate-resistant. Adopting supportive building codes and standards can help guide people and construction companies towards more sustainable options.

Improving and leveraging the network of nature-based infrastructure in cities can serve as a transformative accelerator of climate action. These assets can help cities to improve air and water quality, mitigate the urban heat island effect, enhance biodiversity and reduce vulnerability to flooding. In doing so, nature-based solutions contribute both to climate adaptation and mitigation and thus have an outsized role in achieving global sustainability goals. Ensuring that urban dwellers have access to these facilities and the services they offer—for example, by involving local communities in the planning and delivery of nature-based solutions—can benefit residents by providing ecological and recreational amenities.

Chapter 7:

Multi-level Governance for Inclusive Climate Action

Cities play a unique role on the frontline of climate change, positioning them to design and deliver locally appropriate solutions in partnership with those most affected by its impacts. In practice, however, their ability to act decisively continues to be undermined by their marginal position both in their countries and on the international stage. Even in supposedly decentralized contexts, local governments frequently lack sufficient authority or resources to lead substantively on climate action. Furthermore, national governments remain the primary arbiter of partnerships and agreements with development agencies and financial institutions, affording limited space for local governments to engage autonomously with global development platforms. The need for stronger and more collaborative multi-level governance applies not only to the vertical architecture linking cities with national and international structures, however, but also the horizontal connections between government actors and other stakeholders including communities and civil society organizations. Ultimately, climate action can achieve far more impact if delivered through an inclusive, integrated approach to governance.

Key Findings

The climate emergency is complex and cannot be effectively tackled by local governments, or any single level of government, alone. Addressing the climate crisis calls for a "whole of society" approach, requiring the participation and collaboration of multiple layers of authority as well as cooperation across different jurisdictions, actors and sectors. This requires stronger linkages both vertically between different levels of government (global, national, regional and local) and horizontally (across different departments and sectors, but also between public actors and external stakeholders including civil society organizations, the private sector, academia and local communities). Each of these constituencies can bring specific resources, knowledge and technical capacities to support collaborative climate action.

There is an urgent need to develop and strengthen the capacities of local and regional governments to implement climate solutions, particularly in developing countries. Given the complex and context-specific impacts that climate change can have, cities are often best placed to develop tailored, locally appropriate solutions to the challenges that communities and ecosystems face. Yet in many countries, local authorities face significant resource and capacity constraints to do so. In addition to financial shortfalls that leave them dependent on national governments, it is often the case that cities have limited political space to act autonomously on climate action. However, when conditions permit, cities have demonstrated their ability to pioneer progressive responses to climate change.

Cities and regions across the world are increasingly engaging in multilateral initiatives to advocate for stronger climate action. Networked, bottom-up movements led by cities are increasingly playing a key role in global climate governance. These initiatives are driving multilateral cooperation around urban climate action, not only leading to greater emphasis on local-level efforts in international policy discussions, but also expanding the space for cities to inform, guide and implement these efforts. Increasingly, successful initiatives by cities are now being scaled up with national and international support to achieve an even wider impact.

Hybrid governance approaches, characterized by multi-stakeholder and cross-sectoral collaboration, offer a powerful alternative to conventional top-down approaches to climate action. Bringing together a range of actors at different levels, from the national to the local, not only has the potential to disrupt established hierarchies but also create positive synergies between different constituencies. These partnerships have the potential to facilitate "innovative spaces" where groups often marginalized from conventional decision-making structures, such as Indigenous Peoples, can contribute their unique knowledge and perspectives to resilience-building efforts. Similarly, city networks present an innovative model for local governments in highly centralized contexts where there is limited space for cities to operate independently.

Key Messages

Effective climate action requires multi-level governance and collaboration across different scales. Effective climate governance calls for collaboration and coordinated solutions at all levels. While multilateralism provides the climate agenda a platform for collective action—enabling countries to pool resources, share knowledge and coordinate efforts on a global scale—localizing the Sustainable Development Goals, including Goal 13, is essential. Localization ensures that the global development agenda is not just a set of distant goals and targets, but an implementable framework that is impactful at the local level.

Increasing local capabilities to facilitate and manage adaptation initiatives is vital. It is often difficult to implement city-led actions in practice because of gaps in expertise or funding. In many countries, there has been inadequate support from national governments in terms of funding or policy guidance to support local action. This calls for innovative measures to overcome these challenges, such as cooperative mechanisms for cities and regions to share technical expertise and resources. At the same time, cities should seek to unlock the transformative potential of locally-led climate action through partnerships between local communities, various levels of government, international organizations, the private sector and other stakeholders.

Strengthening the co-existence of formal and informal governance systems offers valuable opportunities to accelerate climate action. The continued exclusion of informality from official decision-making structures is a roadblock to building inclusive resilience in many cities. At present, the rich evidence base of community knowledge on local vulnerabilities and the vast array of resident-led efforts in areas like disaster preparedness are being overlooked. Even when local governments are committed to mounting a meaningful response to climate change, the effectiveness of their interventions is often undone by their failure to engage informal settlement communities, Indigenous Peoples and other groups sidelined from formal governance processes.

Knowledge transfer should be a two-way process, with an emphasis on scaling up local experiences and best practices. Training and capacity development should not only involve technical support and expertise from national to local governments, but also bottom-up processes whereby cities can share their experiences and success stories. This can only be done if inclusive platforms are in place to facilitate these exchanges. With these structures in place, national governments have the opportunity to learn directly from cities and coordinate the replication or expansion of their climate actions elsewhere.

Chapter 8:

Fostering Innovation for Inclusive Climate Action in Cities

Innovation is a crucial catalyst of climate action that cities, with their concentration of knowledge and resources, are especially well placed to cultivate. Importantly, innovation encompasses not only the rollout of "new" or "advanced" inventions, but also the reconfiguration of institutions and systems to achieve positive social and environmental aims. However, it is not the case that innovation is inherently positive: without proper consideration of its wider inequalities and vulnerabilities, it can reinforce existing patterns of exclusion and even create new ones for disadvantaged groups. For cities, the challenge is to reimagine innovation beyond a specific invention, place or creative class, instead facilitating an open and equitable forum for debate, knowledge exchange and collaboration that is inclusive of all residents and their needs. With these conditions in place, cities can achieve far-reaching and transformative outcomes of their existing social and environmental vulnerabilities and injustices.

Key Findings

Cities can accelerate climate action through an integrated process of innovation that supports low-carbon transitions. While technological innovations like renewable energy sources and electrified vehicles show promise, they alone cannot break the dependencies on unsustainable economic pathways. An integrated, inclusive and coordinated approach—including nature-based, financial and social innovations—is necessary to unlock the transformative potential of innovation. Social innovation, in particular, plays a critical role in the transition to more inclusive, resilient cities. It entails the creation of new institutional and social practices that drive behavioural change and promote broader participation to build collective resilience.

Integration and coordination across the three domains of innovation—technological, nature-based and social—is necessary to unlock co-benefits and optimize synergies for realizing climate-resilient cities. Cities are particularly well placed to drive socially inclusive, sustainable innovation because of the concentration of people and resources they bring, making them ideal for experimenting and pioneering social and technological solutions to climate change. However, thinking of the transition towards net zero requires looking beyond specific innovations to consider the wider shifts needed in existing technologies, infrastructures and the supporting ecosystems towards more sustainable social practices and economic systems. These include appropriate governance and institutional conditions that enable the sharing, diffusion and co-creation of innovation.

Innovation can result in adverse outcomes for disadvantaged groups, such as low-income urban residents, if inequalities are overlooked. Climate innovation is shaped by established structures of power and privilege, which influence priorities and how complex trade-offs and ethical dilemmas are resolved, often disproportionately impacting disadvantaged groups. Ignoring these inequalities risks the creation of new forms of climate urbanism that reproduce or worsen existing injustices. A people-centered approach not only addresses what innovations are prioritized, but also how they are developed and who is involved: broadening participation to a diverse range of actors, from grassroots members to local institutions, is crucial for advancing a just urban transition.

The influence of the global climate agenda on urban innovation is not well integrated or clearly framed. Comparative analysis of the Nationally Determined Contributions shows that over two-thirds of NDCs recognize innovations (including nature-based, financial and social innovations) as a strategy for climate-resilient development. However, a sectoral approach still dominates with energy, the built environment and transport receiving more attention related to the urban environment. The insufficient focus on the spatial dimensions of innovation presents a missed opportunity to address trade-offs and unlock synergies across various interventions beyond the sectoral approaches that operate through Avoid-Shift-Improve strategies.

Key Messages

There is an opportunity for national governments during the third revision of Nationally Determined Contributions in 2025 to strengthen their focus on urban innovation. To close the implementation gap, it is crucial to strengthen the linkages between the sectoral approach to innovation and the places where they will be applied, with cities playing a significant role. National governments can do this by supporting an integrated approach within the framework of Nationally Determined Contributions that builds partnerships across sectors and actors and aligns urban innovation with their broader targets. The stronger alignment across spatial and administrative levels—from city to regional to national—will further leverage co-benefits and minimize redundancies between sectoral-based interventions.

Policy and planning at the national level should support inclusive innovation to achieve resilient cities. A supportive national agenda can catalyze and integrate inclusive innovation into large-scale actions. National governments can lead in setting appropriate institutional and regulatory conditions that address the injustices associated with climate innovation, as well as adopt national and regional policies to guide a just urban transition. Policy approaches could include subsidies, tax breaks, regulations, public procurement drives, financial incentives for adoption and certification schemes for climate actions that bring added social benefits to marginalized households and communities.

Local governments can actively foster inclusive innovation ecosystems, particularly when tied to local development agendas, to address community needs. City governments can drive policies that broaden the range of innovation actors and promote knowledge exchange between a wide range of stakeholders. This could include policies that enable innovation arenas such as urban labs and knowledge exchange forums, as well as those that promote access to information, skills and resources for diverse communities. By supporting small producers, informal providers and small-scale operators, local governments can help integrate these groups into the innovation process and address gaps created by their exclusion.

Public institutions, private sector entities and civil society organizations all have a key role to play in advancing inclusive innovation. While government bodies, development agencies and other actors are crucial in facilitating cross-context learning and promoting enabling conditions for innovation, activist groups and networks can drive the development of ethical principles to shape innovation processes. Businesses can also contribute their specific skill sets to socially valuable innovations and participate in collaborative innovation processes, such as innovation platforms or cluster innovations. Intermediaries such as universities and think tanks can also support innovation development or create sustained partnerships.

Chapter 9:

Financing Interventions for Climate Change in Cities

Despite increasing recognition of their importance in winning the climate battle, cities continue to struggle to access adequate financial resources. Currently, most cities lack sufficient financing to deliver the level of climate action needed to ensure sustainable and climate-resilient urban futures. The reasons for this are complex and wide-ranging, rooted in part in the legal and systemic limitations of local authorities to raise own source revenue, coupled with reduced or irregular disbursements from national governments that are themselves overwhelmed by climate and growing debt challenges. While borrowing is a necessary consideration, cities are generally unable to secure loans or grants from financial institutions, leaving them reliant on national governments to negotiate for these external resources. To change this, cities need to embrace long-term and integrated planning for climate projects, working closely with regional and national governments, as well as local and international financial institutions, to facilitate better financial access for cities. This support should be accompanied by capacity building and technical assistance to ensure local governments have the necessary systems in place to deliver climate action effectively. Local governments can also explore various measures to enhance their own revenue streams and further incentivize other actors, including private enterprises, households and communities, to invest in climate action.

Key Findings

Cities are receiving less than 20 per cent of the finance required for effective climate action and are struggling to attract financing, particularly for small-scale local projects. Cities and other urban areas require an estimated US$4.5-5.4 trillion annually up until 2030 to invest in new or retrofitted climate-resilient infrastructure across transport, energy, water and waste, and telecom projects. In 2021-2022, cities only secured US$831 billion per year for climate action. Although the amount of climate finance flowing to cities has more than doubled in the past five years, it remains grossly insufficient to support effective climate action. Cities also face hurdles in accessing finance for local-level climate projects: many projects, while too large for cities to finance through their own budgets, are considered too small by external donors. One useful approach taken by cities is aggregating urban projects, through collaboratively integrating climate actions beyond the city level to improve borrowing power.

The growing imbalance between financing adaptation and mitigation has a more severe impact on the effectiveness of climate action at the city level. In 2021-22, only US$10 billion or just over 1 per cent of the tracked US$831 billion for urban climate action went towards adaptation. This leaves many cities and communities exposed to the impacts of extreme weather events associated with climate change. These impacts disproportionately affect vulnerable groups, especially low-income informal urban communities with limited resources and capacities to respond, weakening the effectiveness of urban climate action.

No single source can deliver the scale and speed of urban climate finance needed. Notwithstanding the varying projections of financing needs, there is a substantial gap between the financing that is currently available and what is needed for effective urban climate action. While national and local governments can direct more of their own resources, the high upfront costs of resilient infrastructure far exceed the resources at their disposal. Well designed, affordable loans and credit can offer a lifeline for cities to invest in climate solutions that will over the longterm pay off through averted damage, enhanced investor security and a range of other social and environmental benefits.

There is significant potential for local governments to scale up land-based revenue sources to finance urban climate action. At present, land rates, property taxes and land value capture tools—such as infrastructure levies, charges on underused land, and development rights—account for only 3.1 per cent of local government's revenue. However, these can be significantly scaled-up as the tools to operationalize them are largely within the control of local governments, including land use regulations, urban design (including parks and green spaces) and urban mobility planning. Additionally, enhancing these revenue sources can improve local governments' creditworthiness, enabling them to access external financial resources at favorable terms.

Reforms to improve access, efficiency, alignment and equity in the international financial systems can enhance the quantity and quality of climate finance available for cities. The ongoing global discussions outline a growing awareness that an equitable transition is crucial for effective climate action. It is anticipated that a higher-value New Collective Quantified Goal aligned with the Paris Agreement will be signed off at the 2024 COP29 in Baku, to replace the US$100 billion per year target. This could yield significant amounts of low-cost capital for developing countries, focusing on adaptation and resilient infrastructure, with positive ripple effects to the city level. The recognition of loss and damage as a third pillar of climate finance—in addition to adaptation and mitigation—further advances climate justice, with strong relevance to cities and other urban areas where a growing majority of the world's population reside.

Key Messages

To develop bankable projects, cities need to adopt an integrated approach through stronger vertical and horizontal collaboration. Strengthening preparation capacity is essential for improving the financial feasibility of projects. However, to scale up the impact of urban climate finance, local governments should align urban climate actions with projects and plans at the regional and national levels. Collaborating with other levels of government to aggregate projects, synchronize bankable projects, leverage economies of scale and reduce the transaction costs associated with smaller projects would make them more appealing for financing, and at more favorable terms.

Borrowing from private sources and tapping into global climate funds is necessary for cities to close the financing gap, but this must be approached strategically. Public sources of finance alone cannot deliver the required scale of urban climate finance. Cities need to engage with private capital providers and leverage diverse financing instruments in ways that are complementary. Global efforts to increase and align the flow of affordable climate finance, especially to developing countries, holds great promise for financing urban climate action. Cities should actively collaborate at regional and national levels to access global sources of climate finance.

Cities need to enhance their creditworthiness and risk profiles to attract financing at favorable terms, especially from private sources. This can be achieved by strengthening city planning, budgeting and financial management systems, including the broader city finance system beyond climate finance, as well as enhancing own revenue collection such as those from land-based income sources. The process of achieving an investment-grade credit rating improves the city's capacity to attract more finance and at more favorable terms. At a project level, with the support of national governments as guarantors and brokers, credit enhancement mechanisms such as credit guarantees, revenue guarantees, first-loss provisions, collateral, loan syndication and insurance can help to make a project bankable.

Cities need to leverage a blend of financial sources for urban climate action. When it comes to financing at the local level, context really matters, with no "one-size-fits- all" approach. It is not only necessary to secure the required levels of financing, but how the different mechanisms and instruments are integrated. Planning and preparing bankable projects within a vertically and horizontally coherent framework, potentially with the support of development finance institutions, is central to unlocking financing for climate interventions. Blended finance helps make projects bankable by combining different instruments to balance risk and attract financing. National governments and financial institutions can help leverage financing through de-risking mechanisms that can incentivize investments in projects that might otherwise be regarded as too high-risk.

Chapter 10:

Building Climate Resilience in Urban Areas

The final chapter looks forward to envision how cities can achieve the transformative change needed to thrive in the face of the climate crisis. While the alarm was raised decades ago on the imminent threats posed by climate change, with UN-Habitat one of many voices calling for urgent action at the local level, the world has yet to see anything close to the required scale of mobilization and investment in response. However, with the right will in place and working together with all stakeholders, including the most marginalized communities, national and local governments can greatly enhance urban resilience while delivering a wider agenda of social inclusion and environmental justice. The more equitable a city is, the better placed it will be to withstand the impacts of climate change and maintain momentum in the coming years.

Key Findings

The intersecting challenges of climate change and urbanization have been on the global development agenda for decades, yet action on the ground is still failing to keep pace with the worsening impacts. Indeed, these issues have been articulated with increasing urgency for years without being meaningfully acted on. However, the narrowing window of opportunity to implement the changes needed still allows for cities to shift course. Through an inclusive, multi-stakeholder approach to resilience building that embraces innovation, local knowledge and a bold vision of transformation that addresses the root causes of vulnerability, cities can pursue a range of pathways towards a more sustainable and secure future.

Cities are only as resilient as their most vulnerable inhabitants: urban resilience cannot be achieved without putting fairness and equity at the centre of urban climate action. Exclusion drives vulnerability, leaving large parts of the urban population exposed. Inclusion must therefore be prioritized in any efforts towards urban resilience. A broader notion of vulnerability needs to consider the different drivers of discrimination people face in urban environments, including gender relations and gender conformity, race, disabilities, ethnic origin and sexual orientation. The best way to ensure resilience interventions resolve rather than exacerbate these issues is to include diverse perspectives in mitigation and adaptation planning, particularly the perspectives of communities with place-based experiences of climate change risks.

Most of the solutions cities need to respond decisively to climate change are already available. Though many local governments in developing countries lack the capacity and resources to enact wide-ranging climate programmes, they can focus their efforts on achieving whatever first steps are feasible on their journey towards greater resilience. For instance, in the area of risk assessment, while smaller urban areas may generally lack the technical capacity to undertake sophisticated scenario modelling, the widespread availability of accessible socioeconomic and geospatial data means that most urban areas can develop simple hazard maps that can contribute to reducing their vulnerability. Ensuring that any investments in immediate needs, such as infrastructure or housing, incorporate even low-cost adaptive elements will help reduce vulnerability.

Resilience interventions achieve the greatest impact when they harness local resources and deliver collective benefits, such as infrastructure and service provision. Well designed, community-led actions can leverage local skills and knowledge that may previously have been overlooked, and have the added benefit of sustaining community buy-in over the long-term. Thus, resilience efforts should wherever possible align long-term objectives with the immediate, pressing needs of residents in areas such as services and housing. These incremental actions, while potentially appearing at first glance to be small-scale or highly localized in their impacts, may over time develop into transformative, city-wide change.

Key Messages

Resilience should be negotiated with communities, rather than imposed on them: a negotiated approach to building resilience can open up different perspectives, identify trade-offs and enable the most vulnerable to define what form it should take. Such an approach, commencing at the beginning of the planning process, will allow a range of stakeholders to explore what to prioritize, how it should be delivered and who should be involved. This process should be open to contestation and diverse viewpoints, especially among those traditionally excluded from decision-making. Most importantly, negotiation is a vital counter-point to the imposition of resilience on communities. Even supposedly participatory approaches that engage local residents in implementation can be disempowering if they are not given the opportunity to define the fundamental aims and mechanisms from the outset.

City authorities should move beyond traditional top-down hierarchies to embrace their role as coordinators, striving to engage a broad range of stakeholders to share responsibility for climate resilience. Local governments should diversify the range of actors involved in decision-making and engage the private sector, civil society organizations and individual residents as collaborators and partners. Though it is important that this process of diffused responsibilities does not leave local communities to bear the burden of climate action alone, authorities can nevertheless empower different stakeholders to lead in areas where their knowledge and skills qualify them to do so. Compared to the limited boundaries of conventional participation that is still widely practiced, this approach requires local authorities to fundamentally reconfigure their own position as dominant power brokers and serve as facilitators instead.

Urban resilience is not a fixed end-point that cities reach through a single prescribed pathway, but rather a horizon to travel towards through incremental steps. Resilience building should not be seen as an isolated target that can be achieved through one-off investments, no matter how large, but a continuous process to be mainstreamed into day-to-day urban management practices. In this regard, cities can achieve the most significant impact through low-profile, small-scale interventions across different sectors and communities that over time accumulate into substantial resilience gains. Many actions to advance urban resilience are "low-hanging fruit": initiatives that require minimal resources to activate once urban communities are aligned with these efforts.

Rather than focusing on the specific, immediate symptoms of climate change, cities should embrace a more holistic approach that addresses the root causes of vulnerability. Responding to increased flooding risk with the construction of dykes or sea walls may benefit some areas in the short-term, for example, but without a wider understanding of the social and environmental dynamics at play these interventions may soon become obsolete or exacerbate impacts elsewhere. National and local governments, businesses, civil society organization and communities should instead work together to ensure more equitable, sustainable cities that by protecting all residents ensure lasting resilience in the coming decades.

Chapter 1:

Cities as Hubs for Climate Action

Quick facts

1. Urbanization continues to be a major source of greenhouse gas emissions, with urban emissions per capita lower than national averages.

2. Irrespective of their levels of urbanization, countries can plan and commit to ambitious climate action targets.

3. Countries are not condemned to face rising emissions while urbanizing: net zero or low-carbon pathways can be achieved through appropriate climate-responsive planning choices.

4. Countries that have a higher share of informal housing and employment are more vulnerable to climate change.

Policy points

1. Climate action, as currently implemented in urban areas, does not reflect the urgency of the threat posed by climate change.

2. People must be at the centre of any meaningful climate action in cities and human settlements.

3. Cities are at the forefront of addressing the challenge of climate change, both in terms of direct mitigation and adaptation efforts and resilience building.

4. Aligning climate change adaptation with poverty reduction and disaster risk reduction through community-led settlement upgrading can help build resilience to climate shocks.

The theme of this volume of the World Cities Report is largely driven by the severity of the threat posed by climate change and its complex relationship with urbanization. This is hardly the first time UN-Habitat has explored the subject: for instance, the Global Report on Human Settlements 2011: Cities and Climate Change engaged with the very same issue.[1] However, the failure in the intervening years of the world's governments to respond adequately to the scale of the challenge means that, if anything, it has even greater relevance today. Today, it is widely recognized that climate change potentially poses an existential threat to humanity, with urban areas particularly vulnerable to rising sea levels, increased temperatures and other effects. In this regard, given the high level of emissions they produce, cities have been framed as both victims of climate change and its most egregious perpetrators.

Today, it is widely recognized that climate change potentially poses an existential threat to humanity

Nevertheless, while this is undoubtedly part of the picture, it is also the case that cities could play—and indeed are already playing—a key role in addressing these challenges. This resonates with the view that "cities are where the climate battle will largely be won or lost."[2] While urban areas concentrate activities that drive greenhouse gas (GHG) emissions, they can also serve as sites for effective and inclusive climate action. In this spirit, four key issues underpin the framing of the World Cities Report 2024:

- the *urgency of action*, given the devastating impacts of climate change as witnessed in different parts of the world: for a variety of reasons, from limited political authority to lack of access to adequate financing, much of the potential of cities as leaders in climate action is still not being realized, despite the serious threat climate change poses.

- the *reinvigorated role of cities*, given their unique characteristics: notwithstanding the challenges listed above, there is increasing recognition at a national and international level of the unique synergies that urban areas offer. This is demonstrated by the experimentation and innovation that cities themselves—including informal settlements—are contributing to adaptation and mitigation efforts.

- the *people-centred nature of climate action:* while technology and finance are both important elements of climate action, residents and communities are indispensable to any meaningful effort to address the root drivers and impacts of climate change. The increasing awareness that resilience at the local level is as much social as environmental could radically reconfigure the dynamics of traditional top-down responses to climate change.

- the *implementation of transformative, inclusive climate action* that cities and human settlements can take: rather than viewing climate change as a discrete problem, separate to the other challenges that cities face, some of the most promising approaches are now integrating climate-resilient planning and investment into wider strategies that also address poverty, inequality and social exclusion. This offers an inspiring alternative vision to the disproportionate impacts that climate change has had until now on the urban poor: the possibility that climate action could not only alleviate these threats, but also lead to a more just future for all.

1.1 The Urgency of Climate Action

The global response to the threat of climate change has witnessed the adoption of landmark agreements, including the Paris Agreement on Climate Change, the Sendai Framework for Disaster Risk Reduction, the Sustainable Development Goals (SDGs) and the New Urban Agenda (NUA). In the same vein, the United Nations Framework Convention on Climate Change (UNFCCC) has convened the Conference of the Parties to assess progress in addressing climate change. The consistent theme emerging from all these is the existential global threat posed by climate change, confirming its severity and the need for effective action. Over 3.3 billion people—more than 40 per cent of the global population—live in regions that are highly vulnerable to climate change.[3] The climate crisis is seen as "the biggest threat to security that modern humans have ever faced".[4] It is, together with pollution and biodiversity loss, a central part of the "triple planetary crisis".[5] The gravity of climate change is such that it has the potential to trigger "civilization collapse".[6]

The year 2023 has been confirmed as the hottest in human history, with scorching temperatures witnessed in different parts of the world. The global temperature for 2023 was about 1.48°C above the pre-industrial 1850-1900 baseline, with the nine years between 2015 and 2023 being the hottest on record.[7] This prompted the Secretary General of the United Nations to state that "the era of global warming has ended, the era of global boiling has arrived".[8] Heatwaves—frequent, longer and more intense—will be the "new normal" for decades to come.[9]

The year 2023 has been confirmed as the hottest in human history, with scorching temperatures witnessed in different parts of the world

All these warnings, which are supported by empirical evidence, show that the world is off track in meeting SDG 13 on climate action and is "edging ever closer" to the 1.5°C threshold, with the potential of it being exceeded for a protracted period.[10] The more the world continues to fall behind in meeting the goals of the Paris Agreement, the greater will be the impacts of climate change as a threat multiplier, hampering development and economic progress.[11] This in turn will exacerbate urban challenges and make it even harder to achieve the SDGs.

The global rise in temperatures continues unabated, leading to a recurring and escalating trend of extreme weather events—heatwaves, hurricanes, storms, floods, fires and other hazards—posing severe threats to lives, livelihoods and well-being, especially among marginalized populations. The effects of climate change are particularly dire in developing regions, particularly Small Island Developing States (SIDS) highly exposed to the destructive effects of climate-related disasters.[12] The vulnerabilities of these communities mean that routine weather events can become full-blown humanitarian crises, with their attendant impacts: loss of lives, property destruction and displacement.

Heatwaves—frequent, longer and more intense—will be the "new normal" for decades to come

The past few decades have witnessed a remarkable rise in the number of climate-related natural disasters, from just 58 in 1970 to 381 in 2021—a more than six-fold increase in just over 50 years.[13] There has also been a doubling in the annual rise in global sea-levels from 2.27 mm per year between 1993 and 2002, to 4.62 mm per year between 2013 and 2022.[14] This is expected to continue despite efforts to limit global warming to 1.5°C, with major implications in particular for the estimated 900 million people—"one out of every ten people on Earth"—living in low-elevation coastal zones.[15]

The impacts of climate change are intersecting with and exacerbating other challenges—poverty, inequality, conflicts, displacement, water scarcity, food security and loss of livelihoods—in the process reversing decades of development gains. The economic costs associated with climate change are staggering: having doubled seven-fold since the 1970s, they now account for hundreds of billions of dollars in damage every year.[16] It is estimated that the global economy could lose up to 18 per cent of GDP by 2050 if no mitigating actions are taken.[17] In the case of the built environment, global average annual losses arising from disasters could reach US$415 billion by 2030.[18] By 2050, according to some projections. extreme weather events associated with climate change could erase 9 per cent (US$25 trillion) from the value of the world's housing.[19]

1.1.1 Contradictions and limitations of climate action to date

Despite the threat posed by climate change, global efforts at mitigation and adaptation are not keeping pace with the increasing risks: even if current pledges are kept to, the planet will still be on track for a 2.4-2.6°C temperature rise by the end of the century.[20] To limit temperature rise to no more than 1.5°C, as called for in the Paris Agreement, global emissions have to decline by 45 per cent by 2030 compared to 2010 levels and achieve net zero by 2050.[21] At present, however, projections suggest that even if the national climate plans for all 195 countries that are signatories to the Paris Agreement are implemented, emissions are still likely to increase by 8.8 per cent by 2030.[22]

Despite the threat posed by climate change, global efforts at mitigation and adaptation are not keeping pace with the increasing risks

Although most countries have agreed to strengthen their climate action plans, lower their emissions and even set net zero targets, there is still a significant gap between rhetoric and action. Bold steps towards reducing emissions are yet to be taken. By contrast, policy support to produce fossil fuels remains strong. A recent assessment of national energy plans and projections shows that "the world's governments still plan to produce more than double the amount of fossil fuels in 2030 than would be consistent with limiting warming to 1.5°C".[23] A further sign of misaligned commitments and actions can be seen in the fact that many major fossil fuel-producing countries are planning to scale up production for years or decades to come, resulting in near-term increases in the global production of coal (until 2030) and long-term increases (until at least 2050) in oil and gas.[24] In line with this trend, fossil fuel subsidies reached a record US$7 trillion in 2022 in the wake of the economic recovery from the COVID-19 pandemic and Russia-Ukraine conflict.[25] In particular, the conflict placed energy transition at a crossroads and provoked a global "gold rush" for oil, gas and even coal.[26]

Although most countries have agreed to strengthen their climate action plans, lower their emissions and even set net zero targets, there is still a significant gap between rhetoric and action

These investments have the potential to lock in new GHG emissions for decades and are essentially competing with efforts to accelerate the energy transition and close the 2030 emission gap.[27] However, the International Energy Agency (IEA) notes that the global energy crisis triggered by the Russia-Ukraine war carries the potential to hasten the transition to "a cleaner and more secure energy system."[28] New policies in major energy markets such as the US, EU, China, Japan, Republic of Korea, and India are likely to push annual clean energy investment to more than US$2 trillion by 2030, up from US$1.3 trillion in 2021.[29] A review of the long-term low-emission development strategies from 62 parties to the Paris Agreement (representing 83 per cent of the world's GDP, 47 per cent of the global population and around 69 per cent of total energy consumption in 2019) indicates that the world is starting to aim for net zero emissions. If fully and timely implemented, these countries' GHG emissions could be 68 per cent lower in 2050 than in 2019.[30]

While this represents a bright spot, there is lingering uncertainty regarding many net zero targets. Questions remain as to the wisdom of postponing into the future much critical action that needs to be taken now. Nevertheless, amidst the lack of ambition characterizing climate action, there is still some optimism, albeit within a decreasing window of opportunity. A decisive milestone for climate action took place at the 2023 United Nations Climate Change Conference (COP28), when almost 200 countries agreed to "transition away" from coal, oil and gas, a move hailed as the "beginning of the end" of fossil fuel dependence.[31] Notwithstanding, there is a sense of disappointment in many quarters that the COP28 agreement was not more far-reaching in calling for the explicit commitment to phase out fossil fuels. It remains to be seen how this agreement will be translated into action and what role cities can play in this process: in the meantime, it is likely that fossil fuels will continue to dominate the energy mix for some time to come.

Box 1.1: Adaptation and mitigation: The two strands of climate action

Throughout this report, the text refers to two important areas of climate action: mitigation and adaptation. The two are distinct, though often interlinked, activities that work together to slow or even reverse climate change while alleviating its effects on communities. *Mitigation* relates to “any action taken by governments, businesses, or people to reduce or prevent greenhouse gas emissions, or to enhance carbon sinks that remove these gases from the atmosphere”.[32] Reducing GHG emissions in cities can be achieved by adopting renewable energy, low-carbon or zero-carbon multimodal transport, sustainable land use, building construction and industrial processes, and models of production and consumption that are more sustainable, including behavioural and lifestyle changes. Carbon sinks can be enhanced through NbS—planning of trees, restoring forests, wetlands, and marshlands, maintaining soil health, and protecting terrestrial and marine ecosystems.[33]

Adaptation to climate change, on the other hand, relates to “actions that help reduce vulnerability to the current or expected impacts of climate change like weather extremes and hazards, sea-level rise, biodiversity loss, or food and water insecurity”.[34] To be effective, adaptation to climate change needs to occur at the local level. Consequently, communities, cities individuals, groups of individuals and a wide range of institutions need to be empowered to play a pivotal role.[35] Adaptation measures include building climate-resilient infrastructure (Chapter 6), developing stronger protection against extreme weather events, developing early warning systems and disaster preparedness, resilience planning (Chapter 5), better management of land, insurance schemes specifically designed to address climate-related threats, addressing the specific needs of vulnerable groups through sustainable sources of livelihood, food and water security, adequate health care and social protection programmes (Chapter 4)—all of which help build resilience.

Successful adaptation leads to resilience, which is the outcome of governments, the private sector, civil society organizations, households and individuals with strong adaptive capacity.[36] While adaptation is implemented at the local level, it needs to be driven at the national and international levels, largely due to the huge financial outlay (Chapter 9) and capacity required (Chapter 7), which is often beyond the scope of cities especially in developing countries.

Flooded parts of Chittagong City, Bangladesh. There has been an increase in unpredictable rainfall that leaves roads and homes flooded as a result of climate change.

1.2 Cities at the Forefront of Reinvigorated Climate Action

Until recently, cities were perceived as part of the problem: namely as exponents of sprawl, informal settlements and climate inaction. This narrative is changing, partly due to the sustained work of the IPCC on cities and human settlements.[37] Indeed, by their very nature, cities should be at the forefront of climate action. Emissions per capita at the urban level are often lower than the national average, particularly in well-planned and managed settings, meaning that urban areas have the potential to be more carbon-efficient.[38] While urbanization has contributed to an overall decline in global green spaces,[39] data covering the period between 1990 and 2014 show that green spaces within cities have increased[40]—demonstrating that, with the appropriate regulatory and urban planning policies in place, urban areas can play a significant role in regreening the planet.

Although urban areas cover only a tiny fraction of the world's surface, their social, economic, and environmental processes and impacts extend beyond their boundaries, often through the production and consumption patterns that link the world together.[41] Much of the energy and resources that cities use is produced and extracted far outside their administrative borders. Cities also benefit from the ecosystem services that rural areas provide in the reduction of climate hazards and carbon storage.[42] Global or national climate mitigation can therefore not be achieved independently from urban climate mitigation.

The central tenet of cities at the forefront of climate action is that cities, defined simply as dense concentrations of people, businesses and institutions, represent not only places of enhanced and clustered vulnerability to climate change. They are also places where climate action can be leveraged through co-creation and co-benefits can be leveraged; places that enable a wide range of uniquely urban policies to lower emissions; and places which act as centres of buoyant innovation and advocacy. Positioning cities at the forefront of climate action does not negate the role of national and subnational governments, but rather highlights the unique nature of cities.

Positioning cities at the forefront of climate action does not negate the role of national and subnational governments

1.2.1 Cities as places of concentrated climate threat exposure

The concentrated nature of people, businesses, institutions, and infrastructure in urban areas makes them vulnerable to climate shocks.[43] It is estimated that a 2°C increase in global temperature in 2050 will expose 2.7 billion people to moderate or high climate-related risks, with the large majority (between 91 and 98 per cent) situated in Africa and Asia.[44] Climate-related disasters account for 91 per cent of the 7,255 major disasters that occurred between 1998 and 2017.[45] Though felt globally, climate change has a distinctive urban impact, as 64 per cent of the urban population has a high level of exposure to disasters.[46] The urban poor, particularly residents of informal settlements, are disproportionately exposed to extreme weather events on account of their location, poor quality of construction and limited savings.[47]

Many cities, in particular coastal urban areas, are vulnerable to sea level rise and flooding. By 2050, there will be over 800 million residents of coastal cities at risk of at least 0.5 metres of sea level rise and flooding.[48] Besides the risk of coastal inundation, cities are also exposed to rainwater flooding as a result of inadequate drainage and the increasing coverage of concrete, asphalt and other materials that prevent water infiltration. In Odense, Denmark, for instance, it is projected that an increase of just 1 per cent in impervious area could expand its flood-prone area by more than 10 per cent.[49] Other climate change impacts that are context-specific to cities are urban heat islands. By the 2050s, more than 1.6 billion urban residents will be exposed to extreme temperatures of at least 35°C.[50] As with flooding, poor residents tend to be disproportionality exposed to extreme heat and its attendant impacts.[51] Another problem is urban air pollution, which is entwined with climate change, accounted for 6.7 million premature deaths in 2019, making it the world's largest environmental risk factor for disease and premature death.[52]

As with flooding, poor residents tend to be disproportionality exposed to extreme heat and its attendant impacts

1.2.2 Cities as places that foster circularity

Cities are uniquely positioned to pursue urban circularity, which has the potential to generate significant co-benefits, thereby making more efficient use of limited resources. For instance, improved public transport can reduce emissions and enhance resilience, while simultaneously, addressing structural inequality by connecting low-income urban dwellers to better jobs.[53] The proximity of disadvantaged groups to sites that generate negative environmental externalities is potentially a risk, but could present an opportunity for investment in climate action that can be leveraged to address persistent problems such as poverty, inequality and inadequate infrastructure. Nature-based solutions (NbS) to enhance resilience to flooding can also enhance food security, provide public green spaces and yield economic benefits.[54]

An electric bus ferrying passangers in Chandigarh, India © PradeepGaurs/Shutterstock

The proximity of people, activities and mix of uses enable cities to easily share and optimize resources, and close existing energy and waste loops through recycling, reuse and energy recovery.[55] This may manifest in several ways: waste-to-energy plants, greywater recycling, urban regeneration and the retrofitting, refurbishment and renovation of buildings. Resources can be shared in cities across a range of activities, including living (co-housing), working (co-working spaces) and travel (mass transit and vehicle sharing schemes).

By localizing the production and consumption of resources, both positive and negative externalities of resource consumption are also localized.[56] This in turn puts communities in a better position to make informed and sustainable choices that preserve their environment. Such negative externalities not only come from polluting land uses, which are often sited near poor neighbourhoods,[57] but also from how climate adaptation can lead to gentrification and displacement of vulnerable communities.[58] This is further discussed in Chapter 4.

1.2.3 Cities as places of unique mitigation and adaptation opportunities

While climate mitigation involves measures in both urban and rural contexts, one distinctly urban mitigation pathway enabled by the concentration of people and land uses that cities bring is the compact public transport nexus.[59] Emissions from the transport sector represent the fastest-growing source of GHG emissions[60] and tend to be higher in low-density urban areas without effective public transport networks.[61] Households in high-density cities, on the other hand, are likely to have lower emissions.[62] Effective public transport and policies such as congestion pricing schemes[63] enable residents to live car-free, potentially reducing their individual emissions by as much as 2.4 tCO_2e annually.[64]

The fight against climate change can only be won when the mitigation, adaptation and resilience agendas are initiated based on specific contextual needs

While public transit is a key mitigation measure in 47 per cent of NDCs,[65] its global take-up has been low. Unless this changes, transport may remain a major hurdle in efforts to mitigate global warming.[66] A somewhat similar situation plays out in Europe where municipal action to accelerate a modal shift to public transport generated the most energy savings, but the high upfront costs constitute a barrier to more transformative shifts.[67]

1.2.4 Cities as places of buoyant innovation and advocacy

Cities have fostered innovation, experimentation and advocacy, especially in the face of the challenges posed by climate change.[68] Since the fight against climate change can only be won when the mitigation, adaptation and resilience agendas are initiated based on specific contextual needs,[69] local experimentation is critical. In this regard, the typical urban infrastructure built in the 20th century—typically characterized as rigid, large, centralized, efficiency-oriented and mechanized[70]—can be bypassed or leapfrogged in developing cities in favour of nimbler, decentralized and resilient infrastructure (as shown in Chapter 6).

Cities and local governments are well-placed to foster experimentation and promote "grassroots innovation".[71] Indeed, they are already at the forefront of global advocacy on climate action: the climate commitments of many cities are often more ambitious than those of their national governments.[72] For instance, an analysis of the GHG emission targets of approximately 6,000 subnational governments and 2,000 companies suggests that by 2030 they could contribute 1.5 to 2.2 $GtCO_2e$ more in emission reductions annually beyond that expected from current national government policies.[73] The impacts of other city and local government-based climate initiatives, such as the Cities Race to Zero, are discussed in Chapter 2.

1.2.5 Global development agendas and the need for local implementation

While the international agreements relating to climate change—Sendai Framework for Disaster Risk Reduction, the Paris Agreement on Climate Change, SDGs and the NUA—reflect national commitment, they all require local implementation. It has been suggested that up to 65 per cent of the SDG targets are under threat if local or urban stakeholders are not assigned a clear role in their implementation.[74] This undoubtedly makes cities the loci to transform global agendas into practicable courses of action in diverse local contexts. In this regard, cities are key to realizing SDG 12 as they can undertake climate-sensitive, low-emission planning that promotes sustainable mobility, green infrastructure and the transition to renewable energy.[75]

Given the slow and uneven implementation of the SDGs, together with the "cascading and interlinked crises" facing the world,[76] there is a need to course-correct and accelerate the localization of the 2030 Agenda. Leading the localization of various global agendas does not imply, however, that cities are expected to meet the "action gap" alone. This requires broader action that goes beyond the realm of local governments, civil society and local businesses, and should be complemented with effective multi-level governance strategies (as discussed in Chapter 7). Local governments must be supported by a network of actors operating at different scales, aligning governmental efforts at both the national and the local level, business interests and the efforts of multiple other actors. With these conditions in place, cities all over the world have proved they can be catalysts for positive change: for example, under the umbrella of the Global Covenant of Mayors for Climate and Energy, more than 13,000 cities have made significant commitments to take measurable climate action.[77]

While the international agreements relating to climate change—Sendai Framework for Disaster Risk Reduction, the Paris Agreement on Climate Change, SDGs and the NUA—reflect national commitment, they all require local implementation

1.3 Links between Urbanization and Greenhouse Gas Emissions

It has been established that urban areas generate around three-quarters of GHG emissions. The IPCC in its fifth assessment cycle notes that cities produce "67-76 per cent of energy use" and "71–76 per cent of energy-related CO_2 emissions".[78] These widely cited estimates are based on 2005 estimates by the IEA[79] and studies using Scope 2 data from 2000.[80] A more recent study, drawing on 2015 data, similarly concluded that between 70-80 per cent of global emissions come from urban areas.[81] Using a consumption-based accounting methodology in which emissions are allocated to the persons whose use caused the emissions, the sixth IPCC Report updated the urban emissions to be 62 per cent of the global share in 2015; and between 67-72 per cent of the global share in 2020.[82]

Based on the idea of planetary urbanization,[83] which is premised on the notion that urban development, urban institutions and urban processes extend far beyond city boundaries in ways that are shaping the entire planet, it may then even be argued that all GHG emissions are inextricably linked to urban processes. In this context, it is useful to understand how urban emissions are accounted for. In the Scope 1 measurements, also referred to as area-based accounting, only emissions that directly originate from urban areas are accounted for. Scope 2 emissions also include emissions resulting from imported electricity, while Scope 3 emissions cover emissions that are linked to all other imports, including food, goods and services.

It has been established that urban areas generate around three-quarters of GHG emissions

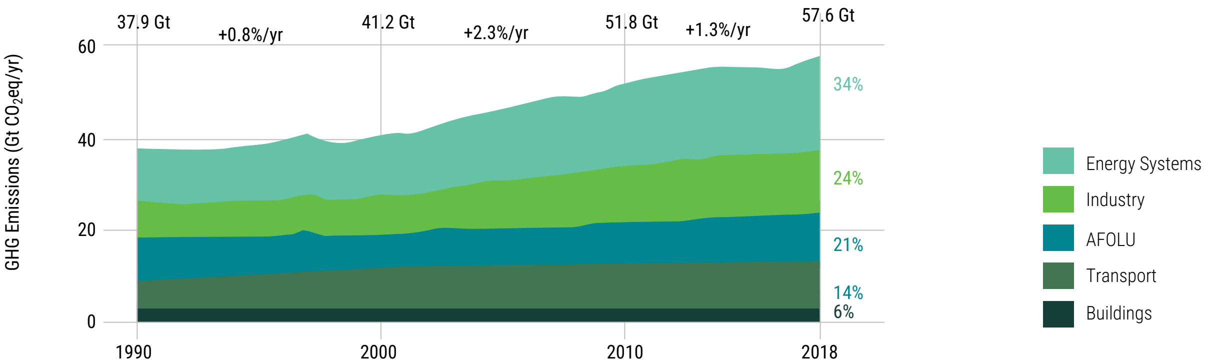
1.3.1 Urbanization and greenhouse gas emissions: Emerging trends

To better understand the role of urban areas, Figure 1.1 provides the global context on GHG emissions disaggregated by sectors based on Scope 1 emissions. Global GHG emissions rose sharply at the rate of 2.3 per cent between 2000 and 2010 and continued on an upward trajectory but at a lower rate of 1.3 per cent annually. Mirroring the global picture, GHG emissions in most regions have been rising, particularly in East Asia. The developed regions of Europe, and to a lesser degree North America, have made the most progress in reducing emissions. This is more evident with CO_2 emissions per capita (Figure 1.2: Average CO_2 emissions per capita (1990-2019), by region2), which declined by 33 per cent between 1990 and 2019.

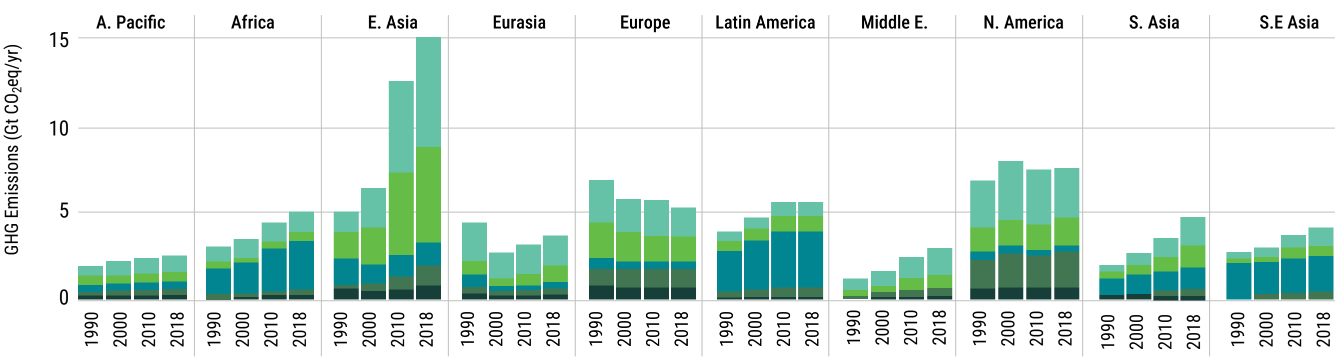
Global GHG emissions rose sharply at the rate of 2.3 per cent between 2000 and 2010 and continued on an upward trajectory but at a lower rate of 1.3 per cent annually

Figure 1.1: GHG emission (Scope 1) trends, 1990-2018, by sector (top) and region (below)

a. Total Global GHG emissions trends



b. Total regional GHG emissions trends



Source: Lamb et al., 2021.

Scope 1 emissions as shown in Figure 1.1: GHG emission (Scope 1) trends, 1990-2018, by sector (top) and region (below)1 can obscure the role of cities and the sectors that are most concentrated in urban areas. For example, the building sector accounts for almost 6 per cent of direct GHG emissions (Scope 1),[84] but when Scope 2 and Scope 3 emissions are included, the building sector accounts for 37 per cent.[85] Figure 1.3: Scopes 1–3 emissions of the five IPCC sectors (1995-2015)3 shows how Scope 2 and 3 emissions compare to Scope 1 emissions for each sector, revealing that when these indirect and embodied emissions are considered, industry dominates global CO_2 emissions.

Figure 1.2: Average CO_2 emissions per capita (1990-2019), by region

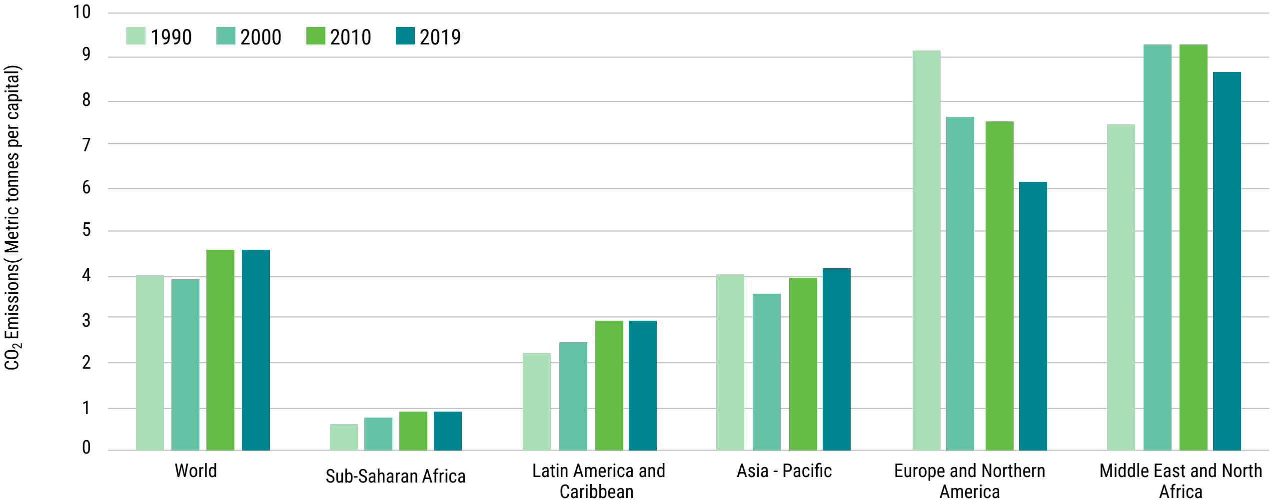
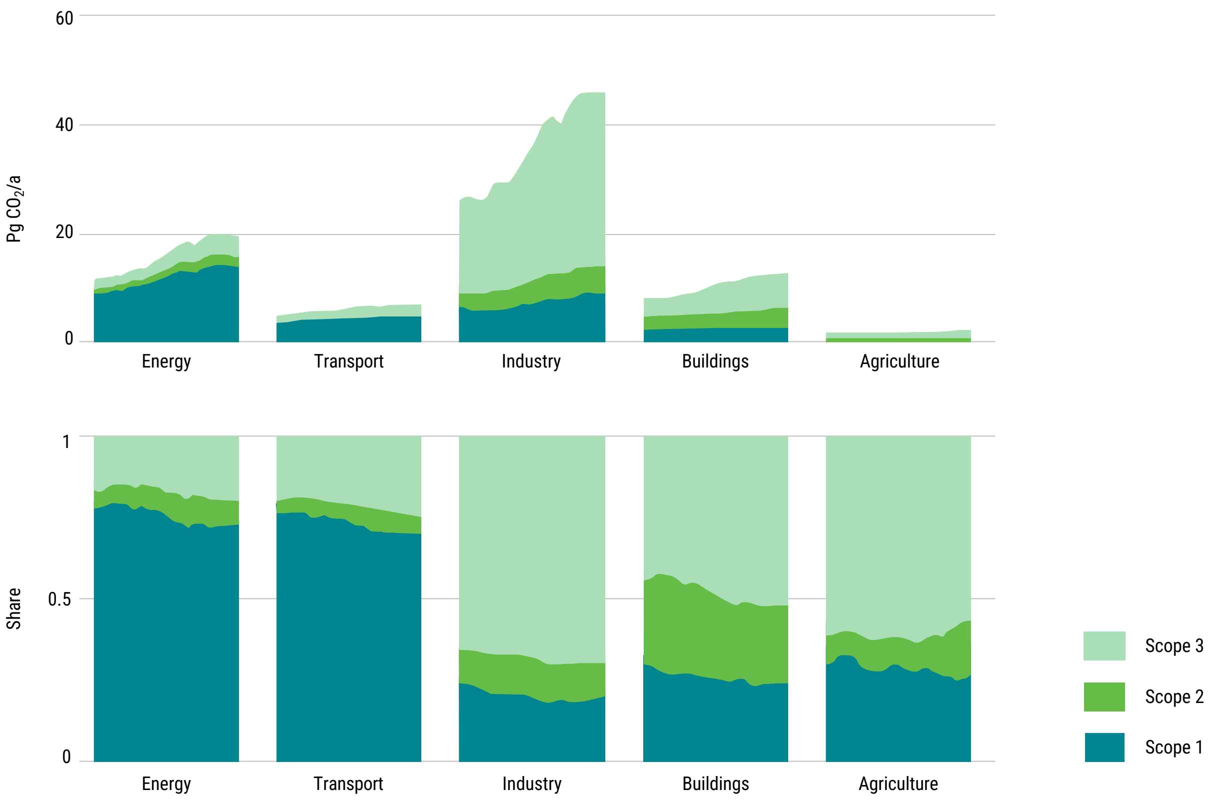


Figure 1.3: Scopes 1–3 emissions of the five IPCC sectors (1995-2015)



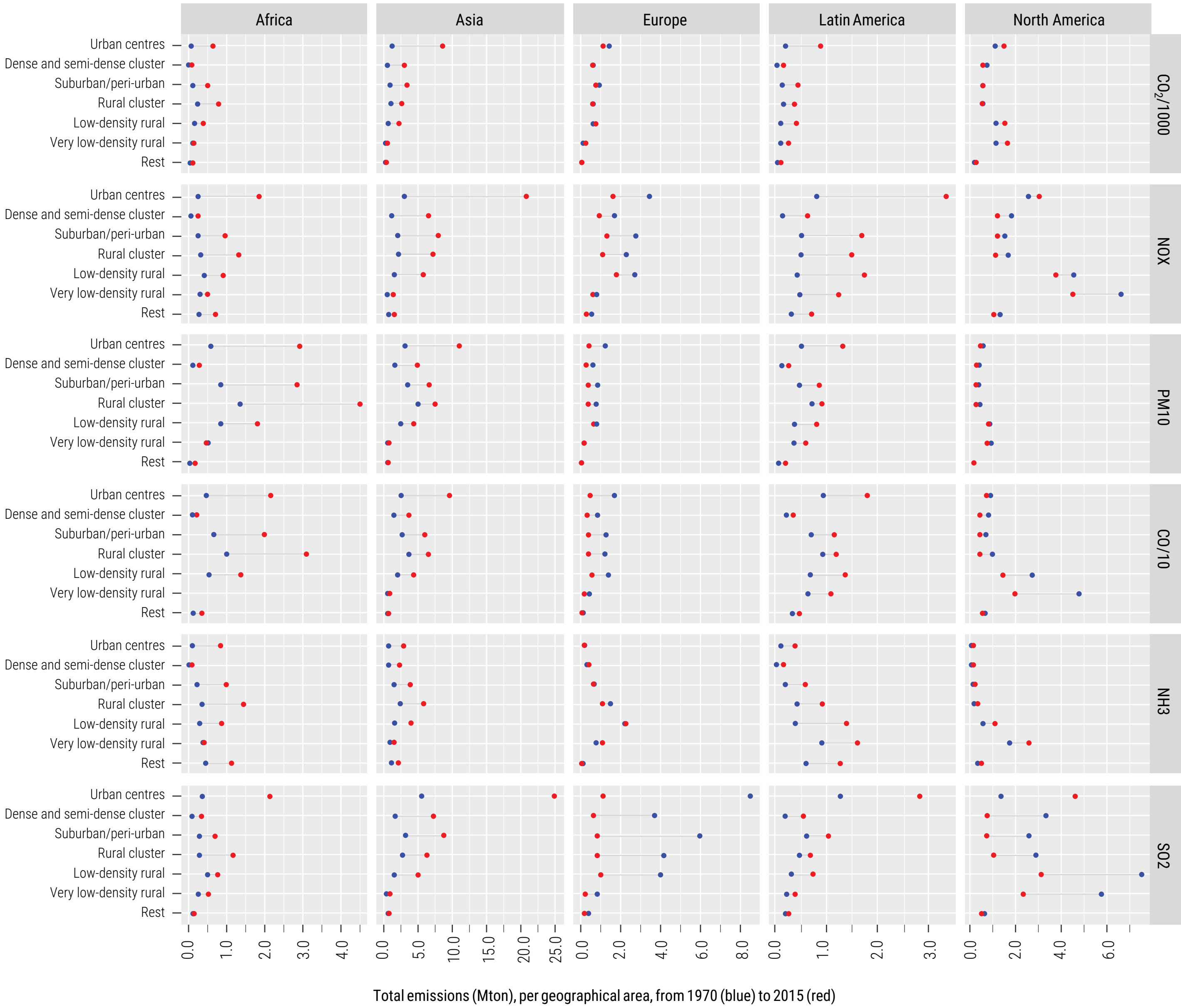
Source: Hertwich & Wood, 2018.

Release of harmful emissions into the atmosphere by industries is a leading cause of global warming. © mykhailo pavlenko/Shutterstock

Emissions and pollutants can be further disaggregated by settlement type within the various regions. This can be done using the recently developed *Degree of Urbanisation*, which is a harmonized definition for urban areas that facilitate global comparison. In this methodology (discussed in greater detail in Chapter 3), *urban centres* are defined as settlements of at least 50,000 inhabitants with greater than 1,500 inhabitants per sq. km; towns and urban clusters are defined as areas with at least 5,000 inhabitants and a density of at least 300 inhabitants per sq. km; and *suburban or peri-urban areas are those urban areas* which fall outside the contiguous area of an urban cluster.

Figure 1.4 shows the change in the range of emissions for these urban categories between 1970 and 2015. This indicates those settlement types where the highest gains in emissions reduction have been achieved. Taking the case of nitrogen oxides (NOx) and CO_2 emissions, high peaks between the two periods are evident in urban centres in Africa, Asia and Latin America, which tend to be associated with vehicular and industrial uses. This is especially the case in Asia where these uses have been significant drivers of emissions. Consequently, policies and practices in both sectors of these regions would need to be overhauled in the quest to achieve net zero emissions. In North America, the high peaks in emissions, especially for sulphur dioxide (SO_2), carbon monoxide (CO) and nitrogen oxides, occur in the low- and very low-density settlements. In Africa, sulphur dioxide and PM10 have high peaks in suburban/peri-urban, rural clusters and low-density rural areas. This in part implies that the biggest gains in emissions reduction for this region can be achieved outside urban centres and other semi-dense clusters. The policies and practices that these trends portend are explored in detail in various chapters of the report.

Figure 1.4 Total emissions (Mton) per geographical area, from 1970 (blue) to 2015 (red)



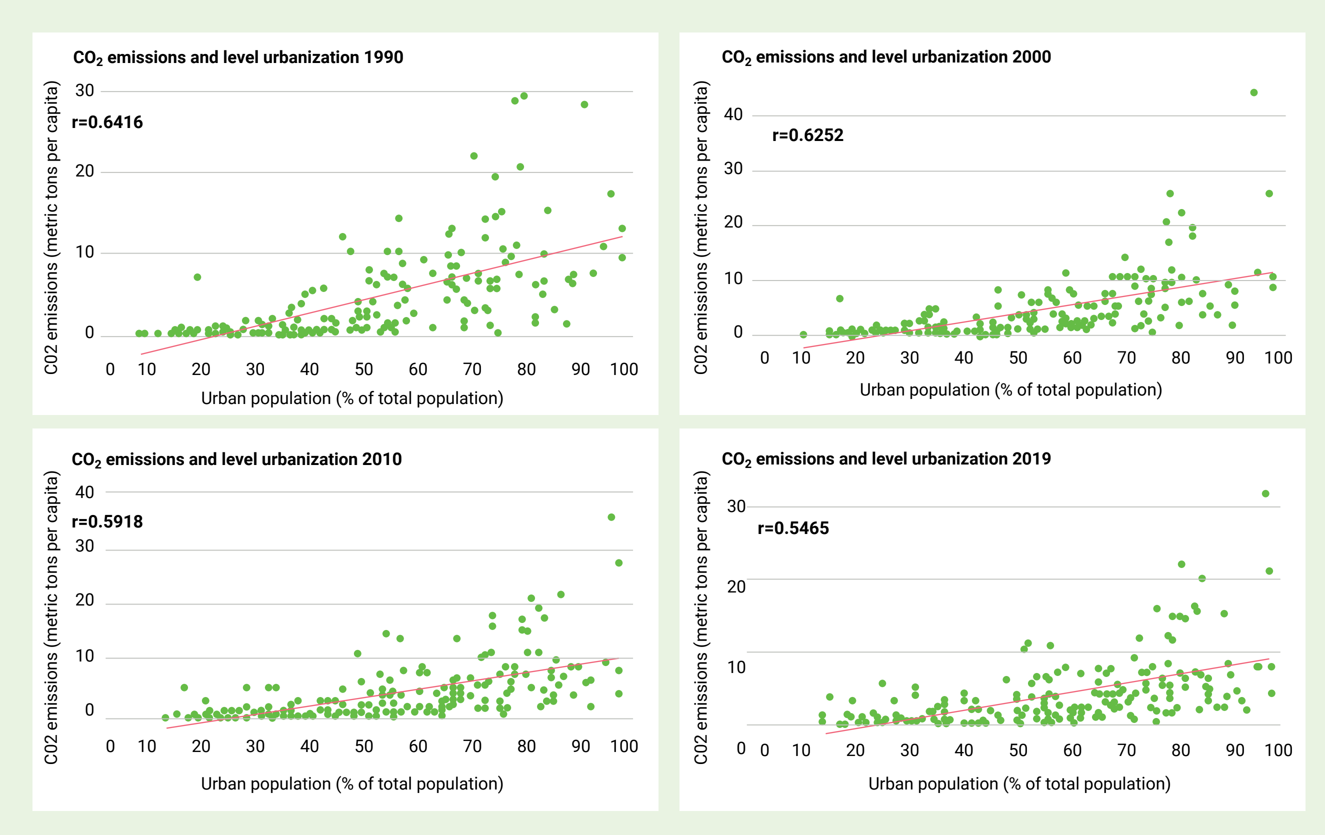
Source: Crippa et al., 2021.

1.3.2 Urbanization and greenhouse gas emissions

There is general acceptance of the existence of a link between a higher share of people living in urban areas and higher rates of GHG emissions.[86] At the global level, the relationship between the level of urbanization and CO_2 emissions per capita is relatively strong but has been declining consistently since 1990, as indicated by the correlation coefficients for the different periods (Figure 1.5: Correlation between urbanization and CO_2 emissions per capita (1990-2019)5).[87] This positive relationship is consistent with previous studies, which reveal that as urban areas expand and concentrate a greater intensity of people, wealth and consumption, GHG emissions tend to increase.[88] Notwithstanding urbanization's role as a driver of climate change, it is important to recognize that climate change is in turn a driver of urbanization, as deteriorating climatic conditions have been correlated with accelerated urbanization.[89]

At the global level, the relationship between the level of urbanization and CO_2 emissions per capita is relatively strong but has been declining consistently since 1990

Figure 1.5: Correlation between urbanization and CO_2 emissions per capita (1990-2019)



The relationship between the level of urbanization and CO_2 emissions per capita observed in Figure 1.5 is replicated to some extent at the regional level (Table 1.1). While the graphs for each period suggest that on average (as illustrated by the red line), higher urbanization levels continue to be associated with greater emissions of CO_2 per capita, at the same time there has been a marked shift in the strength of the correlation between the two, with the correlation coefficient (r) falling from just over 0.64 in 1990 to almost 0.55 in 2019. This suggests that for a variety of reasons, urbanization has become a less decisive determinant of per capita emissions over time. This is especially the case in developed regions where urbanization has reached its saturation point, and the concentration of people in urban areas might not be the major driver of GHG emissions. In this instance, the higher levels of consumption and production that have accompanied income rises in these countries, in the process driving up emissions, appear to some extent to have been reversed by other factors (such as investments in low-carbon infrastructure, energy efficiency improvements and lifestyle change) that have helped push per capita emissions down. The changing association between urbanization and CO_2 emissions raises a fundamental question: is the process of urbanization becoming more sustainable—or at the very least, less unsustainable—over time?

For a variety of reasons, urbanization has become a less decisive determinant of per capita emissions over time

Table 1.1: Correlation between level of urbanization and CO_2 emissions per capita

Region	Correlation coefficients			
	1990	2000	2010	2019
Asia-Pacific	0.81	0.79	0.69	0.70
Middle East & North Africa	0.61	0.65	0.67	0.65
Sub-Saharan Africa	0.54	0.63	0.53	0.47
Europe & Northern America	0.35	0.48	0.43	0.32
Latin America and the Caribbean	0.29	0.16	-0.05	-0.15

Another way of examining the relationship between urbanization and GHG emissions is by correlating the change in the percentage of people residing in urban areas with the change in carbon dioxide equivalent (CO_2e)[90] for the period between 1990 and 2020. The correlation coefficient of 0.15, though positive, shows that the change in the level of urbanization over time is weakly associated with an equivalent change in CO_2. This in turn suggests that changes in GHG emissions per capita are not solely accounted for by changes in urbanization. Consequently, cities are not condemned to facing rising emissions while urbanizing, but rather point to multiple development pathways: some carbon-intensive, others decarbonizing. Such a conclusion speaks to the mitigation potential that is associated with spatially concentrating people, infrastructure and economic activity.[91]

Cities are not condemned to facing rising emissions while urbanizing, but rather point to multiple development pathways: some carbon-intensive, others decarbonizing

Beyond differences that emerge between global regions, the level of economic development and their varied economic roles, variation in emissions extends to differences between and within cities that demonstrate the level of emissions is intimately linked to policy and lifestyle choices and the consumption and production patterns in which these are embedded. This is reflected in the higher correlation (0.50) between the change in GDP per capita and the change in CO_2e between 1990 and 2020, which implies that GHG emissions are more responsive to income/consumption patterns vis-à-vis urbanization. In Europe and North America, where GHG emissions have been declining since 1990, a key driver of consumption-based emissions is energy for heating and cooling. Consequently, several policies at the national and city level have been enacted to promote energy efficiency.[92] Many countries and cities in the region are prioritizing the transition to low-carbon transport, including expanding safe accessible cycle paths and walkways and providing incentives to switch to electric vehicles. This shows that, as with the relationship more generally between urbanization and GHG emissions, even higher levels of wealth—though potentially provoking more carbon-intensive consumption among residents as their incomes increase—do not have to lead inexorably to greater emissions. Indeed, with the right policies and regulations in place, national and local governments can help facilitate the transition of urban areas to more sustainable systems.

Many countries and cities in the region are prioritizing the transition to low-carbon transport, including expanding safe accessible cycle paths and walkways and providing incentives to switch to electric vehicles

Clean mobility concept as a means of tackling emmisions. © Scharfsinn/Shutterstock

Focusing too much attention on the correlation between urbanization and emissions can obfuscate significant action at the local level. For example, previous estimates have shown that the average emissions for a person living in New York are half those for Denver.[93] Residents of informal settlements emit far less GHG than the residents of gated communities within the same city, a trend further discussed in this chapter. The range between the highest and lowest polluters, at the national, urban and local levels, shows that there is enormous potential to limit GHG, even with existing technologies and practices. It is the high consumption lifestyles of the world's wealthiest neighbourhoods, rather than urbanity itself, which results in the most damaging levels of GHG emissions.[94] Thus, urban residents emit more GHG because urbanization is a generator of wealth, not because cities themselves inherently encourage more emissions.

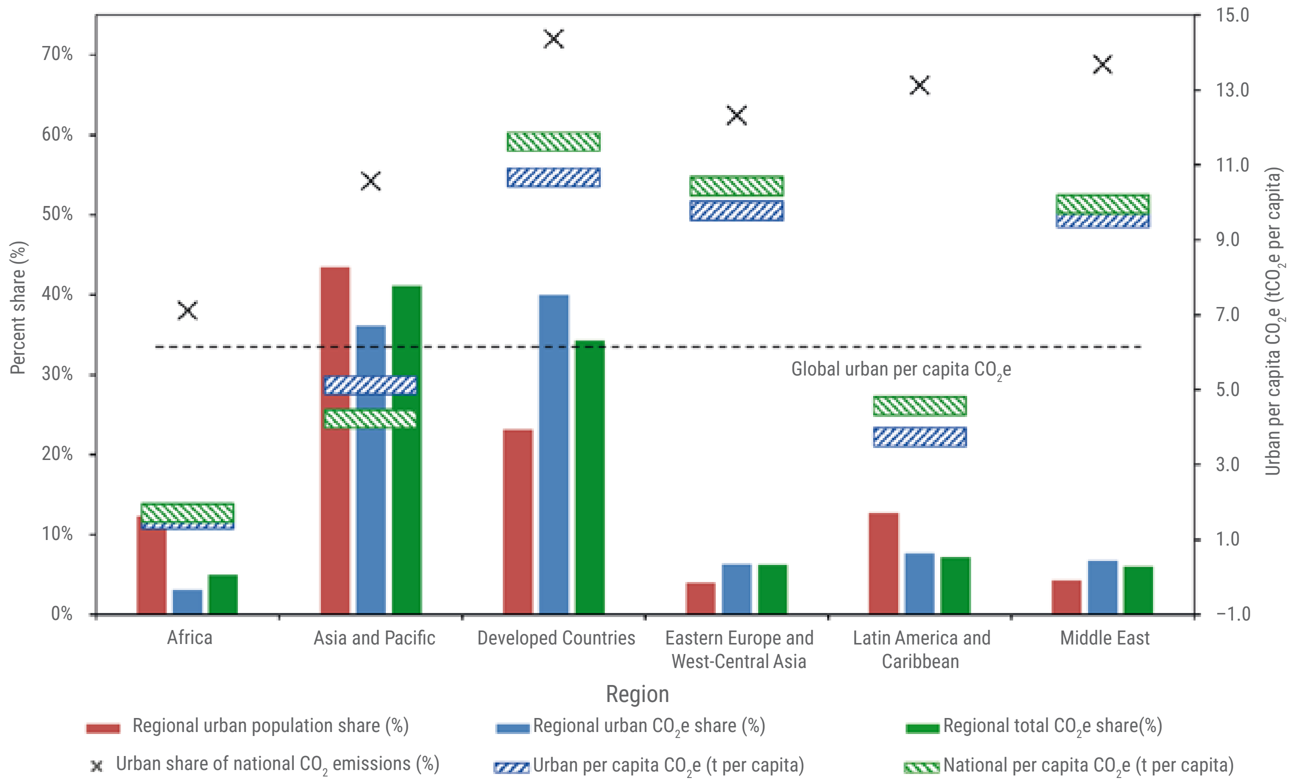
Urban residents emit more GHG because urbanization is a generator of wealth, not because cities themselves inherently encourage more emissions

1.3.3 The potential for urban living to be more sustainable

Various regionally disaggregated studies have both supported and nuanced the idea that urban living is more sustainable than dispersed suburban and rural settlements by comparing emissions per capita in urban areas with the national average. Figure 1.6 uses a "consumption-based" accounting approach—including emissions not only from within urban areas, but also indirect emissions from outside urban areas related to the production of electricity, goods and services consumed in cities—that shows that the difference between per capita CO_2e emissions in urban areas compared to the national level varies by region. The biggest difference is in Latin America and the Caribbean, where average per capita final energy use and urbanization level is lower than national averages (a finding confirmed by other regional studies).[95] This trend is replicated in developed regions, where urban areas have lower CO_2e emissions per capita than non-urban areas.[96] A study of CO_2 emissions in 91 cities across the world concludes that urban per capita emissions tend to be lower than their national average for many developed countries.[97]

In the Asia Pacific region, per capita CO_2e emissions at the urban level tend to be higher than their national average. This region has experienced massive increases in GDP per capita over the past decades. While area-based studies indicate that urban GHG emissions in Asia are lower than national averages,[98] such figures often do not consider energy production occurring outside the cities. When accounting for energy production outside cities, the per capita CO_2e in urban areas tends to be higher than national averages. Such a regional trend is corroborated by a study of 50 cities in Asia, which showed that in the majority per capita final energy use is higher than the national average.[99]

Figure 1.6: Regional comparison of urban per capita CO_2 emissions



Source: IPCC, 2022c

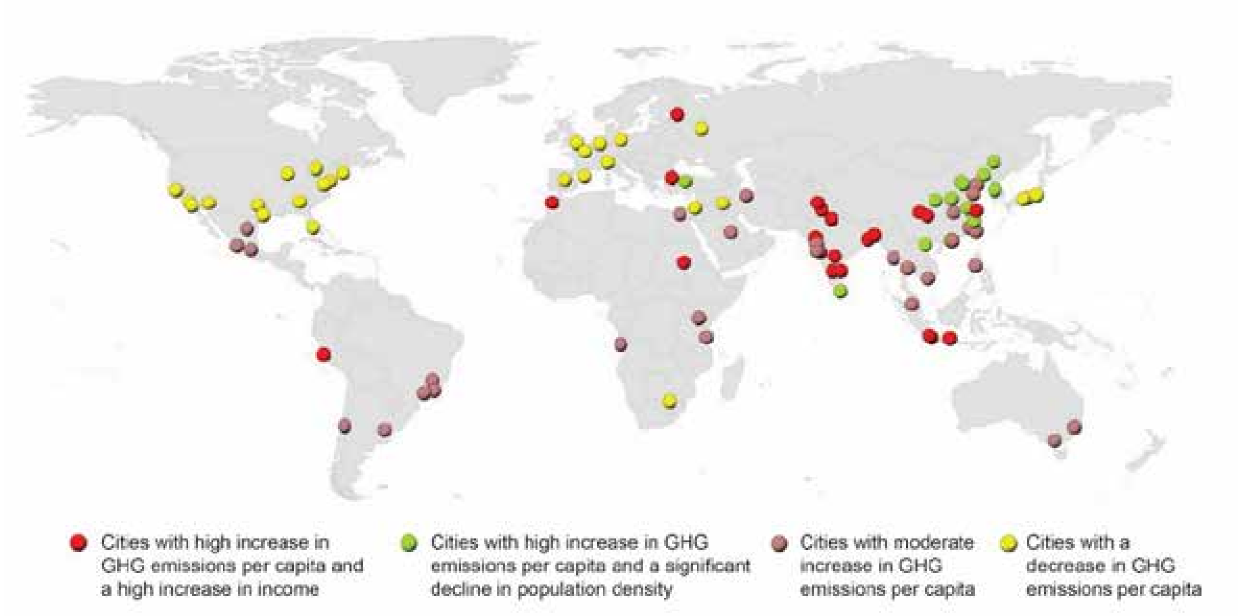
The above-listed rates show a pattern in which per capita emissions in urban areas compared to national averages are relatively high in Asia, almost equal in Africa, and much lower in America and Europe. Figure 1.7: Cluster of cities with GHG emissions per capita (2000-2018) shows four clusters of cities over the period 2000–2018:

- The cities in the *red cluster* had the highest increase in GHG emissions per capita, primarily located in Asia, which has also experienced a very significant rise in income during the corresponding period.
- The cities in the *green cluster* are primarily located in China and are characterized by a very significant rise in per capita emissions, in line with the regionally disaggregated data presented in Figure 1.1: GHG emission (Scope 1) trends, 1990-2018, by sector (top) and region (below)7. However, unlike the cities in the red cluster, these cities have experienced a significant decline in their population density. Indeed, Chinese cities are considered atypical as their GHG emissions tend to be much higher than per capita national averages.[100]
- Cities in the *pink cluster* have experienced a moderate increase in GHG emissions per capita and are mostly located across the developing world.
- Finally, cities in the *yellow cluster* have experienced a decrease in GHG emissions per capita, which are mostly located in developed countries, corresponding with the broader regionally disaggregated data in Figure 1.7.

Such differences are linked not only to different levels of development, but also to the different roles cities play within the global economy. Some serve as "production cities", characterized by a higher share of employment in industrial and export-related functions, while others are "consumption cities" with a higher employment share in service industries and other so-called non-tradables.[101] Area-based accounting of GHG emissions has a distinct bias against production: it is important that cities, in their quest to become net zero, should not be incentivized to simply externalize their polluting industries to other cities or their regional peripheries. For example, in Asia the primary source of GHG emissions in cities is the energy use of industrial and manufacturing processes, which is linked in part to their export economies; in the Americas, on the other hand, the primary source of GHG emissions is from on-road transportation.[102] Such variation implies that effective climate action in cities relies on contextual prioritization based on geographic differences.

In Asia the primary source of GHG emissions in cities is the energy use of industrial and manufacturing processes

Figure 1.7: Cluster of cities with GHG emissions per capita (2000-2018)



Source: Luqman et al., 2023

1.3.4 The relationship of national climate commitments to urbanization levels

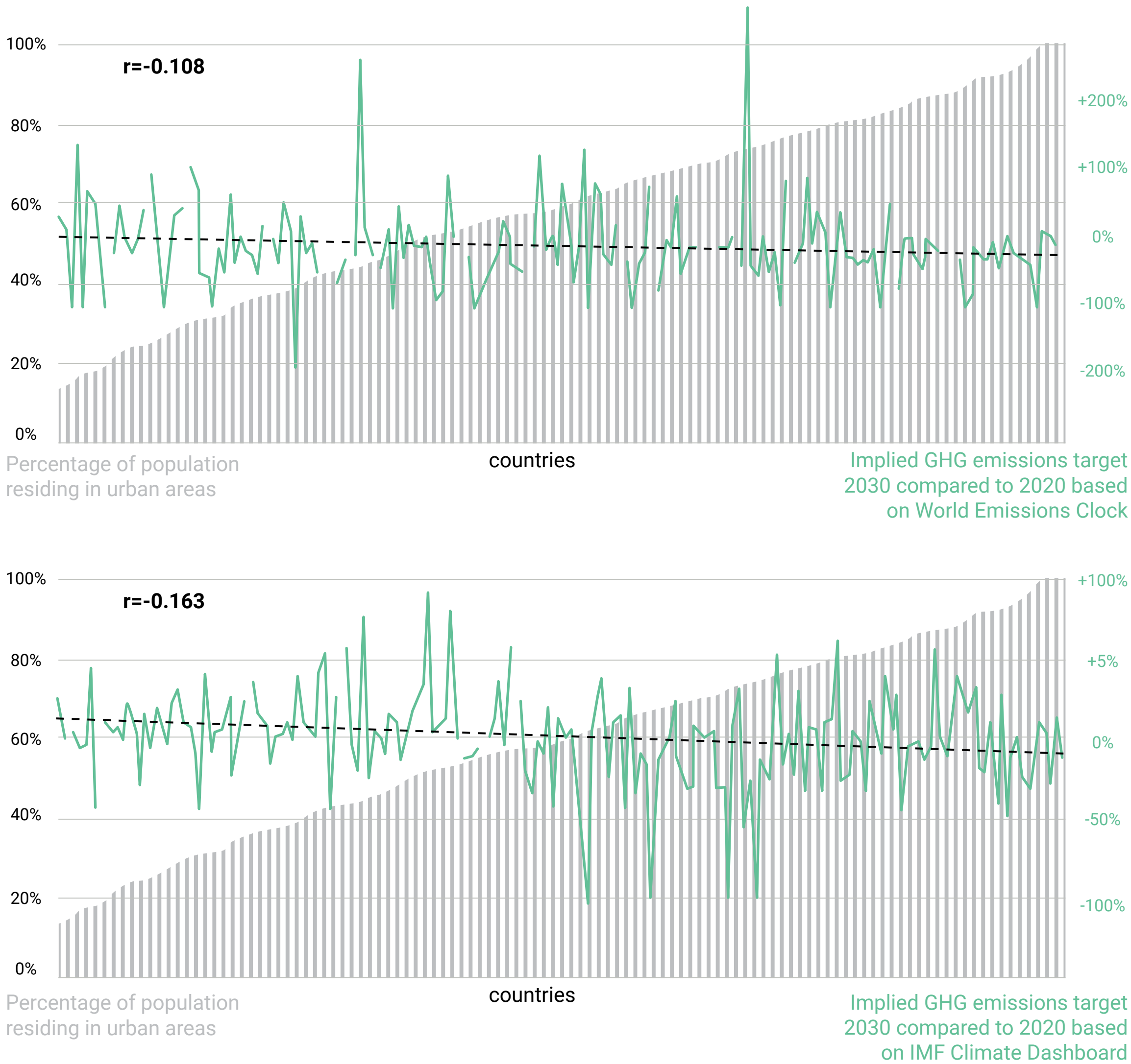
Despite the sustainability gains that can be achieved through urban living, urban activities continue to be major sources of GHG emissions. It is therefore important that countries and local governments commit to lower emissions to leverage the potential that urban areas offer for mitigation. The Nationally Determined Contributions (NDCs) set out each country's climate pledge under the 2015 Paris Agreement, capturing both the efforts by each country to reduce its emissions and adapt to the impacts of climate change. As of 2022 there were 34 countries with a long-term emissions reduction target specifically in their NDC,[103] although outside the context of NDCs many countries have committed to full net zero emissions.[104] The NDCs exclude commitments made by cities and other local governments, many of which are more ambitious than those of their national governments.

It is therefore worth investigating if higher levels of urbanization, expressed as the percentage of people living in urban areas, are linked to higher climate commitments. Given that NDC commitments are expressed in different ways, using different baseline years, it is difficult to assess, review and compare the strength of commitments between countries and other variables such as urbanization.[105] What can further compound a meaningful comparison is that the NDCs themselves are sometimes inconsistent within and between versions.

The IMF Climate Dashboard[106] and the World Emissions Clock[107] are methodologies that have been developed to translate the various commitments into estimates indicative of their emissions by 2030. By comparing the implied conditional NDC 2030 targets to the 2020 total CO_2e GHG emissions,[108] a mitigation target can be calculated as a percentage for the period 2020-2030. Figure 1.8: Relationship between urbanization and implied mitigation targets by countries: World Emissions Clock (top) and IMF Climate Dashboard (below)gure 1.8 shows the results of this analysis, plotted against the percentage of population at mid-year residing in urban areas in 2020. The correlation between the level of urbanization and the climate commitments of countries as implied by the World Emissions Clock and IMF Climate Dashboard is weak and negative, suggesting that the level of climate ambition set out by countries in their NDCs is largely independent of their degree of urbanization.

Amman, Jordan © Cristi Croitoru/Shutterstock

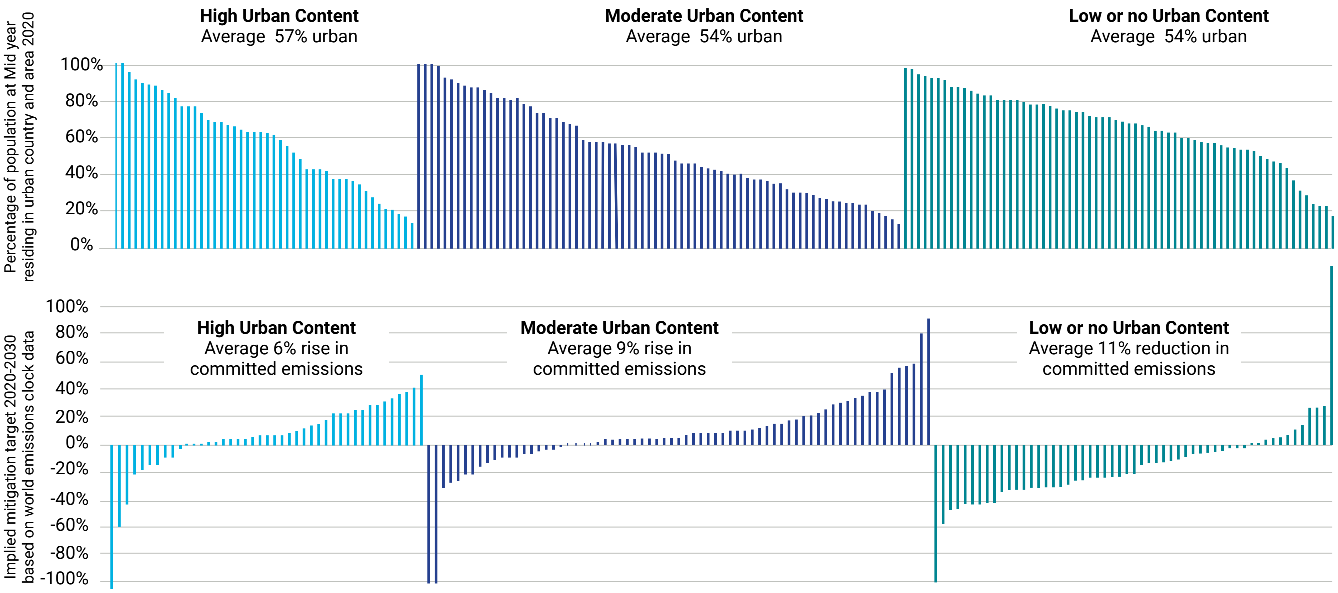
Figure 1.8: Relationship between urbanization and implied mitigation targets by countries: World Emissions Clock (top) and IMF Climate Dashboard (below)



It is important to recognize that the NDCs are at best proxies for national policy on cities and climate change. While urban areas are increasingly mentioned within NDCs, there are many countries with longstanding commitments to urban climate action that are not captured in their respective NDCs (the concise consolidated NDC covering all countries of the European Union serves as an example). City-states may not mention "urban content'" explicitly, but in such contexts all climate change mitigation and adaptation commitments should be considered urban. Consequently, the categorization of NDCs as having strong, moderate or low urban content based on a keyword analysis[109] is not strongly related to the strength of each country's implied mitigation target. Indeed, Figure 1.9 shows that countries with low or no urban content in their NDCs have 66.5 per cent of their population residing in urban areas, compared to 57 per cent for countries with high urban content in their NDCs. Countries with low or no urban content in their NDCs committed to an average of 11 per cent reduction in emissions, while those with a high urban content have committed to an average rise in emissions of 6 per cent.

The foregoing implies that whether countries mention urban areas in their NDCs is largely independent of their levels of urbanization. This means that countries have not yet adequately considered urbanization as a driver of emissions, nor explored the solution space offered by sustainable urbanization. Nevertheless, the preparation of NDCs is documented to positively contribute to national climate policy processes by raising awareness and catalyzing institutional change.[110] In this regard, it is important that NDCs explicitly recognize that urban areas should be at the forefront of reinvigorated climate action in their climate policies to overcome sectoral approaches and empower local governments to pursue ambitious climate agendas.[111]

Figure 1.9: Urban content of the NDCs: links to urbanization and the implied mitigation targets



1.4 Urban Development Pathways to Lower GHG Emissions

The primary role of NDCs is to identify and communicate a country's climate targets under the UNFCCC. Countries are not required to define how they intend to achieve the targets in their NDCs. Such actions and implementation strategies on climate action are more commonly captured in the National Climate Action Plans, National Adaptation Plans, as well as in National Urban Policies and National Disaster Risk Reduction strategies, the latter of which have a strong intersectionality with climate action.

While the NDCs focus on commitments, they do provide a starting point for understanding the potential urban development pathways to reducing GHG emissions and adapting to the impacts of climate change. An urban development pathway can be understood as a series of steps, interventions and policy-enabling environments that provide a tangible and realistic transition between present urban conditions and future goals. Such pathways are shared courses of action across society that put at their core the improvement of well-being and prosperity of all people, especially those who are most vulnerable, while reducing carbon emissions and reducing the risks from climate change.[112]

The UNFCCC Synthesis Report notes that the full implementation of all the latest NDCs would lead to a reduction of about 2 per cent in GHG emissions by 2030 relative to the 2019 level.[113] To limit warming to 1.5°C, however, GHG emissions need to be reduced by 43 per cent by 2030 relative to the 2019 level.[114] According to an analysis undertaken by UNEP, the "emissions gap" (the difference between projected global emissions from current country commitments and the commitments needed to limit global warming to a 1.5°C pathway) remains 23 $GtCO_2e$, even if all unconditional NDC commitments have been met.[115] The new and updated NDCs submitted since 2021 reduce projected GHG emissions in 2030 by an additional 0.5 $GtCO_2e$.[116] The current NDCs are therefore insufficient to achieve the Paris Climate Agreement: emission reductions should increase by 80 per cent beyond what is currently in the NDCs even to meet the 2°C target.[117]

Emission reductions should increase by 80 per cent beyond what is currently in the NDCs even to meet the 2°C target

Box 1.2: A selection of potential low-emission pathways for cities to pursue

Since national commitments within the NDCs are insufficient to achieve the Paris Climate Agreement, it is imperative to look at initiatives and high-potential transitions that are not covered by the NDCs. UNFCCC has identified several mitigation options with high net emission reduction potential, together accounting for approximately half of the total emission reductions required to remain on a 1.5°C pathway by 2030.[118] At least three of the high-potential mitigation strategies identified have a clear link to cities and urban areas:

- *Solar energy* (3.3 Gt CO_2 e/year): Solar urban planning, in which both passive and active use of solar energy are integrated into urban planning, is an important emerging field.[119]

- *Reduced conversion of forests and other ecosystems* (2.28 Gt CO_2 eq/year): Reducing urban sprawl and urban consumption of land and resources will play a key role in reducing the conversion of forests and other ecosystems.

- *Energy efficiency improvement in industry* (1.14 Gt CO_2 eq/year): As a primary source of energy consumption, cities can play a key role in enhancing energy efficiency in industries such as construction.

As shown in Chapter 5, cities play a key role in the solution for effective climate action. A subset of subnational and non-governmental multilateral emission reduction initiatives which preceded the Paris Agreement was shown to have the potential to reduce emissions by 5 $GtCO_2e$ by 2030.[120] Accounting for overlaps, the combined achievement of all subnational and non-state transnational emission reduction initiatives could reduce global emissions by 18–21 $GtCO_2e$ per year in 2030.[121] Table 1.2 summarizes several high-potential global mitigation[122] efforts by coalitions of non-governmental agencies and how these are linked to urban areas. Enabling cities, communities, businesses, and local and regional governments to implement their climate action plans should be part of the effort to localize climate action and bring the world closer to a global pathway compatible with the Paris Agreement.

Enabling cities, communities, businesses, and local and regional governments to implement their climate action plans should be part of the effort to localize climate action and bring the world closer to a global pathway compatible with the Paris Agreement

Table 1.2: High potential initiatives to reduce GHG and their links to cities

High-potential initiatives	Potential mitigation impact	Broad goals and objectives	Link to cities
REscale Low Carbon Technology Partnership initiative	min. 5.0 Gt CO_2e /year	An initiative from the private sector to support the deployment of 1.5 TW of additional renewable energy capacity	Urban residents are the main consumers of energy
The Governors' Climate and Forests Task Force (GCFTF)	1.6 to 8.0 Gt CO_2e /year	A coalition of local and regional governments to end forest loss by 2030 and restore deforested and degraded lands	Urban areas are continuing to expand in forests and agricultural areas
The Under2 Coalition	4.6 to 5.2 Gt CO_2e /year	Commitments by local governments to limit their GHG emissions by 80 to 95 per cent below 1990 levels by 2050	Commitment by local governments to be met in urban areas
The Climate Smart Agriculture initiative	min. 3.7 GT CO_2e /year	Coalition that aims to reduce agricultural and land use change emissions by at least 50 per cent by 2030 and 65 per cent by 2050	Urban areas are continuing to expand in forests and agricultural areas
The Science Based Targets initiative	min. 2.7 Gt CO_2e /year	A coalition of companies to keep in line with a 2°C temperature goal	Urban areas should provide enabling conditions for companies to limit GHG
C40 Cities Climate Leadership Group	0.8 to 3.0 Gt CO_2e /year	Network that encourages cities to have climate action plans and to have cities achieve emissions neutrality by 2050	Commitment by local governments to be met in urban areas
The Global Covenant of Mayors for Climate & Energy	1.3 to 1.4 Gt CO_2e /year	Commitment of over 12,500 cities and local governments to reduce GHG	Commitment by local governments to be met in urban areas
Architecture 2030 organization	1.9 to 2.2 Gt CO_2e /year	Built environment stakeholders commit to meet an energy consumption performance standard of 70 per cent below the regional average for that building type	Urban areas represent the majority of current and future built environments
The RE100 climate group initiative	1.1 to 4.0 Gt CO_2e /year	Corporate initiative in which companies commit to source 100 per cent of their electricity from renewable sources by 2030	Urban areas should provide enabling conditions for companies to limit GHG

Source: Developed from Hsu et al., 2020; Lui, 2021; and Data Driven Yale, new Climate Institute, PBL, 2018

Moving from commitments to action, climate action in cities should focus on those solutions that have the highest mitigation potential against the lowest costs. Using data on mitigation potential from Project Drawdown,[123] Table 1.3 presents key climate solutions that are available to cities now along four key sectors. The figures indicate the reduced or sequestered emissions in $GtCO_2e$ that is achievable up to 2050. While cities and local governments are incentivized to explore all climate solutions, they should prioritize solutions that are affordable and with demonstrated co-benefits for urban residents. Some key solutions have a close interface with urban informality: when implementing these, cities with a high share of urban informality need to ensure these solutions are well embedded. The mitigation potential highlighted here focuses on what cities can do to achieve net zero urban development pathways. Chapters 5 and 7 discuss how urban planning and governance frameworks can facilitate these solutions.

Moving from commitments to action, climate action in cities should focus on those solutions that have the highest mitigation potential against the lowest costs

Table 1.3: What cities can do to reduce emissions now

Solutions with significant co-benefits | Nature-based solutions | Solutions that interface with urban informality

Cost	Food and nature	Energy and recyling	Built environment	Transport
Low Cost*	**88.50 Gt CO_2e** **Reduced Food Waste** Very significant urban component since most consumption and waste happens in cities **22.04 Gt CO_2e** **Tree Plantations** This nature-based solution has significant urban component as there are many opportunities in urban areas to add greenery. Solution has health and well-being co-benefits.	**10.36 + 4.31 Gt CO_2e** **Recycling + recycled metals** Very significant urban component as most recycling already happens in urban areas, and this is where most consumption occurs. Co-benefits can be realized for lowering pollution. Recycling is currently a major source of informal employment **3.89 Gt CO_2e** **Landfill methane capture** Very significant urban component as there are many methane leaks from landfills	**15.38 Gt CO_2e** **Insulation** Very significant urban component as most buildings are within urban areas. Potential application of nature-based insulating material and co-benefits through reduction of living costs **14.45 Gt CO_2e** **LED Lighting** Very significant urban component as most lighting (within buildings and street lights) are within urban areas	**9.06 Gt CO_2e** **Carpooling** Significant urban component as most commuting occurs in urban areas. **2.83 Gt CO_2e** **Walkable Cities** Very significant urban component as the densities within urban areas have the conditions to make walkable cities viable, especially in the global south, where most people walk. Significant co-benefits potential to make cities safer, more sociable and inclusive
Med cost	**78.33 Gt CO_2e** **Plant-rich Diets** Significant urban component as many urban residents live in "food deserts without access to plant-rich diets. Plant-rich diets can also have health co-benefits. This solution can be nature-based when food is supplied through urban farming **1.20 + 0.76 Gt CO_2e** **Coastal Wetland Protection & Restoration** Significant nature-based solutions has an urban component as many of the world's biggest cities are in coastal areas. It also provides co-benefits against flooding.	**31.50 Gt CO_2e** **Clean Cooking** Significant urban component as many urban households, especially in the global south, do not yet have access to clean cooking. Clean cooking can also reduce indoor pollution **26.50 + 3,41 Gt CO_2e** **Distributed Solar Photovoltaics & Solar Hot Water** Significant urban component as solar panels can be installed on roofs and close to their consumption to reduce reliance on transmission infrastructure. This method of generating energy is already cheaper than using fossil fuels. Huge potential source of future employment and tool for poverty alleviation	**4.04 Gt CO_2e** **High efficiency heat pumps** significant urban component as most buildings are within urban areas **0.53 Gt CO_2e** **Green and Cool Roofs** Nature-based solution with significant urban component as most buildings are within urban areas. **7.70 Gt CO_2e** **Alternative cement** Significant urban component as most buildings are within urban areas	**2.73 +1.39 Gt CO_2e** **Bicycle infrastructure & Electric Bicycles** Very significant urban component as the densities within urban areas have the conditions to make walkable cities viable Significant co-benefits potential to make cities safer, more sociable and inclusive **9.42 Gt CO_2e** **Public transport** Very significant urban component as urban areas are the only places with the conditions to make public transport viable. Significant co-benefits by freeing up space from car-use and increasing land-value. Much public transport is currently informally operated.
High cost		**6.27 Gt CO_2e** **Waste to Energy** Significant urban component as most waste processing facilities are within urban areas and they have the proximity of energy intensive uses to make waste to energy viable **6.18 Gt CO_2e** **District heating** Significant urban component as urban areas have the density to make district heating viable	**8.82 Gt CO_2e** **High-performance glass** Significant urban component as most buildings are within urban areas **9.55 Gt CO_2e** **Building automation systems** Significant urban component as most buildings are within urban areas	**7.66 + 1.61 Gt CO_2e** **Electric & Hybrid cars** Very significant urban component as urban areas are the only places with the conditions to make public transport

**Cost indication is only indicative and will depend on local context*

Source: Project Drawdown, 2024.

1.5 Embedding Climate Action in Urban Informality

Urban informality is a pervasive feature of urbanization, particularly in cities in developing countries, but increasingly extending into cities in developed countries too. Urban informality encompasses almost every aspect of everyday life, from housing and employment to transport and service provision. In many cities across Africa and Asia, the majority of the population live in informal settlements: in Kabul, Afghanistan, where more than two-fifths (41 per cent) of the entire country's urban dwellers resides, four out of every five people (82 per cent) are based in informal settlements.[124] While informality is often conflated with illegality,[125] urban informality provides a means for people to cope with the failure of formal mechanisms to provide adequate livelihoods. Understanding of urban informality has shifted from a perspective that was focused exclusively on deprivations and illegality to one that interprets urban informality as "an organizing logic… a process of structuration that constitutes the rules of the game".[126] This is a significant shift that is critical for climate policy interventions that work with informality, rather than against it. There is broad consensus that urban informality offers opportunities and challenges for effective climate adaptation.[127] Meaningful engagement with such practices is essential for inclusive climate action in cities, yet the role of informality in appropriate climate adaptation and mitigation strategies remains a key knowledge gap.[128]

1.5.1 Informality and climate vulnerability

The IPCC notes with high confidence that "the most rapid growth in urban vulnerability and exposure has been in cities and settlements where adaptive capacity is limited, especially in unplanned and informal settlements in low- and middle-income nations and in smaller and medium-sized urban centres".[129] Residents of informal settlements and those engaged in the informal economy are particularly vulnerable to extreme weather events. Chapter 4 shows that climate change intersects with other drivers of poverty to create conditions where the urban poor suffer higher damages and are pushed closer to and below the poverty line.

Residents of informal settlements and others engaged in urban informality face the immediate impacts of climate change, while often creating only limited GHG emissions.[130] In Bogotá, Colombia, for instance, the informal recycling system emits fewer GHGs than the city's formal system, due in large part to reuse of materials such as textiles, reduced landfill compared to formal waste collection and more efficient recycling of valuable metal waste.[131] Despite this, their important contribution is frequently overlooked and informal actors may even be actively targeted by authorities. In addition to social marginalization, there is the problem of environmental risk: informal practices are often the most vulnerable to climate change and other shocks due to their "limited adaptive capacity", their concentration in "disaster-prone zones of urban centres" and their "unequal access to urban services".[132]

Residents of informal settlements and others engaged urban informality face the immediate impacts of climate change, while often creating only limited GHG emissions

Nevertheless, the informal governance within slums and informal settlements has been praised by the IPCC as an essential coping and adaptation mechanism through the application of Indigenous knowledge, the harnessing of informal learning and the engagement of neighbourhood associations. Indeed, social networks, grassroots organizations and inclusive partnerships play a pivotal role in addressing climate-related and other challenges facing informal workers and informal settlements.[133] Although there is value in recognizing community resilience within slums and informal settlements, this should not be an excuse to allow vulnerable groups to be constantly hit by crisis after crisis without adequate support.[134] While informal practices have limited adaptive capacity to initiate and finance larger-scale adaptation measures, they have a distinctive adaptive capacity that relies on flexibility and resourcefulness.

The relationship between informality and climate change is shown in Figure 1.10: The impact of increasing levels of informal employment and informal settlement at the country level with climate vulnerability and climate readiness using country-level data on informal employment, informal settlements, as well as climate vulnerability and climate readiness.[135] The graphs show that informal employment has a very high positive correlation (0.82) with climate vulnerability and a negative correlation (-0.64) with climate readiness. Similar correlations exist between the share of informal settlements and climate vulnerability (0.42) and climate readiness (-0.53). This suggests that countries with a higher share of informal employment and informal settlements are more likely to be vulnerable to the effects of climate change. These results are telling, especially in the case of many African countries, where high rates of informal settlement and employment co-exist in precarious contexts often characterized by low disaster preparedness, inadequate early-warning systems, emergency shelters and low social protection.[136] At the same time, developing climate readiness by leveraging investments and converting these into adaptation actions enhances the resilience of informal employment and informal settlements.

Developing climate readiness by leveraging investments and converting these into adaptation actions enhances the resilience of informal employment and informal settlements

People walk past houses in a slum. New Delhi, India © PradeepGaurs/Shutterstock

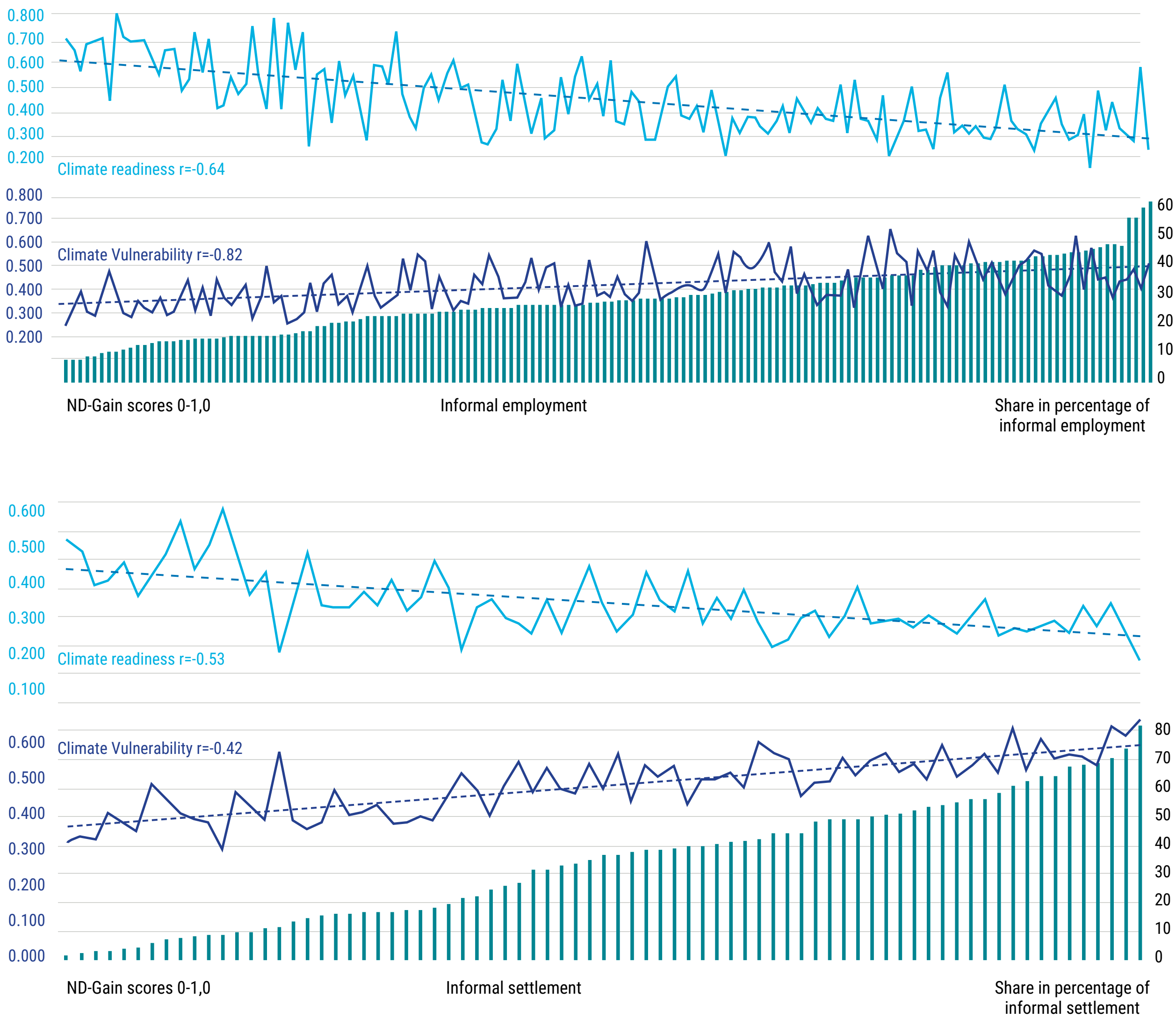
1.5.2 Informal Low-Carbon Pathways

A key opportunity for climate action lies in the way in which many informal practices already embody principles that are aligned with low-carbon pathways. Such low-carbon practices include walking and construction of walkable urban environments, urban agriculture, modular design, environmentally friendly building materials and waste recycling among others.[137] These practices need to be recognized, documented and understood, so that formal interventions can augment and foster these pathways.

A key opportunity for climate action lies in the way in which many informal practices already embody principles that are aligned with low-carbon pathways

Waste collection illustrates such informal low-carbon pathways well, as it often achieves higher levels of coverage than formal systems. By diverting waste materials from landfills, informal collectors increase the quantity of waste that is recycled, thereby generating sizeable environmental benefits.[138] Such informal systems can outperform formal collection not necessarily "because of how its workers recycle, but why they recycle":[139] the economic incentives that effective waste recycling offers, with more efficient collection leading to more income for workers. Other examples of such low-carbon practices are the building of stilted houses to deal with floods or building modifications to allow for more natural airflow through the house.[140] As outlined in more detail in Chapter 8, many ground-breaking sustainable urban practices have either initiated or evolved in the informal sector.

Figure 1.10: The impact of increasing levels of informal employment and informal settlement at the country level with climate vulnerability and climate readiness



It would be naïve to highlight such examples of innovation without acknowledging the unsustainable practices and significant deprivations in informal settlement and employment, such as inadequate water supply or dangerous labour conditions. For example, residents of informal settlements rely mainly on wood-based biomass, a highly polluting energy source that is nevertheless a major component in developing regions such as Sub-Saharan Africa and South Asia, where it makes up 50 and 23 per cent respectively of the urban fuel mix.[141] Within the informal waste and recycling industry, health and livelihood issues exist due to exposure to polluted environments, the handling of hazardous waste and the inability to work during disasters.[142] Indeed, the widespread absence of any environmental or labour regulations within the informal sector mean that its activities can pose threats not only to workers within the sector, but also impact on surrounding communities through toxic contamination, fires and other risks. However, once these issues are recognized, the shortfalls should be approached as opportunities to "leapfrog' to low or zero-emission systems and practices.[143] An example in the context of informal settlements is the adoption of solar panels in community micro-grids, enabling households to leapfrog to decentralized carbon-based energy production.[144] In South Africa, the iShack Project works with communities to supply solar panels in addition to building local enterprising capacity, developing skills and creating green jobs to enhance the resilience of the communities.[145]

Despite the impact of climate change on informal settlements and its tendency to exacerbate the already precarious conditions there, residents often cope with environmental risk as a trade-off to other benefits and have developed coping strategies to deal with negative effects.[146] For instance, those exposed to floods often stay put despite the risks, since their homes often serve as their source of livelihood.[147] Such considerations point to the need to have a community-based vulnerability assessment that foregrounds residents themselves as key evaluators of risk and adaptive capacity. Chapter 3 explores in greater detail how local governments can undertake appropriate vulnerability assessments.

1.5.3 Limitations of current policy initiatives towards informality and climate change

Historically, a limited understanding of informality and its drivers among urban policy makers has contributed in part to slum formation and proliferation.[148] Consequently, climate action in cities must not replicate past mistakes. The distinct anti-informality outlook has prevented many local governments from adequately investing in informally settled urban areas because they are considered illegal, in precarious locations or unworthy of investment. The global stagnation in reducing the total number of people living in slums[149] is indicative of the continuing struggle for the government to adequately acknowledge, incorporate and invest in informal activities and the people that depend on them.

Climate action in cities is often designed to protect existing centres of global investment and infrastructure, and not towards broader environmental and social justice goals that benefit those living in informal settlements.[150] Well-intended climate-responsive land use planning has been documented to produce maladaptive outcomes for historically marginalized residents.[151] "Green" development agendas have been implicated in many forms of displacement and gentrification around the world,[152] and world-class city-making is increasingly aligned with a form of "bourgeois environmentalism" where upper and middle-class residents frame informal settlements as encroachers on green spaces with ecological functions.[153] The eviction of residents from these environments is a form of "eco-cleansing"[154] or "accumulation by green dispossession".[155] These harmful forms of environmentalism extend to approaches to disaster risk management that are premised on the eviction of slum residents as a means to protect "legitimate" residents.[156] Large-scale green infrastructure interventions aimed at generating environmental privileges for upper-class residents often (re) produce inequitable displacement or relocation, threatening informal settlements and livelihoods, weakening social networks, and erasing traditional practices and uses of nature.[157]

Climate action in cities is often designed to protect existing centres of global investment and infrastructure, and not towards broader environmental and social justice goals that benefit those living in informal settlements

Floods stands out as a particular area of concern with regard to maladaptation, as flood control has long been used as an excuse to justify forced eviction.[158] Such climate-related evictions are particularly on the rise in coastal cities in South, South-East and East Asia, where the risk of flooding is especially high.[159] Eviction of informal settlement that has taken place during the last decade along the Gujjar nullah and Orangi nullah in Karachi,[160] the Cooum River in Chennai,[161] the Saigon River in Ho Chi Minh City[162] and the Ciliwung River in Indonesia,[163] displacing thousands in the name of ill-informed climate adaptation.

When governments engage with urban informality, they should refrain from anti-informality approaches aimed at formalization. While formalization in certain contexts can confer benefits to residents, ill-conceived formalization can burden residents with administrative and financial costs that they cannot reasonably bear,[164] drawing people into drawn-out and costly approval processes.[165] In the pursuit of world-class imagery, the urban environment of many informal settlements is needlessly formalized in ways that do not benefit the community. For example, the repressive effect of strict formal building codes on informal settlement and incremental upgrading is widely acknowledged.[166]

Working *with* informality also implies a mindset shift among policymakers that makes them more attuned to the potential challenges of urban informality. Community-level climate initiatives may emerge out of concerns with risks not commonly related to global warming, such as crime, violence against women, food insecurity and unemployment, and such practices can go unnoticed and unsupported when local governments are not attuned.[167] Climate action in an informal context needs to pay attention to communication and language, as the use of abstract concepts such as "resilience" and "adaptive capacity" may be poorly understood, difficult to translate into local languages, or serve to devalue local notions of sustainability.[168]

Rising sea levels as a result of climate change poses severe risks to informal settlements © Fela Sanu/Shutterstock

1.5.4 An opportunity for alignment

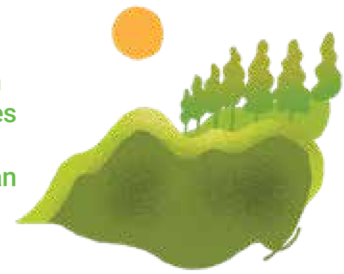
In recent years, the focus of overseas development assistance has increasingly shifted towards climate action.[169] This shift, combined with the existence of informal low-carbon pathways and innovations, as well as the enduring inequalities and development deficits that informal workers and residents of informal settlements face, presents a key opportunity for alignment. Indeed, one of the key messages from the UN-Habitat report *Addressing the Most Vulnerable First: Pro-Poor Climate Action in Informal Settlements* is to align efforts in poverty reduction, disaster risk reduction and climate change adaptation, which all share a focus on mitigating local risks.[170] While upgrading informal settlements is not conventionally regarded as a form of climate change adaptation, participatory and community-led improvements can play a central role in building resilience to future disasters, particularly if they include a public health component that addresses potential climate change impacts.[171]

Informal practices need to be supported so they can develop beyond mere coping strategies into adaptive practices and slum upgrading for long-term benefit and development. Significant synergies can be created in this regard. For instance, the mapping that is required to identify and reduce disaster risk also offers the opportunity to undertake enumeration that can support in-situ upgrading and is critical for conferring other benefits, including more secure settlement tenure.[172]

Informal practices need to be supported so they can develop beyond mere coping strategies into adaptive practices and slum upgrading for long-term benefit and development

There is also growing evidence that NbS contribute to livelihood provisions and poverty reduction, through labour-intensive work that can be aligned with job training or "cash for work".[173] Despite such alignment, nature-based adaptation and resilience approaches remain underfunded and under-recognized in urban planning in developing countries.[174] Another example of alignment is the recognition that the provision of social protection schemes has a very significant impact on building climate resilience for informal workers while contributing to broader development agendas.[175]

Nature-based adaptation and resilience approaches remain underfunded and under-recognized in urban planning in developing countries



Such alignment must be premised on the idea that urban informality is not just a context in which to operate, but that its practices must be central to the planning and management of cities to ensure social injustices are not reproduced. In this regard, Figure 1.11: Embedding climate action in a context of urban informality shows key principles that need to underpin climate action in the context of pervasive informality, particularly as it relates to vulnerable groups. Climate action needs to be aligned with development and disaster risk reduction strategies, and to be appropriately localized within communities. Such localization reinterprets the old idea that urban authorities can empower communities to manage and self-regulate their common resources.[176]

Climate action needs to be aligned with development and disaster risk reduction strategies, and to be appropriately localized within communities

Inclusive climate action needs to include ways to enhance more secure tenure, as insecure land rights are issues that have plagued residents of informal settlements for decades, and significantly limit incentives and public support to upgrade their communities in the face of compounding climate risks.[177] The focus of local climate action should not be on formalization as an end in itself, but on achieving justice for those who work and reside within the informal sector, while simultaneously fostering the low-carbon and adaptive practices that characterize many aspects of urban informality.

Figure 1.11: Embedding climate action in a context of urban informality

Vulnerabilties and development deficit

Policy makers and planners need to:

- Identify and address pre-existing inequalities and vulnerabilities to climate change including attention for
  - **vulnerable groups** including children and youth, the eldery, women and people with disabilities
  - geographies of **intersecting and multiple exposures**
- Incorporate development agendas through adressing pre-existing deficits including attention for
  - Insecure land and **housing tenure**
  - Lack of access to **basic services**
  - Job and **income insecurity** and lack of social safety nets
  - **Compromised health** and exposure to environmental hazards
- Look beyond hazards to consider root causes of risk and vulnerability and mainstream risk management into urban development.

Enablers of climate action in a context of urban informality

Policy makers and planners need to:

- **Community enablers**
  - **Co-produce** with communities though inclusive and participatory processes
  - **Empower** local communities and increase the political leverage of poor households
  - **Downscale** vulnerability assessments and responses to city and neighbourhood level
- **Regulatory enablers**
  - **Regulate** in an adaptive manner that support informal practices of entrepreneurship and social innovation while limiting negative impacts on human health and the environment.
  - **Secure** tenure for residents, especially in the face of climate-driven evictions
  - **Decriminalize** informal work that is essential for livelihoods
- **Operational enablers**
  - produce **tangible** results on people's livelihoods in a hierarchy of improvements
  - produce **affordable** solutions both for installion/ construction, as well as for maintenance and repairs
  - **communicate** in a manner that makes complex climate change concepts understandable

Informal low-carbon pathways

Policy makers and planners need to:

- Acknowledge, identify, foster and scale existing green low-carbon processes and outcomes including those from
  - **Building materials** and local sustainable dwelling and construction techniques
  - **Food production** and urban farming
  - **Recycling** and waste management practices
  - Functional mix and **walkable** neighbourhoods
- Foster the related local knowledge, skills, cultures and community networks including
  - **Educate,** train and engage in 'upskilling' of people towards a green economy
  - Support **cultural** institutions and practices
  - Climate adaptation and disaster response **coping strategies**
- Identify and integrate larger scale ecological structures including blue-green networks

Source: Developed from Taylor & Peter, 2014; Brown & McGranahan. 2016; Global Center on Adaptation, 2022; UN-Habitat, 2018.

At the intersection of the existing low-carbon practices within urban informality and the pre-existing development deficits, engagement with urban informality will have to incorporate several enablers, including community enablers, regulatory enablers, and operational enablers (Figure 1.11). Policymakers and planners need to co-produce with local communities through inclusive and participatory processes and downscale vulnerability assessments in a way that empowers these communities. The regulation of informal practices is still often perceived as a singular planning alternative, bringing informal practices "in line" with formal planning frameworks, but this neglects the plurality of the informal regulations that have emerged among residents, and that can form the basis of a much more participatory, adaptive and effective set of regulations.[178]

For many residents in informal settlements, climate adaptation in itself, without any immediate tangible benefits, would not always be considered sufficient reason for the community to adapt to climate risk.[179] In the context of informality, climate action needs to achieve tangible and rapid impact in improving people's livelihoods in a way that incrementally builds up to larger-scale, longer-term transformation.[180] To ensure widespread access and financial sustainability of climate adaptation, affordability should be adopted as a key consideration.[181]

Policymakers and planners need to co-produce with local communities through inclusive and participatory processes and downscale vulnerability assessments in a way that empowers these communities

1.6 A People-Centred Approach to Climate Action

This section advances a people-centred approach to climate action that promotes effective and inclusive climate action as a framework for building climate resilience in urban areas (Figure 1.12). In the context of urban areas, climate action are initiatives designed to achieve the Paris Agreement, SDG 13 (take urgent action to combat climate change and its impacts) in cities and human settlements, the climate change components of the NUA, and the major milestone decisions reached during various COPs especially as they relate to urban areas. Such actions include but are not limited to mitigating climate change through the reduction of GHG emissions, adapting to the impacts of climate change by building resilience across a wide range of dimensions, reversing of impacts of climate change, and reducing the vulnerability of at-risk individuals, groups, and communities. In practice, well-designed climate change initiatives should cover these actions simultaneously. A people-centred climate action seeks to achieve three things.[182] Through an inclusive process, it identifies and unlocks social and economic benefits that are specifically targeted to ensure equity, while ensuring that the transition away from a high-carbon economy is just and well-managed.

1.6.1 Inclusive climate action: Leaving no one behind

A major thrust of this approach is that urban residents, especially vulnerable groups, must be at the centre of any meaningful climate action in cities and human settlements. Climate action must be inclusive and respond to the needs of specific populations, including children, women, older persons, people living with disabilities, Indigenous Peoples, slum dwellers, refugees and displaced persons (Table 1.4). Chapter 4 shows that these groups are disproportionally affected by the effects of climate change due to their limited access to coping mechanisms and the availability of social protection.

Climate action must be inclusive and respond to the needs of specific populations, including children, women, older persons, people living with disabilities, Indigenous Peoples, slum dwellers, refugees and displaced persons

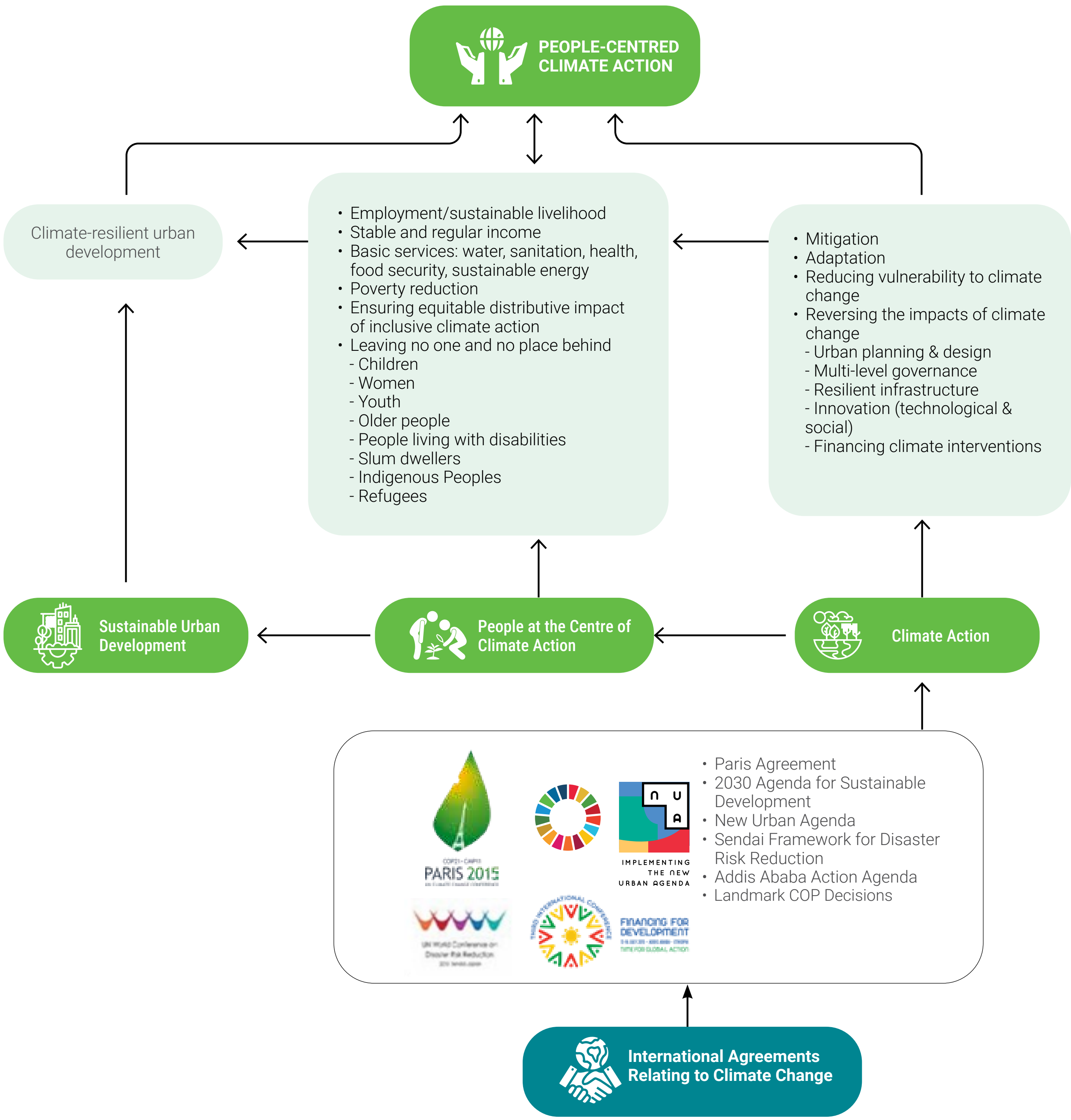
Climate action must respond to the over 780 million people worldwide who are currently exposed to the combined risk of poverty and serious flooding, most of whom reside in developing countries,[183] as well as the 32-132 million people expected to fall into extreme poverty by 2030 on account of the effects of extreme weather conditions.[184] This can be achieved by providing sustainable sources of livelihood, including food and water security and health care, education, health and social protection programmes, to help build resilience. Given that climate change disproportionately affects the poor, eradicating poverty and addressing climate change should not be done in isolation, as both will be much easier to achieve if tackled simultaneously.[185] Without the necessary interventions, climate risks faced by the urban poor will worsen over time. In this regard, climate action should entail building resilience across multiple levels—economic, social, environmental and institutional—to respond to a wide range of shocks, with contingency plans in place for the most vulnerable groups. A case in point is UN-Habitat's Resilient Settlements for the Urban Poor (RISE UP), whereby significant amounts of funding has been mobilized to support community-led urban adaptation and climate resilience programmes in global hotspots of vulnerability.[186]

Climate action must respond to the over 780 million people worldwide who are currently exposed to the combined risk of poverty and serious flooding, most of whom reside in developing countries

Climate action is inclusive when it responds to the needs of persons with disabilities, for whom discrimination and stigma are critical elements (besides poverty) that determine how they are impacted by climate change.[187] Persons with disabilities are often at high risk of being left behind in emergencies and natural disasters. Like most vulnerable groups, they lack meaningful and effective participation and are often an afterthought in climate change decision-making and action (Chapter 4). They are often excluded from the institutional processes by which adaptation decisions are made, thus entrenching existing inequalities and vulnerabilities as opposed to upholding and enhancing their rights and dignity. Nevertheless, people in vulnerable situations in cities are important agents of change as they possess the resilience, knowledge and skills to support effective climate action.[188] Climate action must not entrench existing inequalities and vulnerabilities among the urban population. Instead, it must be human rights-based and inclusive of various interests in urban areas—including, for example, being "disability-inclusive."[189]

People in the streets of Kibera slums, an informal settlement in Nairobi, Kenya © Nick N A /Shutterstock

Figure 1.12: Overview of components of a people-centred approach to climate action



Climate action must address the needs of climate-induced migrants and refugees (Table 1.4). The effects of severe weather and climate events including climate-induced crises have already contributed to the uprooting of millions of people from their homes or country.[190] By 2050, as many as 216 million people could be forced to migrate due to the effects of climate change, with 85.7 million internal climate migrants within Sub-Saharan Africa alone.[191] Increasingly, greater prominence is given to the link between climate change, forced migration, and conflict, which in turn has given rise to the term "climate-security nexus".[192]

Table 1.4: Climate Action and Vulnerable Groups

Groups	Vulnerability to Climate Impacts	Climate Action to Address Vulnerability	Links to SDGs/NUA
Children	▪ Susceptibility to illnesses such as asthma and heatstroke which are exacerbated by extreme heat events and poor air quality associated with climate change. ▪ Climate change negatively impacts the nutrition of children by increasing food insecurity and water scarcity. ▪ Disruption of schooling and children's access to education and future opportunities by extreme weather events.	▪ Inclusive Heatwave Early Warning Systems ▪ Inclusive and accessible cooling centres. ▪ Promoting climate-resilient food systems ▪ Sustainable land management e.g. reforestation and terracing to protect water resource areas and agricultural lands. ▪ Child-centred health and health systems adaptation ▪ Child-centred Disaster Preparedness Plans	▪ Safe, healthy and secure cities. ▪ Equitable access to sustainable basic physical and social infrastructure, housing, drinking water, food, health care, education.
Young people	▪ Disruption of economies and livelihoods such as agriculture, fishing and tourism, affecting young people's employment prospects and income opportunities, and prospects. ▪ Barriers to meaningful participation in decision-making processes and climate action.	▪ Training programs that prepare young people for green jobs and the future of work. ▪ Social safety nets such as employment guarantee schemes to buffer against climate impacts ▪ Foster climate innovation among the youth to promote the diversification of livelihoods. ▪ Participation and leadership in climate change mitigation and adaptation efforts.	▪ Safe, healthy, inclusive and secure cities. ▪ Full and productive employment, decent work and livelihood opportunities. ▪ Access to education and skills development. ▪ Effective participation in decision-making.
Women	▪ Increasing burden of care exacerbated by climate change, despite unequal access to resources such as land and finance. ▪ Vulnerability of pregnant women to extreme weather events such as flooding, heatwaves and hurricanes, increasing the risk of maternal and child mortality and exposure to diseases. ▪ Women are systematically more likely to be economically dependent, making them more vulnerable to climate-related disruptions to livelihoods and income. ▪ Women often have limited decision-making powers, sidelining them from or participation in climate change adaptation and mitigation efforts.	▪ Gender-responsive urban planning incorporates gender considerations into climate change adaptation and mitigation measures. ▪ Strengthen maternal and reproductive health access in disaster response such as mobile clinics during extreme weather disasters. ▪ Diversification of livelihoods to reduce economic dependence. ▪ Capacity building to prepare women for green jobs and the future of work. ▪ Promote women's involvement in climate change decision-making and governance at all levels	▪ Measures to address barriers that disproportionately affect women and girls. ▪ Equitable access to sustainable basic physical and social infrastructure, housing, drinking water, food, health care and education. ▪ Full and productive employment, decent work for all and livelihood opportunities. ▪ Effective participation in decision-making.
Older people	▪ Susceptibility to illnesses or complications associated with pre-existing health conditions exacerbated by extreme weather events including heatwaves and poor air quality. ▪ Limited mobility, physical capabilities and access to emergency services during extreme weather events. ▪ Financial constraints that limit the ability of older people to cope with the impacts of climate change.	▪ Heatwave early warning systems. ▪ Accessible cooling centres. ▪ Upgrading housing and infrastructure to make them more resilient to climate change impacts while addressing the specific needs of older people. ▪ Implementing energy efficiency and retrofit programs targeted at elderly households to reduce energy costs freeing up financial resources for other needs.	▪ Safe, healthy, inclusive and secure cities. ▪ Equitable access to sustainable basic physical and social infrastructure, housing, drinking water, food, health care, culture and information technologies.
Slum dwellers and persons living in informal settlements	▪ Poor access to basic infrastructure and services, which makes residents more vulnerable to climate-related hazards. ▪ Location of slums and informal settlements in hazardous areas increases exposure to natural disasters exacerbated by climate change. ▪ Reliance on informal or precarious livelihoods which are highly vulnerable to climate-related disruptions. ▪ Social marginalization, discrimination, and limited access to decision-making processes.	▪ Slum upgrading programmes that prioritize climate-resilient design principles. ▪ Securing land tenure rights for persons living in informal settlements to enable access to safer housing thus reducing disaster risk and homelessness. ▪ Capacity building and training for green jobs, and green entrepreneurship and innovation. ▪ Participatory urban planning that engages slum dwellers and persons living in informal settlements.	▪ Strengthening and retrofitting all risky housing stock to make it resilient to disasters. ▪ Address multiple forms of discrimination. ▪ Improve living conditions. ▪ Security of land tenure

Groups	Vulnerability to Climate Impacts	Climate Action to Address Vulnerability	Links to SDGs/NUA
Urban poor	▪ Poor access to basic services, adequate housing, healthcare and education, increasing vulnerability to climate change impacts. ▪ Climate change exacerbates extreme poverty by increasing food insecurity and water scarcity. ▪ Reliance on informal or precarious livelihoods such as daily wage jobs, which are highly vulnerable to climate-related disruptions in markets, supply chains, and income sources. ▪ Social exclusion in decision-making processes, which can exacerbate their vulnerability to climate change impacts.	▪ Inclusive urban planning incorporating affordable urban basic services such as affordable housing schemes into climate change adaptation and mitigation measures. ▪ Sustainable land management practices such as terracing, reforestation and erosion control to promote long-term agricultural productivity and water availability. ▪ Climate-resilient food systems ▪ Implementing social protection programs such as cash transfer schemes, food assistance and insurance mechanisms can provide a safety net for the urban poor ▪ Participatory approaches in decision-making processes, capacity-building initiatives and community-based climate projects.	▪ Strengthening and retrofitting all risky housing stock to make it resilient to disasters. ▪ Address multiple forms of discrimination/ ▪ Improve living conditions. ▪ Eradicating poverty.
People with disabilities	▪ Climate-related disasters such as flooding or hurricanes can create physical barriers by damaging infrastructure, thus limiting the mobility and access of people with disabilities and increasing mortality. ▪ Susceptibility to illnesses or complications to pre-existing health conditions exacerbated by extreme weather events and poor air quality ▪ Increased vulnerability due to higher poverty rates, lower levels of education and higher likelihood for unemployment ▪ Barriers to accessing information due to disabilities affecting hearing, sight etc.	▪ Ensuring that early warning and disaster response systems are accessible to people with disabilities through multiple channels. ▪ Invest in inclusive public health systems that consider the unique vulnerabilities of persons with disability to climate change impacts and integrate their needs. ▪ Social safety nets such as cash-transfer programmes, food assistance and affirmative action in employment to protect livelihoods ▪ Mainstreaming disability inclusion in media and communication	▪ Sustainable mobility and transport infrastructure that is responsive to different levels of physical, mental and developmental challenges/ ▪ Safe, healthy, inclusive and secure cities/ ▪ Equitable access to sustainable basic physical and social infrastructure, housing, drinking water, food, health care, culture and information technologies
Refugees and Internally Displaced Persons	▪ Climate change can exacerbate existing drivers of displacement, such as desertification and conflict over natural resources. ▪ Climate-related disasters and environmental changes can disrupt livelihoods leading to reliance on humanitarian assistance. ▪ Displaced populations often lack urban basic services, increasing their vulnerability to illnesses exacerbated by climate change impacts.	▪ Strengthening data collection, monitoring and research efforts on climate-related displacement to inform evidence-based policy and programming responses. ▪ Community-based adaptation and resilience-building initiatives in areas prone to climate-related displacement. ▪ Safe and inclusive shelter options for displaced populations, ensuring that services such housing, healthcare and education is resilient to climate change.	▪ Equitable access to sustainable basic physical and social infrastructure, housing, drinking water, food, health care, culture and information technologies. ▪ Full and productive employment, decent work for all and livelihood opportunities. ▪ Ensuring full respect for human rights.
Indigenous People	▪ Disruption of ecosystems and economies, ▪ affecting Indigenous Peoples' livelihoods including employment. ▪ Climate-induced displacement of Indigenous communities from their ancestral lands. ▪ Political and economic marginalization, discrimination and human rights violations when implementing adaptation and mitigation measures	▪ Community-based adaptation and mitigation that draw upon Indigenous traditional knowledge and local ecological expertise. ▪ Sustainable land management and climate-resilient infrastructure in vulnerable areas occupied by Indigenous Peoples. ▪ Integrating the participation and rights of Indigenous People in adaptation and mitigation measures	▪ The rights of Indigenous Peoples to self-determination, land, and resources, including their right to participate in decision-making processes that affect their communities. ▪ The role of Indigenous knowledge and practices in environmental conservation and sustainable resource management, promoting partnerships between Indigenous communities and urban stakeholders to enhance urban resilience and environmental sustainability.

Groups	Vulnerability to Climate Impacts	Climate Action to Address Vulnerability	Links to SDGs/NUA
Homeless People	▪ Exposure to extreme weather events and other weather-related illnesses. ▪ Limited access to social services, exacerbating their vulnerability during climate-related disasters. ▪ Exclusion from decision-making processes.	▪ Climate-resilient infrastructure and urban design solutions that consider the needs of homeless individuals. ▪ Implementing Housing First Approaches and affordable housing schemes. ▪ Participatory planning that integrates the needs of homeless people in adaptation and mitigation measures.	▪ Support policy that progresses towards the right to adequate housing for all and to prevent arbitrary evictions. ▪ Facilitate full participation in society and eliminate the criminalization of homelessness.

1.6.2 Driving sustainable development through climate action

Climate action offers an opportunity to move the needle forward on all SDGs. This is because of the synergies that exist between climate action and 80 per cent of the targets of the 2030 Agenda for Sustainable Development.[193] Investing in climate action therefore constitutes good practice that can generate development dividends in the form of backward and forward linkages. When carefully designed and implemented, actions to address the adverse effects of climate change should be interrelated and mutually reinforcing. Climate action must not only contribute to adaptation and mitigation efforts, but should also ensure sustainable livelihoods, food security, access to clean water and other basic services including affordable healthcare—all of which will reduce the vulnerability to climate change (Figure 1.12: Overview of components of a people-centred approach to climate action). The impacts of climate change are quite significant, to the extent that adaptation and risk management can be powerful contributors to poverty eradication and sustainable development.[194]

By 2050, as many as 216 million people could be forced to migrate due to the effects of climate change, with 85.7 million internal climate migrants within Sub-Saharan Africa alone

Climate action is most effective when ably supported by NbS. These are designed to protect, sustainably manage or restore green spaces and ecosystems for purposes of addressing societal challenges such as disaster risk, food security, water security or human health.[195] NbS not only protect vulnerable communities from the impacts of climate change, but are cost-effective and strongly aligned with the SDGs.[196] NbS have the potential to deliver around a third of the climate mitigation required to align with the goals of the Paris Agreement, amounting to over 10 Gt CO_2e of reduced GHG emissions per year.[197] However, global investment in NbS needs to increase by almost three-fold, from $200 billion to $545 billion by 2030 to meet the Rio Targets and limit global temperature to the 1.5°C limit.[198]

1.6.3 Planning as inclusive climate action

Planning for inclusive climate action, including the transition to net zero targets, may entail a range of action instruments from zoning, transport planning, densification or building regulations, but they need to be carefully tailored to the existing patterns of urbanization and aligned with the needs of urban dwellers (Chapter 5). Planning strategies to reduce GHG emissions in urban areas include planning and design that supports compact, connected and transit-oriented urban growth; investments in infrastructure for public transit, walking and cycling; and improved solid waste management.[199] Besides reducing GHG emissions, these strategies have a range of economic, environmental and social benefits. Compact urban form brings together various activities and services, reducing the cost of infrastructure provision and enhancing accessibility to jobs, while at the same time minimizing uncontrolled urban expansion and protecting natural ecosystems, biodiversity and food security.

Adaptation planning as climate action provides multiple responses to address the drivers of vulnerability (Chapters 4 and 5). The exposure of cities to climate change impacts is dependent on several interrelated factors, including patterns of urbanization, physical location, exposure to disasters and state of preparedness, among others. Urban planning as climate action must address these issues. In Angola, a priority area is the promotion of risk-informed urban planning and sectoral coordination to reduce exposure to flooding, heatwaves and droughts, which in turn helps build the resilience of vulnerable groups.[200]

The exposure of cities to climate change impacts is dependent on several interrelated factors, including patterns of urbanization, physical location, exposure to disasters and state of preparedness, among others

A recognition of the situated experiences of risk and vulnerability, as well as the differential capacities to reduce carbon emissions and cope with hazards, is essential to deliver just climate action outcomes. Planners and policymakers must avoid a situation in which climate action reproduces and even exacerbates existing inequalities. This is particularly the case when climate action does not take into consideration the social, economic and environmental needs of the most vulnerable communities. For example, with appropriate social protection mechanisms in place, climate urbanism interventions can push up land prices and make "improved" areas unaffordable for poor residents, potentially leading to gentrification or displacement.[201]

1.6.4 Resilient infrastructure as effective climate action

Climate-resilient infrastructure and associated services can serve as crucial targets for effective climate action in urban areas. Natural disasters cost the global economy an estimated US$14.6 billion annually in infrastructure loss and destroy an estimated 7.5 per cent of the world's road and railway systems.[202] In response, cities are increasingly investing in climate-smart and resilient infrastructure (Chapter 6). This

Planners and policymakers must avoid a situation in which climate action reproduces and even exacerbates existing inequalities

is in line with the notion that crucial infrastructure systems will be increasingly vulnerable if design standards do not account for changing climate conditions.[203] Besides their environmental value, investments in climate-resilient infrastructure bring significant social and economic co-benefits that enhance their cost effectiveness. As discussed in Chapter 9, one study has estimated that every US$1 invested in resilient infrastructure in low- and middle-income countries could bring US$4 in benefits.[204]

Providing adequate infrastructure in the form of improved water and sanitation, reliable power supply, efficient transport networks and modern information and communication technologies (ICT) contributes to the resilience of urban areas, especially in low-income and informal settlements. Since infrastructure in developing countries must be provided to meet the needs of a growing population, against a backdrop of rapid urbanization and growing vulnerability to climate change, it is important that new infrastructure is climate-resilient. In the case of Africa, most of the infrastructure to accommodate rapidly expanding urban areas is yet to be built.[205] Moreover, much of this ongoing urbanization is largely informal, occurring in peri-urban, flood-prone or ecologically fragile areas that are highly vulnerable to extreme weather events.[206] This provides an opportunity to build resilience into new infrastructure that will enhance service delivery, increase asset lifetime and lower GHG emissions.

1.6.5 Multi-level governance as climate action

Since the effects of climate change transcend jurisdictional boundaries, no single level of government irrespective of its resources can address them alone. Moreover, climate change policies are subject to complex trade-offs, synergies and interactions, which means a non-siloed approach is imperative. This calls for coordinated multi-level and intergovernmental responses and interventions to climate action, as many of the climate risks that urban areas face require coordination with other jurisdictions (Chapter 7).

Since the effects of climate change transcend jurisdictional boundaries, no single level of government irrespective of its resources can address them alone

In this regard, there is a growing movement of local and regional governments advancing the localization of the global agendas to drive climate action.[207] Urban areas of all sizes, from megacities to small municipalities, have demonstrated that effective climate action is attainable.[208] However, this is only possible when enabling conditions at the city, national and international levels are realized. Managing climate change and delivering responses capable of limiting global warming to 1.5°C requires participatory governance and political frameworks encompassing non-state actors, networks and informal institutions. Resource pooling from multiple levels of government and other actors is possible when institutions are flexible enough to allow for both top-down and bottom-up activity.[209]

1.6.6 Leveraging innovation for inclusive climate action

Climate action is one of the areas that has witnessed the rapid proliferation of innovative solutions. The urgency to decarbonize is driving the convergence of innovation in green and smart technologies. "Innovation—in institutions, understanding, technology and leadership"[210] will be crucial in achieving the goals of the Paris Agreement. The thinking is that the climate target of 1.5°C can only be reached if new technologies are developed at speed. According to some experts, advances in artificial intelligence and digital technology could bring about a reduction of between 4 and 10 per cent in global CO_2 emissions by 2030, rising to 20 per cent by 2050.[211] Elsewhere, it has suggested that the roll-out of a variety of climate technologies at scale could reduce emissions by as much as 90 per cent.[212] While the interdependency of these technologies is high, their levels of maturity vary remarkably, so the scalability and deployment of these technologies will take some time.

The climate target of 1.5°C can only be reached if new technologies are developed at speed

Technological innovation is a necessary condition for addressing the complex social, economic and behavioural aspects of climate change, delivering solutions such as renewable and nuclear energy, energy storage, carbon capture and energy-efficient systems. However, on its own it is insufficient: social innovation is also crucial for implementing these technologies effectively. As a result, climate action has expanded beyond the technological realm to encompass behaviour change and social norms, recognizing the crucial role of societal transformation in addressing climate change. Chapter 8 notes that by fostering new ideas, approaches and collaborations, social innovation plays a vital role in shaping policy agendas and driving transformative policies to promote equity and sustainability.

1.6.7 Finance: A key enabler of inclusive climate action

Finance has been described as "the great enabler of climate action".[213] The scale of investment required to transition to net zero and adapt to climate change is enormous. The Paris Agreement recognizes the importance of making finance flows consistent with a pathway towards low GHG emissions and climate-resilient development.[214] Climate finance plays at least three major roles:

- to *reduce emissions* through the transition from fossil fuels to renewable and cleaner forms of energy.
- to *fund adaptation* to the impacts of climate change by building resilience across a wide range of sectors.
- to *pay for loss and damage*.

Besides the huge funding gaps in advancing the transition to cleaner energy and enhancing resilience in developing countries,[215] climate finance is often concentrated at the level of international and national governments, making it difficult for cities to effectively fund climate

Delegates during a session of the World Climate Action Summit in Dubai © Mark Field /COP28

action.[216] Indeed, some estimates suggest that less than 10 per cent of climate finance trickles down to the local level.[217] Chapter 9 shows that wide financial gaps have implications for meaningful climate intervention at the city level.

Climate finance is often concentrated at the level of international and national governments, making it difficult for cities to effectively fund climate action

Mitigation receives far more attention and funding support than adaptation as 90 per cent of all climate finance in 2021 was devoted to the mitigation of GHG emissions.[218] Climate adaptation, on the other hand, is often neglected in climate financing, despite being an investment priority of developing countries as a basis for achieving sustainable development and poverty reduction. Funding for adaptation generally ranges between 20 and 25 per cent of committed concessional finance.[219]

Mitigation receives far more attention and funding support than adaptation as 90 per cent of all climate finance in 2021 was devoted to the mitigation of GHG emissions

A key question dominating climate finance is how the recently agreed loss and damage fund can be operationalized in cities as a financial mechanism for climate justice and equity. It remains uncertain how the fund will work and how much money developed countries will provide. It is estimated that up to US$387 billion might be needed by developing countries every year until 2030 to adequately respond to climate change and its impacts, yet so far only a fraction of this has been pledged.[220] The operationalization of the loss and damage fund is further discussed in Chapter 9.

1.7 Concluding Remarks

In conclusion, this report provides a greater understanding of the role that urban areas can play in addressing the existential threat posed by climate change. In so doing, it explores how urban areas can be positioned to take effective action towards achieving the Paris Agreement of limiting global warming to 1.5°C above pre-industrial levels and adapting to the impacts of climate change by building resilience across a wide range of dimensions. The report articulates the role that cities can realistically play in the drive towards a net zero or low-carbon world, as well as identify the supportive structures needed to effectively play this role. Throughout the volume, the urgency of moving beyond plans, promises and rhetoric to achieve transformative climate action at scale is stressed. The report identifies the persistent bottlenecks in implementation and critically interrogates why climate action in cities is not moving as quickly as it should, given the devastation that climate change is already exacting in many urban areas—impacts that are only going to escalate in the coming years without bold and meaningful action.

The implementation of effective and inclusive climate action, as described in the preceding sections of this chapter, should culminate in building climate resilience across multiple dimensions in urban areas. Emphasis should be on the implementability of the actions leading to climate resilience by the different levels of government, businesses and relevant stakeholders. Building climate resilience involves implementing mitigation and adaptation options to support sustainable development for all.[221] In the case of this report, this applies mainly to sustainable urbanization (Figure 1.12). Realizing climate resilience in urban areas entails taking the necessary steps to reverse the impacts of climate change and reduce the vulnerability of at-risk communities, groups and individuals (Table 1.4). Climate resilience can help develop the capacity for effective and inclusive climate action and contribute to a reduction of GHG emissions, while facilitating adaptation options that enhance social, economic and ecological resilience to climate change.[222]

In building climate resilience for all, it is important to address the social and economic inequalities associated with gender, poverty, race/ethnicity, disability, religion, age or location that compound vulnerability to climate change and further exacerbate injustice.[223] The pathways for achieving climate-resilient development are shared courses of action that put at their core the improvement of the well-being and prosperity of all people, especially those who are most vulnerable while reducing carbon emissions and reducing the risks from climate change.[224] This resonates with the people-centred approach to climate action in cities and communities which this report advances. Such pathways are attainable but require collective effort at various levels—global, regional, national, subnational and local—including a wide range of stakeholders in different contexts.

Building climate resilience is a multisectoral, multidimensional and multi-stakeholder effort, which requires effective collaboration and cooperation across various scales since the dimensions of climate resilience are interrelated and mutually reinforcing. Realizing climate resilience in urban areas requires a combination of multi-level governance strategies with efforts to localize climate action. Localization efforts respond to the call for action on the ground, in which local governments play a central role. Chapter 7 shows that local governments have demonstrated their capacity to deliver interventions for climate change on the ground, but these are hampered by limited autonomy. To be effective, local governments must be supported by a network of actors able to operate at different scales, aligning governmental efforts from the national to the local level, business interests and the efforts of multiple actors within civil society. Key to supporting these efforts is *inclusive* multilateralism, which entails bringing more groups to the table, including non-party stakeholders such as youth, women, Indigenous Peoples and others, alongside those of international networks that have supported local action for climate change. [225]

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Eindhoven, The Netherlands © Shutterstock

Chapter 2:

Climate Change and International Development: What Have We Achieved Since the Adoption of the Paris Agreement?

Quick facts

1. Climate change has emerged as a critical factor shaping international development policy, with widespread implications.

2. Global climate negotiations and outcomes have not adequately addressed cities and other subnational entities, but this has begun to shift.

3. There have been several significant societal and technological developments since the Paris Agreement, but their impacts have been unevenly distributed.

4. The private sector is a critical source of expertise, innovation and resources for supporting urban climate action.

Policy points

1. The journey towards low-carbon futures is a shared responsibility, requiring collaborative policy and interventions across all scales.

2. To achieve the level of change necessary to keep global warming within relatively safe planetary boundaries, national and local governments need to move beyond piecemeal reforms.

3. Unifying global frameworks is key to achieving global climate and development goals.

4. Mobilization of additional finance and restructuring the financial architecture is required to ensure that climate adaptation, mitigation and loss and damage receive new and additional funding.

5. Addressing equity considerations in climate action remains an urgent global priority.

A central message of the *World Cities Report 2022: Envisaging the Future of Cities* was that ambitious, effectively targeted adaptation and mitigation efforts are crucial if urban futures everywhere are to be sustainable and resilient. As highlighted repeatedly throughout this report, cities are at the forefront of action to tackle climate change. This entails understanding the roles that cities worldwide have played to date, both in their own right and as part of a broader multi-level governance structure with national and regional governments. The critical role of urbanization has been identified as a "mega-trend" significantly impacting the climate crisis, while the policies and strategies adopted for building urban resilience and sustainability have far-reaching implications for vast numbers of individuals, communities and organizations globally.[1]

Effectively targeted adaptation and mitigation efforts are crucial if urban futures everywhere are to be sustainable and resilient

A key dimension of this trend is the promotion of effective climate action as a central part of international development programming and funding. Accordingly, the principal aim of this chapter is to assess progress (or, in multiple cases, lack thereof) since the adoption of the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC) in December 2015 at the Conference of the Parties (COP21). Specifically, it explores the role of climate change in shaping international development policy within the context of promoting sustainable urbanization since the Paris Agreement. Given this broad scope, the aim is to elucidate key thematic areas and indicative issues rather than provide detailed assessments, as these are covered in subsequent chapters.

The Paris Agreement is a legally binding treaty aiming to limit global temperature increases since the beginning of the industrial revolution to 1.5 degrees Celsius (°C) above pre-industrial levels. The central means of implementation is through a voluntary and non-enforceable system of nationally determined contributions (NDCs) to global reductions of greenhouse gas (GHG) emissions. The Paris Agreement identifies the critical role of local governments in addressing climate change and the NDC targets of many countries are underpinned by sector-based commitments that have specific urban relevance for subnational authorities as shown in Chapter 1. While the United Nations (UN) issues recommendations and guidelines of good practice, the extent to which these are followed varies considerably, as does the extent to which national governments consult with subnational and local governments, and/or include specific urban content in their NDCs.

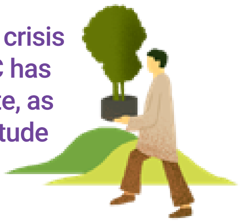
The foregoing poses considerable challenges and increases the importance of global funding mechanisms, including Official Development Assistance (ODA), as a means for promoting appropriate urban climate action in low- and lower-middle-income countries. A related challenge hampering proactive urban climate action in ODA-recipient states is that in many countries, ODA (and indeed other funding) is required to flow to and through the national governments.[2] Subsequent disbursement to subnational and local governments may then be subject to delay, diversion of funds or imposition of additional conditions that hamper or dilute coherent and effective urban climate action (discussed further in Chapter 9).

2.1 Global Progress Since the Paris Agreement

Despite notable advances in policy and knowledge, the global response to the climate crisis since the formation of the UNFCCC has been widely criticized as inadequate, as evidenced by the escalating magnitude of the climate crisis. Consequently, the 2020s have been identified as a critical

decade for climate action, where radical measures are urgently required at the appropriate scale and pace to avoid catastrophic levels of global emissions and avert widespread disasters. Towns and cities are central to any such coherent initiatives.[3] Since 2015, there has been increasing public pressure on governments globally to take climate action. The

The global response to the climate crisis since the formation of the UNFCCC has been widely criticized as inadequate, as evidenced by the escalating magnitude of the climate crisis



Peoples' Climate Vote—the world's largest standalone public opinion survey on climate change—revealed that 80 per cent of the more than 73,000 respondents want their governments to have stronger climate commitments, prioritizing the well-being of people and nature.[4]

Since 2015, many bilateral and multilateral environment and climate agreements have been introduced globally. Degrees of implementation and impact on urban areas vary greatly. Several agreements have coalesced around specific thematic issues such as solar power and coastal issues. The 2024 EU Nature Restoration Law—a first of its kind and a significant achievement for multilateralism—aims to restore at least 20 per cent of the land and sea areas in the European Union (EU) by 2030, and all ecosystems in need of restoration by 2050. Urbanization issues are repeatedly highlighted throughout the regulation text and key measures include no net loss on urban green spaces and tree canopy cover by 2030.[5]

A fully contextualized appraisal of progress since the Paris Agreement requires that this not be seen in isolation, but as one of the five complementary components of the global sustainable development agenda adopted by UN member states during an intense 18-month period from mid-2015 to December 2016. These international agreements underpin the global enabling environment and inform policy for national and urban governments on urbanization and climate action. Table 2.1 summarizes these agreements, which have significant implications for climate action and urbanization.[6] The Paris Agreement, 2030 Agenda for Sustainable Development (with 17 Sustainable Development Goals) (SDGs) and the New Urban Agenda (NUA) strongly emphasize the complex interconnections between local action and global processes of change. International development policies are domesticated or localized in diverse ways, with significant implications for building climate-resilient cities.

Flooded streets and buildings in Chiangmai, Thailand © 501room/Shutterstock

Table 2.1: Representation of the urban in international sustainable development policies and key agendas

Agreement (date of agreement)	Scope of agreement	Relevance for cities, settlements and infrastructure	Relevance for addressing climate change risk
Sendai Framework for Disaster Risk Reduction (March 2015)	Global agreement for reducing disaster risks in all countries and at all levels. Highlights urbanization as a key driver of risk and resilience.	Identifies rapid urbanization as a key underlying risk factor for disasters and driver of resilience. Promotes shift from disaster response to disaster risk management and reduction through cooperation between national and local governments. Limited focus on the role of civil society.	Highlights the need to respond to systemic risk, including compound and cascading risks and impacts from natural, technological and biological hazards. Includes focus on chronic stressors and sudden shocks through governance, planning, disaster response, post-event recovery.
Addis Ababa Action Agenda (July 2015)	Global agreement arising from the International Conference on Financing for Development (United Nations, 2015a) emphasized the need for adequate financing at all levels of government, especially subnational and local, to support sustainable development, infrastructure and climate mitigation (UN-Habitat, 2016b).	Includes general comments on the importance of local actors and recognises the need for strengthening capacities of municipal and local governments. Commits to 'support' local governments to 'mobilise revenues as appropriate'. Offers little on how to get finance to support local governments addressing these commitments.	Financing a critical element of risk reduction in cities and settlements (see Section 6.4). Underlying variability of institutional arrangements inhibits development of universal framework.
Transforming our world: the 2030 Agenda for Sustainable Development (September 2015)	Global agreement adopted by 193 governments that includes the 17 Sustainable Development Goals (SDGs).	SDG 11 speaks explicitly to making cities 'inclusive, safe, resilient and sustainable'. Extensive reference to universal provision of basic services in other SDGs which will require substantial efforts in cities; equality and governance are also stressed. Focuses on national goals and national monitoring with insufficient recognition of key roles of local and regional governments and urban civil society in addressing most of the SDGs.	SDG 13 on climate action requires action in cities and settlements. Integrated approach can address underlying drivers of risk.
The Paris Agreement (December 2015)	Global agreement under UN Framework Convention on Climate Change: signed by 194 and ratified by 189 member states (05/01/21).	References the role of the local or subnational levels of government and cities as non-state actors.	Encourages cities to develop specific agendas for climate action (mitigation and adaptation).
The World Humanitarian Summit (May 2016)	Not an agreement, but a summit of 180 member states generating over 3,500 commitments to action and addressing the role of non-state actors in reducing risk of climate change related forced displacement of people	Includes five agreed 'core responsibilities' with relevance for urban areas, and commitments were made by professional associations, non-governmental organizations and networks of local authorities to address these in towns and cities.	Climate change likely to shape flows of refugees and migrants who are likely to live in highly exposed areas, particularly in low-income cities. However, 'meagre funding for collaboration, poor data collection and sharing' (Acuto, 2016) limits commitment effectiveness (Speckhard, 2016).

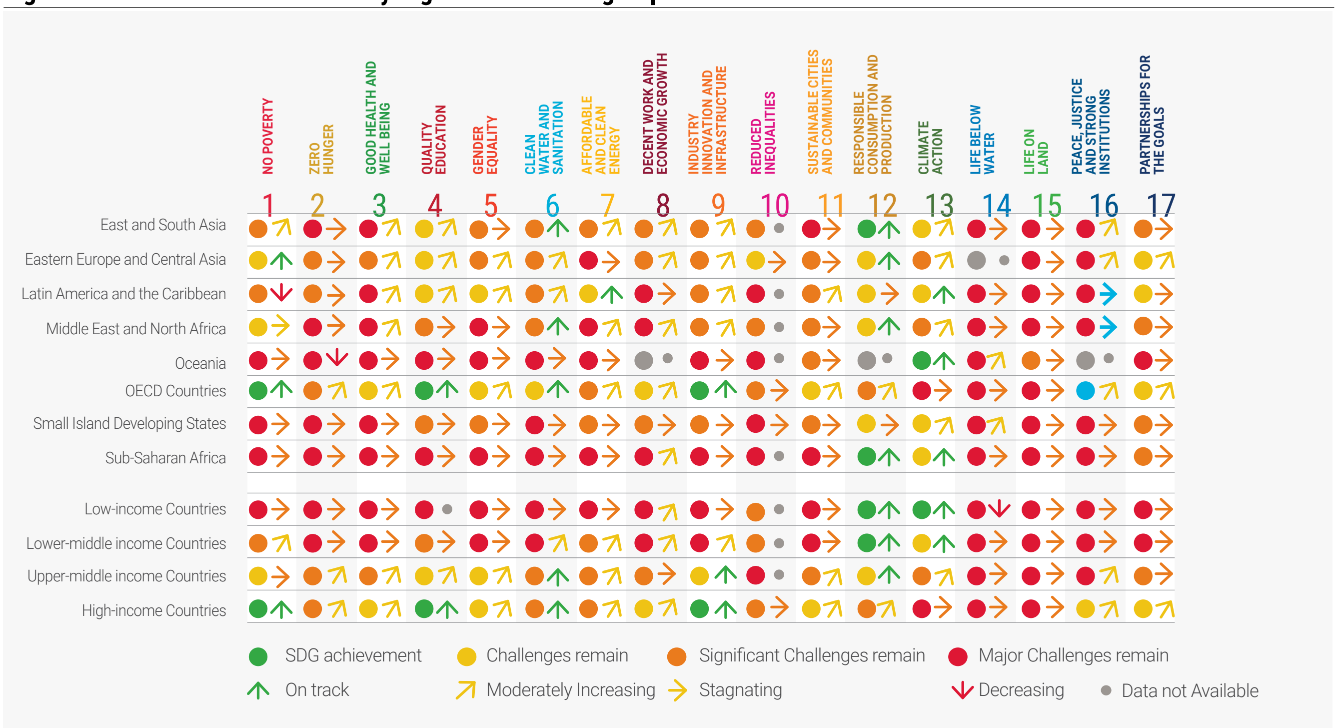
Agreement (date of agreement)	Scope of agreement	Relevance for cities, settlements and infrastructure	Relevance for addressing climate change risk
The New Urban Agenda (October 2016)	Global agenda adopted at UN Conference on Housing and Sustainable Urban Development (Habitat III) envisioned national urban policies and adaptation plans as a central device to inform subnational governments addressing sustainable development.	Intended as the global guideline for sustainable urban development for 20 years, seeking to provide coherence with other agreements. Focus on national policy and action. Limited recognition of urban governments or civil society as initiators and drivers of change.	Clearly frames roles for cities within national and international systems in contributing to sustainability (including low-carbon development) and resilience (including adaptation). Frames the role for cities within national and international systems, including an ongoing assessment of their contribution to sustainability and resilience (Kaika, 2017; Valencia et al., 2019).

Source: Dodman et al., 2022.

Each of these agreements has different lifespans, but of particular relevance to this chapter and international development policy generally are the Paris Agreement, the 2030 Agenda (2016-30) and the NUA (2016-36). To mark the midpoint of the 15-year span of the SDGs, in 2023 a special UN SDG mid-term review Summit was held in New York. The review of each SDG was led by the responsible UN lead agency. Accordingly, in the case of SDG 11 on Sustainable Cities and Communities, UN-Habitat's comprehensive review *Rescuing SDG 11 for a Resilient Planet*[7] indicated that current rates of progress would not enable the targets and indicators to be met. Initial progress on various targets had been set back or even undermined by the combined effects of the COVID-19 pandemic and the impact on food and energy availability and prices following the Russia-Ukraine conflict.

Indeed, the *Sustainable Development Report 2022* had already revealed that no single region was on track to fulfil SDG 11 and most of the others, as illustrated in Figure 2.1. The overall picture is that political ambition and financial commitment would need to be significantly increased if SDG 11 and many of the other SDGs are to be achieved by 2030.[8] A separate review of EU member states using official statistics demonstrated considerable progress, but also expressed reservations about prospects for achieving the targets by 2030.[9] Although not specifically focused on urban areas, SDG 13 on climate action has fared somewhat better. Oceania and all low-income countries are shown as being on track to achievement, while Latin America and the Caribbean, along with Sub-Saharan Africa and lower-middle-income countries, are progressing on track.[10]

Figure 2.1: 2022 SDG dashboards by region and income group



Source: Sachs et al., 2022.

2.1.1 The urban content of Nationally Determined Contributions

There is a substantial body of literature on the NDCs focused on issues such as transparency and implementability,[11] the sectoral implications of NDCs[12] and interlinkages with other global agendas such as the SDGs.[13] The role of non-state actors, including cities, for NDCs is evidently also receiving increasing attention.[14] The most recent analysis of the NDCs declared by 194 countries included 27 that had been updated and submitted for a second time by mid-2023.[15] More countries have reported NDCs, which fall into three clusters: strong, moderate and low or no urban content. Hence two-thirds of NDCs analyzed had strong or moderate urban content,[16] an increase over the previous analysis in 2022 as shown in Table 2.2. However, even this urban content is often vague and fragmented. The methodology of previous iterations differed so direct comparison is less straightforward. As discussed in Chapter 1, whether countries have high, moderate or low urban content in their NDCs is largely independent of their levels of urbanization.

Table 2.2 Extent of urban content in NDCs submitted in 2022 and 2023

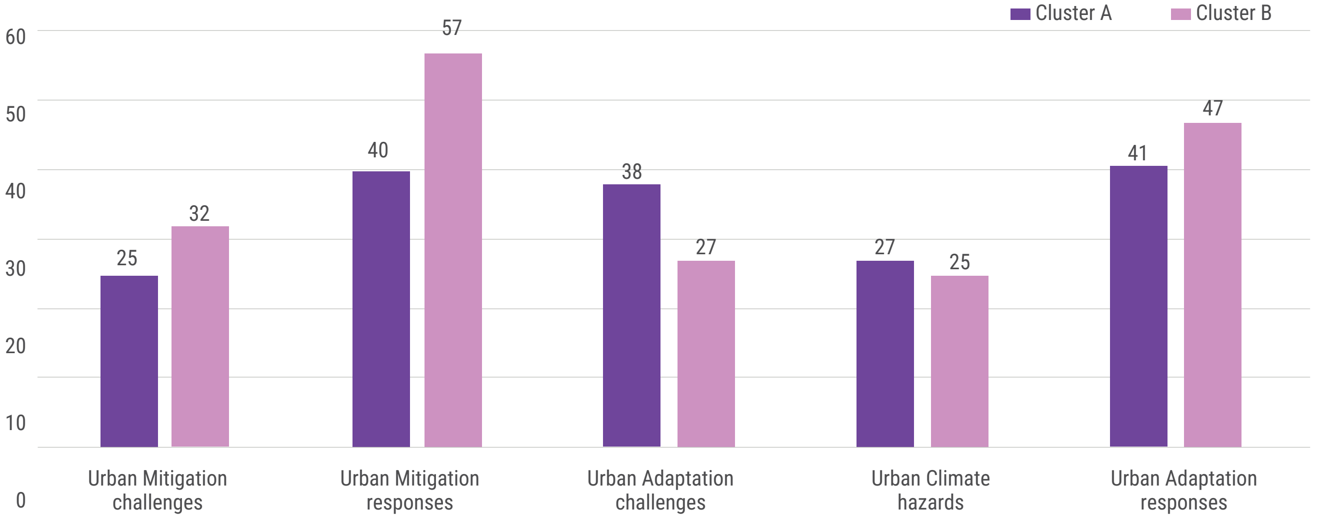
Urban content of NDCs	2022		2023	
	Number	%	Number	%
High urban content (Cluster A)	47	24	52	26
Moderate urban content (Cluster B	76	40	77	40
Low or no urban content (Cluster C)	70	36	65	34
Total	193	100	100	100

Source: compiled from UNDP et al., 2024.

Women cycling near the Leiden central station, Netherlands © Patrick Herzberg/ Shutterstock

How individual NDCs were produced and the degree to which urban local governments were involved in the process varies remarkably.[17] The analysis disaggregated the nature of the clusters of strong and moderate urban content in a stepwise manner. Initially, the numbers of countries that included mitigation and adaptation challenges and responses for each category, as well as urban climate hazards, were distinguished. This revealed some significant differences between Clusters A and B in Figure 2.2, but with mitigation and adaptation responses featuring more strongly in both clusters than challenges and hazards.

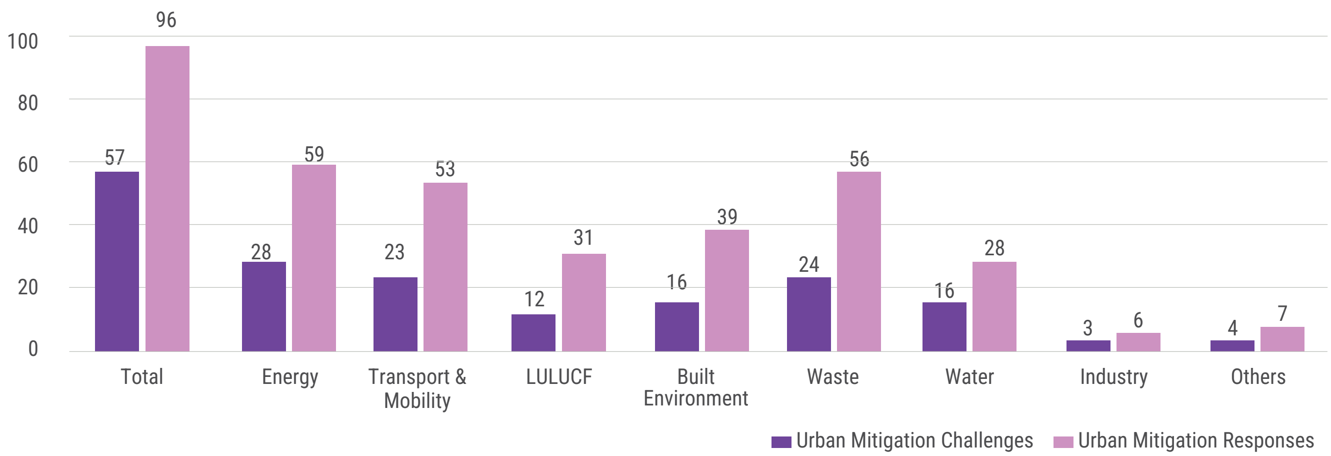
Figure 2.2: Number of NDCs with high and moderate urban content that address mitigation and adaptation challenges and responses, and urban climate hazards, 2023



Source: UNDP et al., 2024.

The principal spheres of action under mitigation and adaptation are identified in Figures 2.3 and 2.4 respectively. These revealed very similar sectoral distributions within both Clusters A and B: in mitigation, energy, transport and mobility, and waste dominated, while in terms of adaptation, the leading sectors were infrastructure, water and coastal areas. The overall analysis was complemented by a representative sample set of country profiles. These provide deeper insights into the diversity of different countries' NDCs and their respective urban content, as well as different income categories and world regions. Straightforward generalization is therefore difficult.

Figure 2.3: Disaggregation of urban mitigation challenges and responses among Clusters A and B (2023)

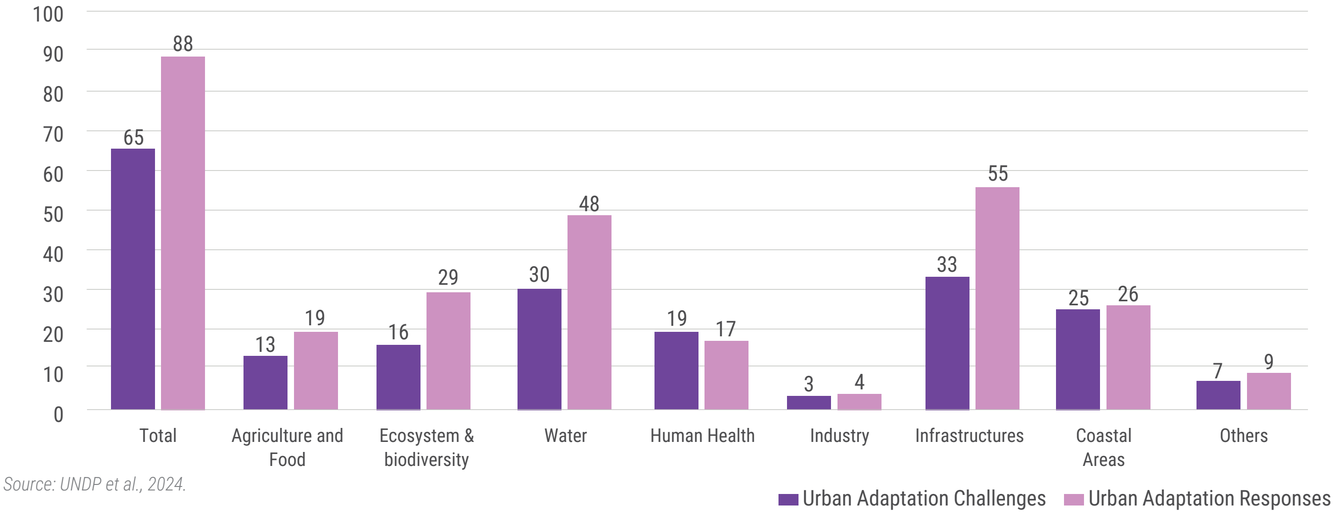


Source: UNDP et al., 2024.

Despite misgivings relating to climate action, especially at the national level, the journey towards net zero or low-carbon futures is a shared responsibility, and as such the broad-brush criticism of the lack of ambition and policy pitfalls by national governments needs to be transcended. While countries are progressing in their recent pledges, as evidenced by enhanced, higher-quality NDCs derived from increasingly inclusive processes involving subnational levels of government, as well as the mainstreaming of gender and youth considerations, among other concerns, the aggregate effect on global emissions remains highly inadequate. Similarly, the combined effect of adding up all the NDCs shows that current pledges are not capable of limiting global warming to 1.5°C above preindustrial levels.[18]

Despite misgivings relating to climate action, especially at the national level, the journey towards net zero or low-carbon futures is a shared responsibility

Figure 2.4: Disaggregation of urban adaptation challenges and responses among Nationally Determined Contributions with high and moderate urban content, 2023



Source: UNDP et al., 2024.

2.2. Progress in Tackling Climate Change Measured by SDG 11

The 2023 global survey by the Organisation for Economic Co-operation and Development (OECD) and the Sustainable Development Solutions Network (SSDN) on the role of cities and regions in implementing the SDGs highlighted significant actions that cities are taking globally to localize and implement the SDGs, as well as facilitators and barriers to achieving them.[19] Table 2.3 provides an indicative snapshot of policies and actions adopted by diverse cities for the implementation of the SDGs.

Table 2.3: Snapshot of policies and actions adopted by diverse cities for implementation of SDGs

Type of action	Example
Policies and actions adopted for the implementation of the SDGs	▪ The city of Tallinn, Estonia, has aligned its strategic and operational targets, integrating SD indicators to drive sustainable development. ▪ The city of Zagreb, Croatia, tracks its performance through SDG indicators that are part of the city's urban development strategy's annual reporting and are directly linked to the national development strategy. ▪ The autonomous province of Bolzano, Italy, has created an alliance for sustainability with research institutes and universities, fostering joint efforts in implementing the SDGs in the province. ▪ The region of Catalunya, Spain, has created the Catalonia 2030 Alliance, a partnership of public and private entities willing to work together to accelerate the achievement of the SDGs. ▪ The city of Manresa, Spain, has established a subsidy scheme for dissemination and training on the 2030 Agenda in its municipality. ▪ The city of Florence, Italy, has integrated the SDGs into its 2030 Agenda strategy. ▪ The state of Brandenburg, Germany, has established discussions fora within and for municipalities and civil society to advance the implementation of the SDGs in its territory.

Source: OECD & SDSN, 2024.

The survey reveals that political leadership is a critical success factor (76 per cent) for local implementation of the SDGs, with dedicated strategies for the SDGs and indicator systems also emphasized. Insufficient financial resources (64 per cent) and governance challenges, shifting political priorities (52 per cent) and insufficient vertical coordination represent considerable challenges to implementation of the SDGs at the city scale. Awareness-raising campaigns are the most common action (62 per cent) reported to localize the SDGs, followed by a dedicated strategy or action plan for the SDGs (56 per cent).[20]

UN-Habitat's report to the High-level Political Forum on Sustainable Development (HLPF) assessed progress and on that basis addressed the requirements for the second half of the implementation period if the targets of SDG 11 are to be achieved. Related to progress since the Paris Agreement, the focus of SDG 13 is on climate action, but none of its targets and indicators specifically address urban areas. This makes it impossible to assess urban contributions to progress against SDG 13 beyond self-assertions being made by urban governments to that effect, which are inevitably hard to verify.

Over 2,300 local and regional jurisdictions in over 40 countries have formally declared climate emergencies in response to the effects of a changing climate, such as flooding and heatwaves.[21] Populations covered by these jurisdictions exceed 1 billion citizens, many of which are in urban areas of varying sizes. Despite these pronouncements and over 30 years of urban climate initiatives, "there remains a persistent concern that urban climate action may at best lack sufficient urgency and at worst exacerbate existing urban inequalities while falling short of addressing the dire challenges faced".[22]

2.2.1. Target 11.5: Reduce the adverse effects of natural disasters

Over 2,300 local and regional jurisdictions in over 40 countries have formally declared climate emergencies in response to the effects of a changing climate, such as flooding and heatwaves

Climate change crosscuts most aspects of SDG 11 but here the specific climate change-related dimensions, which constitute a direct component of three targets and four indicators, are addressed as follows:

- Target 11.5: By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations, and its three indicators,

- 11.5.1: Number of deaths, missing persons and persons affected by disaster per 100,000 people, and
- 11.5.2 Direct economic loss attributed to disasters in relation to global GDP.
- 11.5.3 (a) Damage to critical infrastructure and (b) number of disruptions to basic services, attributed to disasters

The evidence on the two components of Indicator 11.5.1—which correspond to Targets A and B of the Sendai Framework for Disaster Risk Reduction—showed opposite trends: while global average mortality fell by 47 per cent, from 1.64 persons per 100,000 over the period 2005-15 to 0.86 for 2012-21, the global average number of disaster-affected persons per 100,000 population increased by 76 per cent over the same period, from 1,198 during 2005-15 to 2,113 during 2012-21. These data exclude COVID-19-related cases. Globally, on average every year 47,337 people died and another 151 million were affected as a result of disasters during the 2015–21 period.[23] The most plausible explanation for these two variables moving in opposite directions is that enhanced early warning and rapid response capacities in many urban areas have helped to reduce the number of fatalities per extreme event, but that the increasing number, geographical distribution and severity of disasters is increasing the number of people affected.

Globally, on average every year 47,337 people died and another 151 million were affected as a result of disasters during the 2015–21 period

These global averages mask considerable variation at all scales, with greater vulnerability in low-income countries and Small Island Developing States (SIDS). Furthermore, these are aggregate rather than specifically urban data, for which accurate figures are not available. In addition to accelerated action and enhanced funding for disaster risk reduction (DRR), a key priority over the remaining SDG period is further development and operation of effective early warning systems[24]—not least in urban areas—to build on considerable progress achieved by 2021. Focusing in future on collecting more disaggregated urban-specific data for monitoring and evaluation is also critical.

Data on Indicator 11.5.2 are also available only as national aggregates and show that poor and vulnerable states were impacted disproportionately hard. The global total in 2021 was some US$80 billion (0.57 per cent of the total GDP of reporting countries), whereas the numerically low US$4.5 billion reported by least developed countries corresponded to 2 per cent of reporting countries' aggregate GDP, and for SIDS the losses of US$133 million equated to 2.4 per cent of their aggregate GDP.[25] These figures demonstrate that the poorer, smaller and more vulnerable a country is, the greater the relative economic impact of disaster loss. This therefore underlines the importance of global governance interventions through mechanisms such as the recently established Loss and Damage (L&D) Fund.

Figures demonstrate that the poorer, smaller and more vulnerable a country is, the greater the relative economic impact of disaster loss

On Indicator 11.5.3, the respective figures for 2015-21 amounted to over 1 million critical infrastructure units (including schools and hospitals, of which the former accounted for over half the total) and 6.5 million basic service disruptions due to disasters. Again, the losses were proportionately greatest in low-income countries and SIDS. Greater resilience of national infrastructural networks was identified as a top priority for the remainder of the period to 2030, not least to minimize damage and promote rapid and appropriate reconstruction.[26] These issues are elaborated further in Chapter 5.

Several key points warrant highlighting in this context. First, no precise definition of disasters has been included, allowing local flexibility but complicating the task of global aggregation.[27] In part, besides reflecting geographic differences, this was also the result of pressure from organizations representing the urban poor to include the effects of chronic, everyday environmental conditions that accumulate to become disasters.[28] Second, none of the Target 11.5 indicators explicitly includes climate change impacts, so the extent to which these have been included will vary, both because perceptions differ on whether and to what extent a given disaster could be attributed to the effects of climate change, and because the frequency and severity of climate-induced extreme events (and when they become identified as disasters) differs geographically. Third, as with all the targets and indicators in SDG 13, none of the indicators explicitly or exclusively report on urban disasters. In the absence of geographically disaggregated data, there is therefore no way to determine the absolute or relative prevalence of disaster impacts in urban areas. Fourth, as a reflection of these factors, there is very little independent literature on progress with Target 11.5 in urban areas.[29]

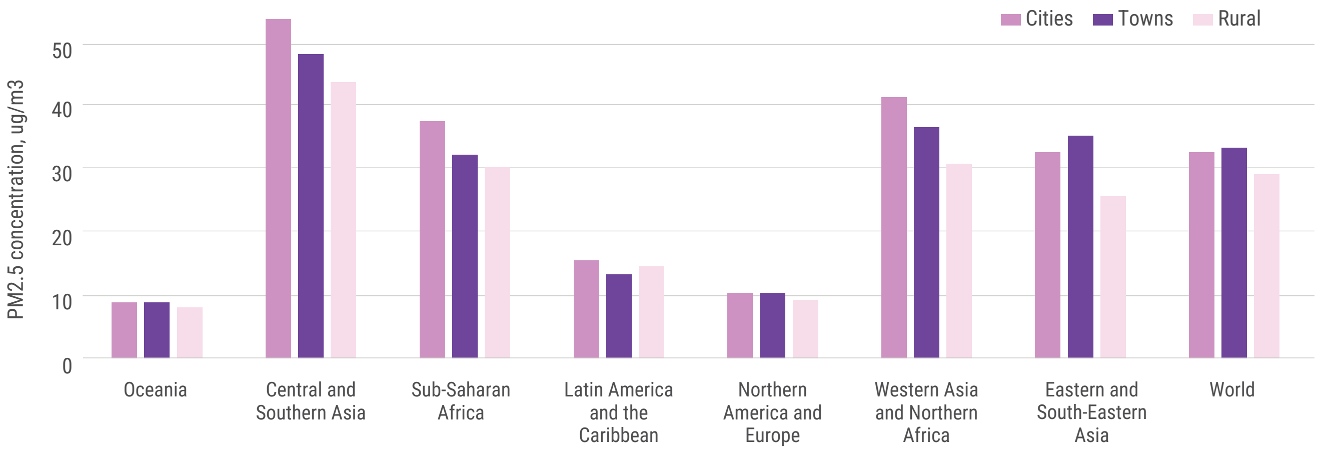
2.2.2. Target 11.6: Reduce the environmental impact of cities

Another relevant area within SDG 11 in relation to climate change is Target 11.6: "By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management". This includes Indicator 11.6.2 on air pollution: "Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted)".

Within the UN system, responsibility for this indicator rests with the World Health Organization (WHO). Though WHO introduced stricter new air quality standards in 2021, 99 per cent of the global urban population live in areas that exceed them: urban air pollution from sources such as road traffic, industrial emissions and waste combustion cost some 4.2 million lives in 2019 alone.[30] Despite the emphasis on improving air quality in both the SDGs and NUA, monitoring is not yet undertaken systematically across many urban areas, with often a small number of measuring points that might not be in the most polluted areas. The level of particulate matter measured varies (not all can yet record PM2.5, for example) and maintenance of facilities is not consistent.[31]

While small towns still receive little attention[32] and in most world regions fare better in terms of air pollution than larger cities, in Eastern and Southeast Asia the reverse is the case, while in North America and Europe the levels are comparable. Nevertheless, there are considerable intra-urban and regional differences (Figure 2.5).[33] Given the gaps in widespread and systematic local monitoring, earth observation, remote sensing, big data and artificial intelligence (AI) are increasingly being explored to provide standardized approaches and scalable data, in part through use of the new UN standard degree of urbanization approach to defining urban areas (discussed in more detail in Chapters 1 and 5).[34]

Figure 2.5: Population-weighted 2019 PM2.5 concentrations for regional groupings



Source: UN-Habitat, 2023b.

2.2.3 Target 11.b: Implement policies for inclusion, resource efficiency and disaster risk reduction

Another area of SDG 11 that is pertinent to climate action is Target 11.b: "By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels."

Of particular relevance in the urban context is Indicator 11.b.2: "Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030." This indicator is the same as Target E of the Sendai Framework. By the end of 2022, 102 countries reported having local governments with DRR strategies, compared to 51 in 2015, with an average of 72 per cent of local governments per country having such strategies.[35] Although not specifically stated, these would have been principally large and intermediate urban governments, reflecting relative institutional capacity and greater likelihood of participation within international city networks and membership organizations. Since this indicator requires collation by national governments, verification and additional detail cannot be obtained independently.

Nevertheless, the clear implication is that global and national governance institutions should prioritize assistance to the establishment of DRR strategies and capacities in small and intermediate urban areas during the remainder of the SDG and Sendai Framework implementation periods. This will also promote wider achievement of urban resilience by 2030, which is the principal focus of the Making Cities Resilient 2030 initiative, which has supported over 1,600 cities in enhancing their DRR preparedness.[36]

2.2.4 Voluntary Local Reviews of progress with implementation of the SDGs

The final element of SDG implementation addressed in this chapter focuses on the integrated self-assessment by individual local urban governments of their progress—Voluntary Local Reviews (VLRs)—as well as the even more recent Voluntary Subnational Reviews (VSRs) by regional governments. Following the withdrawal of the United States (US) from the Paris Agreement, New York City submitted its own local assessment in 2018, which became the first VLR, built around the SDGs as a local counterpart to Voluntary National Reviews (VNRs).[37] This catalyzed a growing movement, with 106 submitted by October 2021, 149 by mid-2022 and 174 by the end of 2023.[38]

Progress on VLRs and their role in supporting implementation of SDGs has been well documented in recent years.[39] Each city's VLR is informed by differing key themes and emphases within the broader framing of the SDGs and NUA. The nature, robustness and degree of detail within VLRs vary greatly; while some are selective in coverage, others are based on detailed assessments. Some of the most robust,

The nature, robustness and degree of detail within VLRs varies greatly

such as those produced by eThekwini and Cape Town in South Africa or Buenos Aires in Argentina, are based on comprehensive mapping of their activities onto all the SDGs, accompanied by case studies of flagship projects[40] that are clearly linked to urban resilience building and wider climate change initiatives. These exercises have led to some shifts in the focus of investment and recurrent expenditure, to enhance synergies across SDGs or align activities more appropriately with wider climate action commitments. Several overarching benefits of the VLRs include: setting local priorities and policy alignment and integration for sustainable development; providing localized data and experiences to inform VNRs; and evidence-based monitoring tools, all of which support implementation of the SDGs.[41]

Beyond VLRs and other diverse mechanisms, city climate action for implementing the Paris Agreement have been reported through recent high-level initiatives such as the Race to Resilience campaign of the UNFCCC and the Sharm el-Sheikh Adaptation Agenda. In combination, these indicate significant progress around several core themes such as nature-based solutions (NbS)[42], early warning systems, community engagement, heat stress response, ocean coastal systems, infrastructure (see Chapter 6), waste and water management, among others. Despite existing efforts by cities on climate action and localizing the global development agendas, illustrated throughout this report, urgent acceleration of efforts is required to reach net zero and create more sustainable futures for all, especially the most vulnerable (see Chapter 4). Particular attention needs to be paid to fostering enabling environments, localized finance, political support and collaboration across scales. Globally documented evidence indicates that climate adaptation actions are largely fragmented and incremental, with limited evidence of transformational adaptation and risk reduction outcomes.[43] This highlights the importance of advancing more effective, locally-led adaptation across rural and urban areas globally.

Urgent acceleration of efforts is required to reach net zero and create more sustainable futures for all, especially the most vulnerable

Aerial view of flooded homes in Kurigram, Bangladesh, highlighting the devastating impact of recent floods on the community. © amdadphoto/Shutterstock

In view of the growing movement to produce VLRs, United Cities and Local Governments (UCLG), UN-Habitat and the Joint Research Centre of the European Commission have produced VLR guidelines, good practice guidance and templates.[44] There is no one defined methodology or approach to developing VLRs. Most recently, UN-Habitat and UCLG developed an action-oriented VLR Methodology to support evidence-based local-level SDG recommendations to drive change from the bottom-up.[45] The diversity of VLRs can be viewed as a significant opportunity to promote knowledge and best practice exchange across varied contexts and typologies. Cities are also increasingly partnering with various organizations such as research institutes and city networks in developing their VLRs and associated monitoring (an example being the partnership between the City of Orlando in the US and Local Governments for Sustainability (ICLEI).[46]

Emphasis on inclusivity in VLR development is mounting to ensure meaningful participation and incorporate local communities, minorities and vulnerable groups into decision-making processes. Relatedly, VLR development has also catalyzed the use of open data dashboards to gather data and display progress, including by the State of Hawaii (US) and the cities of Los Angeles (US) and Helsingborg (Sweden).[47] These accessible platforms help to keep cities accountable to their citizens and relevant stakeholders.[48]

2.3 Focus Areas and Milestones in the UN Conference of the Parties in Strengthening Urban Climate Action

Historically, the UNFCCC COP[49] negotiations and outcomes have not adequately addressed cities and other subnational entities. This has begun to shift in recent years. More specifically, the centrality of cities in addressing the climate crisis has been increasingly recognized, as evidenced by the strong urban representation at both COP27 and COP28 and an unparalleled level of mayoral participation. Table 2.4 presents key outcomes and milestones since COP21 in 2015, with particular reference to the implications for urban contexts. Over the past decade, urban issues have become an increasing focus in international policy debates and landmark reports.[50] Notably, urban-specific chapters were included in the 2014 IPCC AR5 report for the first time, the 2022 IPCC AR6 report is strongly focused on urban issues, and the IPCC Special Report on Climate Change and Cities was commissioned in early 2024.

The centrality of cities in addressing the climate crisis has been increasingly recognized, as evidenced by the strong urban representation at both COP27 and COP28 and an unparalleled level of mayoral participation

Table 2.4: Summary of COP focus areas and indicative milestones since the Paris Agreement

Paris and beyond to 2023	Examples of key milestones and outcomes linked to UNFCCC processes	Implications for urban contexts
COP21 (Paris, 2015)	▪ The adoption of the *Paris Agreement* marked a significant milestone in global climate governance: "all levels of governments", "cities and other subnational as Non-Party Stakeholders. ▪ Emphasis on limiting global warming below 2°C and striving for 1.5°C. ▪ Parties invited to prepare intended nationally determined contributions (iNDCs), at COP19 in Warsaw. ▪ iNDCs became binding NDCs following Paris Agreement ratification in 2016. ▪ Gender equality recognized as guiding principle for effective action.	▪ Ambitious mitigation efforts required to reduce GHGs from building, transportation and energy systems, integration of climate resilience into urban planning and infrastructure development and enhanced multi-level governance.
COP22 (Marrakech, 2016)	▪ Marrakech Partnership for Global Climate Action (MPCGA) encourages collaboration between national governments, cities, businesses and civil society to enhance climate action. ▪ "Human settlements" established as one thematic area for Climate Action Pathways to achieve MPGCA.	▪ Emphasis on multi-stakeholder partnerships and local leadership in driving climate action at the urban level.
COP23 (Bonn, 2017)	▪ Talanoa Dialogue process was initiated, aiming to facilitate inclusive and participatory discussions to enhance climate ambition. ▪ Precursor to the Global Stocktake, with shared aims.	▪ Emphasis on engaging local communities, promoting dialogue and incorporating diverse perspectives in urban climate planning and decision-making processes.
COP24 (Katowice, 2018)	▪ Focused on attempts to finalize the "rulebook" for the implementation of the Agreement—emphasis on transparency, accountability and monitoring of climate actions.	▪ Urgent need for robust urban data collection and reporting systems to track progress, mechanisms for evaluating the effectiveness of climate actions, and ensuring accountability in urban climate governance.
COP25 (Madrid, 2019)	▪ Emphasis on urgency of enhancing climate ambition to bridge the emissions gap and meet the goals of the Agreement. ▪ Recognition of the need for increased financing, technology sharing and capacity building to support climate action in developing countries. ▪ Parties to UNFCCC agreed on a five-year enhanced Lima Work Programme on Gender and a Gender Action Plan (GAP).	▪ Centrality of accessible climate finance to support sustainable urban development and gender considerations in climate action. Promotion of low-carbon infrastructure, and enhanced climate resilience in cities, particularly in vulnerable regions.
COP26 (Glasgow, 2021)	▪ Glasgow Climate Pact emphasizes "multi-level and co-operative action" and urgency of enhancing ambition of action and finance for mitigation and adaptation to address the gaps in implementing the long-term global goals. ▪ Establishment of the Glasgow–Sharm el-Sheikh Adaptation Agenda to promote immediate and tangible adaptation and resilience solutions (for Non-Party Stakeholders).	▪ Cities Race to Zero and Cities Race to Resilience campaigns established through the Sharm-el Sheikh work programme as opportunity to showcase action and drive ambition, according to city's contextually relevant local landscape.
COP27 (Sharm el-Sheikh) 2022)	▪ Establishment of L&D Fund. ▪ COP27 Presidency launched the Sustainable Urban Resilience for the Next Generation (SURGe) Initiative, developed in collaboration with UN-Habitat and facilitated by ICLEI. Endorsed by 70+ global partners. ▪ SURGe was officially launched at the Urban and Housing Ministerial Session on Cities and Climate Change at COP27. ▪ First Movers Coalition (FMC) launched partnership between the World Economic Forum and US Special Presidential Envoy for Climate to help decarbonize the world's heavy-emitting sectors through private sector demand for decarbonization technology.	▪ L&D milestone for urban climate justice but many critical operational and other issues unanswered. ▪ SURGe aims to enhance and accelerate local and urban climate action through multi-level governance, engagement. ▪ Cities will benefit from increasing investment and uptake of decarbonization technologies
COP28 (Dubai, 2023)	▪ First Global Stocktake (GST)confirmed that Parties are *not* on track to achieve ambitions of Paris Agreement. ▪ Parties agreed targets for Global Goal on Adaptation (GGA) and its framework. ▪ Historic agreement on the operationalization of funding arrangements for addressing L&D ▪ Closing Agreement signals the "beginning of the end" of the fossil fuel era by creating initial foundations for a just transition.	▪ Outcome document of first global stocktake. ▪ Important role and active engagement of non-Party stakeholders including cities and subnational authorities, as well as collaborative action strongly recognized.

Table 2.5 provides an indication of progress under the Paris Agreement with respect to multi-level action in the climate emergency response.

The contrast between the period before and after the Paris Agreement is remarkable, demonstrating its importance in galvanizing positive actions by local and regional governments

The contrast between the period before and after the Paris Agreement is remarkable, demonstrating its importance in galvanizing positive actions by local and regional governments under each heading in the table, from the declaration of a climate emergency to the adoption of ambitious 2030 targets and the increased involvement of subnational governments in their respective NDC processes. These milestones are considered in further detail in the chapter. Since 2015, cities and subnational governments have increasingly engaged in intergovernmental climate change processes, elevating their voices and influence, often through Member States and the international community.

Table 2.5: Taking stock of multi-level action and urbanization in the climate emergency response

Indicator	Before Paris (2015)	After Paris (2015-2023)
Local and regional governments that have declared a climate emergency	0	2,200+
Local and regional governments that have committed to ambitious 2030 targets	<100	1,000+
NDCs that have raised ambitions through the engagement of local & regional governments	N/A	60+

Indicator	Before Paris (2015)	After Paris (2015-2023)
Percentage of NDCs with strong urban components	N/A	24%
Relevant UNFCCC decisions	▪ 2010: COP16 "governmental stakeholders" ▪ 2013: COP18	▪ 2015: Paris Agreement "all levels of governments", "cities and other subnational as Non-Party Stakeholders" ▪ 2021: Glasgow Climate Pact "multi-level and cooperative action"
Inside UNFCCC	▪ 2007: LGMA Climate Roadmap ▪ 2008: European Covenant of Mayors ▪ 2009: Local Government Climate Lounge ▪ 2010: Parliamentarians and Mayors Forum ▪ 2013: ADP 2.3 Workshop, Ministers-Mayors Forum, ▪ 2014: SB40 Forum, NAZCA Portal, Lima-Paris Action Agenda, Compact of Mayors	▪ 2016: Global Covenant of Mayors ▪ 2016: Marrakech Partnership Human Settlements Action Pathway ▪ 2018: Global Environment Facility Sustainable Cities Integrated Programme ▪ 2018: IPCC Cities and Climate Change Conference and Action Agenda ▪ 2018: Cities and Regions Talanoa Dialogues ▪ 2019: SB56 COP Presidency Multi-level action event ▪ 2020: Cities Race To Zero ▪ 2021: Cities: Race To Resilience, RegionsAdapt, LGMA Multi-level Action Pavilion ▪ 2022: SURGe Initiative, Ministerial Meeting in Urbanization and Climate Change, IPCC AR6 Summary for Urban Policy Makers Action Event
Outside UNFCCC	▪ 2010: UNDRR Making Cities Resilient ▪ 2010: CBD Biodiversity 10Year Action Plan for Cities, Subnational Governments and other Local Authorities	▪ 2016: SDG 11, NUA ▪ 2018: Local2030, U20 as G20 Engagement Group ▪ 2019: GAP Fund ▪ 2020: MakingCitiesResilient 2030 ▪ 2021: G20 Localization Working Group ▪ 2022: Kunming-Montreal Global Biodiversity Framework Target:12, 2nd 10-Year Action Plan, U7 as G7 Engagement Group ▪ 2023: G7 Roundtable on Subnational Climate Action

Source: ICLEI, 2023.

As evident in Table 2.5, significant urban initiatives focused on multi-level governance have been launched alongside recent COPs, such as the Cities Race to Zero and Cities Race to Resilience campaigns at COP26, explained in further detail in Table 2.6 below. Since its launch in 2021, the Race to Resilience Campaign has grown considerably and as of 2023 included 647 collaborating members, as well as an array of subnational governments (86 cities and 78 regions) that had joined through Cities Race to Resilience or RegionsAdapt.[51] Meanwhile the SURGe Initiative, launched at COP27, aims to accelerate local and urban climate action through multi-level governance, engagement and delivery through five integrated tracks, contributing to achieving the Paris climate goals and SDGs. The SURGe Initiative was developed under the leadership of the COP27 Presidency in collaboration with UN-Habitat and facilitated by ICLEI through the Local Governments and Municipal Authorities Constituency (LGMA).[52] Indeed, advocacy and campaigning by city networks such as ICLEI have been central to the establishment and progress of these key initiatives. By 2023, over 180 partners had endorsed the initiative.[53]

Significant urban initiatives focused on multi-level governance have been launched alongside recent COPs, such as the Cities Race to Zero and Cities Race to Resilience campaigns at COP26

Table 2.6: Global climate action: Key initiatives underpinning the inclusion of non-party stakeholders

Initiative	Summary Description
Race to Resilience	▪ Overarching global campaign for catalyzing global ambition on accelerating investment and implementation of adaptation solutions. ▪ The principal goal of the Race to Resilience is to increase the resilience of 4 billion people living in vulnerable communities by 2030, via partner support, tools and resources.
Cities Race to Resilience	▪ Focuses on encouraging cities to join and pledge their commitment addressing climate change via the global Race to Resilience campaign, coordinated by the UNFCCC high level climate champions. ▪ Aims to foster leadership and support from cities, regions, businesses and investors to help frontline communities build resilience and adapt to the impacts of climate change. ▪ C40 Cities, CDP, GCoM, ICLEI, Resilient Cities Network, UCLG, WWF and the World Resources Institute (WRI) collaborated to mobilize and launch Race to Resilience in July 2021.
Race to Zero	▪ Global campaign launched by the COP26 Presidency and High-Level Climate Champions to foster leadership and support from businesses, cities, regions and investors committed to the Paris Agreement goal to hold global average temperature increase below 1.5° Celsius. ▪ Partners and members focus on progressing towards a resilient, zero carbon transition that prevents future threats, creates decent jobs, and unlocks inclusive, sustainable growth.
Cities Race to Zero	▪ City-focused track where cities are uniting to demonstrate their support for inclusive climate action in line with the goals of the Paris Agreement. ▪ Members pledge to reach net zero in the 2040s or sooner, or by mid-century at the latest, in line with global efforts to limit warming to 1.5° Celsius. ▪ Partners are collaborating to recruit 1,000 cities to the Race to Zero.
The 2030 Breakthroughs (mitigation)	▪ The Breakthrough Agenda was launched by 45 world leaders at COP26 and is a commitment to work together this decade to accelerate innovation and deployment of clean technologies, making them accessible and affordable for all. ▪ To kick-start this Agenda, countries endorsed goals and identified various “2030 Breakthroughs” that identify tipping points for key sectors of the global economy to achieve the race to zero emissions by 2050.
The Sharm el-Sheikh Adaptation Agenda (SAA) (adaptation)	▪ Global adaptation solutions agenda (for Non-Party Stakeholders) launched at COP27 outlining aspirational adaptation outcomes for global adaptation action towards 2030, and to inform state and non-state adaptation agendas. ▪ Aims to facilitate public-private collaboration and partnerships to address existing implementation, finance and planning gaps. ▪ Outlines near-term solutions for facilitating adaptation and resilience across all systems, in support of the goals of Race to Resilience.

Source: Based on report team’s review.

Since the Paris Agreement, advocacy by city networks has strongly supported multi-level governance and the increasing prominence of cities and subnational governments in COP negotiations and international fora addressing climate change

Since the Paris Agreement, advocacy by city networks has strongly supported multi-level governance and the increasing prominence of cities and subnational governments in COP negotiations and international fora addressing climate change. Table 2.7 provides a spotlight on COP28 key initiatives and endorsements which illustrates this increasing prominence, as well as the growing emphasis on NbS and gender considerations in pursuit of the goals of the Paris Agreement. Particularly notable for COP28 is progress on the loss and damage mechanism and the first global stock take (GST) of the Paris Agreement, which confirmed Parties are not on track to achieve its targets. Most parties in their submissions to the GST made specific references to multi-level action and urbanization. The launch of the Coalition for High Ambition Multi-level Partnerships is a further key mechanism to enhance cooperation between national and subnational governments in the development, financing, implementation and monitoring of climate strategies and action, enabling increased contributions from subnational governments in further enhancing NDCs. Despite these notable advances, cities and subnational authorities are still marginalized in formal COP negotiation processes.

Table 2.7 Key initiatives and endorsements on climate action from COP28

Global stocktake and local stocktakes	▪ First global stocktake of the Paris Agreement concluded at COP28: an official mechanism to assess progress towards 2015 Paris Agreement. ▪ In 2023, over 25 cities and regions across six continents (including 9 in the Global South) hosted "local stocktakes" under the banner of #Stocktake4ClimateEmergency, as subnational contributions to the GST, many of which were supported by youth communities. ▪ These facilitate consultations between national and subnational governments, as well as civil society, in preparation for NDCs and are supported by the LGMA (of which ICLEI is the key focal point).
Loss and damage	▪ Historic agreement on the operationalization of funding arrangements for addressing L&D.
Multi-level action	▪ Unequivocal momentum behind multi-level action: over 15 paragraphs in the COP28 UAE Consensus contain specific references to local and subnational governments, multi-level action and urbanization.
Coalition for High Ambition Multi-level Partnership (CHAMP)	▪ Launched by UAE COP28 Presidency and Bloomberg Philanthropies. ▪ Fosters multi-level governance and collaboration. ▪ Sets out new process for how subnational governments can contribute NDCS. Nearly US$500 million mobilized toward urban climate action. ▪ 70+ nations signed CHAMP for Climate Action.
Local Climate Action Summit	▪ First ever Local Climate Action Summit attended by over 300 subnational leaders. ▪ Signals new phase of collaboration between all levels of government.
NbS	Nature Positive for Climate Action Call to Action: ▪ Joined by over 150 businesses and financial institutions. ▪ Contributes to delivery of Sharm El-Sheikh Adaptation Agenda and the 2030. ▪ Breakthroughs, committing to nature focused targets, disclosure and investments. Urban Nature Program: ▪ Launched by diverse partners (including World Bank, UN Environment Programme (UNEP), ICLEI, WRI and the International Union for Conservation of Nature (IUCN) at the Local Climate Action Summit). ▪ Showcases lighthouse cities exemplifying global leadership. ▪ Focus on developing a pipeline of ambitious green urban infrastructure and NbS projects that address climate change.
COP28 Gender Responsive Just Transitions and Climate Action Partnership	▪ Major political achievement and initiative for enhanced recognition of gender perspectives in climate action. ▪ Endorsed by 78 national governments.

2.4. International Development Policy and Climate Financing: Implications for Urban Contexts

While the interconnections between climate change and urbanization are increasingly recognized, cities have highly inadequate climate funds for mitigation and resilience building.[54] The above-mentioned global agendas have been widely criticized for their lack of clarity and ambition on finance, particularly at finer urban scales. For example, while the Addis Ababa Action Agenda, SDGs and NUA recognize the need for widespread reform of global financial systems, they do not adequately consider what such reforms might entail in practice at subnational or city scales.[55] Critics argue that global agencies often lack the necessary commitment and capacity to drive transformation of financial systems to ensure that poverty reduction, social justice and equity are achieved on the ground across diverse urban, peri-urban and rural contexts.[56]

There are major gaps in urban adaptation finance, accounting for under 10 per cent of total climate finance from both the public and private sectors (as discussed in Chapter 9 in greater detail). Cities, municipalities and subnational governments have struggled to access and mobilize adequate financing to implement climate strategies, often due to mismatches between funders' requirements and subnational governments' financial needs. Diverse finance mechanisms such as municipal green bonds have received increasing attention over the past decade and are well documented in previous World Cities Reports.[57] The centrality of climate justice and inclusivity for such mechanisms have been increasingly emphasized as they continue to proliferate, particularly across urban Africa and Latin America.[58] This is critical to all emerging and mainstream urban finance mechanisms to avoid the production and reproduction of social, economic or environmental injustices embedded in the built environment.

There are major gaps in urban adaptation finance, accounting for under 10 per cent of total climate finance from both the public and private sectors

Mobilization of further private finance, particularly for urban adaptation, is urgently required.[59] As discussed in Chapter 9, a far larger share of climate finance at present is being directed towards mitigation than adaptation programmes: a major reason is that returns on urban investment are considerably lower and slower for adaptation than for mitigation activities (such as wind or solar power generation). More urban private financing can be supported through greater emphasis on "de-risking" climate finance led by government intervention and more supportive enabling policy environments, amongst other factors.[60]

A far larger share of climate finance at present is being directed towards mitigation than adaptation programmes: a major reason is that returns on urban investment are considerably lower and slower for adaptation than for mitigation

ODA plays a key role in bridging urban development and climate agendas.[61] The extent to which ODA and other financial flows for promoting climate action include explicitly urban components, and whether this represents a step change since the Paris Agreement, cannot easily be assessed without specific detailed research. ODA records focus predominantly on sector-specific funds disbursement with limited urban- specific details per country. Additionally, there is great diversity regarding how ODA flows are reported and presented. Besides, not all urban components are intended for disbursement to urban governments to spend; a substantial proportion is very likely to be spent by central government departments and agencies on urban issues.

Urban environmental and climate change issues have evidently become an increasing ODA focus by multiple countries. For example, in the case of the United Kingdom (UK), bilateral programming has included several significant initiatives in cities in Africa, Asia and other developing regions, spanning disaster-resistant planning, knowledge exchange and pro-poor resilience building.[62] By demonstrating donor confidence and sharing capital and/or operating costs, ODA plays a key role in de-risking private commercial investments through reducing the perceived or actual risks

Urban environmental and climate change issues have evidently become an increasing ODA focus by multiple countries

associated with investing in low- and middle-income countries. Thus, ODA helps to leverage greater financial flows towards climate action, including private sector investments, philanthropic contributions and multilateral climate funds.

Beyond direct provision of finance, ODA can play a critical role in urban resilience building through co-benefits such as capacity building and supporting the development of enabling legal frameworks, regulatory systems and institutional arrangements for facilitating climate action. This notwithstanding, the extent to which dedicated climate finance is additional to ODA in line with the UNFCCC's "additionality" clause[63] has been under increasing scrutiny, particularly in relation to adaptation activities.[64] Recent research found that "93 per cent of the climate finance reported by wealthy countries between 2011 and 2020 was taken directly from development aid" and "only three countries (Luxembourg, Norway and Sweden) have consistently surpassed the commitment to provide 0.7 per cent of their GNI as ODA as well as providing large per capita amounts of climate finance".[65]

There is little clarity on the specific urban component of this funding. Furthermore, estimates show that of the US$73.1 billion climate finance through the public sector via bilateral and multilateral channels in 2021, almost two-thirds (US$49.5 billion) were provided as loans, thereby risking further indebting urban local governments in low- and lower-middle-income country contexts.[66] Consequent debt-service repayment burdens may create additional pressures for cities to increase taxes or reduce public spending on essential services including healthcare, education and infrastructure projects, thereby inadvertently undermining climate resilience.

2.5 Loss and Damage through an Urban Justice Lens

Demands for climate finance and reparations from high income countries have gained traction in international climate negotiations, particularly over the past five years and most notably through the loss and damage mechanism. The momentous decision reached at COP27 to create the L&D Fund is a milestone for climate justice,[67] with considerable potential to address the unfair global financial system, which is short-term oriented, crisis-prone, and further exacerbates inequalities.[68] Chapter 9 explores the L&D Fund in more detail.

Only 3–5 per cent of adaptation finance is designated explicitly for urban contexts, thereby creating major barriers to adaptation action.[69] Thus, it is critical for L&D funds to be localized, accessible and equitably distributed to ensure that the most vulnerable regions and communities receive the necessary support. The earlier discussion about ODA funds—which will almost certainly include L&D disbursements—is thus relevant here too.[70]

Loss and damage occurs when attempts to reduce emissions are not ambitious enough and when climate change adaptation efforts are inadequate or impossible to implement, thereby leading to irrevocable

Only 3–5 per cent of adaptation finance is designated explicitly for urban contexts, thereby creating major barriers to adaptation action

harm.[71] The interlinkages between urban and rural areas require central attention in all climate planning and actions: "Without attention to the rural and non-urban spaces, the city cannot become sustainable or just".[72] Cities are at the forefront of loss and damage and in urban settings marginalized communities with inadequate infrastructure, housing insecurity, and limited access are disproportionately affected by climate-induced destruction.[73] Approaching loss and damage through an urban climate justice lens is thus vital for addressing these stark disparities and vulnerabilities faced by urban communities.

The formalization of climate justice elements through L&D is a major legacy of the Glasgow and Sharm-el-Sheikh COP summits.[74] Climate justice emphasizes that those least responsible for climate change often bear the brunt of its consequences. Loss and damage is fundamentally an issue of climate justice across countries and regions, generations, as well as within and between cities, where the most vulnerable are impacted the most.[75] The L&D Fund has considerable potential to assist urban communities experiencing climate-related impacts and losses; however, clearer guiding and implementation criteria are necessary to ensure equitable and just outcomes, particularly regarding "non-economic" loss and damage (such as the destruction of cultural heritage sites).[76] At the centre of these losses are issues of human rights, well-being and environmental sustainability.[77]

More effective and inclusive methodologies for assessing such often-intangible impacts are required.[78] Implementing dedicated assessments and appropriate financing mechanisms will help to rectify the major gaps in addressing non-economic loss and damage generated by both sudden and slow-onset events.[79] Several countries have recently begun to improve documentation of non-economic losses and develop risk retention instruments to address loss and damage used by slow-onset events. In 2019, for instance, the government of Fiji established a trust fund to finance the planned relocation for vulnerable communities in areas of the country that are highly exposed to extreme weather and slow-onset events.[80]

Displacement is an increasingly crucial urban dimension of loss and damage. One 2018 projection suggested that as many as 84 per cent of the world's fastest growing cities would be at "extreme" risk within the next 30 years, the majority of them in Africa and Asia, including a number of major commercial hubs such as Jakarta (Indonesia), Manila (the Philippines), Lagos (Nigeria) and Addis Adaba (Ethiopia).[81] Furthermore, cities globally are experiencing higher levels of in-migration due to multiple interacting forces, including climate impacts, creating new challenges for urban planning and service delivery.[82]

There is growing emphasis on migrants as critical "sustainability actors" supporting urban resilience building in destination locations

These challenges notwithstanding, there is growing emphasis on migrants as critical "sustainability actors" supporting urban resilience building in destination locations such as Sweden, where rates of volunteering in environmental protection organizations are higher among international migrants than among those born in the country.[83] However, social exclusion exists in parallel with sustainability engagement as migrants and refugees globally are confronted with limited access to citizenship rights and housing tenure, public provisions in health and finance and participation in urban decision-making.[84] For improved understandings of the urban dimensions of loss and damage, it is critical to adopt inclusive governance and rights-based approaches. This will also help ensure that the systemic injustices embedded in the development and climate finance landscape are addressed, with strong implications for international development policy.[85]

2.6 Societal Trends Across Scales

Several major societal and technological trends have intensified since the Paris Agreement, and these are often most pronounced and interconnected in urban settings. Key thematic areas include, but are not limited to: awareness and civil action (particularly linked to justice and equity); policy and governance; investors and business; energy and industry sectors; and information technology (particularly AI) and innovation. As detailed throughout this report, there are some notable positive shifts underway under each thematic area, yet benefit distribution is highly unequal within and across cities globally. Much more acceleration and scaling are needed to support climate-resilient societies.[86] While it is beyond the scope of the chapter to explore each in depth, the following sections focus on several trends in more detail, highlighting their cross-cutting nature.

Several major societal and technological trends have intensified since the Paris Agreement, and these are often most pronounced and interconnected in urban settings

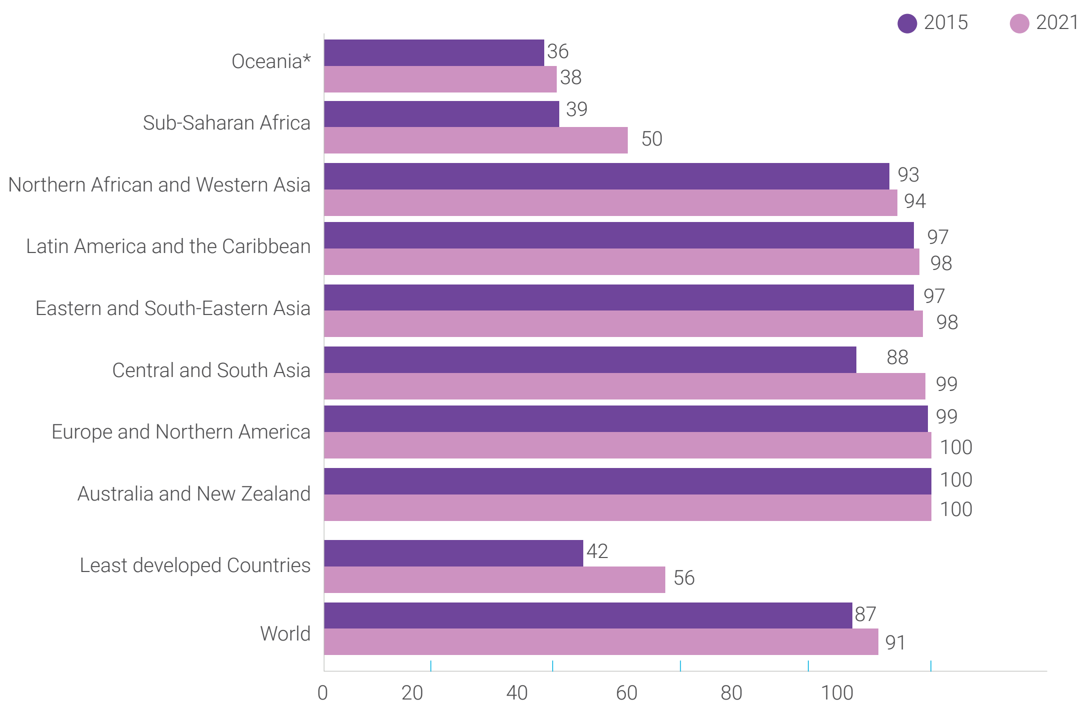
2.6.1 Accelerated electrification of society and its interlinkages

Energy is intricately connected to the ambitions of the Paris Agreement and the SDGs, particularly 7 and 11.[87] Figure 2.6 shows that access to electricity grew from 87 per cent of the global population in 2015 to 91 per cent in 2021. Nevertheless, as of 2021, 675 million people still lacked access to electricity, the majority (576 million) located in Sub-Saharan Africa.[88] SDG 7 ("Ensure access to affordable, reliable, sustainable and modern energy for all") has gained importance for local and regional governments since the start of the Russia-Ukraine conflict, with 23 per cent of local and regional governments in the global 2023 OECD-SDSN survey revealing it as a top priority, while another 57 per cent highlighted its increased relevance.[89] Directly linked to the Paris Agreement, transitions from fossil fuels to low- and zero-carbon sources of energy (44 per cent) and improving energy efficiency in the built environment (37 per cent) were identified as the two key priorities of local and regional governments to achieve SDG 7.[90] This picture is corroborated by the fact that under the Global Covenant of Mayors for Climate and Energy, over 10,000 cities globally have committed to reducing their emissions by a total of 24 Gigatons (Gt) by 2030.[91]

At the current rate of electrification, around 660 million people will still be without electricity by 2030, most of whom are in low-income countries, particularly in informal settlements

Despite steady progress, at the current rate of electrification, around 660 million people will still be without electricity by 2030, most of whom are in low-income countries, particularly in informal settlements.[92] In 2023 and for the first time, renewable energy—solar, wind, hydro and other sources—accounted for 30 per cent of global electricity generation (Figure 2.7), with solar and wind outpacing any other source of electricity.[93] Key clean electrification technologies are already making a significant contribution globally and expected to accelerate in coming decades. However, fundamental transformations linked to increased electrification remain highly unequal across and within countries, and particularly between formal and informal areas, and urban and rural settlements.[94]

Figure 2.6: Percentage of population with access to electricity, 2015 and 2021



*Excluding Australia and New Zealand

Source: United Nations, 2023c.

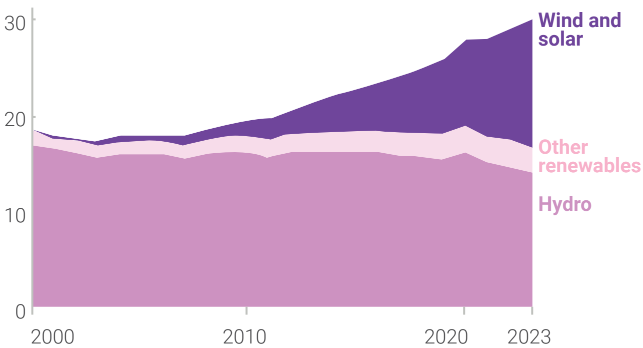
In the meantime, coal and gas still dominate, producing 61 per cent of global electricity in 2023.[95] Cities as major centres of GHG emissions are beginning to shift from fossil fuel-based to sustainably-powered electricity sources under the global just transition towards low carbon energy production.[96] For example, Basel and Reykjavik have reported meeting their goal of 100 per cent renewable electricity, on the path towards 100 per cent renewable energy.[97] Many challenges remain, such as inadequate investments for upscaling; the resilience of sustainable power systems is affected by the seasonality of supply and demand and extreme weather events which create infrastructure vulnerabilities such as blackouts.[98]

Cities as major centres of GHG emissions are beginning to shift from fossil fuel-based to sustainably-powered electricity sources under the global just transition towards low carbon energy production

While the decarbonization impacts of electrification are well documented at the regional and national levels, there is limited documented evidence on the impact of urban electrification on the sustainability of the current energy transition.[99] (Chapter 8 discusses innovations in renewable energy and technologies in more detail). Increased electrification represents and symbolizes a multifaceted societal transformation. From electric vehicles to smart infrastructure and renewable energy integration, this trend—which is increasing in cities across diverse regions, particularly mature economies such as the EU and US—is beginning to reshape residential areas, industries, transport and other sectors while contributing to global zero-carbon strategies to combat climate change.

Figure 2.7: Share of global electricity generation from renewable sources

Source: EMBER, 2004.



It was agreed at COP28 to double annual energy efficiency improvements by 2030, which will be central to delivering the full potential of economy-wide electrification. Rapid electrification of transport, heating and industry has significant potential to help reach global emission reduction targets and provide cost saving benefits through reduced energy waste. Electrification has been identified as a major driver of decarbonization across industries as the global power supply becomes cleaner: it is already playing a pivotal role in an array of smart cities where digital technologies are harnessed to enhance urban living and improve overall efficiency. Balancing such technological advancements with inclusivity, sustainability and effective governance remains a key challenge for smart city development globally.[100] Diverse cities including Buenos Aires, Johannesburg, São Paulo, Singapore and Sihanoukville have adopted people-centred approaches to these promising new tools, ensuring their adoption is underpinned by principles of inclusion, human rights and ecological sustainability.[101]

Electrification has been identified as a major driver of decarbonization across industries as the global power supply becomes cleaner

An added co-benefit of electrification and urban greening is job creation. A recent study of 74 C40 member cities revealed that 16 million green jobs have already been created across diverse sectors.[102] Electric scooters, bikes and motorcycles are shifting mobility patterns in cities globally, largely driven by the need to reduce CO_2 emissions and advancements in technology. For example, the Iskandar Regional Development Authority in Malaysia is addressing transportation challenges through the Smart Integrated Mobility Management System.[103] The integration and utilization of data collected through this portal will support evidence-based urban and transport planning. The shift to electrified transportation could also deliver significant benefits in terms of climate change mitigation. For example, there are an estimated 570 million two- and three-wheelers in Africa, Asia and Latin America, predominantly in urban areas. The majority still rely on internal combustion engines: converting them to electric power could lead to emission reductions of between 0.5 and 0.6 $GtCO_2e$ annually.[104]

The shift to electrified transportation could also deliver significant benefits in terms of climate change mitigation

2.6.2 Growing emphasis on Artificial Intelligence for supporting climate action

Advances in technology and innovation are evidently central to increased electrification and energy efficiency. Indeed, AI is becoming increasingly prominent in supporting diverse urban climate action, policies and societal trends set in motion by the Paris Agreement (Chapter 8). Globally, there is growing attention on the application of AI for climate action to support acceleration of the implementation of the Paris Agreement, particularly in cities.[105] AI has considerable potential to advance sustainable energy systems by fostering further development of clean technologies through a new phase of sci-tech innovation and transformation. In addition,

AI is becoming increasingly prominent in supporting diverse urban climate action, policies and societal trends set in motion by the Paris Agreement

Advances in technology and innovation should support climate action © Shutterstock

AI-powered models can provide early warning systems to inform communities about disaster events. AI algorithms can even predict energy demand and optimize grid operations, enhancing the efficiency and reliability of renewable energy systems.[106]

Investment in the AI sector is growing rapidly in Asia, Europe and North America and set to be worth more than US$1.8 trillion billion globally by 2030.[107] In 2023, the UNFCCC launched the Technology Mechanism as a significant initiative on the role of AI for supporting climate action. This has received growing engagement from diverse stakeholders interested in exploring the role of AI in scaling up transformative climate action, particularly in cities.[108] The initiative focuses on least developed contexts and SIDS. AI is also playing a growing role in supporting urban planning: for instance, the city of Durban has applied an innovative software developed by UNITAC Hamburg that uses deep learning technology to accelerate the spatial recognition of informal settlements and structures based on aerial imagery. As shown in Chapter 8, the application and benefits of AI are skewed towards cities in middle-to-high-income countries.

Investment in the AI sector is growing rapidly in Asia, Europe and North America and set to be worth more than US$1.8 trillion billion globally by 2030

The potential risks of AI application also require more attention; indeed, AI-powered mis- and disinformation has been identified as possibly the world's greatest short-term threat, with major gaps in readiness across diverse contexts.[109] Since 2018, the Cities Coalition for Digital Rights, which includes some 50 cities and organizations, has shared best practices and coordinated collaborative initiatives on AI, machine learning and big data applications for sustainable development and climate action.[110] There is growing attention to diversity and inclusion considerations. Some cities, such as Barcelona, New York and Amsterdam, have developed AI ethical frameworks in response to concerns around the impacts of these technologies on human rights and gender equality.

The centrality of integration between modern AI technologies and citizen science to embed people-centred approaches to urban climate action and DRR is increasingly recognized.[111] For example, at COP28 the Technology Executive Committee collaborated with the UNFCCC Local Communities and Indigenous Peoples Platform to co-convene a multi-stakeholder dialogue and showcase Indigenous and community-led technologies.[112] Relatedly, the digital divide between and within cities and countries is a pressing challenge, since globally marginalized groups with limited internet access and digital skills are underrepresented in data and experience limited benefits from digital technology expansion.[113]

2.7 Harnessing Nature-Based Solutions to Accelerate National and Local Climate Action

The interconnectedness between the climate emergency and global loss of nature and biodiversity is clear, with their scale and complexities increasing rapidly.[114] The principle of attaching monetary values to natural assets and ecosystem services to promote sustainability and NbS has become well established and widely applied, even though the practice has at times been criticized as simplistic, narrowly formulated and even unethical, particularly if used to provide a "business case" for the destruction of local environmental assets. Precise methodologies vary and the extent to which different stakeholders, and especially Indigenous or traditional knowledge holders, are involved in determining such values can be important in gaining wide acceptance in diverse urban settings. NbS are crucial for cities for enhancing climate resilience, improving air and water quality, and promoting overall well-being.

Nevertheless, the data analyzed for the 2023 analysis by UN-Habitat, UNDP and SDU of the urban content of NDCs discussed earlier in this chapter revealed that only 15 of the 129 NDCs with high or moderate urban content (Clusters A and B) mentioned NbS or green-and-blue infrastructure explicitly. Such mentions were brief and lacking in specificity so the significance is hard to assess. However, based on the other relevant evidence reported below, the NDC data are likely to underrepresent the actual importance of NbS within national and urban climate change strategies to achieve net zero.

Many cities now express their urban greening activities in terms of ecosystem services or NbS, whether in relation to mitigation (such as the provision of shade to alleviate the urban heat island), public health (increased access to physical activity and mental well-being) and/or biodiversity enhancement (through habitat restoration and the like). More recent conceptualizations include combining blue, green and brown components into an integrated "soft" infrastructural approach addressing land-based and water-based elements to maximize co-benefits, including active leisure locales and wildlife.

Many cities now express their urban greening activities in terms of ecosystem services or NbS, whether in relation to mitigation

These interventions are being adopted and expanded by cities and regions globally. For instance, Durban's Metropolitan Open Space System covers 33 per cent of the municipal land area and is central to the city's climate and resilience strategies.[115] Examples exist across developing countries, ranging from networks of blue-green infrastructure to reforestation, pocket parks, street trees and urban/peri-urban agriculture. These schemes vary in ambition, scale and complexity—hence the nature of appropriate governance—but key ingredients include cost-effectiveness, scalability and rapid demonstration of tangible results in tackling climate change, with additional co-benefits for poor and marginalized communities.[116]

City networks and other transnational actors have been active proponents of such actions, providing guidelines and examples of good practice and peer learning opportunities.[117] For instance, since its launch in 2021, more than 40 member cities have engaged in the C40 Urban Nature Accelerator: signatories pledge by 2030 to "increase the overall amount of nature to reach 30-40 per cent of the total built-up city surface area" and/or to "ensure 70 per cent of the city population has access to a green or blue space within 15-minutes".[118] The importance of such initiatives is more relevant than ever, given that urban green spaces as a share of total area and per capita have reduced in the past three decades, with severe consequences for carbon capture, pollution, public health and well-being (see Chapter 5).

Such initiatives as the Urban Nature Accelerator are consistent with the Global Framework for Biodiversity adopted at COP15 of the Convention on Biological Diversity,[119] the work of the Intergovernmental Panel on Biodiversity and Ecosystem Services, and the UN-Habitat *White Paper on Cities and Nature*.[120] The latter sets out key principles, actions and tools for maximizing the role and benefits of urban nature, while minimizing existing or future conflicts, including land-sparing measures to prevent future habitat loss. Other innovative examples include the ICLEI Urban Natural Assets for Africa programme, previously discussed in the *World Cities Report 2022*,[121] which established a network of participating cities to share lessons. The maintenance of positive dynamics beyond project funding is a key challenge and further reiterates the importance of ongoing city-to-city co-operation facilitated by such city networks. Central to these have been multipurpose NbS projects to make individual neighbourhoods more liveable.

Towns and cities in arid and semi-arid regions face particular challenges because of the more extreme conditions and water shortages that make many NbS and ecosystem services impracticable. In recent summers, cities in the Gulf region have experienced record high temperatures, with Kuwait perhaps the most extreme at over 50°C for periods. Under such conditions, planning to establish "15-minute neighbourhoods" (a compact, mixed use urban design approach covered in Chapter 5) would be problematic as this amount of time by bicycle or on foot would be impossible for most people. Similarly, in the Southwest of the US, several consecutive years of drought have depleted the Colorado River and Lake Mead, threatening both water and electricity supplies to the region: the scarcity has driven a fierce debate on the competing claims of urban and rural water consumers, underlining the sustainability challenge of rapid urban development in such an arid region.[122]

Towns and cities in arid and semi-arid regions face particular challenges because of the more extreme conditions and water shortages that make many NbS and ecosystem services impracticable

Implementation of NbS tends to be most successful when undertaken in people-centred ways that are culturally appropriate, socially inclusive and environmentally sustainable—including climate mitigation and/or adaptation elements. The evidence base on community experiences of NbS design and implementation has grown significantly since the Paris Agreement, including from low-income and informal settlements.[123] Recent NbS "niche" projects across three informal settlements in Nairobi and Dar es Salaam revealed that residents' perceptions and valuation of urban nature clearly shifted through co-design and co-implementation, thereby fostering community ownership and sustainability of NbS effectiveness.[124] Older residents, who are often repositories of Indigenous and traditional knowledge about NbS practices, can perform valuable services in guiding locally appropriate interventions such as shoreline mangrove restoration. Optimization of the effectiveness and impact of NbS also requires an integrated city- or metropolis-wide approach, with ecological elements integrated with traditional engineered or "grey" infrastructure where appropriate.[125]

Implementation of NbS tends to be most successful when undertaken in people-centred ways that are culturally appropriate, socially inclusive and environmentally sustainable

2.8 Private Sector Involvement in Urban Climate Interventions Since the Paris Agreement

The Paris Agreement calls for greater involvement of the private sector in climate action. The private sector has played an increasingly prominent role at successive COPs since 2015, particularly since COP26 when the First Movers Coalition (FMC) was launched, bringing together a collation of companies, corporations and other actors engaged in the development and promotion of low-carbon technologies.[126] The private sector is a critical source of expertise, innovation and resources under multi-level governance approaches for supporting urban climate interventions such as climate-smart infrastructure and insurance products.[127] The significant appetite for engagement from some parts of the private sector is demonstrated by the thousands of companies and investors who have already registered commitments on the UNFCCC Global Climate Action portal.[128] Private sector climate action in cities takes various forms, from investing in renewable energy and energy-efficient buildings to supporting sustainable transportation and waste management initiatives.

The private sector has played an increasingly prominent role at successive COPs since 2015, particularly since COP26

The private sector is a critical source of expertise, innovation and resources under multi-level governance approaches for supporting urban climate interventions

Despite these signs of progress, however, the pace and scale of action remains inadequate.[129] As evidenced in the well-established body of literature[130], private sector climate interventions have been largely mitigation-orientated to date. As the most recent IPCC report attests, evidence of private sector involvement in urban adaptation is weak: while the literature on private sector-led adaptation action at national scales is more developed,[131] there are major gaps in investment in adaptation at the local level, particularly in rapidly urbanizing countries.[132] One study of 402 cities worldwide found that adaptation efforts were focused principally on the public sector, particularly municipal premises, operations and housing stock, and considerably less on facilitating adaptation or behaviour change among private sector and civil society actors.[133]

Nevertheless, over the past decade there has been growing, albeit fragmented evidence of private sector commitment and action on urban adaptation and mitigation. Since 2015, public-private collaborations for climate action have played an increasing role in cities and take diverse forms.[134] These are emerging through formal bodies and public-private partnerships such as the innovative cycle network in Bogotá (Colombia)—a shared bicycle system in partnership with the company Tembici, with an innovative model utilizing public space.[135] A similar model is evident in Rwanda in Kigali's Imbuga City Walk—a 520-metre corridor comprising the city's largest car-free zone, developed by the local government and managed by a private company.[136] Other successful alliances include the Energy, Water & Waste Forum in Cape Town (South Africa)[137] or the Indian city of Pune's Electric Vehicle Cell, where collaboration between the city government, businesses and other stakeholders facilitates the achievement of climate goals.[138]

Over the past decade there has been growing, albeit fragmented evidence of private sector commitment and action on urban adaptation and mitigation

In support of adaptation, the municipal government of Rotterdam, the Netherlands, has increasingly focused on eco-innovation and partnerships with the private sector. One initiative sought to increase flooding protection through the construction of floating housings, with multiple co-benefits for diverse stakeholders including construction industries, technology firms and home owners.[139] Cities collaborating with the private sector on essential sustainable urban development projects have in some cases achieved multiple co-benefits while securing financing to support their climate goals. For example, between 2019 and 2023, Mexico City invested US$57 million in infrastructure into the Vallejo-I industrial area to catalyse mixed land use, expanded green spaces, increased densities and affordable housing.[140] The development helped promote business investment and relocation to the area, with over US$800 million in private investment from 300 small and large companies raised by the time the project was completed.[141]

However, private sector engagement in urban climate action has significant justice implications that should not be overlooked. The conflicting interests and potential risks of maladaptation that can arise from private sector-led climate action need to be addressed. For example, the latest IPCC report highlights rapidly growing evidence, particularly in North American cities such as Miami, Philadelphia and New Orleans, of real estate responses to flooding creating climate gentrification by displacing low-income residents and entrenching injustices.[142] At the same time, unregulated private development in flood-prone coastal cities in India has exacerbated flooding for some low-income communities.[143] Private sector climate investments and interventions need to form part of co-operative governance arrangements and rooted in locally-led considerations such as culture and accessibility to ensure inclusion of marginalized communities, persons with disabilities, women and children. Supportive enabling environments and partnership arrangements are key to facilitating this.[144]

2.9 Participatory Knowledge Co-Production to Advance the 2030 Agenda

The challenges outlined in the 2030 Agenda are complex and interconnected, requiring transdisciplinary approaches and collective action. By bringing together stakeholders from various sectors—governments, academia, civil society and the private sector—knowledge co-production processes enable the synthesis of scientific evidence, local knowledge, and practical experience. Emphasis on co-production for addressing climate change and related policy development in urban locales has become a prominent feature globally.

Co-production encompasses multiple forms of "deep" participatory multi-stakeholder collaboration that cut across sectors, disciplines and cultures to acknowledge the complexity, uncertainty and contested nature of urban development. These processes differ from conventional planning and implementation practice in two fundamental respects.

Emphasis on co-production for addressing climate change and related policy development in urban locales has become a prominent feature globally

First, a guiding principle throughout is that *all* stakeholders have relevant knowledge and experience of local conditions to contribute equitably to new urban planning and development interventions. Second, co-production should enable the eventual intervention to be far more locally appropriate and acceptable than conventional "expert-led" projects developed with minimal input from affected stakeholders. There is a growing body of supportive experience and evidence from urban areas of varying sizes and complexity in different world regions.[145]

The IPCC strongly emphasizes that since the Paris Agreement, civil society and private actors have emerged as central knowledge holders and drivers of experimentation, increasingly shaping and changing public policy in the process.[146] Participatory approaches to climate action help to ensure that the needs of all residents, particularly marginalized groups disproportionately exposed to climate change impacts, are properly considered. Locally-led urban adaptation and DRR approaches have proliferated globally, often supported by NGOs and city networks. One example is the DARAJA (Developing Risk Awareness Through Joint Action) community-led early warning initiative: having been piloted in Nairobi (Kenya) and Dar es Salaam (Tanzania) between 2018 and 2020, the programme is being scaled up across East Africa and linked to the UNFCCC's Race to Resilience Campaign.[147]

Since the Paris Agreement, civil society and private actors have emerged as central knowledge holders and drivers of experimentation, increasingly shaping and changing public policy in the process

Such approaches are increasingly based on hybrid coalitions consisting of multiple state and non-state actors, with intermediaries or "bridge builders" playing key facilitation and other roles.[148] There is growing emphasis on mobilizing local communities in supporting disaggregated and inclusive data generation and monitoring. For instance, informal community profiling supported by Slum Dwellers International's network and community organizations in Freetown (Senegal) and Dar es Salaam (Tanzania) helps strengthen capacity building and create increased visibility to city planners to ensure more informed, inclusive strategies.[149] The Resilient Urban Sierra Leone Project is a similarly innovative and participatory initiative supporting Freetown in the restoration of its canopy cover through community-based reforestation to address landslide risk and rising urban heat stress.[150] The project uses innovative digital tools such as the mobile based TreeTracker app, applied by communities as a monitoring system that incentivizes and tracks the growth of the vegetation planted through digital cash micropayments to participants who care for the new plants.[151]

2.9.1 The role of activist movements in urban action

Since the Paris Agreement, there has been growing emphasis on equality and inclusion in urban climate action, often spurred by activists, youth, Indigenous Peoples, academics and unions.[152] The rise of global climate

Since the Paris Agreement, there has been growing emphasis on equality and inclusion in urban climate action, often spurred by activists, youth, Indigenous Peoples, academics and unions

justice solidarity movements such as Fridays for Future and Extinction Rebellion, often centred in cities, has begun to influence policy debates by highlighting the urgency for transformative climate policies that address systemic injustices.[153] Such movements have also catalyzed an increase in localized youth-led climate actions and alliances across diverse regions, with their actions often concentrated in cities. Consequently, there is mounting pressure on local urban and subnational governments to be more accountable and increase the participation of historically marginalized groups in decision-making processes through more people-centred and equitable climate actions. In Canada, the National Adaptation Platform recognizes the importance of Indigenous knowledge in addressing climate impacts on Indigenous communities and ecosystems, with implications for urban governments. Similarly, in New Zealand, the Climate Change Commission has emphasized the need to engage with Māori communities and incorporate their perspectives into climate policy development. Furthermore, Nemonte Nenquimo, an Indigenous leader of the Waorani Nation, set a legal precedent for Indigenous rights in Ecuador by successfully suing the government in 2019 to protect 500,000 acres of Waorani ancestral territory in the Amazon rainforest from oil extraction.[154]

There is mounting pressure on local urban and subnational governments to be more accountable and increase the participation of historically marginalized groups in decision-making processes

Attention to gender and intersectionality in climate policies and actions across scales has increased significantly over the past decade. Since the Paris Agreement, cities globally have increasingly embedded gender-responsive approaches into DRR and climate resilience planning by applying gender-disaggregated data and analysis, setting clear goals and actions to improve gender equality and monitoring progress in gender-responsive budgeting and implementation of plans.[155] These gender-sensitive and equity-based adaptation approaches reduce vulnerability for marginalized groups across multiple sectors, including livelihoods, water, health and food systems across diverse countries in urban and rural settings. There are significant mentions of gender in 90 per cent of the most recent NDCs and 94 per cent of National Adaptation Plans of Action.[156] However, it remains to be seen to what extent these stated ambitions are realized on the ground. Indeed, studies across diverse contexts in East Africa, Latin America, the EU and elsewhere show that, despite explicit gender considerations within climate policies and urban plans, implementation remains modest. This is attributed to multiple interacting factors such as limited gender-sensitized policy staff, lack of political will and inadequate finance allocations.[157]

Since the Paris Agreement, cities globally have increasingly embedded gender-responsive approaches into DRR and climate resilience planning

2.10 Concluding Remarks and Lessons for Policy

This chapter has presented a reinvigorated call to urgent and transformative action across all fronts in pursuit of the commitments under the Paris Agreement. Climate change has emerged as a critical factor shaping international development policy, with widespread urban implications. Despite some progress, as evidenced throughout this report, the world is not on track to remain within the 1.5°C ceiling for global warming set by the Paris Agreement. Indeed, the latest estimates suggest that we may already have reached the 1.5°C threshold.[158] Initial progress on many of SDGs was set back and, in many cases, reversed by the combined effect of the COVID-19 pandemic and the impact of food and energy price increases triggered by the Russian-Ukraine conflict on livelihoods, economic activity and poverty levels.

Despite some progress, as evidenced throughout this report, the world is not on track to remain within the 1.5°C ceiling for global warming set by the Paris Agreement

The reduction in emissions witnessed during the COVID-19-induced lockdowns proved very short-lived, but the other effects are taking far longer to recover from, not least because of the diversion of local government funds into emergency coping efforts.[159] Whether the world might have achieved the 1.5°C or even 2°C targets without these crises remains a moot point, and all have considerable implications for the Paris Agreement. GHG emissions are rising again and driven by a wide range of factors, which include the lifting of mobility restrictions, the return to normalcy, the rebound of the global economy as well as unsustainable patterns of production and consumption, often in urban areas.

Clearly, urban issues have risen to prominence in international policy and agendas in the past decade, with considerable implications for climate action and development. However, more supportive enabling environments and enhanced assistance are urgently required, particularly in small- and medium-sized cities and informal settlements in low-income countries, in order to ensure achievement of the Paris Agreement and other global agreements. Key areas include effective local governance, data and monitoring and accessible finance.

Urban issues have risen to prominence in international policy and agendas in the past decade, with considerable implications for climate action and development

Policy related implications include, but are not limited to:

- Historically, COP negotiations and outcomes have not adequately addressed cities and other subnational entities, yet this has begun to shift. City networks play a significant role in ensuring that cities and subnational governments are recognized in international negotiations and agreements. Localization of global agendas has become more mainstream in sustainable development and climate approaches as cities are increasingly acknowledged as key arenas for effective climate action. The proliferation of local and subnational climate advocacy, action and policies is also redefining global climate politics across scales.

- The journey towards low-carbon futures is a shared responsibility, requiring collaborative policy and interventions across all scales. While countries are showing progress in their recent pledges, as evidenced by enhanced, higher-quality NDCs, the aggregate effect on global emissions remains disappointing and requires urgent action across all quarters, including increased mainstreaming of gender, youth, Indigenous knowledge and other considerations. Much more needs to be known about the role of urban governments in shaping and supporting the achievement of NDCs and linked policy developments.

- There are major gaps in urban climate finance from both the public and private sectors. Mobilization of further finance and restructuring of the existing financial architecture is urgently required at all levels to ensure that adaptation, mitigation and L&D receive new and additional funding. Furthermore, it is important that local governments and communities have direct and equitable access to allocated funds.

- Key societal trends such as electrification and AI have increased in scale and application in cities over the past decade. While resulting in many positive adaptation and mitigation impacts, their impacts are distributed highly unevenly across and within cities globally, with informal settlements in particular largely excluded from these benefits. Similarly, interventions to address climate change have inequitable implications, with potential for negative consequences for low-income and other marginalized groups: to prevent this, it is essential they are developed in a co-produced manner, with explicit focus on people-centred and inclusive approaches.

Endnotes

1 Dodman et al., 2022.
2 UN-Habitat 2022a, p.310; Climate Governance Commission 2023, p.55.
3 Dodman et al., 2022; Pauw & Klein, 2020; UNEP, 2021a.
4 UNDP & University of Oxford, 2024, p.13.
5 EU, 2024.
6 The World Humanitarian Summit is included for its significance in generating over 3,500 commitments to action and emphasizing the role of non-state actors.
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9 Ionescu et al., 2024.
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12 Altieri et al., 2016; Antwi-agyei et al., 2018.
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21 Climate Emergency Declarations, 2024.
22 Bulkeley et al., 2023.
23 UN-Habitat, 2023b, p.58.
24 UN-Habitat, 2023b, pp.58-59.
25 UN-Habitat, 2023b, p.60.
26 UN-Habitat, 2023b, p.60.
27 While variously defined, a widely accepted definition is: "serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts'" (UNDRR, 2016).
28 Simon, 2024, pp.37-38; Fraser et al., 2017.
29 Simon, 2024.
30 WHO, 2022.
31 Simon, 2024, p.39.
32 Simon, 2024.
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34 Bailey et al., 2023; Guo et al., 2024.
35 UN-Habitat, 2023b, pp.88-89.
36 UNDRR, n.d.a.
37 As such, did not form part of the original SDG monitoring and reporting system established by the UN.
38 Simon, 2024, pp.92-97.
39 UN-Habitat & UCLG, 2023.
40 UN-Habitat & UCLG, 2023.
41 UN-Habitat & UCLG, 2023; Ortiz-Moya and Reggiani, 2023.
42 NbS solutions and critiques are explored in multiple case studies throughout the Report.
43 Berrang-Ford et al., 2021.
44 UN-Habitat & UCLG, 2023.
45 UN-Habitat, 2024a.
46 Roberts, 2021.
47 United Nations, 2022e.
48 Ortiz-Moya and Reggiani, 2023.
49 The annual COP is the highest decision-making forum for UNFCCC implementation. Each year, UN Regional Groups appoint a national government as the COP Presidency, nominate the High-Level Climate Action Champion, and identify key themes for action and negotiation based on their national and regional priorities.
50 UN Environment, 2019; Brondizio et al., 2019; UNDRR, 2019; IPCC, 2019; Hoegh-Guldberg et al., 2018.
51 Race to Resilience, 2023.
52 ICLEI, 2023. The LGMA represents cities and regions in the climate negotiation process. ICLEI is the focal point for the LGMA which works on behalf of the Global Taskforce of Local and Regional Governments; a joint global policy advocacy initiative of the major international networks of local governments, working on climate-related issues
53 SURGe, 2023. It was also anchored in a resolution on "Enhancing Interlinkages between Urbanization and Climate Change" at the second UN-Habitat Assembly. Work packages for operationalization will be presented in early 2024.
54 UN-Habitat, 2022b, p.310; Climate Governance Commission, 2023.
55 Mitlin et al., 2018.
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57 UN-Habitat, 2022b.
58 Herrera, 2024.
59 OECD, 2023c.
60 OECD, 2023c.
61 Yap et al., 2022.
62 Yap et al., 2022.
63 The clause states that developed countries "shall provide new and additional resources to meet the agreed full costs incurred by developing country Parties in complying with their obligations under the convention" (UNFCCC Article 4 Commitments, p.3).
64 OECD, 2024b.
65 CARE, 2023.
66 OECD, 2024b.
67 Wyns, 2023.
68 United Nations, 2023c.
69 Richmond et al., 2021, p.17.
70 Boyd et al., 2021. Clear guidelines and transparent mechanisms are necessary to distinguish between urban adaptation and loss and damage financing, to prevent unintended consequences of depleting funds meant for proactive measures to cope with the irreversible loss and damage resulting from climate change impacts.
71 Bhandari et al., 2022; Serdeczny et al., 2024.
72 Pellow, 2022, p.16.
73 C40, 2023c.
74 Adger, 2023, p.142.
75 C40, 2023c.
76 Vousdoukas et al., 2022. Under the Loss and Damage Fund, countries responsible for high greenhouse gas emissions will compensate vulnerable countries suffering from these impacts, but details of how the fund will operate are still being finalized.
77 Roberts and Pelling, 2019.
78 Dodman et al., 2022.
79 Mechler and Deubelli, 2021.
80 United Nations, 2019b.
81 Irwin-Hunt, 2018.
82 Armiero et al., 2023.
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84 Chu and Michael, 2019; Fry et al., 2024; Kotsila, 2023; Romero-Lankao & Norton, 2018.
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90 OECD, 2024b.
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125 Frantzeskaki & Bush, 2021; McPhearson et al., 2022; Collier et al., 2023.
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151 Global Environment Facility, 2023.
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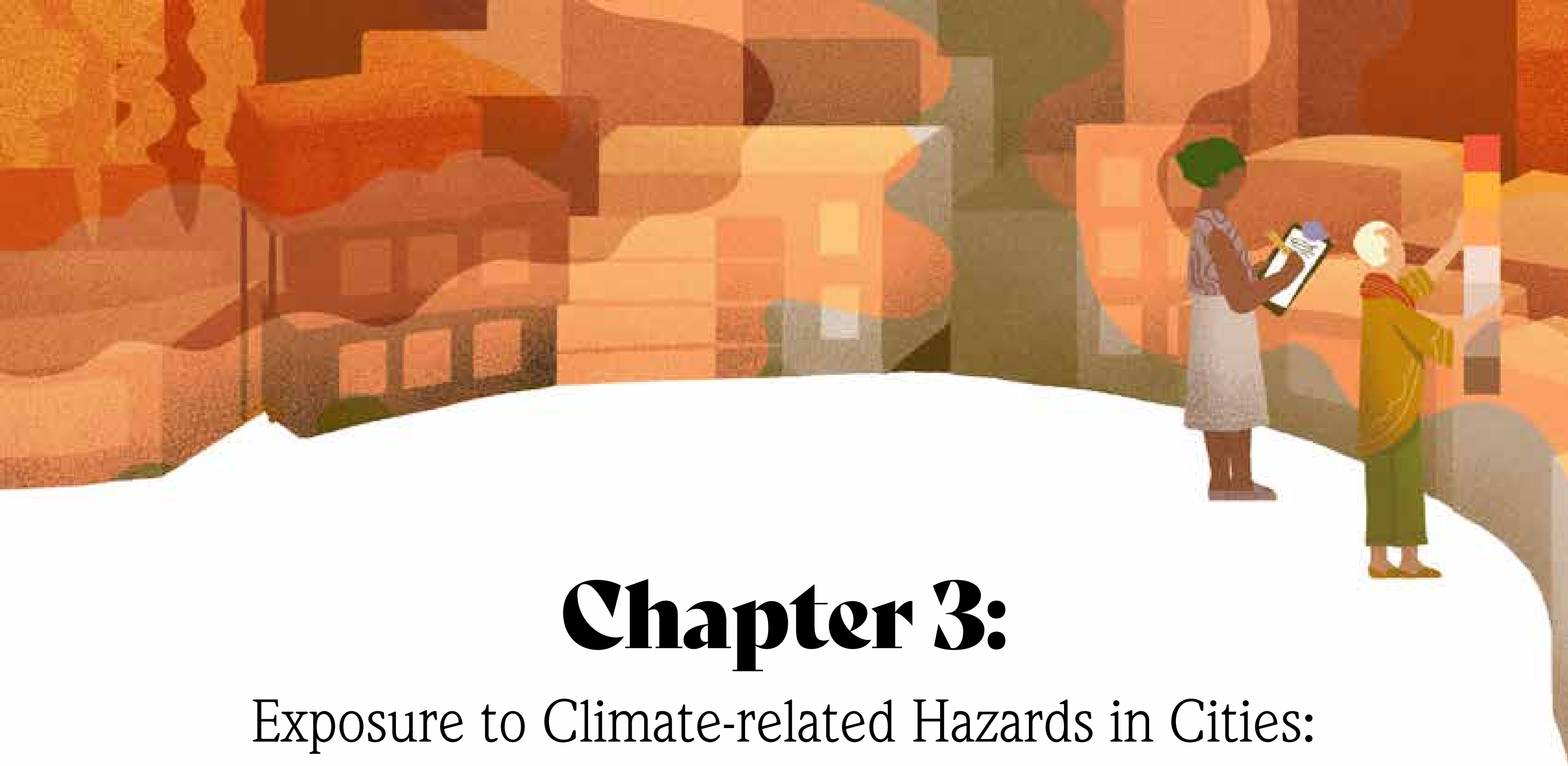
Tanner Springs Park, a remediated wetland and naturalized public space, in Portland, Oregon © Shutterstock



Chapter 3:

Exposure to Climate-related Hazards in Cities: Current and Future Trends

Quick facts

1. Climate exposure is increasingly urbanized, as urban exposure to climate hazards has grown disproportionally faster than exposure of people living in rural areas.

2. By 2040, more than 2 billion people currently living in urban centres could be exposed to at least 0.5°C temperature increase compared to current temperature.

3. The number of cities expected to change climate type between 2025 and 2040 varies from a minimum of 14 per cent in a low-emission context to 26 per cent in the worst-case projection.

4. By 2040, more than 2,000 urban centres will be located in low elevated coastal zones less than 5 metres above sea level.

5. As of 2025, areas prone to riverine flood events with 100-year return periods host about 1 billion people: of these, half are based in urban centres, 39 per cent in urban clusters and the remaining 11 per cent in rural areas.

Policy points

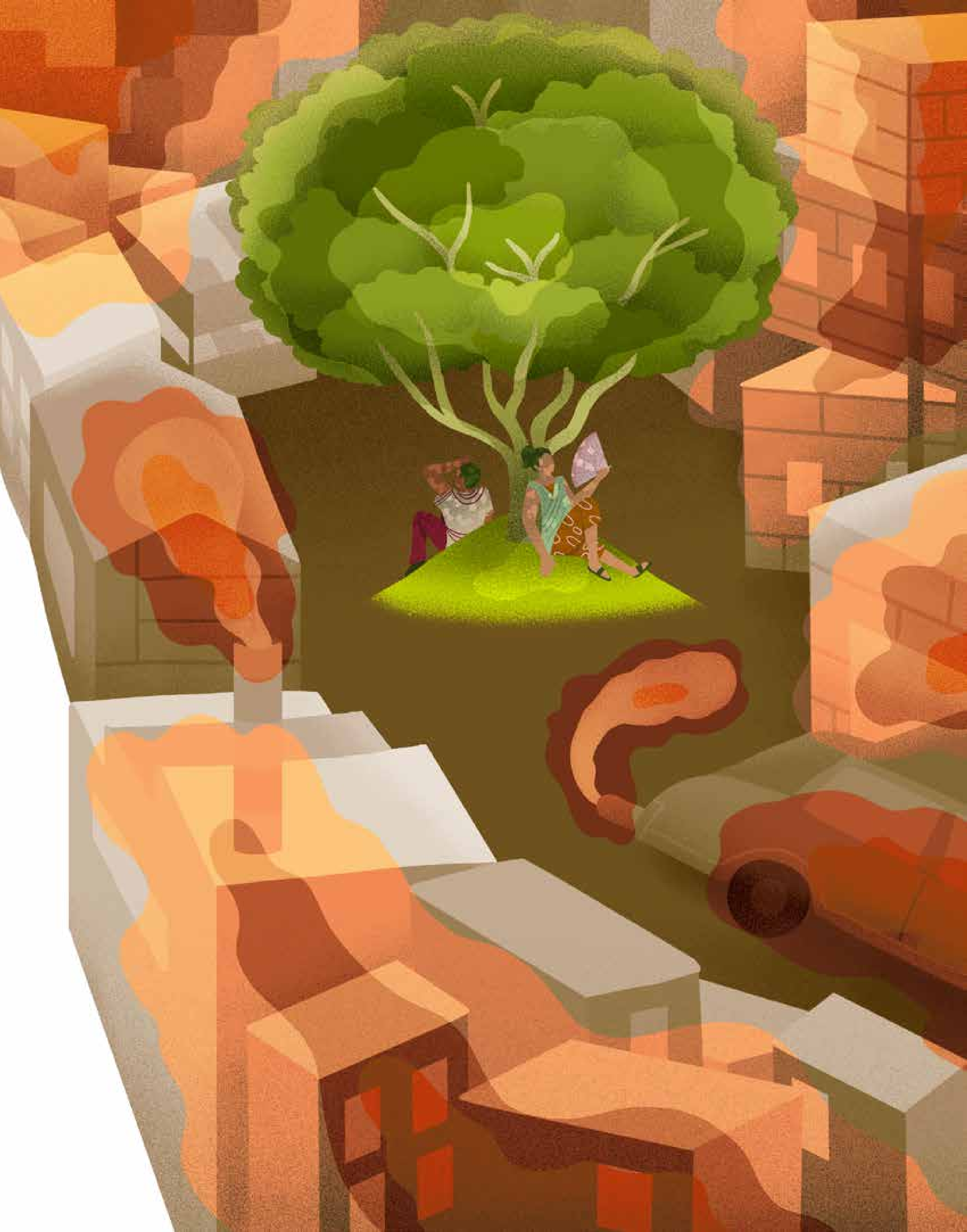
1. The difference in urban exposure associated with the policy measures shows that climate action implemented in cities today can lead to substantially lower levels of urban climate exposure.

2. The urbanization of climate exposure means that strategies to reduce vulnerability must be grounded in an integrated urban planning approach, rather than isolated actions that may unintentionally increase risks.

3. Closing the urban exposure and vulnerability data gap is critical for cities to effectively prepare for and respond to climate risks.

4. With the right resources in place, local authorities and other stakeholders could lead a data revolution that could transform climate action.

5. There is a need to transition from measuring exposure to assessing vulnerability to inform policy, supported by localized exposure and vulnerability assessments.



Cities are places of intense climate exposure. The way people, businesses, institutions and infrastructure concentrate in urban areas makes them vulnerable to climate shocks. A 2°C increase in global temperature by 2050 is likely to expose 2.7 billion people to moderate or high climate-related risks.[1] In 2023, the European Union (EU)'s Copernicus Climate Change Service already estimated that average temperatures that year were 1.48ºC above the pre-industrial average.[2] The effects, magnitude and impacts of climate extremes are increasingly being felt by urban inhabitants. To build resilience to these impacts, it is essential that practitioners and policy makers have access to comprehensive, globally consistent and updated information on exposure of people and settlements, the extent of hazards and the interplay of these factors to determine risk.

This chapter reviews the exposure of human settlements to climate hazards, by adopting a geospatial and data-driven approach. It focuses particularly on the exposure of *cities* (defined throughout this chapter as *settlements of more than 50,000 people*) and their inhabitants, in alignment with the Degree of Urbanisation methodology which facilitates international comparison between urban areas (see Box 3.1 for definitions and concepts). This chapter analyses human settlements at a global scale and over time, combining data from the Global Human Settlement Layer and other environmental, climatological and disaster risk-focused scientific sources. The scope of this analysis is not to review past and future risk engendered by climate change in cities, but rather to focus on the urban exposure to climate hazards. This chapter proposes a baseline estimate of the number of cities and urban population subject to changes in the climate exposure over the last three decades (since 1990) and projects changes in exposure up to 2040.

The findings outline the urgent need to translate global information characterizing human settlement into knowledge that is useful and relevant to local stakeholders engaged in climate action and policy at different levels, based on multi-thematic data from the Copernicus Programme, the United Nations Integrated Geospatial Information Framework, the Global Statistical Geospatial Framework, the Group on Earth Observation and other sustainable development policy initiatives.

Such knowledge contributes to the scientific evidence for global, multi-stakeholder initiatives like Early Warnings for All, the Climate Resilience Initiative and the Race to Resilience Campaign. Other programmes benefitting from these data work on adaptation, mitigation and climate resilience at various governance levels and territorial scales, as the other chapters and case studies in this report demonstrate. The chapter does not establish a direct relationship between exposure and risk: rather, it suggests to downscale and localize the analysis to support mitigation, adaptation and resilience building efforts.

The chapter explores several geographical scales and hazards, using the Shared Socioeconomic Pathways (SSPs),[3] which are climate change scenarios defined by the Intergovernmental Panel on Climate Change (IPCC). This chapter begins by providing an overview of the current urban climate exposure data gap, as well as the relevant international frameworks and concepts that are used in the methodology applied in this chapter. The following sections examine four different categories of climate exposure: exposure to temperature change, exposure to changes in climate type, exposure to sea-level rise and exposure to riverine flooding. Throughout, each section highlights how changes and shifts in exposures have significant implications on adaptation planning. The final section considers what can be done to further close the urban climate change exposure data gap, through the need to add vulnerability components and by localizing risk assessments.

3.1. Measuring Exposure to Climate Hazards

Cities are the places on Earth where population densities are the highest. While they occupy only 1.7 per cent of the world's surface,[4] urban areas currently host 57 per cent of the global population and collectively account for 70-80 per cent of anthropogenic air pollution.[5] Cities and other urban settlements are often located in hazard-prone areas like those exposed to floods, earthquakes, cyclones, tsunamis, coastal flooding, landslides and heatwaves, among others. Understanding the intersection between hazards and human settlements, including their population and physical assets, is key for effective disaster risk management. Data on climate exposure is needed to inform how policymakers, planners and practitioners in cities can best close the "adaptation gap": the difference between adaptation measures realized in cities and the societal goals that have been set.[6] This section of the chapter articulates the exposure data gap and the international frameworks and methodologies that are relevant to help close this gap in the subsequent sections of the chapter.

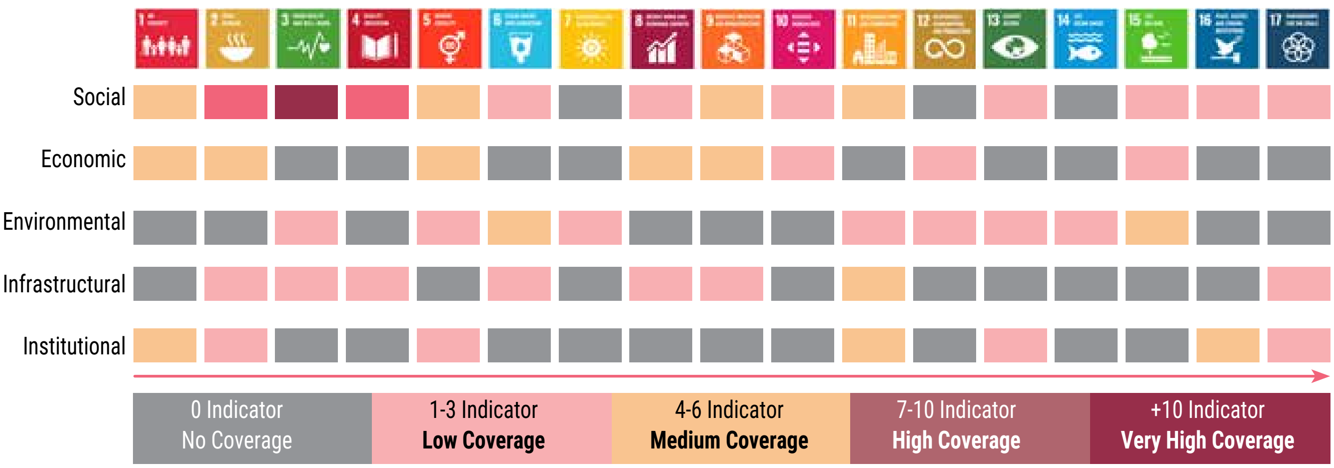
3.1.1 Data integration for climate action

Measuring climate exposure is fundamental to a wide range of global development agendas. The Sendai Framework for Disaster Risk Reduction calls for the need to understand disaster risk "in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment."[7] Such knowledge is critical for effective risk assessment, prevention, mitigation, preparedness and response. Disaster risk reduction plays a key role in the implementation of sustainable urban development, boosting the resilience of environmental and human systems across several domains.

The Sustainable Development Goals (SDGs) reaffirm the need for resilience and sustainability of human settlements (SDG 11), resilience of infrastructure (SDG 9) and broaden the approach to resilience of food systems (SDG 2), education (SDG 4), adaptive capacity to climate-related hazards and natural disasters (SDG 13), and several other SDGs across the social, economic, environmental, infrastructural and institutional domains (see Figure 3.1). At the same time, climate change poses a direct challenge to achieving the SDG targets. Figure 3.2 shows how up to 72 targets across 16 SDGs could be undermined by the effects of climate change.[8]

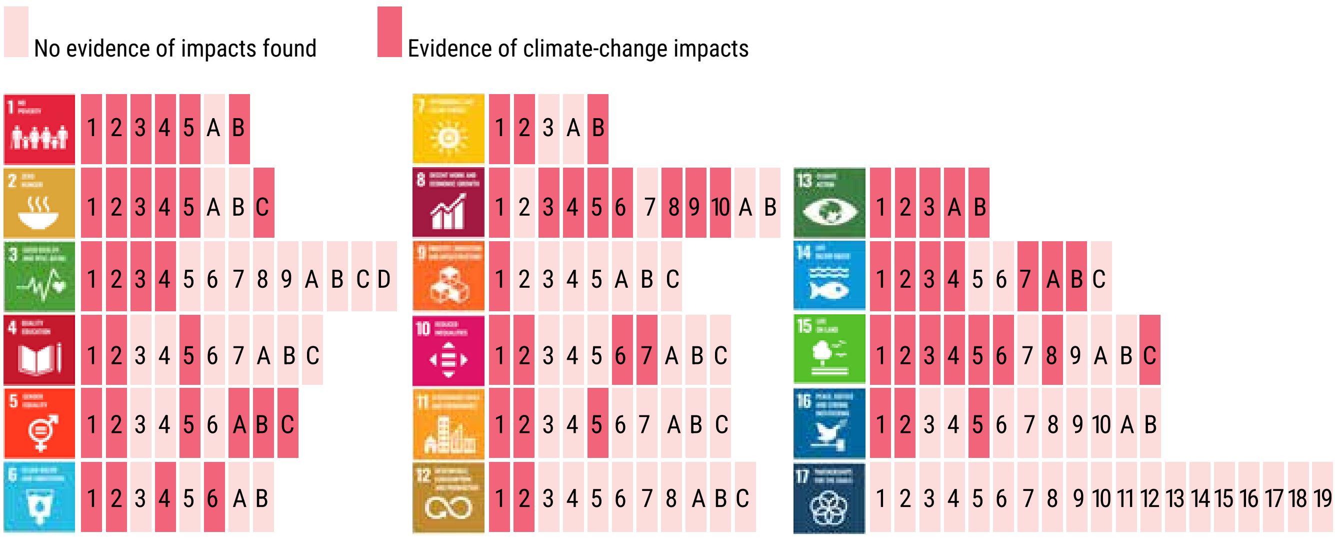
The latest UN DESA and UNFCCC series of reports (Seeking Synergy Solutions[9]) focus on how action to tackle climate change and achieve the SDGs can be accelerated by addressing them synergistically in policy frameworks. A key component of this synergy is the integration of knowledge and data for policymaking, particularly in an urban context. Data presented in this chapter show both the urgency and the magnitude of climate change and related hazards on cities, all over the globe, of any size and levels of affluence.

Figure 3.1: Categorization of the SDGs based on their coverage of resilience dimensions



Source: Assarkhaniki, et al., 2023.

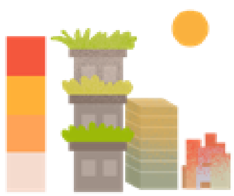
Figure 3.2: Interlinkage between climate change impact and SDG targets



Source: Fuso Nerini, et al., 2019.

The pivotal role of data integration for climate action builds upon work by the One UN Geospatial Network and the UN Committee of Experts on Global Geospatial Information Management, as well as scientific institutions engaged in policy support and various scientific networks. By integrating and sharing geospatial data among all stakeholders, both UN agencies and beyond, information like Earth observation data, added-value GIS products and other spatial data can be combined and used to monitor and analyse the intersection between cities and climate change. Even more important is the transformation of such data into a detailed mapping of climate-related hazards, exposure, vulnerability and risk.

A key enabler of the data presented in this chapter is the deployment of a harmonized international definition of urban areas, called the Degree of Urbanisation (Box 3.1). By defining human settlements into three main classes, it facilitates international comparisons and helps to harmonize



A key enabler of the data presented in this chapter is the deployment of a harmonized international definition of urban areas, called the Degree of Urbanisation

the definition of such areas, thereby overcoming one of the fundamental challenges linked to monitoring urban trends and global development agendas. Throughout the analysis in this chapter, *the primary focus is on cities within this definition*, though the data are cross-compared with those for *towns and semi-dense areas* as well as *rural areas* to give a comparative picture of developments globally and regionally in these different contexts.

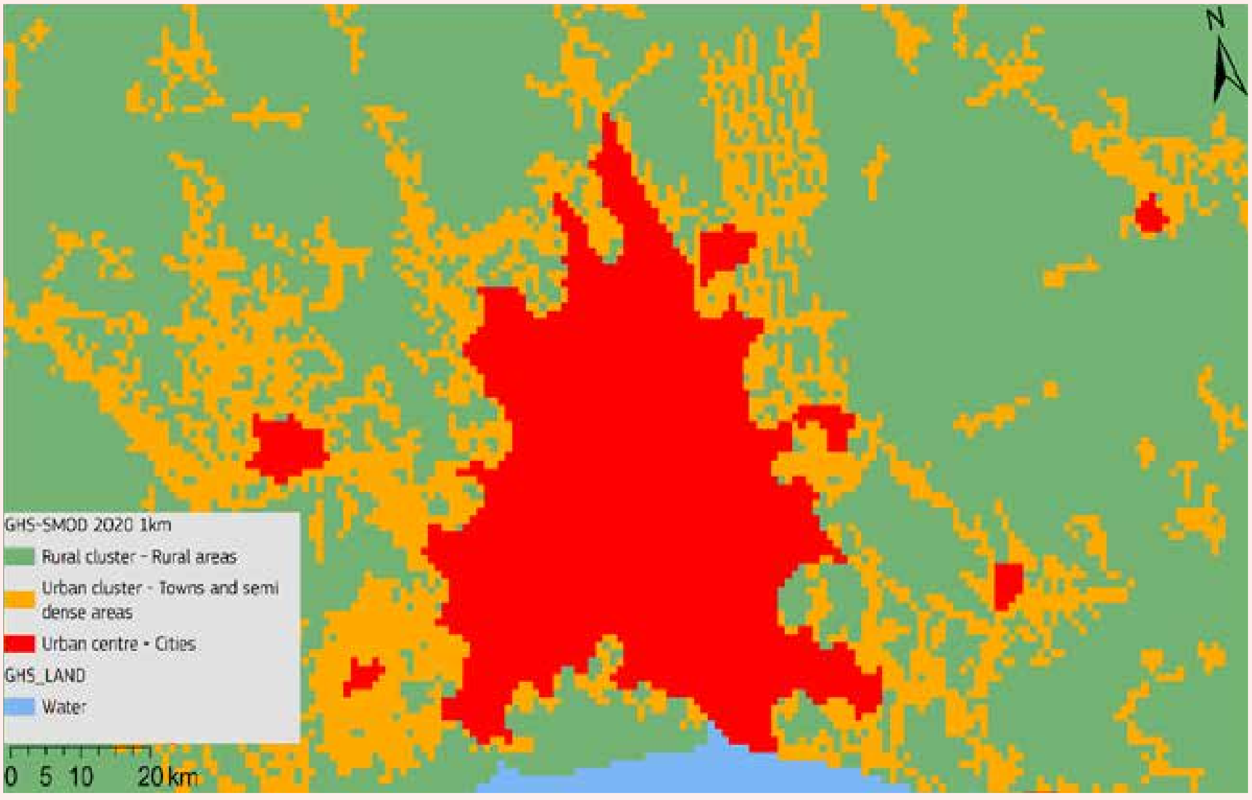
Box 3.1: Degree of Urbanisation: A tool for mapping cities

The Degree of Urbanisation has been explored in detail in the World Cities Report 2022. The uptake of this metric as a standardized definition offers a solution for international comparisons of urbanization. This classification system delineates three categories of human settlements:

- *Cities (also referred to as "urban centres" in some nomenclatural systems)*: settlements of at least 50,000 inhabitants in a high-density grouping of grid cells (greater than 1,500 inhabitants per square kilometre [sq. km.]).
- *Towns or semi-dense areas (also referred to as "urban clusters" in some nomenclatural systems)*: an area with at least 5,000 inhabitants in contiguous moderate-density grid cells (at least 300 inhabitants / sq. km.) outside cities. In the majority of countries that apply the degree of urbanization, this is typically the minimum threshold for an area to classify as urban.
- *Rural areas:* grid cells with a density of less than 300 inhabitants / sq. km. or higher density cells that do not belong to a town and semi-dense area or city.

By encompassing the entire urban-rural spectrum, in accordance with research and data evidence, the Degree of Urbanisation addresses a longstanding issue in monitoring urban trends and development agendas. The method is based on the simple criteria of population size and density by analysing grid cells of one square kilometre.

Visualization of cities, towns and semi-dense areas, and rural areas in 1 sq. km grids



Source: EU et al., 2021.

A second key aspect is the use the Global Human Settlement Layer (GHSL) produced by the European Commission Joint Research Centre, which provides a common global baseline of data on human settlements by combining Earth observation and population survey data and other thematic data (Box 3.1 and 3.2). Baseline data on exposure (people, settlement and assets like built-up surfaces) produced by the Exposure Mapping component of Copernicus GHSL[10] are crossed with hazard data coming from other scientific domains.

Box 3.2: The Global Urban Centre Database

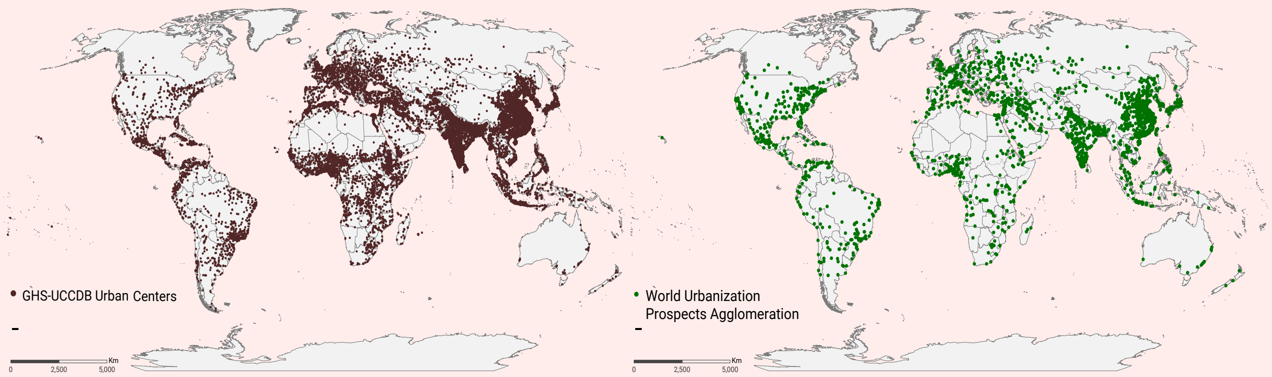
This chapter is supported by geospatial data on world human settlements derived from the Global Human Settlement Layer (GHSL) of the European Commission Joint Research Centre. GHSL produces global information on the distribution of population and built-up surfaces, as well as settlement classifications globally and over time.

Information on exposure to natural hazards requires the integration of several data sources: in the GHSL framework, this is accomplished in the Urban Centre Database (GHS-UCDB). The GHS-UCDB is produced by geospatial data integration, to characterize more than 11,000 cities with more than 50,000 people worldwide. The delineation of urban centres is based on the Degree of Urbanisation method. The database is multi-dimensional and multi-temporal, containing indicators relative to cities, organized in fifteen domains. It relies on five principles of standardization accompanying the definition of cities:

- Standardized definition of the areas of interest
- Consistent global mapping
- Spatially explicit delineation of cities
- Multi-thematic, multi-dimensional, and multi-temporal attributes
- Comparability of information in space and time

The map below shows the distribution of cities at global level (left), compared to the location of urban agglomerations contained in the World Urbanization Prospects (right), demonstrating that the GHS-UCDB captures urban areas much more comprehensively.

Comparative mapping of urban areas using Urban Centre Database and World Urbanization Prospect



Disclaimer:
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by The United Nations.
Final boundary between the Republic of Sudan the Republic of South Sudan has not yet been determined.
Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

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Final boundary between the Republic of Sudan the Republic of South Sudan has not yet been determined.
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Source: Melchiorri, 2022; Melchiorri et al., 2024; UN DESA, 2019b.

The IPCC Sixth Assessment Report made use of the 2019 GHSL release[11] to identify baseline exposure of people and built-up areas to climate impacts, combining mean sea-level rise scenarios with coastal population density, and built-up area and population with extreme heat and maximum precipitation.

The focus of the IPCC's analysis was on changes in climate hazards for global warming levels of 1.5°C and 3°C for the baseline period 1995–2014, combined with information on present exposure or vulnerability. Among the main conclusions, it was recognized with high confidence that the warming of the world is already affecting natural and human systems, but also that the impacts are distributed unevenly across economic sectors, regions and societal groups.

This chapter is able to provide in much greater detail the changes in exposure of cities.

3.1.2 Hazard, exposure and vulnerability

Effective people-centred climate action in cities relies on a detailed understanding of risk. It is only when the combination of most likely, and impactful risks are identified that climate action can be designed to address those most at risk. The IPCC has advanced a risk-centred assessment framework[12] that can better help policy makers understand the way in which climate risk is produced from the interplay of hazards, exposure and vulnerability (see Figure 3.3). It assesses climate-related risks by considering four key components:

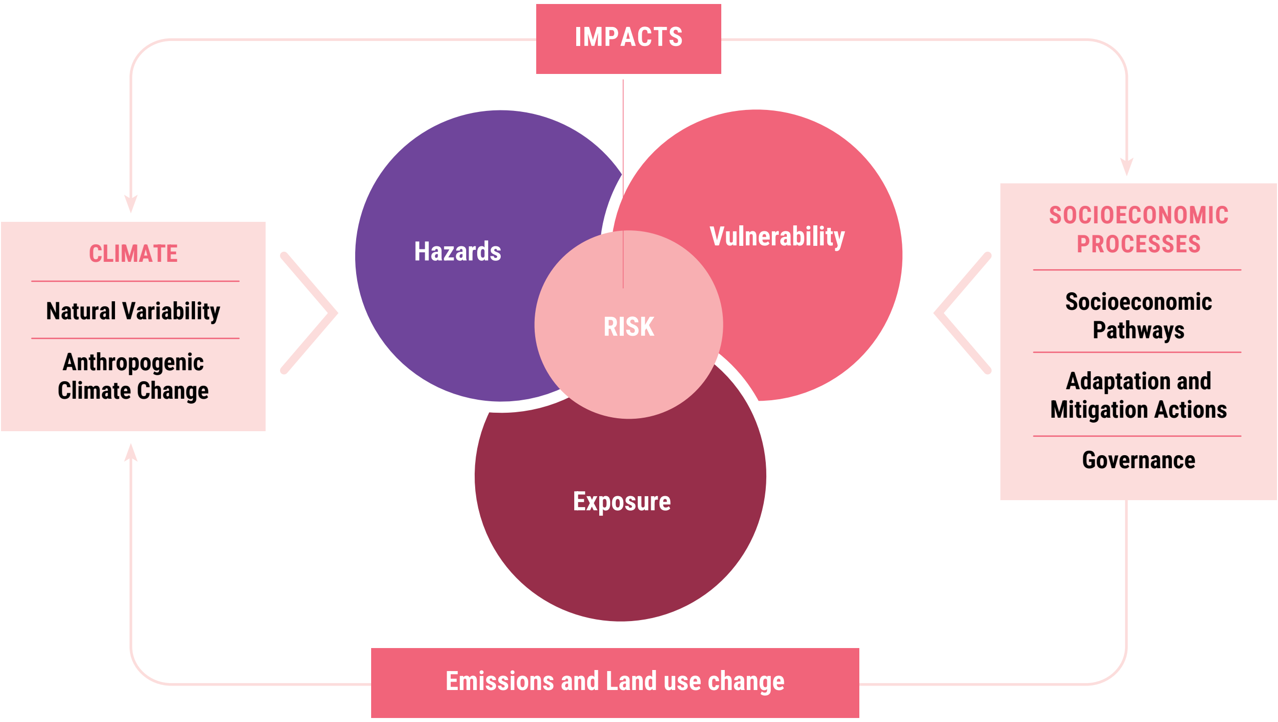
- *Hazard,* which is a potential situation or event that can cause harm, such as temperature increase or sea-level rise.

- *Exposure* refers to the presence of people, assets and systems in areas that could be affected by a hazard.

- *Vulnerability* is the propensity of exposed elements being affected, considering both their sensitivity and adaptive capacity.
- *Sensitivity* is a component of vulnerability as it describes the degree to which a system will endure a change in climate conditions, while adaptive capacity is the ability to adjust to climate-related stresses and respond to hazards.

Risk, then, is "the potential for adverse consequences" which results from the interaction between vulnerability, exposure and hazards and are often represented by the probability of a climate hazard multiplied by the impacts of that hazard. By understanding the relationships between these components, policymakers, researchers and practitioners can develop targeted strategies to manage climate-related risks and promote resilience.

Figure 3.3: The Intergovernmental Panel on Climate Change risk framework



Source: IPCC, 2014b.

It is important to highlight that there is no automatic causal link between urban development and risk. Urban development may create risk if it is not sustainably planned, and the degree to which climate risk may threaten urban development depends on a number of intersecting factors. Data figures presented in this chapter use data on climate hazards to estimate the urban exposure. Many attributes required to quantify urban vulnerability are not commonly available at a global level—an issue that the latter section of this chapter will return to.

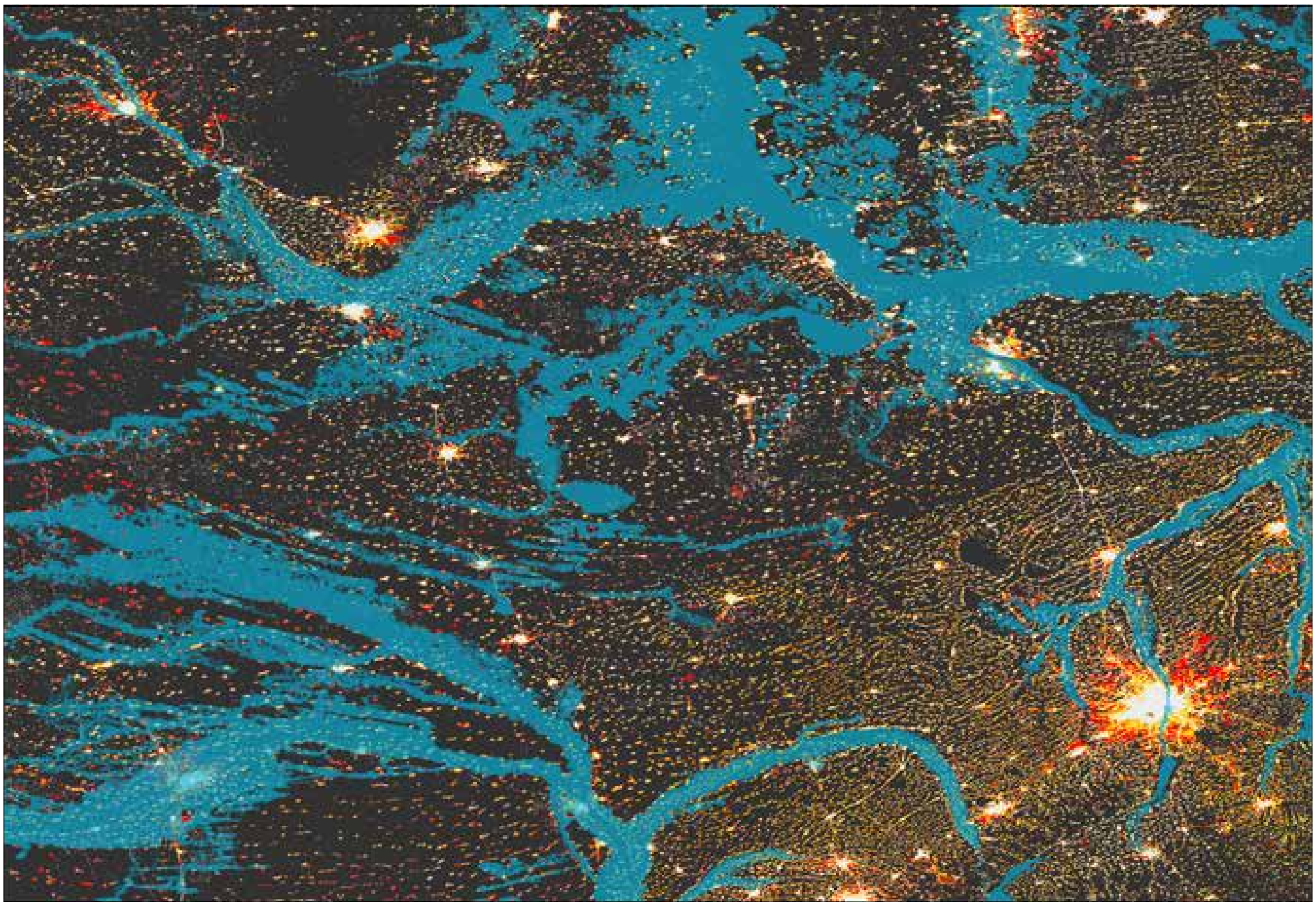
3.1.3 The urban climate impact and exposure data gap

While information about hazards has become increasingly available at various scales and for multiple hazard types, databases tracking disaster events and their characteristics such as location, severity, impacts, and loss and damages, are often not comprehensively available at global level, nor complete or comparable.

One of the sources of disaster events that has been widely used by researchers, practitioners and some policymakers is the International Disaster Database (EM-DAT).[13] EM-DAT inventories disasters worldwide and compiles a free database with 26,000 records covering the period from 1900 to present. Over this period, EM-DAT estimates about 4.5 billion people were affected by a multitude of disaster types. The types responsible for the largest share of affected people have been hydrological, climatological and drought events, affecting respectively 1.8, 1.7 and 1.6 billion people worldwide. People in developing countries have been particularly impacted by these disaster events.

EM-DAT records suggest that the relationship between the share of total deaths and affected people by disaster type is very different for climatological, hydrological and meteorological disasters versus geophysical ones (i.e. earthquakes). For the latter, the relative impact on human life is highest, with more than half the deaths accounted for in the EM-DAT database relating to geophysical disasters, even though more than 95 per cent of the affected people were related to climatological, hydrological and meteorological events. Figure 3.4 shows an example of how the spatial extent of a hazard overlaps with a wide range of settlements and settlement types.

Figure 3.4: Real-world data scenario of the intersection between hazard maps and human settlements dynamics



50km

Flood hazard
Flooded area
100 years return period

Built-up surfaces
1975
2000
2025
Non Built-up

The EMDAT figures on the number of people affected by disasters since 1900, mentioned above, remain at the national and global aggregated level due to the unavailability of global disaster data in geospatial format. Despite efforts by researchers and experts, EM-DAT data is only loosely linked to a subnational disaggregation (i.e. location name). This chapter takes a geospatial approach that is able to be much more precise in the urban disaggregation of climate exposure. While information contained in databases like EM-DAT helps to quantify the impacts of disaster events that have already occurred, the analysis of future exposure to hazards explored in this chapter is a key aspect for understanding future risk and is essential for anticipatory, adaptation and mitigation actions.

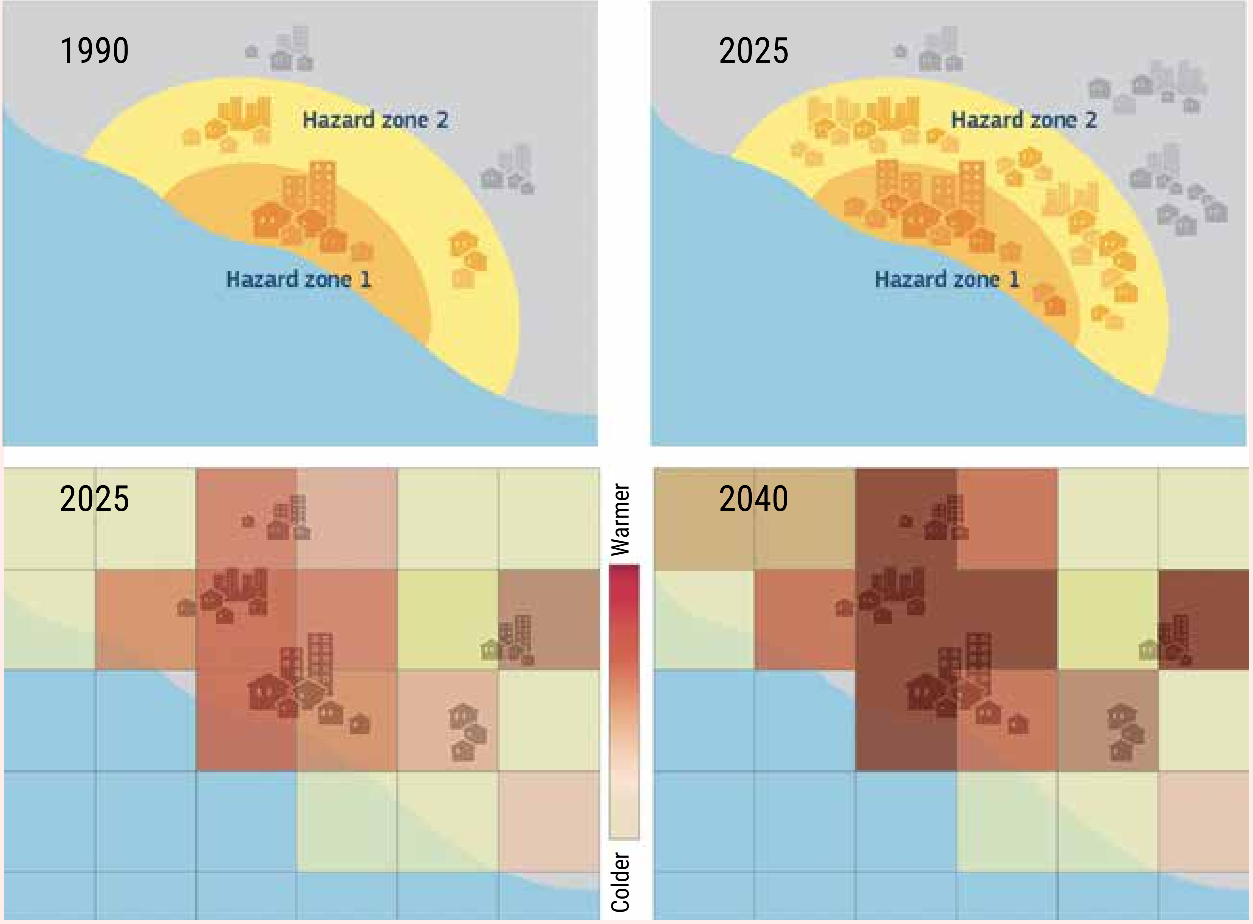
Further improvement to the implementation of the Sendai Framework for Disaster Risk Reduction (especially understanding disaster risk) can be boosted by enhancing the availability of comprehensive and harmonized global geocoded datasets on disaster events and attributes. This would allow a new generation of statistics to be compiled, one that allows the disaggregation between different degrees of urbanization to understand how settlements of varying size and characteristics are affected by disasters.

People can be exposed to climate-related risks in a wide range of ways. This includes exposure to extreme temperature, heatwaves, droughts, extreme precipitation, cyclones, wildfires, wind threats, river flooding, coastal flooding and sea-level rise. Lack of global harmonized and geospatial data on more hazard types (such as droughts) or specific manifestations (such as heatwaves) have narrowed the scope of this chapter, which looks at four exposure types: exposure to *temperature change*, exposure to *change in climate type* (including changes in humidity and aridity), exposure of *low lying coastal areas* (for both slow and rapid onset hazards like sea-level rise or tsunamis) and exposure to *riverine flooding*. The methodology that is used in this chapter to calculate the exposure further relies on concepts developed for the Atlas of the Human Planet 2017 (Box 3.3).[14]

Box 3.3: Methodological insights for the integration of human settlement and hazard data

The methodology employed in this chapter is developed from the conceptual framework of the Atlas of the Human Planet 2017. It relies on geospatial processing of high-resolution geospatial data at the grid level (various resolutions) and on the overlay between hazard extents (i.e. flood maps), and exposure datasets produced by the Copernicus Exposure Mapping Component of the European Union (EU) Copernicus Emergency Management Service, to quantify the number of people and built-up area exposed to the selected hazards. The graphics below illustrate abstract data scenarios of the intersection between hazard maps and human settlements dynamics over time. The upper panel show how an increase of exposure can result from the growth of populations and built-up areas into a hazard-prone area, while the lower panel shows how the extent of a hazard can change across time.

To advance disaster risk management with vulnerability precursor data, GHSL provides global information on human settlement infrastructure. Built-up surfaces are characterized in built-up typologies based on the combination of the number of floors and the building use. These features were obtained through processing of satellite imagery, based on linear regression techniques applied to global digital elevation models and morphological filtering.



Source: Ehrlich et al., 2018; Pesaresi et al., 2017.

3.1.4 Shared socioeconomic pathways

The severity of future climate change impacts on humanity is highly dependent on the policy choices and action undertaken today. The SSPs are a set of scenarios introduced in the IPCC Sixth Assessment Report that delineate greenhouse gas (GHG) emissions projections in relation to different sets of climate policies. They are used in this chapter to calculate the urban exposure to different climate hazards. SSPs are designed to span a range of challenges to climate change mitigation and adaptation; they are used to assess future exposure, vulnerability and challenges to adaptation based on levels of GHG mitigation (see Table 3.1).

The SSPs (summarized in Table 3.1) combine socioeconomic assumptions, levels of climate mitigation, land use and air pollution controls. Figure 3.5 shows the projected increase in GHG and temperature based on different SSP scenarios. In addition, Representative Concentration Pathways (RCPs) have been used in previous IPCC assessments that describe solely GHG concentrations, with no assumptions on socioeconomic factors. There are many RCPs, but below are highlighted five commonly used pathways (the analysis in this chapter uses RCP 4.5 and RCP 8.5):

- RCP 1.9: aims to *limit global warming to below 1.5°C*, which is the ambitious target of the Paris Agreement.
- RCP 2.6: characterized by its very *strict approach to emission reductions*, it represents the most optimistic RCP in that it envisions a sharp reduction in emissions from 2020.
- RCP 4.5: this is considered an intermediate scenario by the IPCC whereby *emissions continue to rise until 2040* and then reduce until 2080 before levelling off for the remainder of the century.
- RCP 6: this projects that *emissions reach their peak around 2080* before declining.
- RCP 8.5: indicates a *continuous increase in emissions throughout the 21st century* on the assumption of a worst-case scenario where no climate action is taken, resulting in very high emissions.

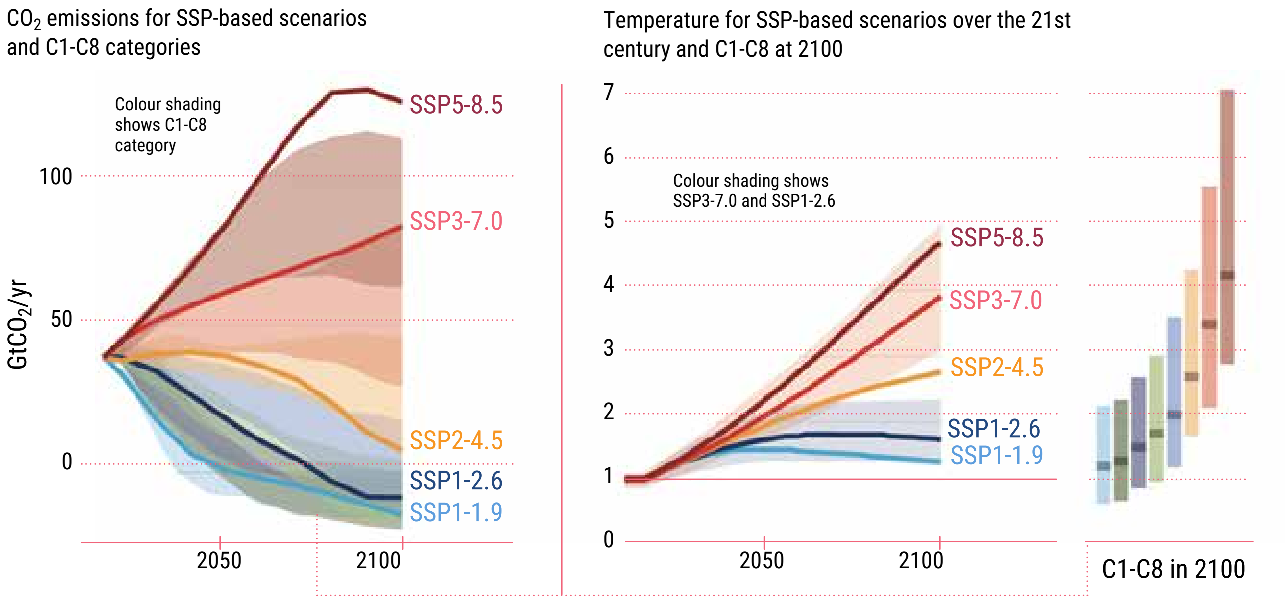
The figures presented in this chapter are based around these different SSPs and RCPs, depending on the way in which different geospatial data in other datasets on climate exposure have been made available. Numbers in this chapter are always presented with their corresponding pathway. For example, maintaining very low GHG emissions (SSP1: Sustainability) would only lead to 1 per cent of cities changing climate type by 2040, while this share triples under a very high GHG emissions trajectory (SSP5: fossil-fuelled development). It should be that within each pathway, there are a range of possible scenarios that could still occur: in some of the analysis in this chapter, multiple scenarios (SSP119, SSP126, SSP245, SSP370, SSP434, SSP460 and SSP585) are modelled to develop a representative picture of range of possibilities that could occur.

Table 3.1: Summary of key aspects of the Shared Socioeconomic Pathways

Shared Socioeconomic Pathways	Key Challenges	Policy focus and urban trends	Expected CO_2 and temperature trends
SSP1: Sustainability – "Taking the Green Road"	Low challenges to mitigation and adaptation	▪ Policy focus on sustainable urban development ▪ Effective multilateralism ▪ Reduced inequality ▪ Low consumption and population growth	Only scenario (SSP1-1.9) that meets the Paris Agreement
SSP2: "Middle of the Road"	Medium challenges to mitigation and adaptation	▪ Continues current urban development patterns	CO_2 emissions stabilize before falling mid-century, but do not reach net-zero until 2100
SSP3: Regional Rivalry – "A Rocky Road"	High challenges to mitigation and adaptation	▪ Policy focus on national security and barriers to international trade ▪ Increasing inequality ▪ Low population growth in developed world, high population growth in developing world	CO_2 emissions could be roughly double from current levels by 2100
SSP4: Inequality – "A Road Divided"	Low challenges to mitigation, high challenges to adaptation	▪ Policy focus on interests of the wealthy and elite ▪ Increasing inequality ▪ Low population growth in developed world, high population growth in developing world	
SSP5: Fossil-fuelled Development – "Taking the Highway"	High challenges to mitigation, low challenges to adaptation	▪ Policy focus on free markets ▪ High consumption and economic growth	Current CO_2 emissions levels roughly double by 2050

Source: based on Riahi et al., 2017 & Climate data for a Resilient Canada, n.d.

Figure 3.5: Projected CO_2 emissions and global temperatures for different Shared Socioeconomic Pathways



Source: IPCC, 2023c.

3.2 Cities and Temperature Change

Increasing GHG emissions are leading to higher temperatures around the world. According to data by the IPCC, global temperature in the first two decades of the 21st century was already approximately 1°C higher than in the period 1850–1900.[15] Depending on the policy choices that are being made, if current pledges are kept, then the planet would be on course for a 2.4-2.6°C temperature rise compared to pre-industrial levels by the end of the 21st century.[16] These rising temperatures result in heat stress and affect people in a wide range of ways, including the impact of sea-level rise (discussed in more detail in Section 3.5 of this chapter) and effects on shifting weather patterns. Heat stress is a rapidly growing health issue that also, through reduced productivity and threats to livelihoods, has severe economic impacts.[17] Warmer temperatures and the increased frequency and intensity of heatwaves can lead to higher demand for cooling, straining the electrical supply and potentially leading to grid failure and interruptions.[18] A better understanding of heat stress is therefore crucial for effective adaptation planning, particularly for people living in informal settlements.

The world continues to break heat records. The 12 months between November 2022 and October 2023 were "Earth's hottest on record", with an estimated 7.3 billion people exposed to temperature peaks for at least 10 days that were "strongly affected" by global warming.[19] By integrating data from the Copernicus Climate Change Service, it is possible to track the annual mean temperature in cities over long time periods. This section uses two Representative Concentration Pathways, namely the "mid-range" RCP 4.5 and the high-emissions scenario RCP 8.5, to gain insights into the temperature change in urban settlements of at least 50,000 inhabitants.

3.2.1 Temperature increases in cities since 2000

In the period from 2000 to 2025, more than 70 per cent of cities (circa 8,500) were subject to a temperature change of at least 0.5°C in the RCP 4.5 scenario, rising to 80 per cent (more than 9,700) in the context of RCP 8.5. Figure 3.6 and Figure 3.7 show that cities around the world are experiencing rising temperatures: no one can evade the impact of climate change. Within the broad category of rising temperatures, however, there is significant variation in the effects on different cities and across multiple climate scenarios:

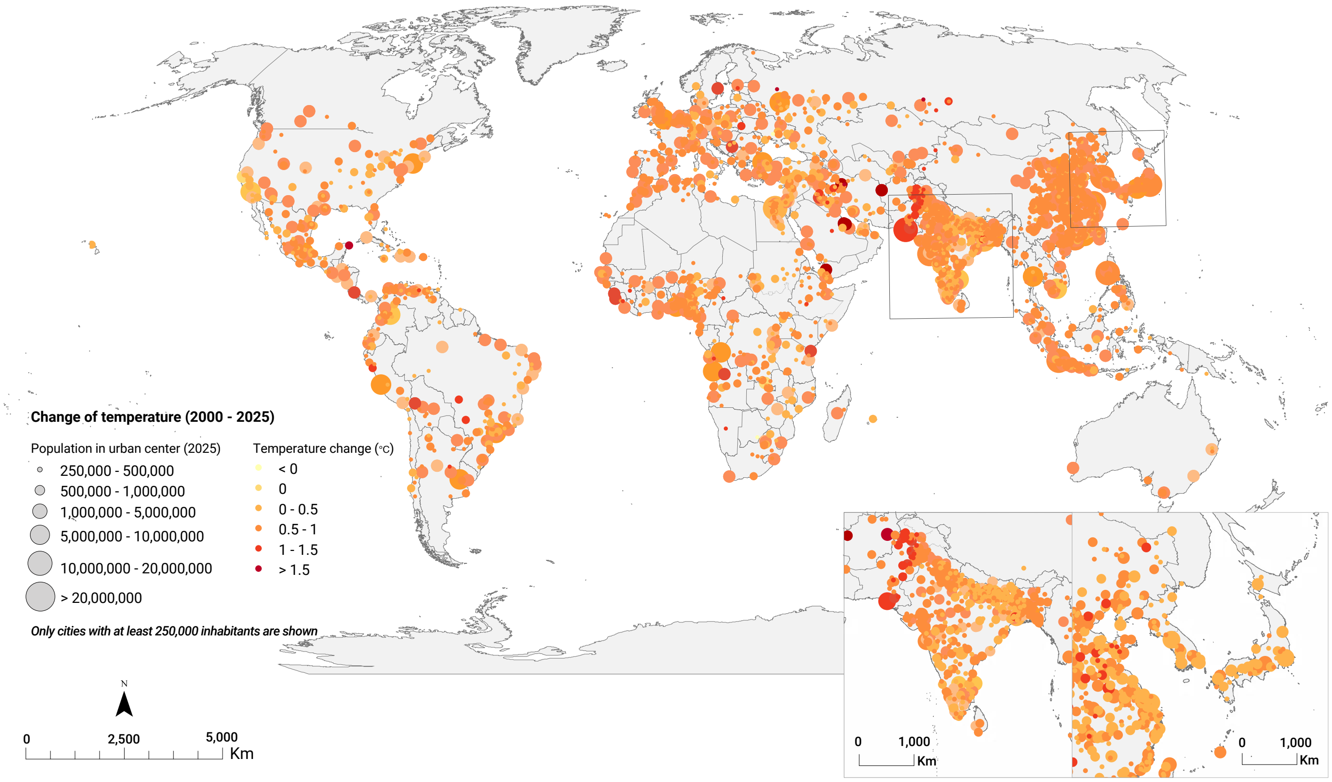
No one can evade the impact of climate change

Under RCP 4.5, at least 1 billion inhabitants of cities around the world (28 per cent) live in places that experienced a temperature increase up to 0.5°C, 2.5 billion (69 per cent) between 0.5 and 1.0°C, 78 million (2 per cent) between 1.0 and 1.5°C, and about 9 million people (0.25 per cent of the global population) more than 1.5°C in the last 25 years (Figure 3.7, left).

Under RCP 8.5, about 2,200 cities incurred a temperature change of at least 1°C since 2000, and almost 190 experienced more than 1.5°C (338 and 39 cities respectively under RCP 4.5). Under such a high emission scenario, 67 per cent of the population of cities globally faced a temperature increase between 0.5 and 1°C, 16 per cent (553 million people) between 1 and 1.5°C, and 1.5 per cent (55 million people) above 1.5°C in the last 25 years alone.

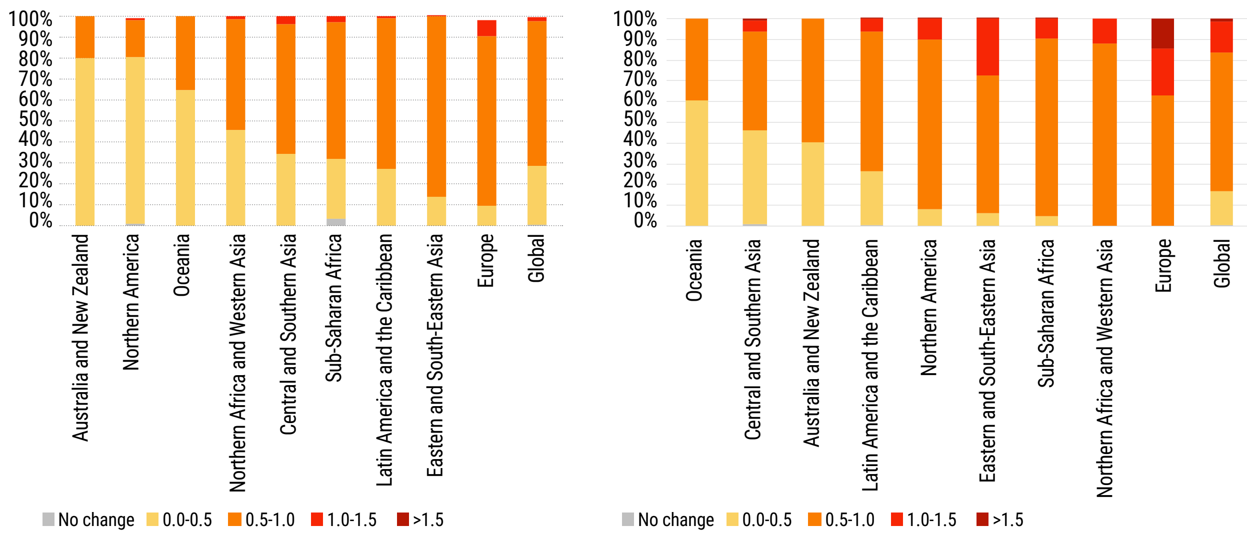
Figure 3.7 (right) breaks down this trend by region of the world: it highlights that, in a high-emission scenario (RCP 8.5), the share of residents of cities which face a high temperature increase (i.e. above 1°C in 25 years) is greatest in Europe (37 per cent) and Eastern and South-Eastern Asia (27 per cent). Across all regions, the proportion is significantly higher in comparison with the medium-emission scenario (RCP 4.5).

Figure 3.6: Global temperature increase in the period 2000-2025 under RCP 4.5



Disclaimer:
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by The United Nations.
Final boundary between the Republic of Sudan the Republic of South Sudan has not yet been determined.
Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

Figure 3.7: Share of population in cities experiencing warmer temperatures between 2000 and 2025, in different regions and under different climate scenarios: RCP 4.5 (left) and RCP 8.5 (right)



3.2.2 Increased exposure of cities

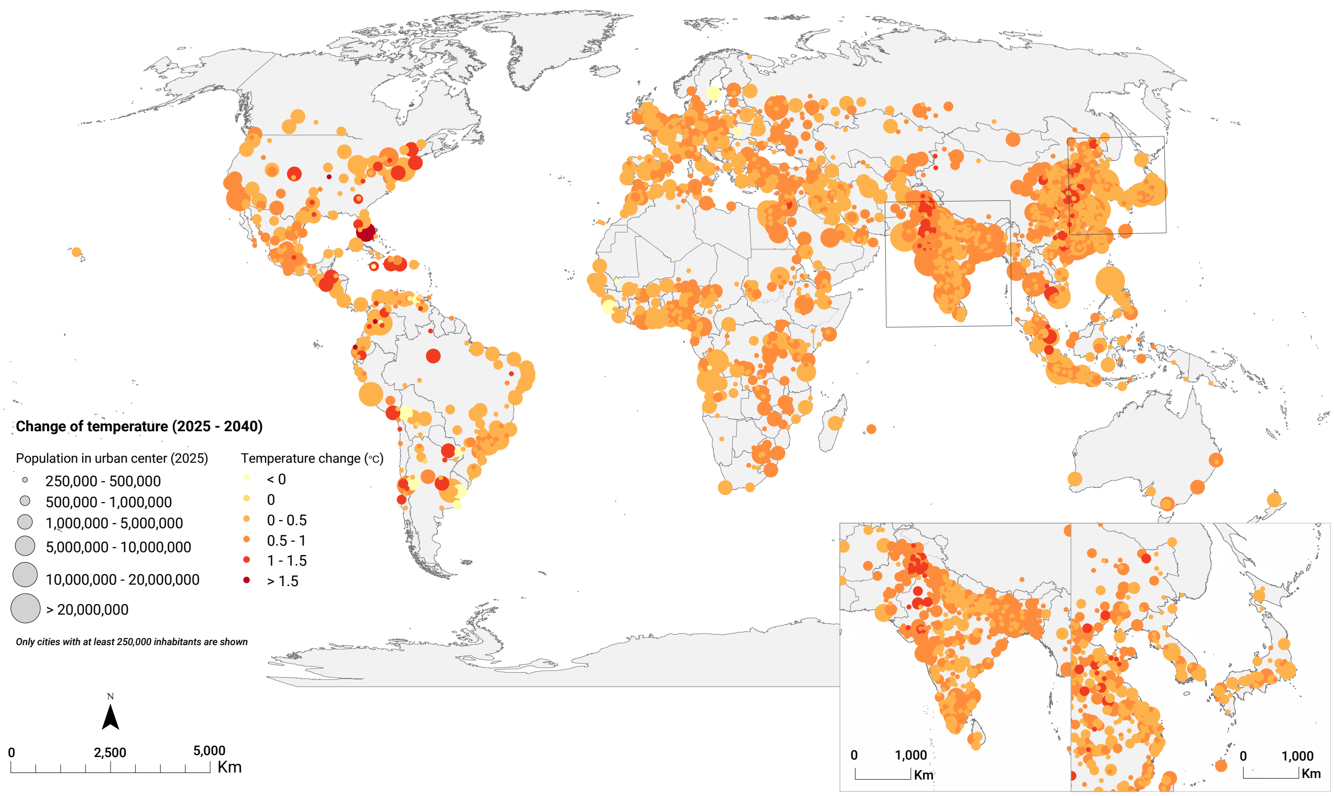
Shifting from historical patterns to future projections, it is expected that half of the world's cities in 2040 will be reaching a mean annual temperature of at least 0.5°C warmer compared to 2025. Of these, about 400 cities will experience a temperature increase between 1 and 1.5°C, while a few cities in North America could even see an increase of more than 1.5°C. In total, 3.7 billion people living in cities in 2025 would face a rise in temperature by 2040: this is almost the totality (over 99 per cent) of the current global population in cities. By 2040, in the most disruptive high-emission scenario, more than 2 billion people currently living in cities could be exposed to at least 0.5°C temperature increase. It should be noted that, as with other projections extrapolated as a relative share of the current city population affected by a particular impact by 2040, the figures are likely to be higher in practice if the global city population itself has increased by then, as is likely.

Figure 3.8 shows that most of the cities in North America would continue warming from 2025 towards 2040 (12 per cent would be warming up to 0.5°C, 43 per cent up to 1°C, and 41 per cent up to 1.5°C under RCP 4.5). With a high-emission scenario (RCP 8.5), about 60 per cent of cities (predominantly in Eastern, Central and Southern Asia) would experience an increase in temperature between 0.5 and 1°C by 2040.

Assuming a high-emission scenarios (RCP 8.5) and continued population growth (SSP3), an estimated 36 per cent of the global population living in cities would live in conditions with mean annual temperatures of 29°C or above. This is a full 6 percentage points higher than the exposed global population,[20] demonstrating that cities are disproportionally impacted by temperature increase. These data suggest that temperature increase in cities is higher than in rural areas—in other words, the data shows the *urbanization of climate exposure*, in which urban residents are disproportionately exposed.

Six megacities (cities exceeding 10 million inhabitants in 2025) in lower-middle income countries (Dhaka, Cairo, Kolkata, Karachi, Lahore and Lagos) and three in high-income countries (Tokyo, Osaka and Los Angeles) could be up to 1°C warmer by 2040. Five cities exceeding 5 million inhabitants today (New York, Chicago, Toronto, Luanda and Tianjin) could be between 1 and 1.5°C warmer by 2040.

Figure 3.8: Temperature increase in the period 2025-2040 under RCP 4.5 showing the global reach of temperature increase in cities



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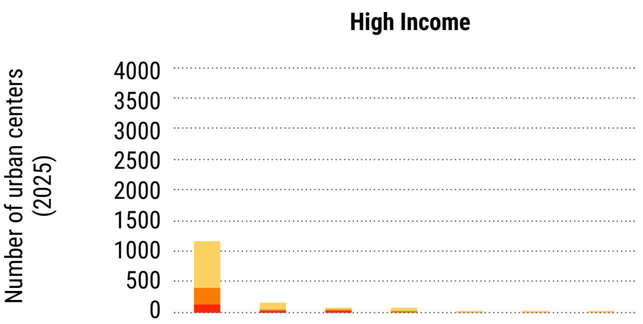
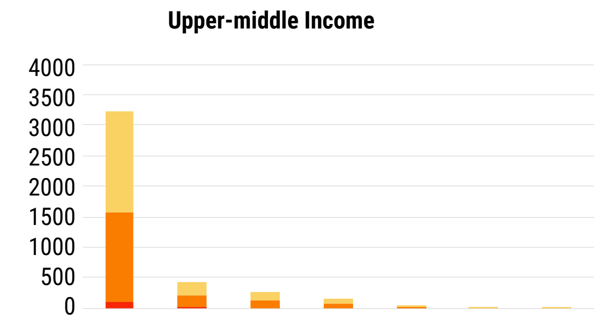
Final boundary between the Republic of Sudan the Republic of South Sudan has not yet been determined.
Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

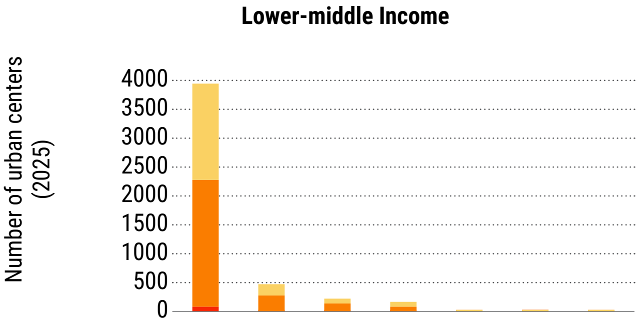
Figure 3.9: Temperature increase in the period 2025-2040 under RCP 4.5 of cities, by size and income group



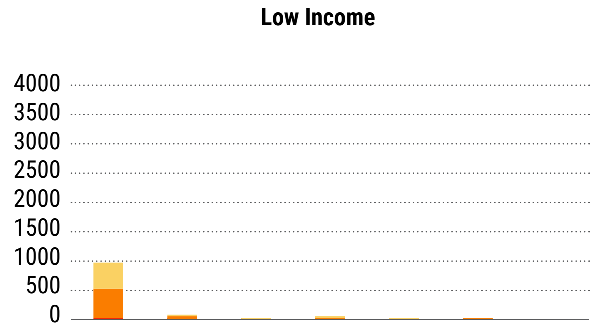
Temperature Increase(⁰C)	50k -250k	250k -500k	500K -1M	1M -5M	5M -10M	10M -20M	>20M
0.0-0.5	762	96	53	48	6	1	1
0.5-1.0	280	39	22	28	2	2	1
1.0-1.5	126	13	13	5	2	1	0
>1.5	8	2	1	0	0	0	0



Temperature Increase(⁰C)	50k -250k	250k -500k	500K -1M	1M -5M	5M -10M	10M -20M	>20M
0.0-0.5	1646	219	118	74	5	6	2
0.5-1.0	1483	194	132	76	10	4	0
1.0-1.5	94	15	7	4	1	0	0
>1.5	0	2	0	0	0	0	0



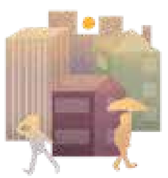
Temperature Increase(⁰C)	50k -250k	250k -500k	500K -1M	1M -5M	5M -10M	10M -20M	>20M
0.0-0.5	1682	199	88	77	6	3	4
0.5-1.0	2180	267	129	81	2	2	4
1.0-1.5	78	12	5	2	2	1	0
>1.5	0	0	0	0	0	0	0



Temperature Increase(⁰C)	50k -250k	250k -500k	500K -1M	1M -5M	5M -10M	10M -20M	>20M
0.0-0.5	464	46	12	11	3	0	0
0.5-1.0	488	49	11	23	1	1	0
1.0-1.5	28	1	2	0	0	0	0
>1.5	0	2	0	0	0	0	0

Temperature changes between 2025 and 2040 will affect cities with different population sizes (Figure 3.9). Cities in high-income countries have relatively higher rise in temperature (i.e. exceeding 1°C), but indeed many more cities also in developing economies will be experiencing temperature increases. This trend further undermines many aspects of human life already threatened by deprived living conditions.

It is estimated that cities facing up to 0.5°C temperature rise by 2040 host almost half of the population in cities (under RCP 4.5), slightly less between 0.5 and 1°C, and up to 4 per cent of the population in cities will experience temperature increase between 1 and 1.5°C (Figure 3.10) by 2040. This latter share rises to 10 per cent with a high-emission pathway. Figure 3.11 compares the absolute amount of population exposed to temperature increase for the mid-range (left) and high-emission pathways (right). The difference is significant, and RCP 8.5 would expose an additional 400 million urban residents to temperature increase between 0.5 and 1.0°C, and more than double the exposure to temperature increase between 1.0 and 1.5°C. The regions of the world most exposed to significant temperature increase (in an RCP 4.5 scenario) would be Eastern and South-Eastern Asia (1 billion people), Central and Southern Asia (900 million), Sub-Saharan Africa (475 million), Latin America and the Caribbean (345 million), and Northern Africa and Western Asia (345 million).



Just 1 per cent of the population in cities globally will be spared temperature increases

Of today's population living in cities, 4 per cent will experience warming above 1.0°C, primarily located in high-income countries (Figure 3.10). Almost all residents in cities, however, are expected to experience higher temperatures to some degree: indeed, it is expected that just 1 per cent of the population in cities globally will be spared temperature increases (Figure 3.11).

Figure 3.10: Percentage of global population in cities affected by different temperature increase, 2025-2040 (RCP 4.5)

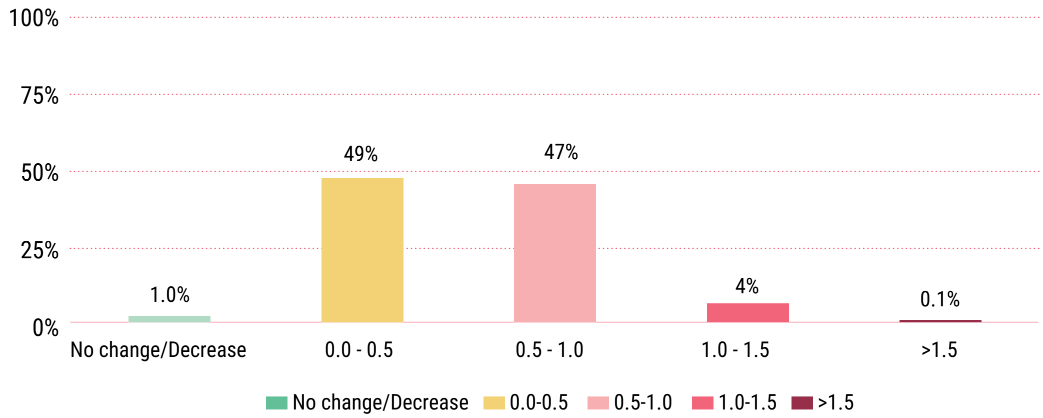
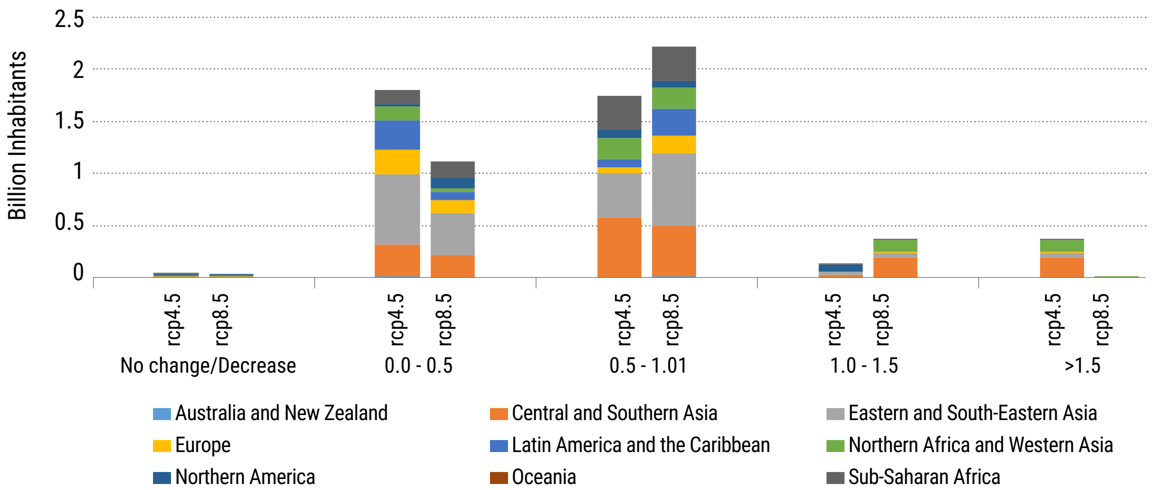


Figure 3.11: Population in cities by region of the world experiencing warmer temperatures, 2025-2040, by RCP



3.2.3 Extreme temperatures

While the rise in mean temperature in cities across the world shows that no urban inhabitant is unexposed to climate change, the exposure to extreme temperatures is disproportionally affecting some cities more than others. According to data from International Organization for Migration's (IOM) Global Data Institute (GDI), up to 2.8 billion people could be exposed to heatwaves by 2090 under a high-warming scenario.[21] By the 2050s, more than 1.6 billion people living in cities could be exposed to occasional extreme temperatures of at least 35°C.[22] The impacts on cities of these conditions of extreme heat will be wide-ranging: besides the heat-stress experienced by their inhabitants, they could potentially experience food and water scarcity as each city's catchment area and resources will be strained.

The places that will likely be exposed to these extreme temperatures and heatwaves are geographically concentrated. Broadly speaking, cities in the tropics are set to experience the greatest increase in the frequency and intensity of extreme heat events.[23] By 2090, exposure to temperatures of 30ºC or higher in the year's hottest month is projected to increase across most low- and mid-latitude regions. The majority of these heat-exposed people will be in Southern Asia, coastal Western Africa, the Middle East and Eastern China.[24] Indeed, almost half (1.3 billion) of the people potentially exposed to heatwaves are predicted to be based in Southern Asia.[25] Some of the most affected regions to extreme heat, such as Northern India and coastal West Africa, have rapidly growing populations yet relatively low adaptive capacity, putting the lives and livelihoods of millions of urban inhabitants at risk.[26]

The conditions of extreme heat are also likely to lead to climate migration. Analysis by the World Bank has shown that without adequate climate action, up to 216 million people could be displaced due to slow-onset climate change impacts by 2050.[27] Many climate migrants are expected to move to cities, and particularly to informal settlements, many of which are already struggling to provide basic infrastructure and services.[28]

However, the population gravity model used by the World Bank has a stronger focus on capturing rural push factors than urban pull factors. Studies of climate-induced displacement and migration are typically calibrated by historical population movements based on water availability and crop productivity,[29] and overlook the critical pull factors that cities and informal settlements have on migrants through the opportunities they offer.[30] Recent projections based on the scenario of RCP 8.5 and SSP4, show that those countries that currently have large populations living in urban informal settlements are also those that will likely face the greatest number of internal climate migrants by 2050.[31] Chapter 6 will explore in more detail what cities can do to provide climate-resilient urban infrastructure to growing populations.

3.3 Human Settlements and Changing Climate Types

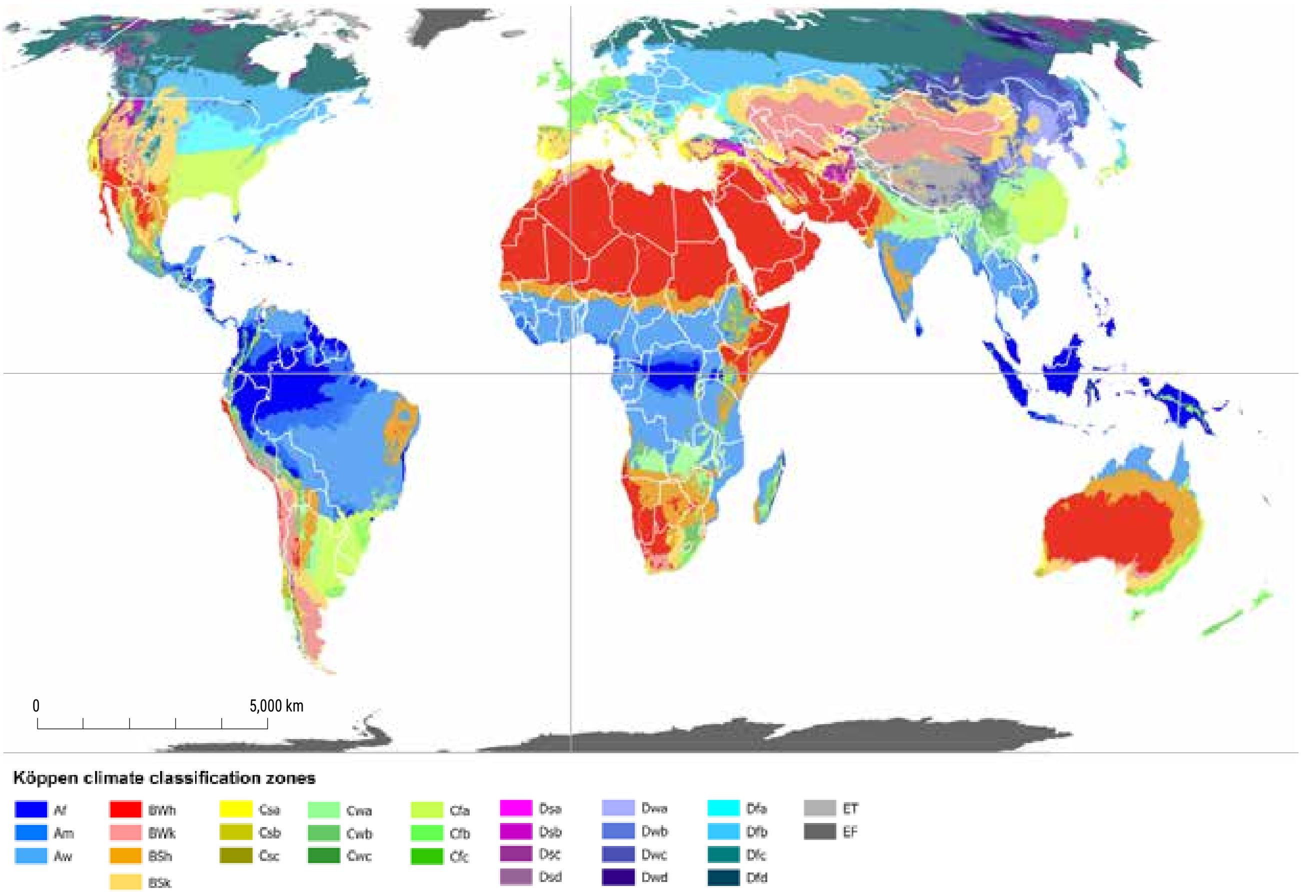
Global warming is among the most notable impacts of climate change. As the previous section demonstrated, temperatures are rising in cities, with significant impacts on the health and well-being of urban communities. But climate change also involves complex changes in the composition of the atmosphere, which can alter weather patterns in permanent ways, leading to changing climate types. Over time, as incremental changes accumulate, climatological conditions can deviate from the status quo and become structural. As a result of these complex interactions, some cities may become drier, while others may receive more rainfall or become more humid.

This section looks at changes in climate type of cities across the world over the last 35 years, and the projected changes to 2040. Understanding the structural and long-term changes in the climate is an essential prerequisite for the development of effective adaptation plans. An adaptation plan that is based on current climatic conditions, but not geared towards future changes in exposure, will have serious limitations in reducing the impact of climate change.

3.3.1 Changing climate types projected in cities

The Köppen climate classification is the most commonly used way to describe climate types. It divides the globe into five main climate groups (with a nested subdivision based on seasonal precipitation and temperature), namely: tropical (A), dry (B), temperate (C), continental (D) and polar (E) (see Figure 3.12). Out of the total of 30 climate classification typologies in the Köppen climate map, the three most populated groups host 46 per cent of the global population. Hosting more than 1 billion people each, these are: arid, desert, hot (BWh); temperate, dry winter, warm summer (Cwb); and temperate, no dry season, warm (Cfb) summer.

Figure 3.12: Visualization of the 2021 Köppen climate classification map



Between 1990 and 2025, 1,483 cities (12.5 per cent of the total surveyed) had already changed climate type, the vast majority to warmer climate types. The number of cities projected to change climate type between 2025 and 2040 varies significantly, depending on the policy choices and implementation of different climate scenarios, from a minimum of about 1,500 under SSP1 (14 per cent) to almost 3,000 under SSP5 (26 per cent). In population terms, that corresponds to between 460 million urban residents (under SSP1) and 830 million (under SSP5) that will be exposed to changing climate types (Figure 3.13). The share of urban populations impacted by a change in climate type varies from region to region (Figure 3.14).

Figure 3.13: Population (as of 2025) in cities projected to change climate type by 2040, under different Shared Socioeconomic Pathways and by income group

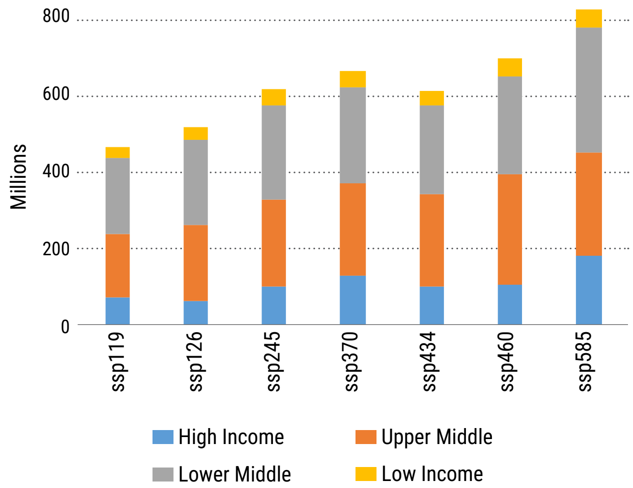
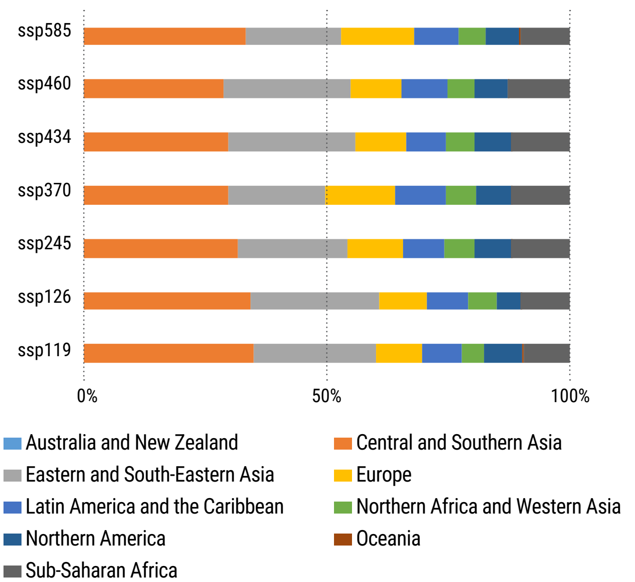


Figure 3.14: Share of population (as of 2025) in cities projected to change climate type by 2040, by region and SSP



Looking at the data, the share of population living in cities exposed to a changing climate type varies significantly by income group:

- Under SSP1 (the required pathway to meet the Paris Agreement), the proportion of people living in cities affected by changes in climate type range from about 15 per cent of the urban population in high-income groups to above 40 per cent in lower-middle-income countries.
- Under SSP2, envisaging medium-level challenges to mitigation and adaptation, cities in high-income countries would be relatively more impacted.
- Upper- and lower-middle-income countries would account for an increasing number of cities affected by climate type change by less ambitious, higher emission SSP scenarios.

Figure 3.13 shows that while the total volume of city residents who are exposed increases along SSP with higher emissions, the income group trajectories do vary:

- The weight of exposure in cities in high-income countries would increase from 15 per cent of the total under SSP1 (70 million people) to 19 per cent under SSP3 (130 million people) and about 22 per cent (180 million people) under SSP5.
- The weight of low-income countries is stable at 6-7 per cent across scenarios, but in absolute terms the affected population in cities would range from 30 to 48 million people.

Regions of the world would also change their weight in terms of exposure to climate class change (Figure 3.14):

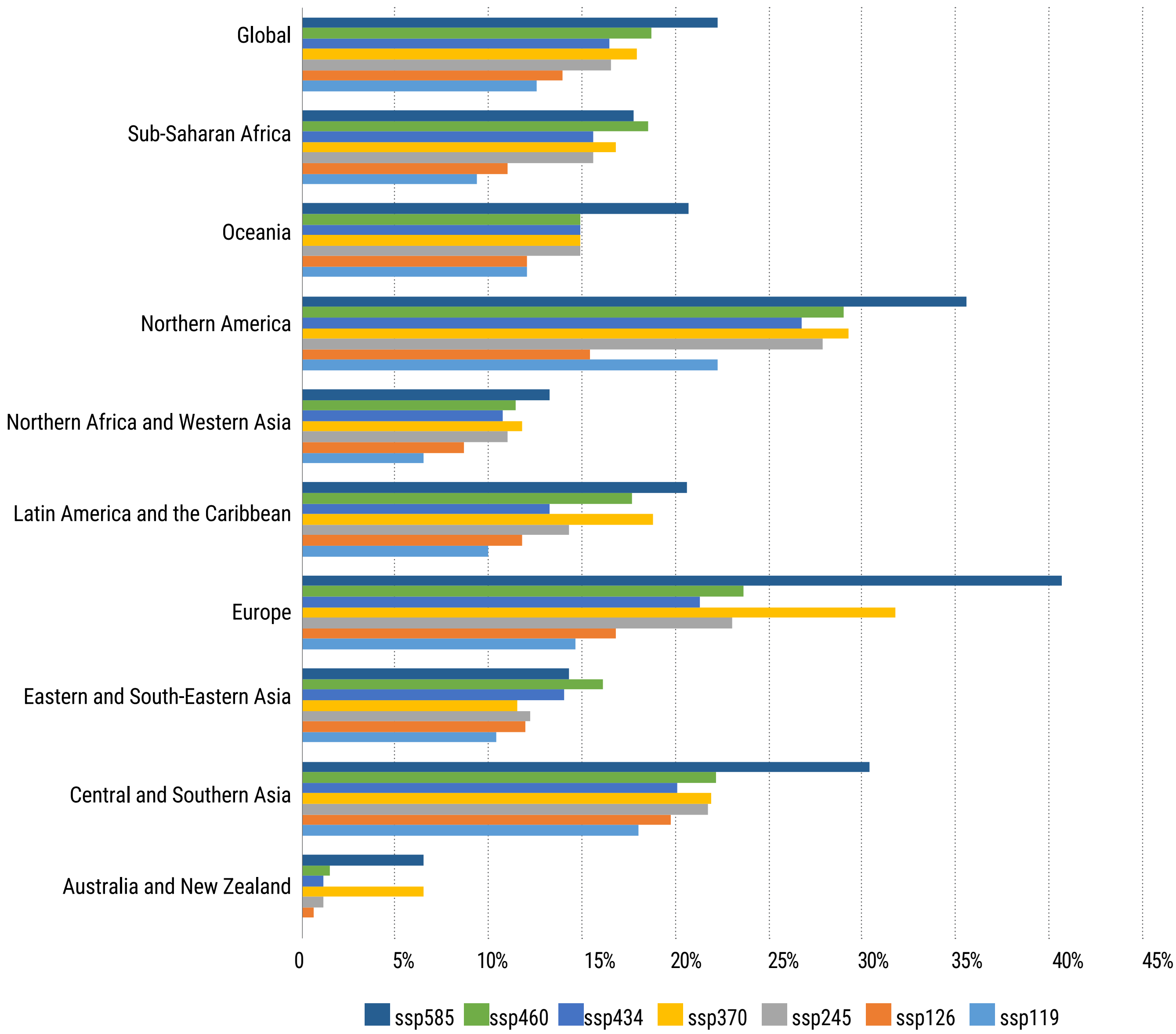
- Under SSP1, Asia would accommodate 55 per cent of the city population projected to change climate type by 2040, with 10 per cent each for Europe and Sub-Saharan Africa and 8 per cent each for Northern and Latin America. However, the relative weight of Asia would decline in scenarios with higher emissions, and Europe would increase by doubling the number of potential people exposure from 45 million people under SSP1 to 95 million under SSP3.

Besides the above considerations on the location and distribution of exposed people, Figure 3.15 shows how the share of the population living in cities exposed to a change in climate type by 2040 varies by SSP and across regions:

- At the global level, the share of the urban population (as of 2025) exposed to a change in climate type change would range from 13 per cent (in SSP1) to around 20 per cent (in SSP4). Under SSP2 (the "middle of the road" pathway), about 17 per cent of the current population in cities globally would be exposed to a change in climate type, corresponding to about 615 million people: this exposure affects 1.2 per cent of population in Australia and New Zealand, 23 per cent in Europe and 28 per cent in Northern America.

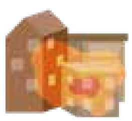
- The income group with a significant susceptibility to SSP scenario variation is Europe, where for example under a scenario to meet the Paris agreement pledges (SSP1), 15 per cent of the population in cities globally would be exposed to climate type change, while under SSP3 up to 32 per cent would face a change in climate type (more than 40 per cent under a Fossil-Fuelled Development scenario SSP5). This increase in population corresponds to about 180 cities experiencing climate type change under SSP1, compared to more than 400 under SSP3 (the "regional rivalry" scenario).

Figure 3.15: Share of population (as of 2025) in cities projected to change climate type, by region in different SSPs



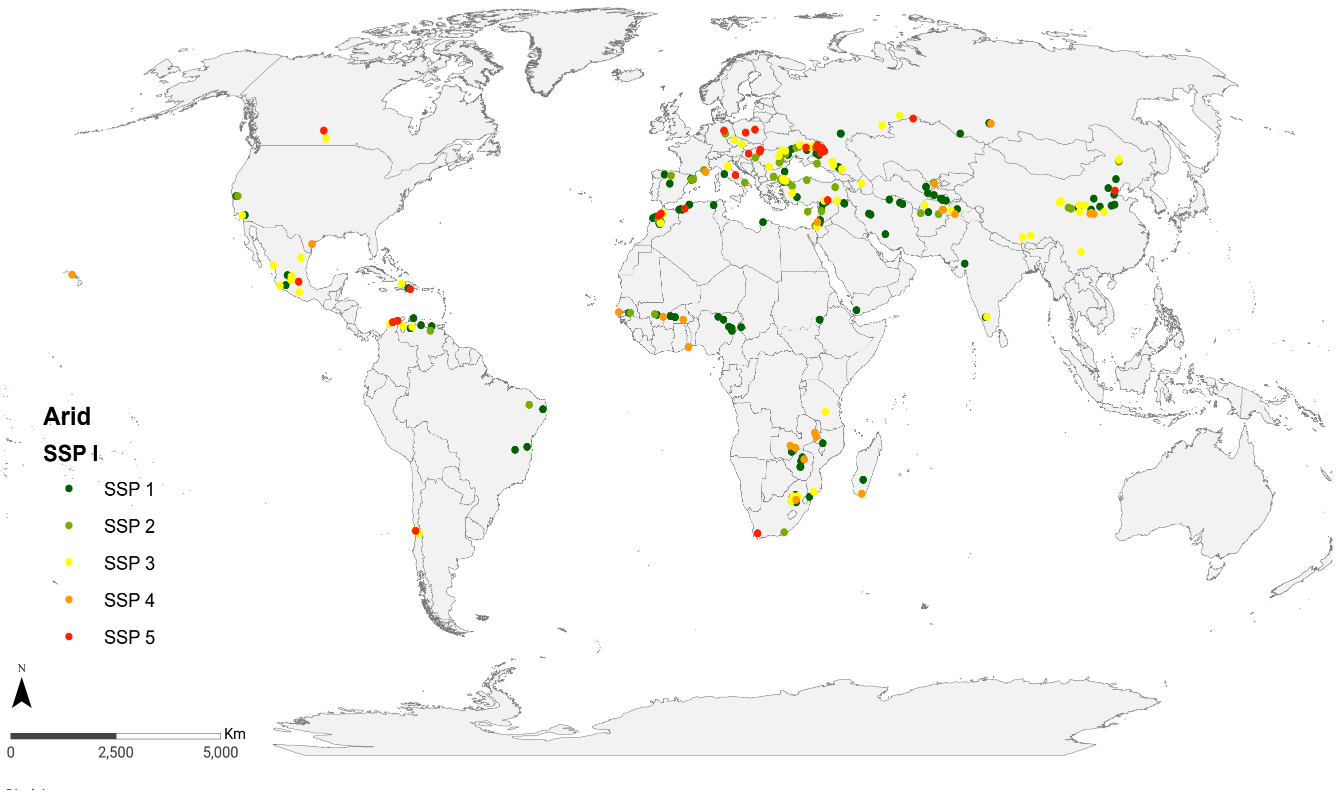
3.3.2 Transitions to arid or humid climate types

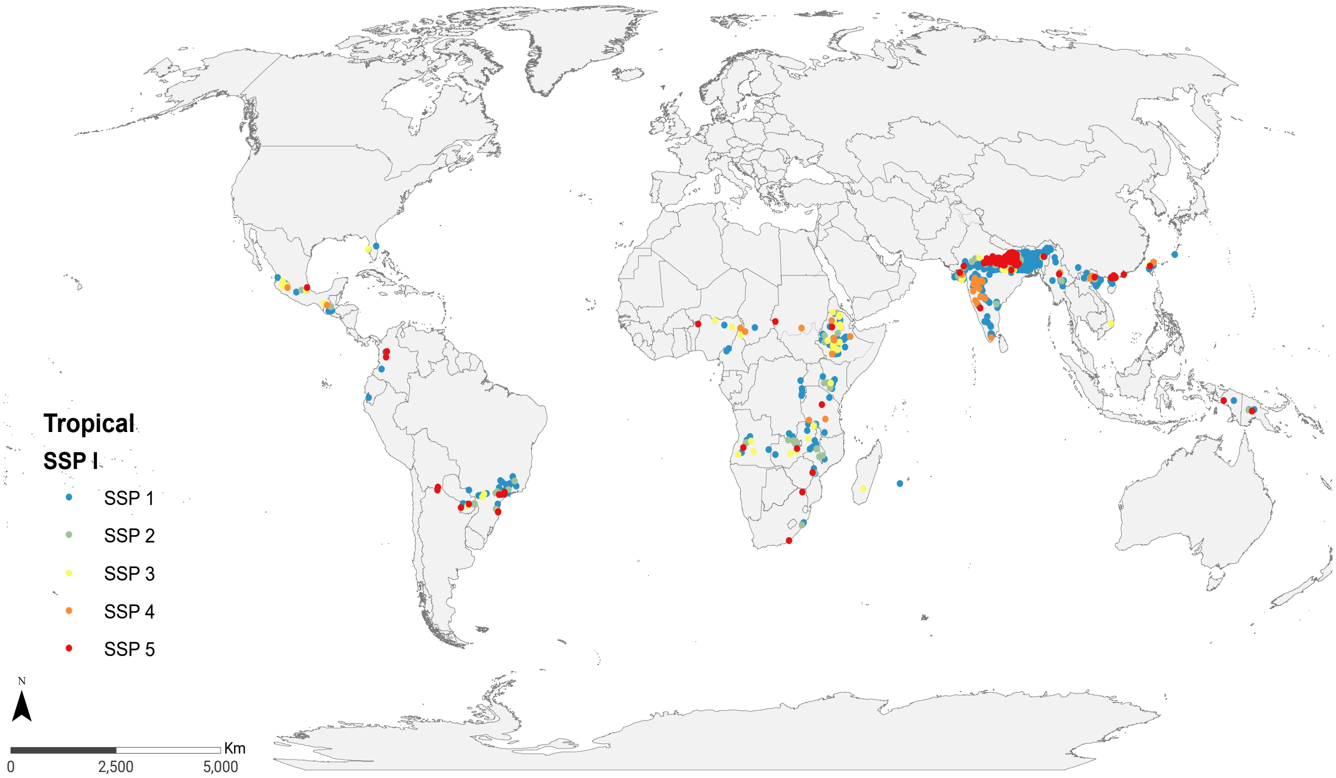
The transition to warmer climate types affects cities globally, but significant regional variation exists in terms of transitions towards more arid or more humid climates (Figure 3.16). At least 600 cities across the world could be transitioning to drier climates by 2040, exposing more than 180 million additional people to the challenge of drier climate types. The transition to an arid climate will mainly happen in the coastal Mediterranean cities, Black Sea area, in Southern and Western Africa, in Central Asia, and in a couple of clusters in Central and South America (Mexico, Venezuela). Under SSP1, an estimated 27 million people in cities would transition to more arid climates by 2040, while this estimate jumps to 85 million people under SSP5. Most of these cities currently belong to the temperate class, with fewer characterized by a tropical climate to become considerably drier.

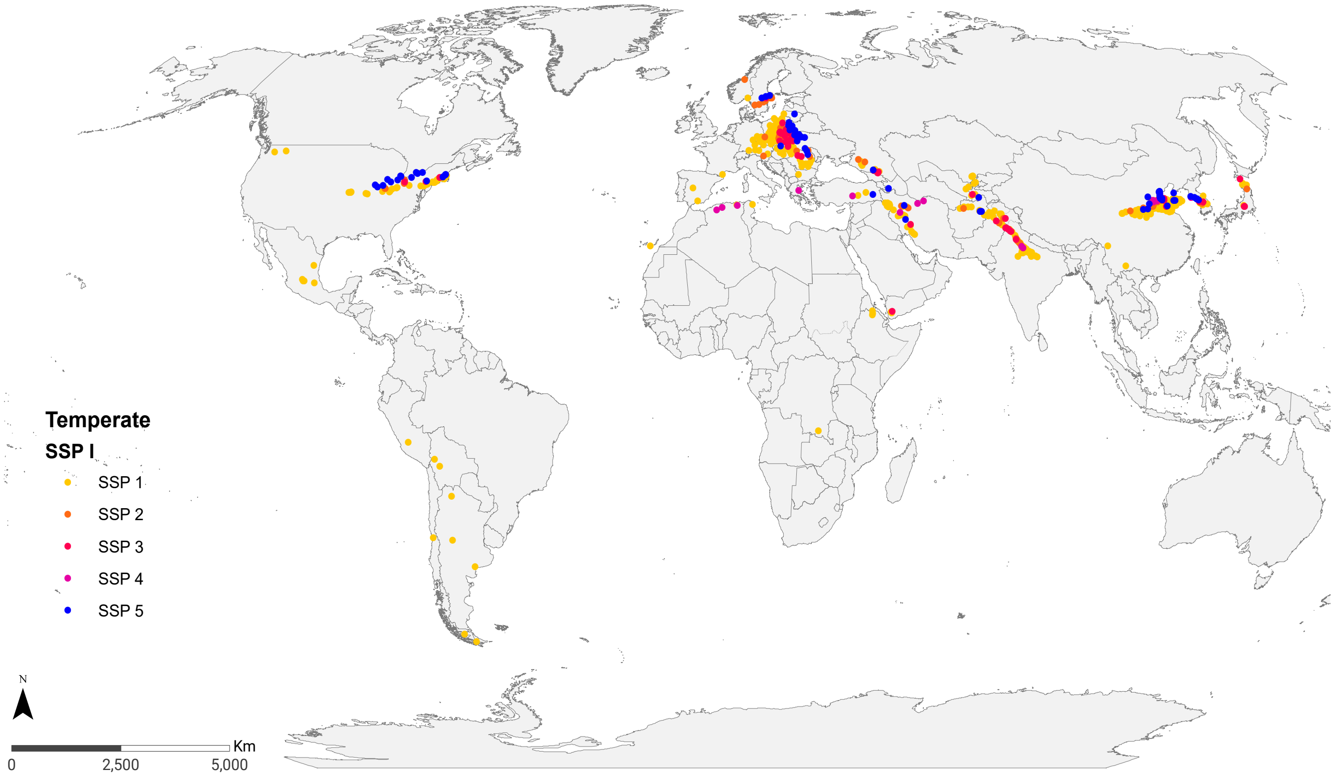


A transition to a more arid climate will impact cities in profound ways, especially with regard to water scarcity

Figure 3.16: Cities projected to transition Köppen Geiger classification between 2025 and 2040, by Shared Socieconomic Pathway







Disclaimer:

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by The United Nations.

Final boundary between the Republic of Sudan the Republic of South Sudan has not yet been determined.

Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

Environmental engineers work at wastewater treatment plants/Shutterstock

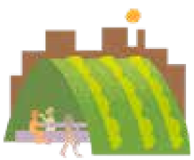
A transition to a more arid climate will impact cities in profound ways, especially with regard to water scarcity. The scarcity of water may lead to political instability and increased competition in certain regions,[32] or to increased infrastructural cost for water distribution. Countries in the Southern Mediterranean are already among the most water stressed globally,[33] and the data in this chapter shows that cities in the Northern Mediterranean and Black Sea area will soon face similar challenges. While many coastal cities are exploring expensive desalination solutions to combat such water stress, a recent UNEP report found that better processing of wastewater could supply more than 10 times the amount of water that is currently provided by the world's desalination plants.[34] This would have the added benefit of increasing the percentage of household wastewater that is safely treated, thereby lowering environmental pollution. Case Study 10 in the Case Study Annex provided with this report shows how wastewater is being used to address water scarcity in the city of Ramallah in the Eastern Mediterranean.

The transition of cities to a tropical climate will concentrate in Eastern Africa, Brazil, India and South-Eastern Asia, mostly by humidification of temperate regions. Between 1990 and 2025, an estimated 160 million people in cities already transitioned to more humid climate types, while under SSP1, this figure would rise to 280 million urban inhabitants by 2040. By 2040, at least 900 cities could be transitioning to more humid climates by 2040, exposing an additional 250 million people compared to current exposure.

The transition to a more humid tropical climate has significant implications on how these cities manage extreme temperatures and urban heat island (UHI) effects. A higher air humidity means that the air is more saturated with water, which limits how much cooling can occur through evaporation from trees and other greenery.[35] At the same time, an increase in humidity means that air-conditioning systems no longer function optimally, meaning that energy consumption is likely to go up in these cities as a result of increased cooling load.[36] A transition to a tropical climate can also pose challenges for disease control, as vector-borne diseases such as dengue fever and malaria may proliferate in these wetter conditions. Case 22 of the Case Study Annex show how data and machine learning is being used in Bengaluru, India to mitigate the risk of Dengue.

Other cities are expected to transition to a temperate climate in the future. Of these, the majority are currently situated in continental cold areas, like Eastern Europe, Northern America, Central Asia and Eastern China. In Northern China, many cities will shift to a wetter continental climate by 2040 as a result of more intense precipitations.

Overall, transitioning to warmer climate types means an increasing financial burden to public spending and private assets.[37] Among other impacts, it results in increased energy demand for cooling (partially compensated by a lower energy demand for heating),[38] changes in the crop growing seasons with a considerable impact on (urban) agriculture,[39] and growing pressure on vulnerable population affected by heat-related illnesses, reverberating on the health sector.[40] Temperature patterns do not only change annually, but also monthly and daily, with larger temperature differences between day and night, turning urban settlements into more challenging environments. The combination of warmer temperatures and fewer precipitations ultimately intensifies the risk of wildfires, threatening biodiversity and forested areas.[41] All these factors make it more urgent than ever for cities to take action to adapt, as is the case in Barcelona (Box 3.4).



Transitioning to warmer climate types means an increasing financial burden to public spending

Box 3.4: Adaption to heat stress: Climate Shelter Network, Barcelona

The impact of heat stress on urban residents is a growing concern globally, affecting approximately 1.7 billion people.[42] The World Health Organization (WHO) projects that between 2030 and 2050, heat exposure will result in approximately 38,000 annual deaths among the elderly,[43] particularly affecting urban areas where urban heat island effect exacerbates the impact of rising temperatures.

The Climate Shelter Network (CSN) in Barcelona aims to address the health impacts of climate change by providing thermal comfort to vulnerable residents during extreme heat and cold episodes. Utilizing existing social infrastructure such as libraries, sports centers and schoolyards, the CSN offers safe spaces accessible to all, particularly those with limited mobility. A climate shelter serves as a refuge from extreme temperatures while maintaining their typical functions. These shelters can be indoors (such as libraries or civic centres) or outdoors (like parks or block interiors). For indoor spaces, the air conditioning is set at 26°C in summer and 21°C in winter to ensure comfort and efficiency. Additionally, efforts were made to transform schoolyards into green spaces, providing shade and planting trees.

Through internal collaboration and coordination, Barcelona leveraged existing resources to establish the CSN, expanding it with additional funding and partnerships. Complementary to the network, training sessions are provided to care professionals to protect vulnerable individuals who cannot access climate shelters. By the summer of 2023 Barcelona had 227 shelters, with 97 per cent of residents within a 10-minute walk of one. The city has since extended its network even further, with 353 shelters established in the summer of 2024 to protect residents from the heat.

Despite these efforts, challenges remain as Barcelona is projected to have more frequent heatwaves in the future. Vulnerable populations, including the elderly and those living in energy poverty, face increased risks from extreme heat. Measures such as expanding public care home capacity are needed to address the growing ageing population and mitigate heat-related mortality.

Climate Shelter Network in Barcelona

Source: WCR2024 case study submission.

3.4 Human Settlements in Low Elevated Coastal Zones

Coastal zones have always been attractive places for people to settle and for urban areas to expand. The connectivity that is afforded by harbours along the coast provides access to wider trade and exchange networks, while fertile deltas and resources from the sea have offered a reliable food supply. While these geographic advantages have always come with some risk, such as the possibility of storm surges, with accelerating climate change many coastal cities now face an existential threat to life and well-being. Low-lying topographies that previously facilitated urban expansion in many coastal deltas now must contend with their high exposure to sea-level rise. Rising sea levels may also lead to saline intrusion into water supplies, increasing the danger of potable water scarcity.

Through the effect of higher global temperatures on the thermal expansion of water bodies and the melting of glaciers and ice around the poles, global sea level is rising. The IPCC estimates that global mean sea level will likely rise between 0.43 and 0.84 metres by 2100, relative to sea level in 1986-2005.[44] This rise in sea level and associated flooding hazards will impact low elevated coastal zones (LECZs)—defined in this report as areas either within 5 and within 10 metres elevation above sea level—around the world.

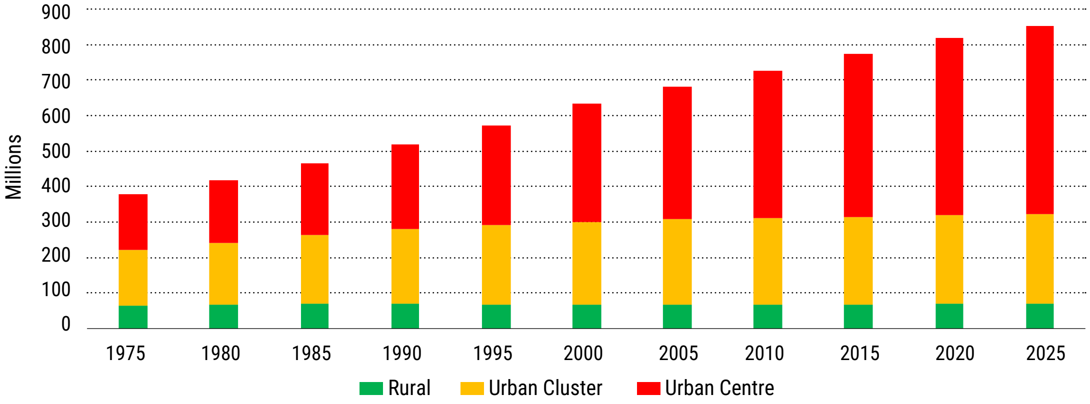
3.4.1 Increasing exposure in coastal cities

Globally, more than 850 million people currently live in LECZs less than 10 metres above sea level: of these, 62 per cent reside in cities, 30 per cent in towns and semi-dense areas and 8 per cent in rural areas (see Figure 3.17). Almost half the global population in LECZs live in low- and lower-middle income countries (421 million people).

By 2040, it is estimated that more than 2,000 cities will be located in LECZs less than 5 metres above sea level, rising to 2,620 cities for those in LECZs less than 10 metres above sea level. The current population in these exposed cities is already 1.4 billion and expected to increase further by 2040.

Population in cities in LECZs has increased faster than in other settlement typologies, contributing to a significant increase in exposure. In the around 2,100 cities in LECZs lower than 5 metres above sea level, the population increased by 12 per cent between 2015 and 2025, compared to only a 5 per cent increase in non-exposed areas (those with an elevation of more than 10 metres above sea level). The data illustrates the urbanization of exposure to sea-level rise and storm surges. Over the last 45 years, the share of the global city population in LECZs increased from 13 to 17 per cent, compared to a relative decline in the share of LECZ population in towns and rural areas. This shift is the result of differential population growth rates and various demographic factors, including a broader movement towards cities.

Figure 3.17: Population in cities in Low Elevation Coastal Zones less than 10 metres above sea level by degree of urbanization



From 1975 to the present, the population living in cities in LECZs with an elevation of less than 5 metres above sea level—the most exposed to sea-level rise and storm surges—increased from around 50 million to over 150 million (Figure 3.18). Asia hosts the majority of these people: indeed, the vast majority of the increase in the population living in cities in LECZs less than 5 metres above sea level since 1975 has occurred in Eastern and South-Eastern Asia. While Eastern and South-Eastern Asia only account for 40 per cent of the global urban population, these regions account for 60 per cent of the world population in cities within LECZs at 5 metres or less above sea level, comprising around 1,100 cities.

Figure 3.18: Population in cities in Low Elevation Coastal Zones less than 5 metres above sea level, 1975-2030, by region

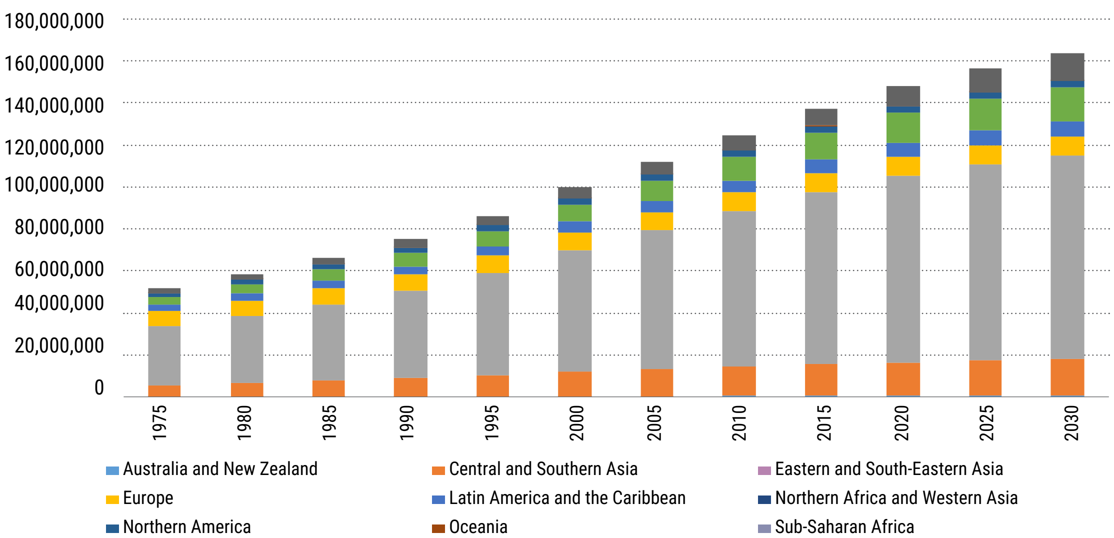
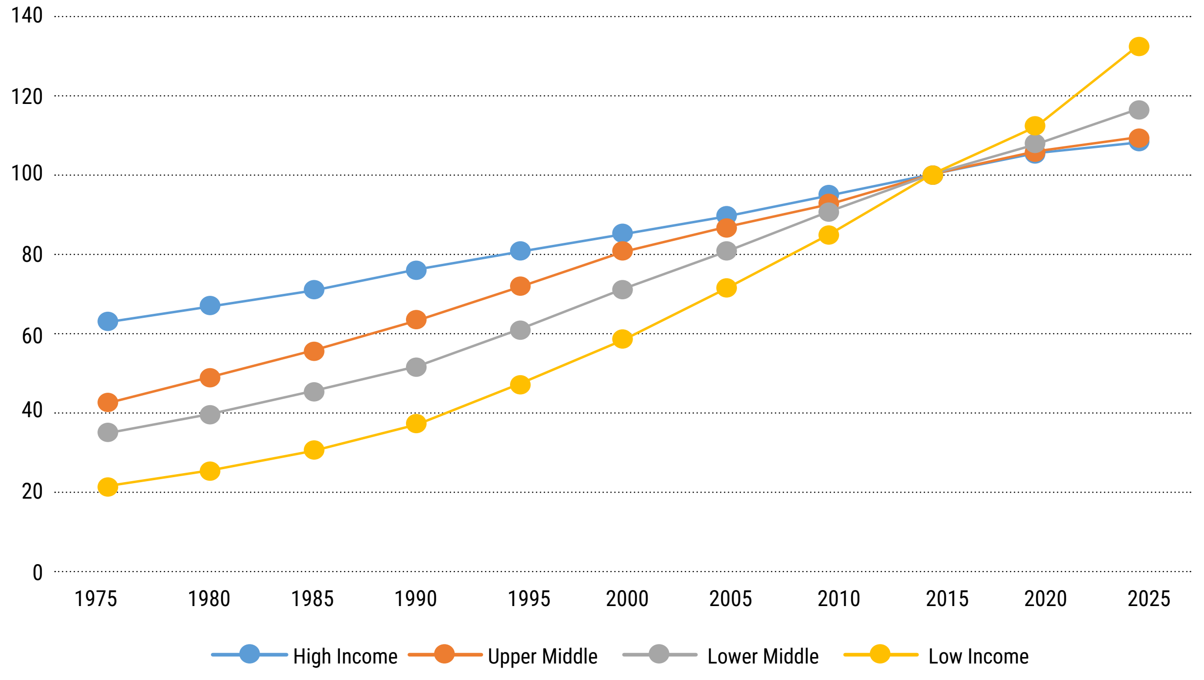
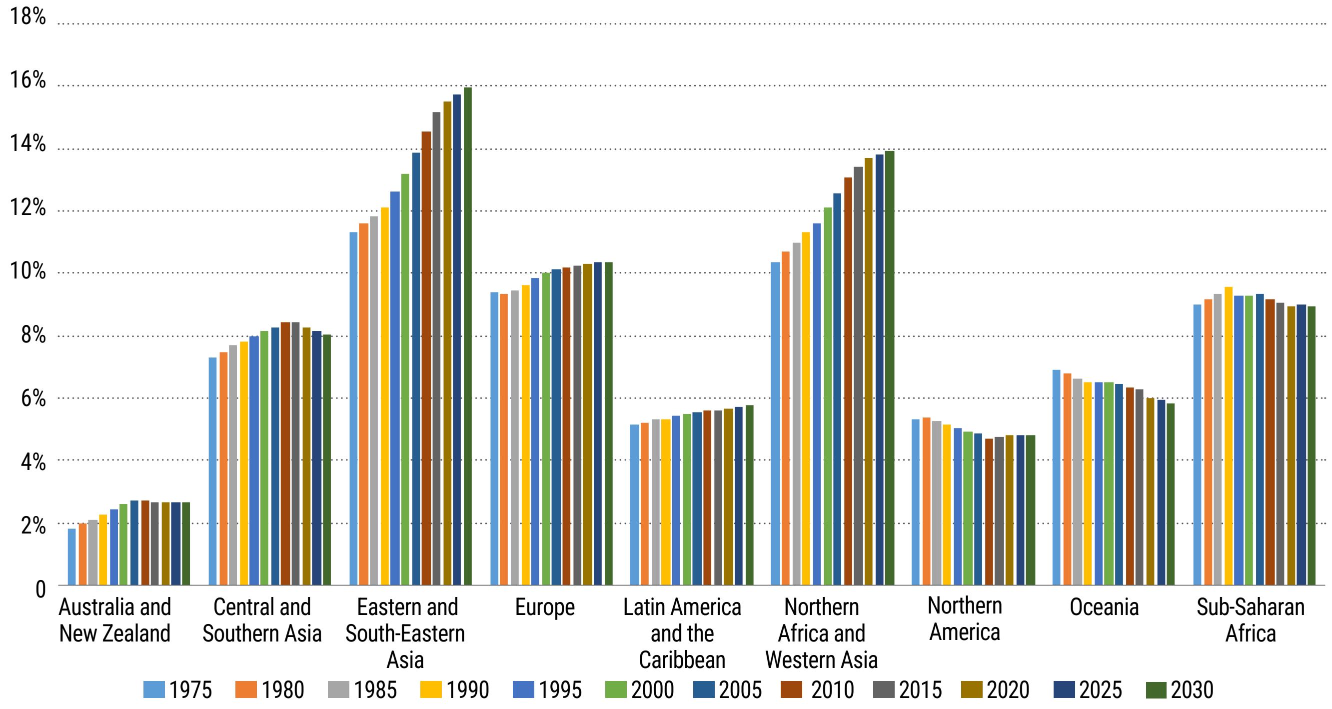


Figure 3.19: Population growth in cities in LECZs less than 5 metres above sea level, by income groups (2015=100)



Looking at cities in LECZs less than 5 metres above sea level by income group (Figure 3.19) reveals how populations in low-income countries are projected to have the highest growth (35 per cent compared to 2015) and the most significant overall relative increase in the period 1975-2030.

Figure 3.20: Share of the population in cities in LECZs of less than 5 metres above sea level, 1975-2030, by region



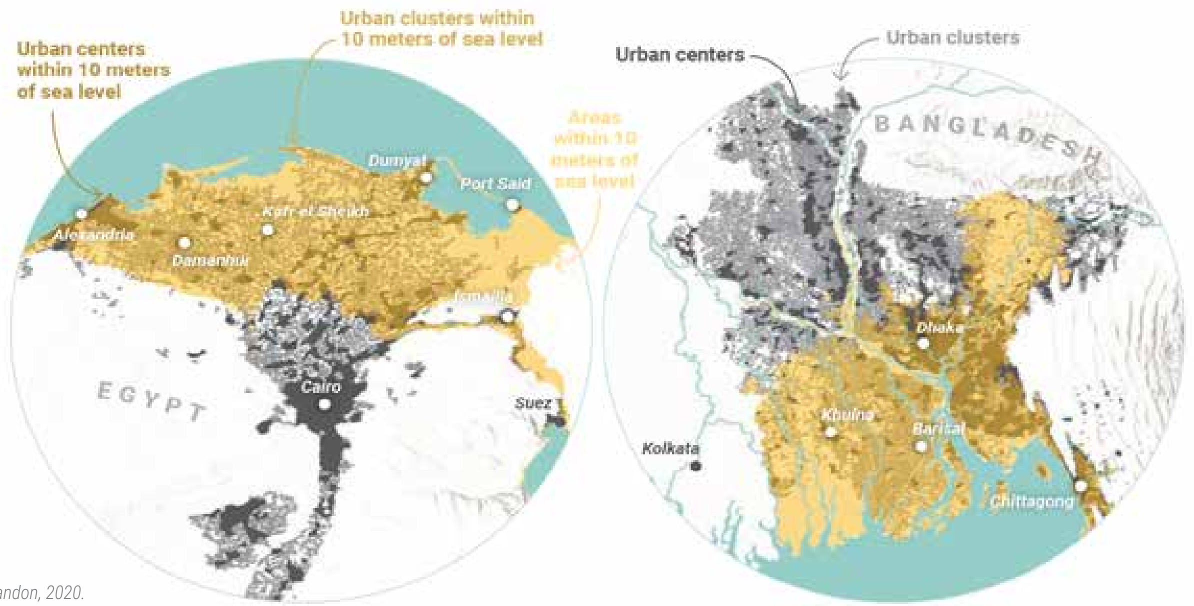
Looking at the share of the population living in cities in LECZs less than 5 metres above sea level, Eastern and South-Eastern Asia stand out again as the most exposed. In total, about 25 cities worldwide have all their population under 5 metres of elevation: half of these cities are in Eastern and South-Eastern Asia. However, Figure 3.20 also shows that a relatively large share of the population in cities in Northern Africa and Western Asia are exposed to sea-level rise. More specifically, Figure 3.21 shows two of the world's urbanized regions that are particularly vulnerable to sea-level rise, namely the Nile and Ganges deltas.

In proportional terms, cities in the Americas are relatively less exposed. While from 1975 to 2025, the total population of cities in LECZs less than 5 metres above sea level in the Americas has doubled to 10.3 million, they only represent around 5 per cent of the total population in cities in the entirety of the region (see Figure 3.18). At a regional level, Latin America and the Caribbean represents 11.6 per cent of the total global urban population living in cities, but only accounts for 4.3 per cent of the total population in cities exposed to sea-level rise.

The data in Figure 3.20 also shows that cities in Oceania have relatively low exposure, but it is important to note that the number of cities in Oceania with at least 1 grid cell of LECZ less than 5 metres above sea level is just 11. This small sample may not be very representative of the total population living in other urban areas.

Several regions where the exposure to sea-level rise has grown remarkably fast is in Western Africa, Northern Africa and Western Asia. The population living in cities in LECZs less than 5 metres above sea level in West Africa increased from 1.8 million in 1975 to 10.4 million in 2025 (an increase of 477 per cent). Similarly, the population exposed to sea-level rise in Western Asia and North Africa grew by 480 per cent and 268 per cent respectively during the same period. In 2025, 9 out of every 10 people in cities in LECZs less than 5 metres above sea level in Sub-Saharan Africa were living in a city in West Africa.

Figure 3.21: Extent of exposure of LECZs in Nile (left) and Ganges (right) regions



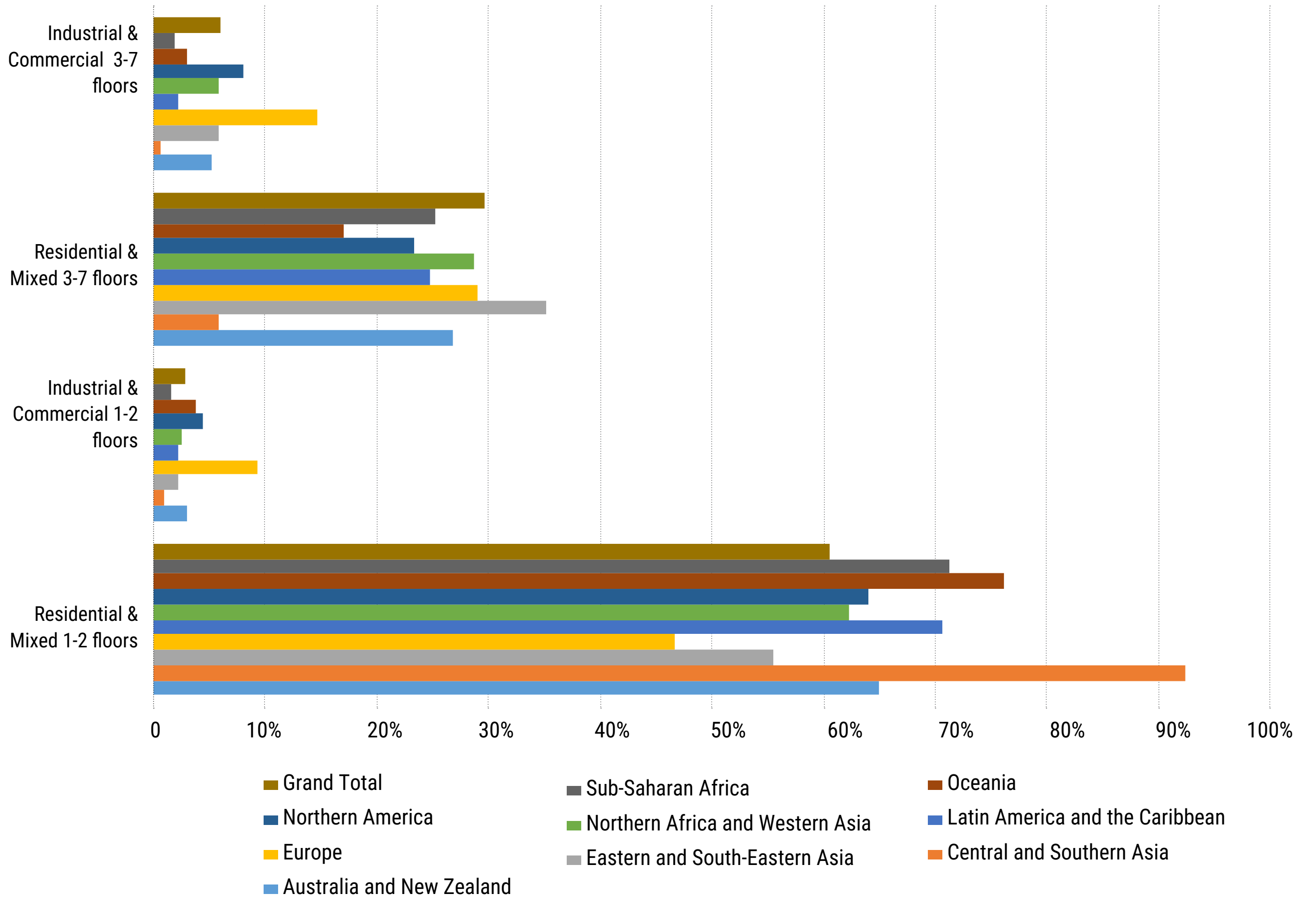
Source: Brandon, 2020.

3.4.2 Disaster preparedness in coastal areas

The protection of coastal cities to sea-level rise and associated coastal flooding events requires additional data to assess how they can best be adapted to these exposures. Building heights and functional mix in coastal cities can serve as a proxy to gain insights on basic settlement characteristics. Figure 3.22 shows how, as of 2020, 64 per cent of the built-up area of cities worldwide in LECZs less than 10 metres above sea level is estimated to be low rise (comprising 1-2 floors), with most of it being residential and mixed type (61 per cent). This proportion of low-rise mixed residential typology is higher in Eastern and South-Eastern Asia (93 per cent) and lower in Europe (47 per cent). Overall, disaggregation by income groups highlights that most of the built-up of the residential or mixed buildings in low-income countries is estimated to be 1-2 floors.

Residential and non-residential uses have different profiles in terms of loss and damage estimation, which is a key data input to make assessments that inform different approaches to adaptive planning. For instance, multi-storey buildings offer residents a place to evacuate for the short-term until flood levels from storm surges have receded. Through the lens of long-term exposure, however, multi-storey buildings in LECZs are an increasing concern, as they expose a greater concentration of people and infrastructure to sea-level rise. Similarly, the extent of exposure different buildings face can also vary depending on the time of day. While residential buildings are most vulnerable at night, industrial and commercial uses are typically most at risk during working hours. Disaster preparedness strategies need to take such distinctions into account.

Figure 3.22: Share of built-up areas in cities in LECZs less than 10 metres above sea level by typology, 2020, globally and by region



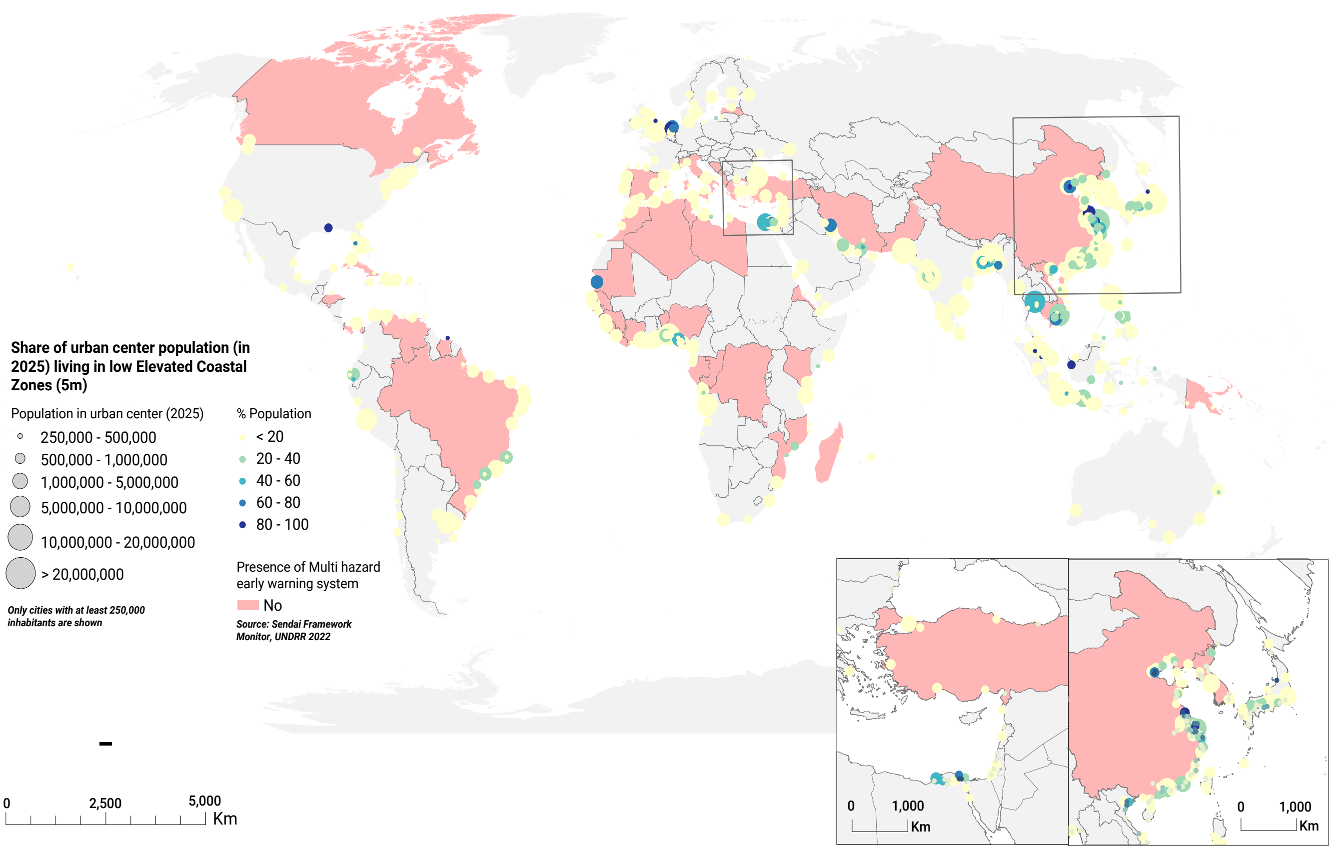
Note: class 8+ floor accounting less than 1 per cent is omitted

The intersection of fast onset hazards, like storm surges and tsunamis, with densely populated coastal cities points to the need to boost disaster preparedness and early warning systems. Recognizing their potential to help save lives and minimize harm to people, assets and livelihoods, the United Nations Secretary General has made the deployment of early warning systems a priority, calling for "every person on Earth" to be covered by them by 2027.[45] Figure 3.23 overlays data on cities in LECZs, as well as the share of the population in cities in these areas as a share of the total population living in cities worldwide, to the global mapping of access to early warning systems by the United Nations Office for Disaster Risk Reduction (UNDRR).[46] It demonstrates that many coastal cities are currently not covered by early warning systems – putting their population at risk.

The Early Warning Systems for All initiative is an initiative from the World Metrological Organization to bring together the broader UN system with governments, civil society and development partners to accelerate action and deliver "people-centred, end-to-end multi-hazard early warning systems".[47] Collecting data to increase knowledge on hazards, exposure and vulnerability is a foundational pillar of the initiative, as it provides the base data that can inform better observations, monitoring, warning dissemination and preparedness to respond.

Tornado alert notification on the smart phone/Shutterstock

Figure 3.23: Comparison of risk exposure in LECZs less than 5 metres above sea level and coverage by early warning systems



Disclaimer:
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Final boundary between the Republic of Sudan the Republic of South Sudan has not yet been determined.
Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

Note: Geographical distribution of cities in LECZ of less than 5 metres above sea level by population size and corresponding share of the population in LECZ is overlaid with presence of Multi Hazard Early Warning System in places with coastal cities. Source for presence of Multi Hazard Early Warning System: UNDRR, 2022.

3.4.3 Policy responses to sea-level rise

The exposure to sea-level rise poses an existential threat to many urban areas and the communities living in them. For example, it is expected that 80 per cent of the Senegalese city of Saint-Louis could be at risk from sea-level rise, meaning that by 2080 up to 150,000 people may have to relocate if no action is taken.[48] However, in recent years efforts have been growing in some countries to strengthen resilience, including through collective action. For example, responding to the global challenge of sea level rise, the Sea'ties initiative was launched to support "coastal cities threatened by sea level rise by facilitating the conception and implementation of adaptation strategies." Signed by 40 mayors, governors and city networks in 2022, it calls for long-term planning that anticipates different sea-level rise scenarios, combining a variety of solutions including hard and soft protection, ecosystem-based adaptation, accommodation and planned relocation. Sea'ties also offers a database of solutions to rising sea level through the interactive platform.[49]

One approach to preventing catastrophic disaster is the pre-emptive managed retreat of exposed coastal areas. Managed retreat is one of three main categories of response to sea-level rise that also includes protection to sea-level rise and accommodation of sea-level rise.[50] However, managed retreat is a controversial response as it involves the relocation of communities, uprooting them from the places they call home.[51] Recently, the island of Gardi Sugdub, off the coast of Panama, was a test case for what managed retreat in Latin America may look like, with 300 families moved to prefabricated housing in the mainland. The island chain that Gardi Sugdub is part of is on average only half a metre above sea level, and government officials and scientists expect the relocation of more than 60 communities along the coast. However, even at such a small scale, the relocation is expensive, with estimates of up to US$1.2 billion to relocate the approximately 38,000 inhabitants who will face rising sea levels in the coming decades.[52] Along more densely populated coastlines, cities may need to accommodate sea level rise, as was done through an adaptative strategy in Shenzhen in box 3.5.

Box 3.5: Typhoon Proof: Shenzhen's triple dyke coastal defense

Many cities around East Asia are facing increasing flooding risks and climate hazards from extreme weather events, and rising sea levels, which exacerbate risks for coastal and riverine communities across the region. Shenzhen has particularly faced intense flood challenges due to its coastal location, intense rainfall and rapid urbanization. In response to the damage caused by Typhoon Mangkhut in 2018, an international competition was held to develop a plan to restore the coastline and enhance protection against extreme weather events. The final strategy that was selected and implemented by Shenzhen is a good example of the transition towards more adaptative flood management approaches. Rather than having a single line of protection, the city implemented a triple dyke approach, in which different flood mitigation measures complement each other and allow for other social and ecological activities to occur in the coastal zone:

- The first "outer" dyke zone increases resilience through wave attenuation, erosion reduction, and sediment enhancement using "wave-gardens" planted with robust vegetation and rocks.
- The second "middle" dyke is an elevated embankment that functions as a multifunctional area with parks, promenades, and public spaces. It consists of a series of shifting walls at varying heights, creating terraces, plazas, and scenic pathways for public use.
- The third "inner" dyke is a hybrid structure managing rainwater runoff through rain-parks, raingardens, and wetlands, following the Sponge City Principle. In Shenzhen, this was applied through various projects that integrate green infrastructure, such as permeable pavements, green roofs, and urban wetlands, to improve stormwater management and reduce flood risks.

This triple dyke strategy demonstrates good climate action practice by enhancing existing natural qualities of the impacted area while unlocking potential for economic and social activities. The small-scale identity of the coastline was preserved by confining new developments within existing boundaries, strengthening the unique character of the area and its recreational facilities. The approach minimizes infrastructural impact and improves connectivity, boosting ecological functions through an interconnected mountain and marine landscape. This integrated, nature-based and community-oriented approach highlights effective and sustainable climate action practices that provide shade and cooling that improve comfort levels reducing heat related health issues, creating spaces where people can gather, fostering social bonds and community cohesion.

Wave gardens of the first "outer" dyke zone. © Felixx Landscape Architects & Planners

Source: WCR2024 Case Study submission

What option is best for any given city is highly context specific. In navigating response types, governments are encouraged to adopt the IPCC risk framework and carefully document each community's vulnerability, sensitivity and adaptive capacity to climate hazards. One promising policy response to sea-level rise is the recognition and strengthening of nature-based solutions (NbS), an area explored in more detail in Chapter 6. Coastal ecosystems including coastal forests, mangroves, coral and oyster reefs, salt marshes and coastal wetlands can provide excellent coastal flood protection. However, an estimated 21 per cent of the world's wetlands have disappeared since 1700,[53] and this has greatly increased the vulnerability of cities.

Retrofitting existing buildings, communities and neighbourhoods to cope with rising sea levels are common solutions to protect and accommodate sea-level rise, but such adaptations can be both expensive and difficult to implement, so cities are encouraged to avoid increasing the future risk of new urban extensions and settlements. For example, adaptation to sea-level rise in Victoria, Australia is primarily through restrictions on development on low-lying land.[54] Such approaches to avoid future risk require inclusive urban planning, and are particularly relevant in those regions where cities are still rapidly increasing in size and population.

Shaped by biophysical, cultural, socioeconomic and institutional factors, cities are encouraged to map their climate adaptation solution space to see what approaches are possible given the timeframe, available resources and severity of the climate threat each is operating in.[55] As the hazards from rising sea level and flooding intensify, many cities may need a deeper societal debate on what is the most desirable pathway to build urban resilience, particularly with regard to highly impactful decisions such as partial retreat from the most exposed urban areas.[56]

3.5 Human Settlements and Riverine Floods

Of all climate hazards, floods impact the most people globally. UNDRR estimates that 1.65 billion people were affected by floods in the period 2000-2019.[57] According to the IPCC, climate change is leading to increases in precipitation intensity (high confidence) as well as an increase in local flooding events (medium confidence).[58] Flooding poses a threat to infrastructure and basic services, both through inflicted damage (requiring repair and reconstruction) and service disruptions (creating an array of direct and indirect costs to users). According to different estimates, between 2000 and 2019 flooding was responsible for US$651-1,089 billion worth of economic losses.[59]

Flooding typically results from one of three ways, namely, fluvial floods (from rivers and waterbodies), pluvial floods (from precipitation) and coastal floods (from storm surges and seas level rise). Whereas the last section captured the exposure to coastal floods, this section looks at the rise in exposure to riverine flooding.

3.5.1 Urban exposure to riverine flooding

The new analysis carried out in this report shows that in 2025, areas prone to riverine flood events with 100-year return periods host about 1 billion people: of these, half are based in cities, 39 per cent in towns and semi-dense areas, and the remaining 11 per cent in rural areas. By 2030, at least 517 million people living in cities will be exposed to riverine flooding, which is 14 per cent of the global population living in cities.

These areas all demonstrated different population trajectories over time (Figure 3.24):

- In rural areas, the proportion of the population exposed to riverine flooding has been almost stable since 1975, at around 3 per cent, and in the period 2015-2025 even slightly declining.

- In towns and semi-dense areas, the population's exposure to riverine flooding increased significantly from 1975 to 2000 from 5 to 8 per cent), then continued to increase more slowly (to around 10 per cent in 2025).

- In cities, the population exposed to riverine floods has grown the fastest of all settlement typologies, rising from 3 per cent in 1975 (only slightly higher than the share in rural areas at the time) to 13 per cent in 2025. Between 2015 and 2025 alone, the population in flood-exposed areas in cities increased by 18 per cent, compared to a 13 per cent increase in cities in unexposed areas.

These trends point towards the urbanization of riverine flooding risk, where the exposure of cities has been rising much faster than the exposure of rural areas. Over the last 45 years, the population in these flood-prone areas has more than doubled, increasing by 585 million people (129 per cent). The majority of that increase has taken place in cities. Cities now have the highest share of the population exposed to floods (13 per cent). Since 1975, exposure to flooding in cities has grown 3.5 times more than exposure to flooding in rural areas.

Ladek Zdroj, Poland - September, 17, 2024: Biala Ladecka riverbed, flooded and destroyed houses, destroyed river bank,two days after the flood wave passed through the city. View from Kosciuszki Street/Shutterstock

Figure 3.24: Share of the population exposed to riverine flooding by degree of urbanization, 1975-2025

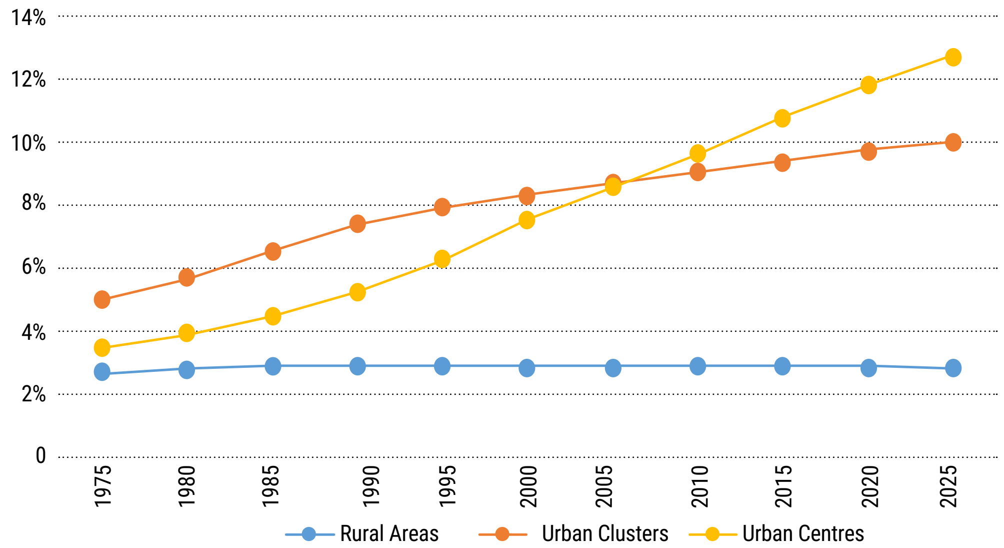
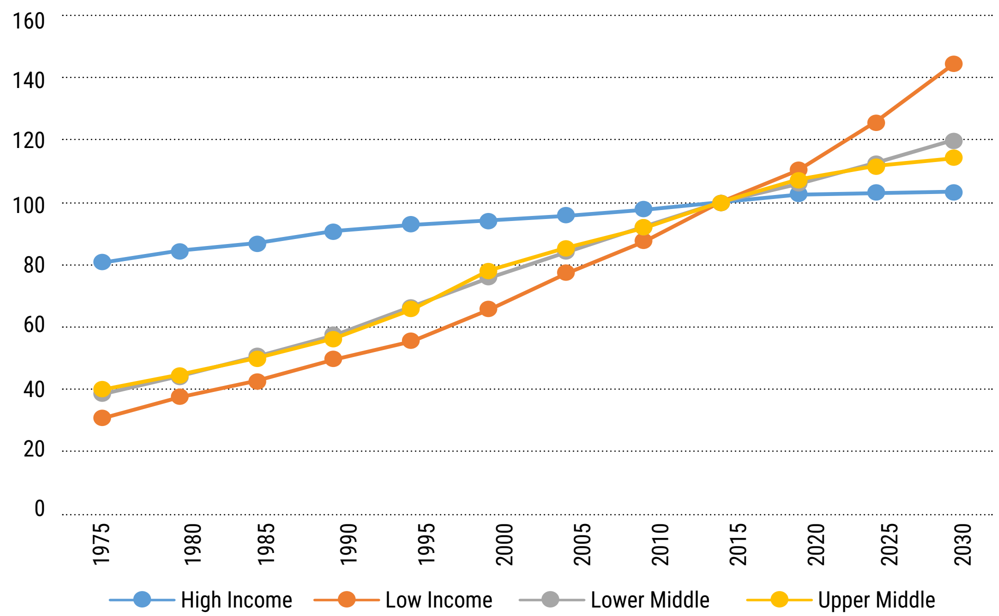


Figure 3.25: Population change (%) in cities exposed to riverine flooding by income group, 1975-2030 (2015=100)



3.5.2 Geographic concentration of exposure to riverine flooding

Most of the population living in cities exposed to riverine flooding, both in absolute and relative numbers, are concentrated in three regions: Central and Southern Asia, Eastern and South-Eastern Asia, and North Africa and Western Asia.

Exposure to riverine flooding has been particularly growing in low-income countries. Just 40 per cent of the exposed population in 2015 was already settled in these areas in 1975, while the additional exposure is mostly due to increases in population in flood-prone urban areas. In cities in these countries, population has grown significantly (by 40 per cent) from 2000 to 2015, by an additional 20 per cent from 2015 to 2025, and is projected to grow by another 20 per cent until 2030.

In upper-middle income countries, population growth in urban areas exposed to riverine flooding has slowed, with an increase of about 7 per cent from 2015 to 2020 and 4 per cent from 2020 to 2025, with another 2 per cent projected from 2025 to 2030 (totalling 14 per cent during 2015-2030). In lower-middle income countries the trajectory is very similar over the same periods, amounting to a 19 per cent increase over the entire 2015-2030 period.

Figure 3.26: Population exposed to riverine flooding, 1975-2025, by degree of urbanization and region

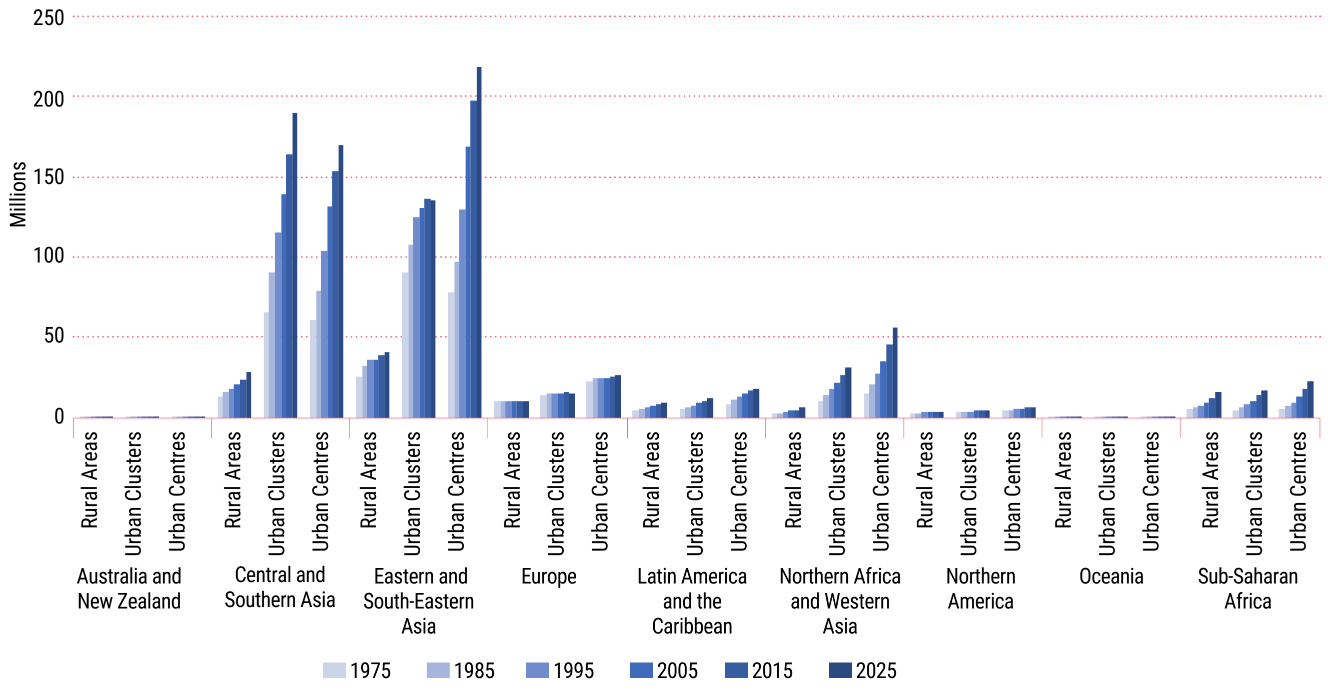
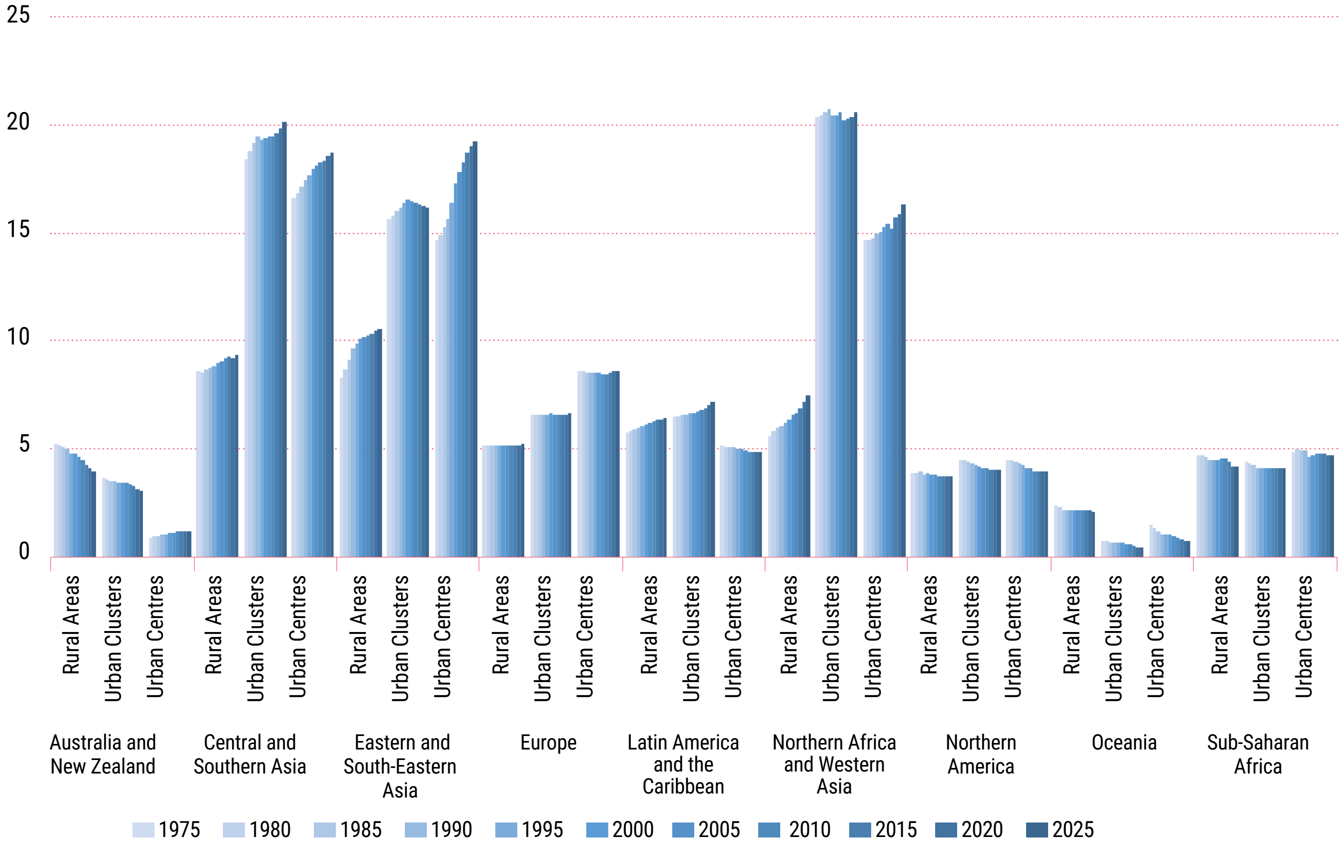


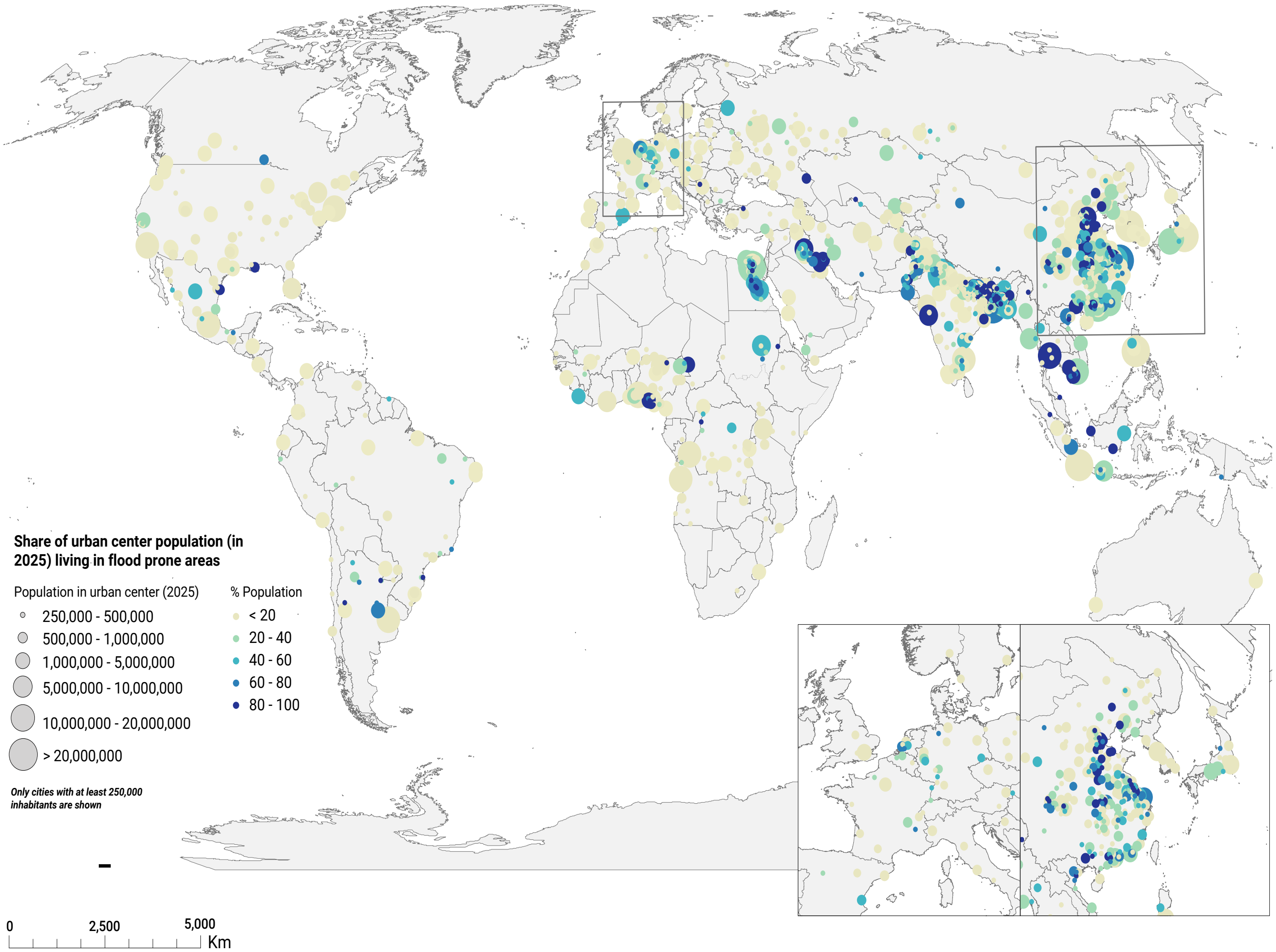
Figure 3.27: Share of the population exposed to riverine flooding, 1975-2025, by degree of urbanization and region



The geographically disaggregated data presented in Figure 3.26 show in more detail how exposure to riverine flooding in cities has grown at a faster rate that rural exposure to flooding in most regions. However, the data in Figure 3.27 show a slightly more nuanced picture, where the share of the population exposed to riverine flooding in towns and semi-dense areas and cities is higher than rural areas for most regions, but not all. In Sub-Saharan Africa, North America, Latin America and the Caribbean, Australia and New Zealand, and Oceania, the share of population exposed to riverine flooding is similar for all three degrees of urbanization, meaning that rural areas and cities in these regions are similarly exposed. In the other regions, including all of Eurasia and North Africa, riverine flooding is a distinctly urban phenomenon.

Figure 3.28 provides an alternate view on the same data showcasing the share of each city of 250,000 that is exposed to riverine flooding. In most cities across the world, less than 20 per cent of the city's population in typically exposed to riverine flooding. In these cities, exposure is concentrated along the riverbanks. However, the figure also shows how in some cities, the exposure to riverine flooding affects a much larger share—sometimes even more than 60 per cent—of the city's entire population. Most of the cities that have a very large share of the population exposed to riverine flooding are located along some of the world's biggest flood plains, shaped by rivers like the Nile, Tigris, Indus, Ganges and Huang He. The need to invest even more in adaptation measures is especially urgent in these cities, given how much of their population and built assets are exposed to flooding.

Figure 3.28: Share of population in cities exposed to riverine floods in 2025



Disclaimer:

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by The United Nations.

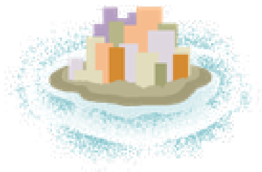
Final boundary between the Republic of Sudan the Republic of South Sudan has not yet been determined.

Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

Note: cities with no exposure to flooding with 100-year return period are not shown.

3.5.3 Towards a more adaptive policy response to flooding

The past several decades has seen an important shift in how local governments and planners are responding to exposure to flooding. Whereas the past policy emphasis was largely on flood control, a paradigm shift has occurred towards more adaptation-focused flood resilience.[60] Among the most ambitious and far-reaching examples of this approach is the Delta Programme in the Netherlands. Its "room for rivers" programme shifted away from traditional embankment measures to providing more space for rivers to fluctuate, generating significant co-benefits in the wetlands and recreational areas that allowed for this additional space.[61]



A paradigm shift has occurred towards more adaptation-focused flood resilience

Reliance on dyke systems to mitigate riverine flooding can have significant drawbacks, as raising river dykes tends to increase the magnitude of peak flows and may lead to flood risk downstream. Cost-benefit analyses that are solely based on economic gains and losses can exacerbate inequality, as adaptation to flooding in wealthier areas is prioritized over lower-income neighbourhoods and informal settlements.[62] Reducing flood peaks using detention areas for excess water flow, such as those created by the "room for rivers" programme, is also an economically attractive option. One study of several innovative flood-adaptive programmes in Europe estimated that every US$1 invested in them generated US$4 in returns.[63]

Shifting to a more adaptation-focused flood resilience approach plays into the strengths of urban nature based-solutions, which are explored in more detail in Chapter 6 of this report. Urban NbS can help to manage storm- and wastewater by reducing runoff and giving water more time to drain into the soil. Cities can reduce the risk associated with flooding through reducing the amount of land that is paved and integrating more pervious surface areas into neighbourhood design. Studies have suggested that even a modest increase in impervious surface area could substantially increase the intensity of urban flooding events in some settings.[64] The Case Study Annex included with this report documents how the city of Belén in Costa Rica has launched a programme to transform into the country's first Sponge City.

Informal settlements tend to experience a higher exposure to flooding. One of the key challenges in this context is to support a shift from reactive coping strategies that have been adopted through recurrent and persistent exposure to flooding (for example, evacuating homes during flooding or moving valuables to a higher floor), to transformative adaptation that includes longterm improvement strategies that help to build a community's resilience and improve their living conditions.[65] In building the resilience of informal settlements and their residents, it is important to acknowledge that in-situ upgrading programmes alone are not enough, but require an integrated city-wide approach to planning. For example, reducing flood risks of an informal settlement may require watershed management upstream, far beyond the settlement's boundaries.[66]

3.6 Closing the Data Gap: Localized Vulnerability Assessments and City Profiles

The data in this chapter has demonstrated the scale of exposure of cities to climate change impacts. To generate targeted and appropriate action in cities, there is a need to fill the climate change vulnerability data gap. This gap is informed by the absence of data (whether at the local or global) level, but also problems with what data is available: a lack of granularity to make it meaningful for city stakeholders, inadequate local capacity to process and interpret it meaningfully, limited accessibility and other challenges. Closing this gap requires "actionable science" that is focused on providing information that specifically addresses societal problems and advances knowledge to close feedback loops between science and policy.

3.6.1 Closing the climate change vulnerability data gap

One of the key barriers to closing the data gap is that accessing and exchanging data between the local, regional and global levels remains difficult. Data produced at the local level is often not made freely accessible by local governments or private parties. On the other hand, many local authorities lack the technical capacity to access and work with data that is available at the global level. Cities need to invest in knowledge and capacity building within cities (especially for secondary and tertiary cities) to strengthen data management. With the right resources in place local authorities and other stakeholders could lead a data revolution, given the vast and valuable data being produced at this level.

For this to happen, there needs to be much closer cooperation between different levels of government to enhance the exchange and comparability of data: for example, by setting standardized definitions and data formats (such as machine-readable outputs). At the local level, different standards may be applied, making aggregation into regional and global figures difficult. Data may also be fragmented and scattered, reducing the accessibility or impact of these collections. Vice versa, global data is not always sufficiently granular or up-to-date for use in local assessments. Transforming high resolution geospatial data from many sources, like the census in population grids, is key to understanding the vulnerability of populations exposed to localized UHIs and other hazards, including climate-related ones. There is a growing recognition that the application of an urban lens is a prerequisite to better understanding how climate change impacts people.[67]

City networks and city associations can play an instrumental role in this regard, acting as places of data training and as brokers of data. Addressing the challenge of accessing data can be mediated by encouraging the adoption and implementation of organizations and conventions that promote open date. Encouraging stakeholders to abide by FAIR (Findable, Accessible, Interoperable and Reusable), data principles[68] will enhance exchange and collaboration. Another key initiative to promote such exchange is the International Open Data Charter,[69] founded in 2015 as a collaboration between governments and data experts to promote data that is open by default, timely and interoperable. More than 150 governments and organizations have since joined the movement. Closing the climate change vulnerability data gap must be done in such a way that it generates usable tools developed for local stakeholders through multi-disciplinary efforts by climate researchers, co-producing them with decision agencies and communities.[70]

An example of this is UN-Habitat's Earth Observations Toolkit for Sustainable Cities and Human Settlements[71] and other efforts to support the integration of open, free geospatial data for common areas of analysis, like the cities in this chapter. With such information, a new generation of publicly available, periodically updated data for cities can be compiled in the form of city profiles. Datasets like the Urban Centre Database and other urban scale information systems can be built and queried to address specific uses like hazard assessments, vulnerability profiles and exposure trends, but also—beyond the specific lens of disaster and climate—to address land consumption, services distribution and a variety of topics for sustainable cities. For this purpose, it is vital to close the data gap by integrating local and remote sensing data into fit-for-purpose solutions.

To help policy makers allocate often scarce resources most effectively, and limit the likelihood of maladaptation, it is critical that data on exposure is transformed into data on vulnerability and in turn transformed into cost-benefit data that can inform decision-making. However, there remains a clear knowledge gap on the socioeconomic value of different adaptation measures, particularly in the Global South.[72] As captured in the IPCC risk framework, while communities may face similar exposure to hazards, their vulnerability can vary significantly. Attributes and characteristics of the exposed population such as demographics, health, cultural and behavioural traits, levels of awareness and information available, insecurity and deprivation can all affect local vulnerability.[73] Gathering such data requires breaking silos to achieve multi-thematic, multi-stakeholder coordination. Chapter 7 of this report explores in more detail how multi-level governance can enable such climate action. Efforts have been made in the direction of vulnerability proxies, but further collaboration and data policy implementation is needed to establish interoperable and open data records for each of the dimensions of vulnerability (see Table 3.2). Better data around characteristics of the affected populations is essential to transition from reporting exposure to measuring vulnerability.

Table 3.2: Dimensions of vulnerability

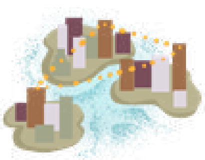
Physical	*Critical infrastructure*	Essential components to day-to-day business activities, such as roads and energy systems.
	Environmental	Green space, vegetation and other nature-based assets.
	General urban assets	Other physical assets that do not fall in categories above, including housing, emergency shelters and transport networks.
Social	*Awareness and information*	Access to reliable, relevant updates on hazards to inform preparedness and emergency response.
	Crime and conflict	Ranging from perceptions of insecurity to direct physical violence from gangs, security forces and other urban actors.
	Cultural and behaviour	Social norms and traditions (for example, around gender) that impact on health, communal solidarity and resilience.
	Demographic	Age, sex, education levels, ethnic origin and other key characteristics of the urban population.
	Economic	Deprivation levels, employment patterns, income security and other determinants of economic well-being.
	Governance	Organizational capacities relating to urban planning, inclusive policy development and partnership building, up to the point of implementation.
	Health	Access to medical treatment, across different social and income groups, as well as the prevalence of health conditions and related factors such as the provision of safe drinking water.
	Institutional	The ability of authorities to execute urban policies on the ground, enabled by technical capacity, understanding of local conditions and resource availability.

Source: adapted from Stolte et al., 2024.

3.7 Concluding Remarks and Lessons for Policy

The data produced in this chapter of the report has demonstrated the increasing urbanization of climate exposure. Urban areas are places of concentrated and disproportionate climate threat exposure, which calls for cities to be at the forefront of climate action through the unique mitigation and adaptation opportunities available to them. This means that strategies to reduce vulnerability must be conceived through an urban lens.

In an urban context, isolated actions that respond to climate exposure are less effective and, in some cases, detrimental to the collective protection of urban areas. For example, when individual plot owners elevate their land to protect against flooding, this may exacerbate flooding in adjacent properties and communities.[74] Likewise, the excess heat generated by the use of air conditioners can increase the outside temperature by 1-1.5°C Celsius at night, considerably amplifying the magnitude of the urban heat island effect.[75]



Isolated actions that respond to climate exposure are less effective and, in some cases, detrimental to the collective protection of urban areas

Cities need to mainstream disaster risk reduction strategies in their urban development plans to shape collective and equitable responses to increasing exposure to climate hazards. Dealing effectively with the threat of climate change requires adequate authority and capacities at the local level, such as those needed to develop a strategic adaptation plan. Yet, in one UNDRR study, less than half of surveyed governments had "full authority and capacity" to undertake the required disaster reduction actions needed at the local level.[76] When cities and communities are empowered and capable, however, successful action at the local level can have knock-on effects at regional and national levels, multiplying the benefits.[77]

The chapter has demonstrated how the exposure of human settlements to climate-related hazards is a global phenomenon, regardless of development pathways. Indeed, global research, operational disaster risk management and resilience building are all intertwined. The chapter demonstrates that cities have already undergone, and will experience for decades to come, changes in climate type, further temperature rises and expansion of flood-prone areas, particularly as populations continue to expand in LECZs.

From the technological and data standpoint, it is important to emphasize that operational programmes such as the Copernicus space program, in-situ measurement networks as well as the various data partnership initiatives all achieve added value when scientists go beyond data acquisition and production. Initiatives like the Group on Earth Observation are engaged in the uptake of Earth observation technologies and products into policymaking and statistical integration. It is essential to move from the monitoring of the planet to the understanding of human impacts on land management, atmosphere, climate, emergency management and marine environments.

The geospatial approach presented in this chapter aimed to deploy simple tools, data-driven results and visual analytics to show that building knowledge and understanding of disaster risk is key. The aspiration is that similar analyses are carried out at both the national and local levels, with the results of these local studies then be translated into localized adaptation plans, developed in a participatory fashion by a range of experts and stakeholders from different sectors.

Endnotes

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Chapter 4

Climate Action and Vulnerable Urban Groups

Quick facts

1. The impacts of the climate crisis are being unleashed in an unprecedented manner on many inter-connected urban systems, including economic, social, ecological and urban infrastructure systems.

2. Urban informality is a key driver of vulnerability, with slums and informal settlements among the most exposed to disasters and other impacts.

3. The climate crisis is profoundly discriminatory, intersecting with and reinforcing pre-existing vulnerabilities among certain groups.

4. Current urban adaptation and mitigation efforts are failing to protect the most vulnerable populations from climate change—and even making their situation worse.

5. The way cities grow, develop, expand and are planned creates unequal conditions for resilience, leaving some areas more vulnerable to climate risks than others.

Policy points

1. Adaptation plans that are co-created with diverse urban groups are more likely to result in inclusive, effective solutions that build the resilience of the most vulnerable to climate shocks.

2. Municipal governments should support locally-led climate adaptation to address vulnerability, boost resilience and enhance city-wide climate action.

3. Cities should prioritize investing in resilient infrastructure in underserved communities as a basis for building their resilience to climate-induced shocks.

4. Strengthening social protection programmes that address climate shocks is critical for building the resilience of vulnerable urban groups.

From record-breaking heatwaves to increasingly catastrophic flooding, the climate crisis is unleashing an unprecedented strain on cities. This is creating complex and multifaceted challenges that extend beyond environmental concerns, displacing countless residents, endangering public health and exacerbating socioeconomic disparities. While no one will be unaffected by climate change, it is impacting on people and places differently due to a range of factors, including varying degrees of vulnerability, exposure and adaptive capacity. In this regard the climate crisis intersects with existing urban challenges, such as persistent poverty, lack of access to basic services and inadequate housing, to create a vicious cycle of suffering.

From record-breaking heatwaves to increasingly catastrophic flooding, the climate crisis is unleashing an unprecedented strain on cities

Back in 2019, the Special Rapporteur on extreme poverty and human rights warned of an impending era of "climate apartheid", a world "where the wealthy pay to escape overheating, hunger and conflict while the rest of the world is left to suffer".[1] In many cities, particularly those contending with the some of the most extreme impacts, this reality is already here. This chapter explores how climate change is disproportionately affecting the most marginalized urban populations—women, children, people with disabilities, Indigenous communities, refugees, migrants and ethnic minorities, among others—and how their resilience can be strengthened to reduce damage to livelihoods and loss of lives. It examines how urbanization creates differential patterns of vulnerability to climate change and how diversity within communities, including factors like gender, sexuality, disability, ethnic origin, educational background and employment status, can create very different levels of risk.

All too often, urban policies are not only failing to address these challenges, but actively making them worse

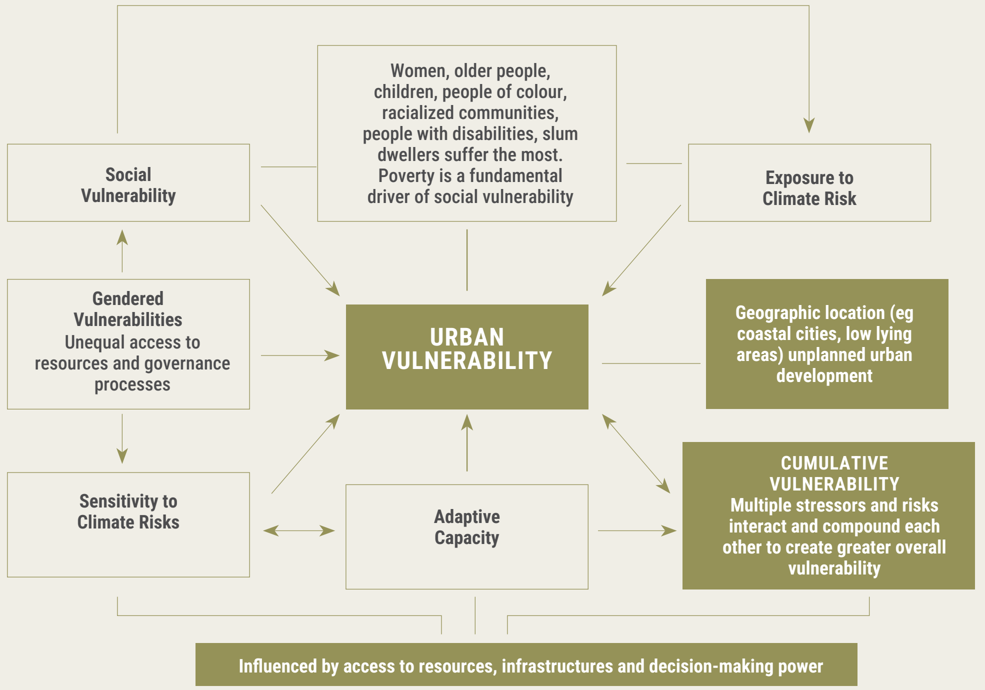
All too often, urban policies are not only failing to address these challenges, but actively making them worse. The chapter analyzes how governance and political structures perpetuate vulnerability in informal settlements and deprived neighbourhoods, highlighting how power relations and institutional frameworks impact marginalized populations. It also discusses climate urbanism, focusing on how climate action can reproduce and exacerbate inequalities. Additionally, the chapter explores the relationship between climate change and social capital, noting how disasters can both erode and foster social capital through shared preparedness and response. It also examines how climate-induced crises and conflicts increase vulnerability through displacement. Finally, the chapter discusses the challenges and opportunities of climate-resilient urban development, emphasizing a people-centred approach and highlighting how cities globally are integrating climate justice into their policies and programmes.

Pfaffenhofen Ilm, Germany was severely affected by floods in 2024/Shutterstock

Box 4.1: Conceptualizing urban vulnerability to climate change

Vulnerability to climate change refers to "the degree to which people, places, institutions and sectors are susceptible to, and unable to cope with, climate change impacts and hazards"[2]. The concept of vulnerability is multidimensional and is the product of a number of variables, such as:

- **Exposure** pertains to the character and magnitude of a system's exposure to notable climatic fluctuations. Cities with high exposure to climate hazards are more likely to have vulnerable populations living in areas prone to flooding, extreme heat, or other risks.
- **Sensitivity** encompasses the extent to which a system is impacted by climate variability or change. Excluded populations, such as residents of informal settlements, are sensitive to climate impacts due to poor living conditions, lack of access to basic services, and limited economic opportunities. High exposure combined with sensitivity creates a feedback loop where climate events have a more significant impact on already vulnerable communities.
- **Adaptive** capacity relates to the system's capacity to adapt to climate change, mitigate potential harm and effectively manage the resulting consequences. Like sensitivity, adaptative capacity is to a significant extent determined by access to resources, official recognition and other socioeconomic dimensions. Poor and marginalized urban communities generally face greater challenges responding adequately to climate risks due to the limited financial or technical assistance available to them.
- **Social vulnerability** considers the inequalities and disparities that exist within a city, which can amplify the impact of climate change on marginalized communities.[3] This is influenced by a variety of social and economic characteristics including (but not limited to) race, gender, ethnicity, socioeconomic status, age, health, level of ability, sexuality and non-conforming gender orientation. Poverty is a fundamental driver of social vulnerability, with the potential to give rise to additional dimensions of social vulnerability: this may include limited access to education, insecure legal tenure and other factors that further compound their precarity.
- **Cumulative vulnerability** acknowledges that multiple stressors and hazards can interact and compound one another, resulting in greater overall vulnerability. This recognizes that urban areas may face a combination of climate change impacts, such as extreme heat, flooding, food insecurity, water insecurity and sea-level rise, which interact and worsen overall vulnerability.



The drivers of urban vulnerability are interconnected and mutually reinforcing, shaping unique experiences of risk and adaptive capacity between different groups and individuals. The interaction of these factors amplifies vulnerability, creating a challenging environment for urban areas to address the impacts of climate change. Recognizing these relationships is essential for developing comprehensive climate adaptation and resilience strategies that target the root causes of vulnerability.

4.1 Vulnerability of Cities to Climate Change: An Overview of Issues and Trends

Due to their high concentration of people, activities and infrastructure, cities are highly vulnerable to the extreme weather events associated with climate change. Their impacts on the complex economic, social, ecological and infrastructure systems in urban areas are triggering significant economic losses, perennial disruption of essential services and negatively affecting the well-being of residents (Table 4.1).[4]

Due to their high concentration of people, activities and infrastructure, cities are highly vulnerable to the extreme weather events associated with climate change

Table 4.1: Multiple climate shocks and their impact on cities

Shocks (from fast to slow onset)	Direct (single) impacts	Indirect, cascading and compounding impacts	Asymmetric impacts across places and or people
Floods and storms	▪ Damage to urban infrastructure (e.g., roads, energy) and housing. ▪ Disruption of urban services (e.g., water, transport and energy). ▪ Damage to schools and public health facilities. ▪ Degrading coastal ecosystems, such as mangroves or coastal reefs.	▪ Disruption of urban services (e.g., health, food supply) due to damage to urban infrastructure (e.g., energy and transport). ▪ Emergence of waterborne diseases. ▪ Displacements due to climate migration create higher demand for public services and increase the population living in informal settlements.	▪ Economically and socially marginalized communities (living near rivers) may be more vulnerable to floods and damages to urban infrastructure. ▪ Children affected and more vulnerable to waterborne diseases. ▪ Where mangroves are already affected, there is increased vulnerability of coastal communities.
Heatwaves	▪ Heat stress on human health. ▪ Pressure on energy, water infrastructure and supply. ▪ Damage to urban infrastructure.	▪ Decrease of general labour productivity for both manual and cognitive tasks. ▪ Extended fire weather seasons (i.e., periods of time where weather conditions are conducive to the outbreak of wildfires). ▪ Increased morbidity from vector-borne diseases.	▪ Children and the elderly are more vulnerable to heat stress. ▪ Low-income households living with inadequate housing conditions (e.g., without air conditioning) are more vulnerable. ▪ Psychological or mental health impacts on the most exposed population.
Droughts	▪ Impacts on food supply system in cities. ▪ Water shortages affecting the population access to safe drinking water.	▪ Limiting the hydropower capacity of dams. ▪ Changes in ecosystems' functioning. ▪ Changes in labour and agricultural productivity. ▪ Impacts on food production leading to rise in food prices.	▪ Disruption of agricultural production leads to severe and more chronic food insecurity, increasing the propensity of malnutrition, as well as rising food prices. This problem is strongly concentrated in vulnerable populations
Sea-level rise	▪ Potential damage to urban assets in coastal areas. ▪ Impacts on urban land use and infrastructure investment strategies.	▪ Coastal defenses become increasingly expensive to adapt and to maintain over time. ▪ Decrease of tourism-related activities.	▪ Vulnerability is higher in Small Island Development States (SIDS) located in low-lying coastal zones.

Source: OECD, 2023, p.14.

4.1.1 Adaptive capacity constraints

Despite these complex climate risks and shocks, the implementation of urban climate adaptation plan is very low. The failure of cities to prioritize the implementation of climate-resilient urban planning (see Chapter 5) significantly aggravates their vulnerability. Cities in the developed world are better placed to address the consequences of the climate crisis compared to their counterparts in the developing world. This advantage arises from several key factors, including greater access to resources, a wealth of technical expertise and robust governance systems. Additionally, cities in developed countries have established practices for integrating long-term risk considerations into their land use planning processes. While adaptation efforts in these cities may entail substantial costs, the primary focus is often on integrating new data, cutting-edge technology and advanced practices into their existing planning procedures, investments and regulations.

Conversely, the context for cities in developing countries is markedly different and presents a unique set of challenges for climate change adaptation. These challenges mirror the existing deficiencies within systems coping with rapid urbanization.[5] These shortcomings include ineffective land use practices, inappropriate and inadequately enforced regulatory systems, the vulnerability of housing stock to disasters, inefficient infrastructure planning and funding mechanisms, and poorly functioning land markets.

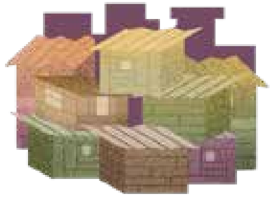
4.1.2 Trends in urban vulnerability to climate change

Urban areas are increasingly becoming hotspots of vulnerability to climate change, driven by a convergence of factors including rapid population growth, economic activities and inadequate infrastructure. Limited drainage, sanitation and other essential systems is rendering many cities in Sub-Saharan Africa especially vulnerable to the current and future impacts of climate change. In Antananarivo, Madagascar, for instance, regular bouts of heavy rainfall coupled with deforestation have increased the risk of urban floods and landslide. The danger is especially pronounced in the city's rapidly expanding informal settlements, where the impacts of climate change and extreme weather are exacerbated by the absence of functioning stormwater management or waste management.[6]

Cities in the developed world are better placed to address the consequences of the climate crisis compared to their counterparts in the developing world

Cities located along the world's tidal zones are highly vulnerable to sea-level rise, a challenge that is likely to intensify in the years to come. By 2050, over 570 low-lying coastal cities are projected to face sea level rise of at least 0.5 metres in a high-emission scenario, putting them at risk of flooding.[7] The intersection of climate change volatility and poorly managed urban growth in flood-prone locations has troubling implications for the exposure of coastal cities in the coming decades. One study, extrapolating from a 2013 estimate that put average flood losses among the 136 largest cities worldwide at a total of US$6 billion every year, projected that by 2050 the impact of continued urbanization in these areas would have increased their potential exposure to US$52 billion annually. However, when factoring in a relatively modest scenario of 20 centimetres of sea-level rise, this figure increased exponentially to as much as US$1 trillion if no efforts were made to upgrade existing protections.[8]

This vulnerability is globally distributed. In the Caribbean, where the bulk of housing, industry and urban infrastructure are concentrated in Low Elevation Coastal Zones (LECZs), it is projected that almost all port and harbour facilities in the region will suffer inundation in the future.[9] Among the capital cities, Nassau in the Bahamas is the most highly exposed to risks of sea-level rise and flooding, with 82.8 per cent



Urban areas are increasingly becoming hotspots of vulnerability to climate change, driven by a convergence of factors including rapid population growth, economic activities and inadequate infrastructure

of its population living in LECZs.[10] A similar picture emerges in the Arab region, where coastal flooding and saltwater intrusion will impact at least 43 port cities:[11] from Alexandria (Egypt) and Beirut (Lebanon) to Kuwait City (Kuwait) and Bandar Abbas (Iran), many major cities are located in high-risk areas vulnerable to sea level rise.[12]

Asian cities are exceptionally susceptible to the severe repercussions of climate change, amplifying the urgency for proactive measures and strategic investments in resilience and sustainability.[13] Their increasing exposure is illustrated by the cities of Guangzhou, Mumbai, Shenzhen, Tianjin (China), Mumbai, Kolkata (India), Jakarta (Indonesia) and Ho Chi Minh City (Viet Nam), all large cities in increasingly high-risk locations: while in 2005 they collectively suffered a total of US$1.5 billion in losses due to coastal flooding during the year, their collective loss from coastal flooding is projected to increase to an annual average of almost US$32.1 billion by 2050.[14] This stark increase underscores the imperative for urgent and substantial action in building resilience against the growing risks of coastal flooding. In Europe, too, with the exception of the Baltic coastline, most cities have already witnessed sea-level rise and are projected to experience greater exposure in future.[15]

Climate-induced heatwaves have become one of the deadliest threats confronting cities, a trend that is only likely to worsen in the future. Cities on the eastern China seaboard, for instance, such as Beijing and Shanghai, witnessed multiple record-breaking temperatures in 2023, only to experience another cycle of extreme heat in 2024.[16] At the same time, the global urban water crisis is expected to worsen as a result of climate change, impacting on hundreds of millions of residents worldwide.[17] Across Asia, many cities are already enduring acute climate-induced water scarcity and droughts: in India, 22 of 32 major cities are experiencing shortages while in Kathmandu, Nepal, community members are in some cases forced to queue for hours to obtain drinking water.[18] Limited water supplies will in turn trigger food insecurity. By 2050, according to one projection, 2.5 billion urban residents in over 1,600 cities will live in countries where one or more major crop (wheat, maize, rice or soya) is projected to decline.[19] As these and other climate-induced threats become more frequent and intense, societies may struggle to recover from one event before the next one occurs.[20]

4.2 Existing Patterns of Urbanization and Differential Vulnerability to Climate Change

Urbanization exhibits heterogenous patterns across regions, shaping the varying degrees of vulnerability to climate change.[21] Globally, most cities are experiencing rapid urban sprawl, characterized by the unchecked expansion of urban areas into previously rural or undeveloped land. Indeed, the physical extent of urban areas is growing much faster than their population, thereby consuming more land for urban development.[22] This has serious implications for energy consumption, greenhouse gas (GHG) emissions, pollution, climate change and environmental degradation. Moreover, as suburbanization–long evident in developed countries such as the United States (US)—has become increasingly prevalent in affluent neighbourhoods in developing countries too, it has led to the privatization of public spaces and the decline of public infrastructure, green projects and local ecosystems.

The growth of informal settlements, while driven by very different social and economic dynamics, is similarly characterized by their rapid expansion at the periphery of sprawling cities. Densely populated but lacking even basic infrastructure, frequently situated in flood-prone or unsanitary locations, they are particularly vulnerable to climate-induced disasters. These expanding peri-urban settlements, evident across Africa, Asia and Latin America, pose specific structural constraints to addressing climate risks. In addition to their environmental vulnerability, institutional factors such as limited land ownership and tenure insecurity hinder the ability of residents to invest in permanent infrastructure to buffer themselves from flood events. The multi-faceted nature of these vulnerabilities was illustrated by the protracted flooding in Nairobi, Kenya, in 2024 that disproportionately affected its slums: among other factors, the location of many informal settlements in flood-prone areas, the absence of adequately functioning drainage and the steady depletion of open spaces that previously would have absorbed some of the water all contributed to the severity of the situation.[23]

Globally, most cities are experiencing rapid urban sprawl, characterized by the unchecked expansion of urban areas into previously rural or undeveloped land

By contrast, more systematically planned urban areas demonstrate a more resilient infrastructure but still face unique challenges related to climate adaptation. Even in well-planned cities, urban sprawl can lead to increased surface runoff, reduced green spaces and the urban heat island effect, which exacerbates the impacts of extreme weather events. Nevertheless, it is not inevitable that cities should be exposed to these threats. If well-managed, urbanization can lead to a reduction in vulnerability to the direct and indirect impacts of climate change; if poorly managed, however, it can increase levels of climate risk for large sections of the urban population, particularly the most marginalized residents.

4.3 Disproportionate Impact of Climate Change on Vulnerable Groups

The climate crisis is unevenly experienced due to differences in the degree of vulnerability, exposure and adaptive capacity between urban residents and communities. Even among the most marginalized populations, there are often complex power dynamics at play around access to resources, social recognition and even the fundamental right to be in a particular city: migrants, refugees and stateless persons, for instance, may lack legal residency regardless of the length of time they have lived there, creating specific risks and deprivations. As discussed below, an array of intersectional factors can shape how different individuals or groups may be more or less susceptible to the same shocks, including the impacts of climate change.

More systematically planned urban areas demonstrate a more resilient infrastructure but still face unique challenges related to climate adaptation

4.3.1 Diversity and differential vulnerability to climate risks

The urban poor are not a homogenous group: they experience a multitude of differentiated vulnerabilities that are shaped not only by factors like age, health, disability, ethnicity and gender, but also by considerations such as income stability, tenure status (including renters or property owners), educational levels and the duration of their residence in the city. Women, for example, often bear the brunt of climate risks since they are largely responsible for domestic chores such as fetching water—duties further complicated by growing water stress in these communities—and in many contexts are more exposed to climate-related disruptions due to patriarchal laws, customs, and institutions that discriminate against them.[24]

To take one example, when Hurricane Katrina struck New Orleans in the US in 2005, almost two-thirds of jobs lost in the wake of the disaster belonged to women. Furthermore, close to 80 per cent of the people living in the flood-affected part of the city were members of ethnic minorities.[25] This illustrates how individuals can have different degrees of sensitivity, despite experiencing the same event in the same community. For those with limited social support or precarious housing situations, the effects of Hurricane Katrina were more traumatic and long-lasting. In Australia, too, a similar picture emerges where the physical effects of climate change interact with the legacy of racism and social exclusion. Aboriginal populations face a disproportionate level of exposure to a spectrum of climate extremes, including but not limited to heatwaves, erratic rainfall patterns and prolonged droughts. This existing imbalance in exposure is expected to intensify in the coming decades because of climate change.[26]

Climate change also interacts with pre-existing inequalities to further entrench urban poverty. In India, for instance, a clear correlation exists between states marked by elevated urban poverty and heightened social vulnerability to climate change risks. This connection is particularly evident in central and eastern states, such as Bihar, Chhattisgarh, Jharkhand and Orissa, where a significant portion of the urban population grapples with persistently high poverty rates, substantial inequality and limited access to essential services like clean water and sanitation. The challenge in these states is further compounded by the rapid expansion of urban populations without a proportionate increase in income levels to meet essential needs, as well as the inadequate development of urban infrastructure, including safe drinking water, sanitation facilities and housing.

While people living with disabilities are highly vulnerable to the climate crisis and "up to four times more likely to die in disasters", [27] they remain marginalized or invisible in climate adaptation efforts, with limited

The climate crisis is unevenly experienced due to differences in the degree of vulnerability, exposure and adaptive capacity between urban residents and communities

access to essential resources, information, programmes or support (as noted in Chapter 1). Therefore, cities and subnational governments need to implement processes and mechanisms to understand and address the needs of people with disabilities as part of their response to the climate crisis. They also need to ensure the full participation of disabled people as experts, decision makers and participants in climate action. Additionally, cities should develop climate policies to help eliminate existing barriers faced by people with disabilities. Toronto's First Resilience Strategy (2019), for instance, stresses the importance of prioritizing measures for the city's most vulnerable residents and identifies persons with disabilities as an "equity-seeking group" in this context.[28] Nevertheless, while Toronto has committed to a raft of disability-inclusive policies, like other cities it is still working to undo the accumulated effect of many years where people with disabilities were overlooked. For instance, the physical design of public spaces and transportation infrastructure continues to be a source of obstruction for some residents, despite the city's stated intentions to be fully accessible for all:[29] these and other general vulnerabilities will need to be addressed to strengthen the resilience of people with disabilities to climate change impacts specifically.

4.3.2 Urban informality and climate vulnerability

Informality, which manifests through unplanned settlements, irregular housing and employment is highly vulnerable to climate change. Indeed, Chapter 1 shows that countries with a higher share of informal employment and informal settlements are more likely to be vulnerable to the extreme weather events and shocks associated with climate change. Current estimates suggest that more than 1 billion urban dwellers live in slum-like conditions where they endure precarious living conditions with inadequate infrastructure, little or no basic services, overcrowded housing and tenure insecurity.[30] Given that many slums and informal settlements suffer from inadequate drainage systems, substandard construction and precarious locations such as riverbanks, these challenges are likely to worsen with climate change as the environmental risks facing residents intersect with social drivers of vulnerability, such as gender discrimination.[31] For instance, the impact of climate change falls disproportionately on the livelihood sources of the poorest residents (especially those living and working informally), undermining their already limited income streams and increasing their vulnerability (Figure 4.1).

Figure 4.1: Climate-induced impacts on urban populations living in slums and informal settlements and working in the informal economy

PROJECTED CHANGES	LIKELY IMPACTS	IMPLICATIONS FOR THE POOR
Changes in simple extremes: Higher (and increasing) maximum temperatures, more hot days, and heatwaves over nearly all land areas	Rise in mortality and illness from heat stress in many urban locations.	Higher population densities and poor ventilation amplify health risks. The largest impacts are among particularly vulnerable groups - infants and young children, the elderly, expectant mothers, and those wit certain chronic diseases. There are health risks from outdoor workers
Higher (increasing) minimum temperatures, fewer cold days, frost days and cold waves over nearly all land areas	Decreased cold-related human morbidity and mortality. Extended range and activity of some disease vectors - including mosquito and tick borne diseases	Most informal settlements are without public health measures to control or remove disease vectors and without health care systems that provide needed responses. Infants and young children are particularly vulnerable.
More intense precipitation events and riverine floods	Increased flood, landslide, avalanche, and mudslide damage resulting in injury and loss of life, loss of property and damage to infrastructure	Many informal settlements are concentrated on sites most at risk of flooding, with a lack of risk-reducing infrastructure and poor-quality housing less able to withstand flooding. Homes, possessions and assets for generating income are not covered
Changes in complex extremes: Increased summer drying over mid latitude continental interiors and associated risk of drought.	Decreased water resource quantity and quality: increased risk of forest/bush fire; decreased crop yields and higher food prices.	Informal settlements residents (Including home-based enterprises) usually face more water constraints and are more vulnerable to food and water price rises.
Changes in the mean: Sea level rise	Coastal erosion, land loss, more floods from storm surges, and hundreds of millions of urban dwellers living in low elevation coastal zones.	Many informal settlements close to the sea have poor quality housing and lack drainage infrastructure

Source: Prepared based on information from Dodman et al., 2019.

The climate crisis is exacerbating pre-existing vulnerabilities within slums, trapping the urban poor in an unrelenting cycle of enduring hardship

Figure 4.1 shows that the climate crisis is exacerbating pre-existing vulnerabilities within slums, trapping the urban poor in an unrelenting cycle of enduring hardship. The failure to take decisive action not only undermines the overall well-being of these vulnerable groups, but also stifles the prospect of an inclusive and prosperous urban future for all. Informal workers in most developing regions already face precarious living and working conditions that intersect with various climate-related risks. Climate change, although intertwined with socioeconomic, political and environmental factors, exacerbates some of these issues and introduces new challenges for informal workers. For instance, extreme weather events can further deteriorate the substandard shelter and working conditions experienced by informal workers, potentially leading to increased health issues, deepening poverty and even displacement.

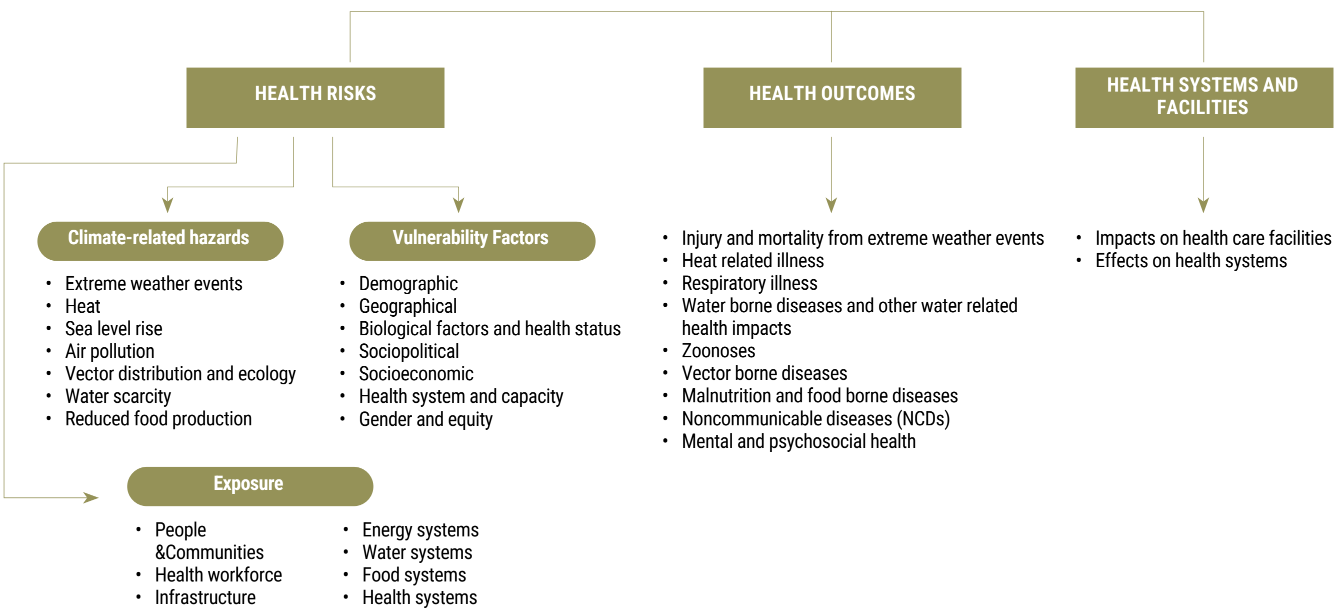
For those living in slums and informal settlements and other poor neighbourhoods, climate change can place a huge strain on their lives and livelihoods by disrupting disrupt local economies, especially those dependent on agriculture or vulnerable industries. Extreme weather events such as heatwaves, exacerbated by difficulties in accessing proper water, sanitation and hygiene services, can profoundly affect informal workers in particular, restricting working hours and productivity. This, coupled with the increased cost of living due to climate impacts, can lead to economic instability for vulnerable urban populations. When the financial burden on low-income urban residents intensifies—for example, due to unexpected expenditures such as housing repairs resulting from extreme weather events—it can result in the escalation of debt and erosion of assets, pushing vulnerable populations deeper into poverty and making it harder for them to recover from shocks. Vulnerable urban populations may face challenges in accessing essential resources such as water, food, and energy, which can further contribute to economic vulnerabilities. These findings underscore the underlying risk factors faced by informal workers, which, in conjunction with climate change impacts, can exacerbate health issues and socioeconomic exclusions. If governments fail to act urgently and aggressively, the consequences on the urban poor will be catastrophic.

4.3.3 The impact of climate-induced health risks on marginalized populations

Climate change poses a variety of potential threats to public health and well-being. Besides death and injury arising from more frequent extreme weather events such as storms or heatwaves, there is also the impact of food system disruptions, water contamination and the spread of vector-borne disease and zoonoses, not to mention the considerable negative effects on mental health. Climate change is undermining many of the social determinants of health and welling, such as sustainable livelihoods, equality, access to medical treatment and social support structures. These climate-sensitive health risks are disproportionately felt by the most vulnerable and disadvantaged, including women, children, ethnic minorities, poor communities, migrants or displaced persons, older populations and those with underlying health conditions (Figure 4.2).

Extreme weather events such as heatwaves, exacerbated by difficulties in accessing proper water, sanitation and hygiene services, can profoundly affect informal workers in particular

Figure 4.2: An overview of climate-sensitive health risks, their exposure pathways and vulnerability factors



Source: WHO, 2023.

Climate change is undermining many of the social determinants of health and welling, such as sustainable livelihoods, equality, access to medical treatment and social support structures

There has been a sharp increase in the prevalence in non-communicable diseases (NCDs), such as cancers, cardiovascular disease, diabetes and chronic respiratory diseases: collectively, NCDs now account for 74 per cent of deaths worldwide, impacting low-income countries disproportionately.[32] Climate change also threatens to aggravate health risks in underserved communities like slums and informal settlements, exposing residents to increasingly unsanitary conditions as both the quality and quantity of water supplies diminish. These trends have already been observed in Accra, Ghana, for example, where climate change is interacting with challenges of urban informality to create a host of public health hazards.[33]

The combined effects of climate change and the continued expansion of urban areas will amplify the phenomenon of urban heat islands (UHIs), resulting in increasing heat-related illness and mortality that will affect the most vulnerable first and foremost while driving up energy consumption for air conditioning (among those who can afford it) and air pollution levels. This will lead to more frequent and extreme heatwaves that will impact particularly on vulnerable groups, including the elderly, children and people with disabilities or chronic diseases. Social factors such as class, gender and migrant status also contribute to differentiated vulnerability to urban heatwaves.[34] In cities across the US, for example, Latino, Black and poor individuals routinely reside in areas most affected by UHIs, exposing them disproportionately to the threat of severe dehydration and heat stress.[35] Similarly, when the City of Montreal in Canada was hit by a succession of heatwaves in the summer of 2018, much of the death toll was concentrated among older residents, the homeless and people with severe mental illness.[36] Similarly, intensifying urban heat in Johannesburg (South Africa) is disproportionately affecting the urban poor (Box 4.2). To address the problem of intensifying heatwaves and their particular impact on certain groups, Barcelona (Spain) has implemented its ground-breaking Climate Shelter Network (discussed in detail in Chapter 3), offering a variety of cost effective, accessible areas throughout the city by reconfiguring public spaces such as schools and libraries. Its success provides a replicable model for other cities to tackle the intensifying issue of heatwaves.[37]

The combined effects of climate change and the continued expansion of urban areas will amplify the phenomenon of urban heat islands

Box 4.2: The discriminatory impacts of urban heat rise in Johannesburg, South Africa

Johannesburg, a South African city known for its historically mild climate, is expected to experience a significant rise in temperatures in the coming decades. This temperature increase will have a disproportionate impact on impoverished neighbourhoods, which tend to absorb and retain heat more effectively. The Highveld region, where Johannesburg is located, has already seen a 1.2 degree Celsius (°C) rise in average temperatures compared to preindustrial levels: by 2050, it is projected to warm by an additional 1.2–1.7°C, in the process transitioning from a temperate to a hot and dry climate zone. Detailed heat maps generated from a community monitoring initiative reveal that Johannesburg is already grappling with a pronounced UHI effect: most neighbourhoods in the city are 3–4°C warmer at night than nearby rural areas. Particularly affected are neighbourhoods like Alexandra, Katlehong, Soweto, Tembisa and the Central Business District, where temperature differences can reach up to 6.5°C higher.

Notably, these neighbourhoods—which have a history of marginalization and are predominantly inhabited by non-white and low-income communities—exhibit high building and population density, along with minimal vegetation and tree cover. Many of the residences in these areas are cheaply constructed and prone to overheating, while their occupants often lack the means to adapt to extreme heat, such as by using air conditioning. Historical factors, including land use practices from the apartheid era, have contributed to stark inequalities in heat distribution that may widen in the years ahead. Urban climate models suggest that by 2050, the number of hot nights (when the temperature remains above 20°C) annually will increase significantly, with the hottest neighbourhoods (primarily the most impoverished townships) experiencing the most substantial rise.

These disparities in heat exposure pose significant health and livelihood risks, particularly for disadvantaged communities already contending with significant challenges. Modeling indicates a notable increase in heat-related deaths by 2050, potentially resulting in several hundred additional fatalities each year. Vulnerable populations, such as the elderly and individuals with conditions like tuberculosis or HIV/AIDS, as well as those living in homes that absorb and retain heat, face higher health ri ks. Indoor temperature measurements conducted in February 2022 reveal that indoor temperatures in dwellings constructed with wood frames and corrugated iron can be as much as 15°C higher than in nearby brick and concrete homes. Furthermore, outdoor and informal sector workers may experience reduced labour productivity as heat stress becomes more frequent and severe, affecting their ability to work effectively.

Source: Souverijns et al.,2022.

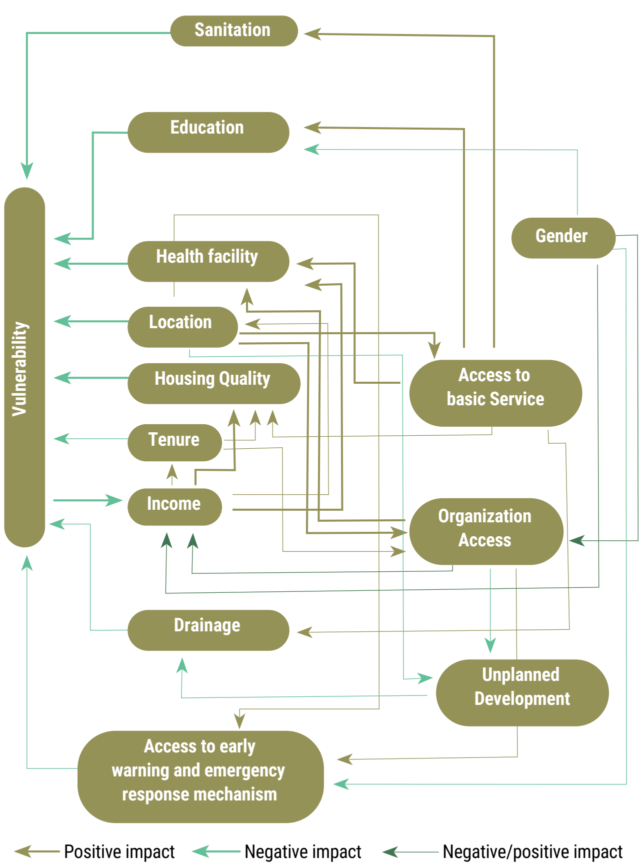
4.3.4 Governance and institutional drivers of vulnerability to climate change.

Governance and institutional structures determine the allocation of resources, implementation of policies and overall adaptive capacity, significantly influencing how urban communities prepare for and respond to climate-related impacts. Weak and fragmented governance, characterized by corruption, lack of transparency and insufficient policy enforcement, exacerbates vulnerabilities by hindering efficient resource distribution and stymieing proactive climate action. Conversely, strong institutions with clear, inclusive and forward-looking policies can enhance resilience by fostering sustainable development, ensuring equitable resource access, and promoting community engagement in climate adaptation strategies. This section explores the complex interplay between governance, institutional effectiveness and the varying degrees of vulnerability experienced by different populations in the face of climate change.

Governance and institutional structures determine the allocation of resources, implementation of policies and overall adaptive capacity, significantly influencing how urban communities prepare for and respond to climate-related impacts

In developed and developing country contexts alike, social exclusion or limited political representation can serve to undermine protection from climate change impacts. In the US, for instance, a comparative study of African American communities in the Eastern Shore of the Chesapeake Bay identified the role of racial injustice (namely, the apparent neglect of vital local infrastructure) as an important factor in the flooding of certain neighbourhoods by Hurricane Sandy.[38] Similarly, in slums and informal settlements across the world, vulnerability to climate change also stems from historical legacies of (post)colonial and (post)apartheid discrimination, reflected in inequalities in infrastructure and service provision that persist to this day.[39] In Bengaluru, India, the discriminatory effects of colonial-era land use and planning policies continue to affect the ability of the city's poorest residents to access safe drinking water.[40] The vulnerability of the urban poor to climate change is further amplified by inefficient urban planning (discussed further in Chapter 5), weak institutional coordination and ad-hoc adaptation efforts that do not contribute to sustainable outcomes. Within slums and informal settlements, there are complex and multifaceted drivers of risk and exposure that are often mutually reinforcing, contributing to a vicious cycle of deepening vulnerability (Figure 4.3).

Figure 4.3: Vulnerability system in low-income urban settlements



Source: Haque, 2020, 112.

Note: Bold lines refer to reinforcing loops. To avoid excessive complexity, the influence of each factor on different types of vulnerability (i.e., social and physical) has not been shown.

People carrying their belongings as they wade through a flooded street after heavy monsoon rains in Vijayawada, Andhra Pradesh, India/Shutterstock

This systems analysis underscores the pivotal role of institutional accessibility in shaping the vulnerability of low-income urban populations, as a multitude of system drivers are either directly or indirectly influenced by it. Without representation of the urban poor in governance processes, climate resilience planning is likely to be irrelevant or even hostile to their needs.[41] In the cases of informal settlements, their lack of official recognition as part of the larger city fabric often results in them lacking meaningful risk-reducing infrastructure such as storm drains, roads, bridges and sanitation facilities.[42] For instance, in Bangladesh, the urban poor are routinely overlooked in national climate strategies. This invisibility leaves them even more exposed to potential disasters and closes off the possibility of meaningful collaboration between local authorities and communities.[43]

Without representation of the urban poor in governance processes, climate resilience planning is likely to be irrelevant or even hostile to their needs

As depicted in Figure 4.3, the variables within the system exhibit not only close interrelations but also mutual reinforcement. For example, insufficient income is frequently exacerbated by the absence of organizational access to various financial schemes, loans and savings initiatives. This financial strain, in turn, ultimately results in precarious living conditions and limited access to essential services, including health facilities and education. Each of these deficiencies contribute to a diminished adaptive capacity, creating a feedback loop that exacerbates vulnerability and perpetuates poverty.[44]

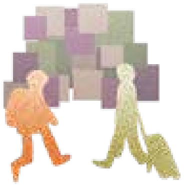
4.3.5 The challenge of climate-induced migrants in cities

The climate crisis has displaced millions of people who have been forced to leave their homes or country as a result of natural disasters, extreme weather or other impacts. Current projections suggest that by 2050 over 216 million people could move within their countries for climate-related reasons across six regions, including Sub-Saharan Africa (86 million), East Asia and the Pacific (49 million), South Asia (40 million), North Africa (19 million), Latin America (17 million) and Eastern Europe and Central Asia (5 million).[45] Based on trends to date in climate-vulnerable countries such as Bangladesh, a large proportion of climate-induced migrants are likely to end up settling in urban areas, many in informal settlements or disaster-prone areas.

For children, climate-induced displacement can have deadly consequences. For example, an estimated 2.5 million children across the Philippines are at risk of being displaced during the next 30 years by storm surges, with the worst affected areas projected to be around large cities including Davao, Cebu and Manila.[46] Climate change impacts and displacement may also exacerbate the potential for local conflicts.[47] For instance, competition over scarce water resources can lead to elevated tensions as the arrival of migrants may place additional demands on already limited water supplies in host communities. Data produced by the Pacific Institute in 2019 suggested that over the previous 10 years, reported cases of water-related conflict had more than doubled, including incidents where urban water supplies had been specifically targeted.[48] While the connections between conflict, migration and climate change differ depending on the political, economic and social contexts, inadequate institutional capacity and a lack of state support for affected individuals worsen pre-existing vulnerabilities. This neglect leaves the underlying causes of vulnerability unaddressed and, in some instances, contributes to maladaptation.[49]

As the climate crisis looms, a key question remains: when the impacts of flooding, landslides, storms, drought, water scarcity, disease and high food prices become overwhelming, what choices do, or will, migrant or displaced population in urban areas have? Urban migrants who lack the capital or connections to move will likely experience repeated instances of forced or involuntary immobility, leaving them with few options for survival. In situations of protracted immobility, the vulnerability of these groups may develop into a full-scale humanitarian emergency, exerting additional pressure on already overstretched national and local resources. Those who choose to move to cities may also face heightened vulnerabilities as they grapple with the dual challenges of forced displacement and the harsh realities of navigating precarious conditions in host communities.

Consequently, migrant and displaced populations who have had to move to cities in contexts of environmental stress or climate change are often among the most vulnerable populations worldwide. Besides the risk of becoming officially "invisible", making any form of targeted support difficult, the irony is that many climate-induced migrants face new climate threats in the cities where they sought refuge and new opportunities. Despite these pressures, some urban destinations have risen to the challenge of climate-induced migration and developed their own solutions. From São Paulo (Brazil) to Freetown (Sierre Leon), Nairobi (Kenya) to Makassar (Indonesia), there are many cities that have welcomed and integrated migrants by providing services such as emergency housing, health care and access to services.[50]



Migrant and displaced populations who have had to move to cities in contexts of environmental stress or climate change are often among the most vulnerable populations worldwide

Cities will likely face many different iterations of climate change, with unpredictable repercussions. The urban crises that climate change could cause or contribute to may become a source of destabilization and civil unrest, with potentially increased discrimination and destitution for the poorest urban residents, including those who arrived within mixed migratory flows. In Bangladesh, residents of vulnerable coastal communities have already begun moving inland to towns and cities already struggling with overstretched resources, limited institutional capacity and social tensions, issues that could be exacerbated by rapid and unmanaged population growth.[51]

Despite these challenges, there have been notable efforts to address climate-induced migration in cities. Organizations such as C40 Cities and 100 Resilient Cities (2013-2019) have linked climate change to cities, while the Mayors Migration Council is the most recent municipal governance network to have a specific focus on migration issues in cities. São Paulo, Brazil, is one example of a city that has taken concrete steps to support inclusive migration policies, committing to implement its first-ever municipal plan for migrants, developed through a collaborative process with IOM, UNHCR, refugees and migrants living in the city.[52] Some local governments in countries that have already been impacted by the dual pressures of climate change and mass displacement, such as Burkina Faso, have even begun to factor these trends into their spatial planning to accommodate future population growth.[53] Similarly, in Baidoa, Somalia, in a context of widespread displacement as a result of drought and conflict, municipal authorities have taken steps to strengthen emergency preparedness, regularize public land and expand basic facilities to provide internally displaced persons with durable solutions.[54]

A key takeaway for cities struggling with the impacts of climate-induced migration and displacement, such as Dhaka in Bangladesh (Box 4.3), is to create the enabling conditions for new arrivals to integrate fully into city life. This is important to break the vicious cycle of cumulative vulnerability and set the stage for resilience building. However, more concerted action is required to decisively address the many issues that climate migrants may face. Climate mitigation and adaptation actions can advance the inclusion of migrants in cities or further entrench their marginalization and exposure to inequality and risk. Support for climate-induced migrants should be embedded within wider city strategies or plans for the urban poor: doing so can increase the level of assistance displaced people receive, as well as manage social tension, promote integration into local economies and increase access to public services, thereby building resilience to climate shocks. Cities, in collaboration with subnational governments, civil society and community organizations, should design targeted programmes to improve their access to critical services such as housing and employment.[55] By doing so, cities can enhance social cohesion and economic opportunities for migrant and displaced populations.

Box 4.3: Inclusive and equitable service provision: Emergency shelter for migrants in Dhaka, Bangladesh

In response to increasing climate-induced migration from across Bangladesh, Dhaka South City Corporation has developed an emergency shelter to meet the needs of thousands of migrants at perhaps their most vulnerable moment—their arrival in the city. Capable of accommodating as many as 1,500 people, with designated areas for men and women, the space provides a range of recreation and support, from yoga to childcare, as well as other essential resources to meet their complex and wide-ranging needs. While the shelter only offers temporary housing, it serves as a vital lifeline for new migrants to orient themselves, providing them with the information and support to settle safely and sustainably in Dhaka in the longterm.

Source: C40 Cities, 2021, p.25.

4.3.6 Social capital and vulnerability to climate change

One of the most significant impacts that climate-induced displacement can have is the disruption of social capital, such as the fragmentation of familial and communal bonds. At the same time, social capital plays a crucial role in determining the vulnerability of communities to climate change. As networks of relationships and social structures within a community, social capital can enhance resilience by fostering cooperation, resource sharing and collective action in the face of environmental challenges.

Social capital is an important asset to leverage when building resilience to climate risks in marginalized urban areas such as slums

Social capital is an important asset to leverage when building resilience to climate risks in marginalized urban areas such as slums. Communities with pre-existing networks of trust and reciprocity are more likely to prepare for, respond to and recover from climate change shocks and natural disasters.[56] For example, residents of Abese old quarter, an informal settlement in Accra (Ghana), have successfully mobilized their social capital by pooling their minimal resources together and modifying their houses to address structural weaknesses, poor housing conditions and overcrowding.[57] This local initiative highlights the potential for community-led actions to address housing challenges and climate vulnerability in informal settlements. Local action and advocacy play a vital role in both building and rebuilding social capital, driving meaningful change in the face of climate change. For instance, recent research suggests that disaster-prone Japanese cities with higher levels of bonding social capital generally experienced lower levels of vulnerability to disasters overall.[58] Across multiple slums and informal settlements in diverse settings across the world, strong social capital has enabled vulnerable populations to tackle climate-related threats such as flooding and sea-level rise. In Small Island Developing States (SIDS), for example, evidence shows that adaptation projects have a higher chance of successful implementation in urban communities with high social capital.[59]

4.4 Climate Urbanism and Emerging Forms of Climate Injustice

Climate urbanism, an evolving paradigm that integrates climate resilience and sustainability into urban planning, is becoming a cornerstone in the quest to mitigate and adapt to climate change. However, as cities implement ambitious climate policies and infrastructural projects, new forms of climate injustice are emerging. These injustices often manifest in the form of "green gentrification", which aggravates existing urban inequalities. This section discusses the paradox of climate urbanism, focusing mainly on green gentrification, unintended outcomes of flood mitigation as well as the dynamics of participation in climate adaptation planning.

As cities implement ambitious climate policies and infrastructural projects, new forms of climate injustice are emerging

4.4.1 The paradox of climate urbanism and green gentrification

Urban climate adaptation and planning interventions are aimed at promoting resilience and address the underlying drivers of vulnerability in cities.[60] Despite the good intentions of climate adaptation measures, these interventions have the potential to drive new vulnerabilities, particularly for low-income communities.[61] When these projects are not inclusively planned and executed, they can inadvertently exacerbate social inequalities and displace vulnerable populations. This process, sometimes referred to as green gentrification, is a frequent by-product of environmental improvements in urban areas (such as parks, green spaces and other sustainability initiatives) that lead to an increase in property values and living costs. This, in turn, often results in the displacement of poor residents and small businesses, who can no longer afford to live or operate in the improved areas.[62] A case in point is Medellín's El Cinturon Verde Metropolitano initiative, an ambitious programme of housing and greenbelt encircling the city: while it has already brought substantial benefits to public health, safety and well-being, the redevelopment of what was the city's main waste dump has also led to the displacement of 14,000 low-income households to the periphery and deprived local waste pickers of their livelihood.[63]

Despite the good intentions of climate adaptation measures, these interventions have the potential to drive new vulnerabilities, particularly for low-income communities

Poor urban residents, particularly people of colour, Indigenous Peoples and migrant communities, are disproportionately likely to be the victims of green gentrification. Experiences from urban settings as diverse as Amsterdam (the Netherlands) and Dhaka (Bangladesh) point to a common theme of climate injustice and "racial capitalism" underpinning the logic of urban resilience interventions in developed and developing country contexts alike.[64] In these and other cities, urban climate adaptation projects hold the potential to inadvertently intensify existing inequalities. Therefore, the critical question is how to invest in climate resilience through green infrastructure projects without amplifying existing urban inequalities.

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This can be achieved through a people-centred approach where cities identify vulnerable populations, understand local experiences by engaging directly with communities and respond to their needs through just adaptation strategies which unlock social and economic benefits. Additionally, to ensure accountability, municipal governments should invest in measuring and tracking inclusion and equity impacts of climate actions. Disaggregated data by neighbourhood, income, gender and other key indicators will inform city decision-makers whether policies are well-designed and if their impacts are equitably distributed. For example, Pittsburgh (US) has identified key indicators (such as access to green space) that the city can use to measure improvements in equity (for instance, the ratio of access between black and white residents over time) to ensure equitable outcomes of its climate interventions.[65]

4.4.2 Unintended outcomes of flood mitigation

Another common side effect of failing to factor in social considerations into climate resilience programmes is *maladaptation*, when adaptation measures have an adverse impact on sections of the urban population.

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For instance, flood mitigation strategies can potentially exacerbate inequalities if they only prioritize the protection of affluent neighbourhoods or exclude peripheral and unrecognized informal settlements from their plans.[66] The construction of the Great Garuda Sea Wall in Jakarta (Indonesia) to defend against flooding and sea-level rise has been criticized for favouring elite ambitions to achieve "world class" city status over the needs of vulnerable populations.[67] In Lagos (Nigeria), similarly, the development of the Great Wall of Lagos had unintended outcomes: informal settlements outside its protective area are as a result more exposed to the threats of erosion and coastal inundation as the sea wall pushes waves and storm surge towards them.[68]

In other instances, poor residents are excluded from the benefits of a project through conscious design. In Hanoi, Vietnam, an Ecopark developed in the flood-prone delta has not only led to the displacement of local farming households, but is also largely inaccessible to the urban poor as entry is carefully monitored by security guards.[69] These and other examples represent a stark picture of the phenomenon of "climate apartheid" discussed at the beginning of this chapter. To return again to the case of New Orleans (US) in the wake of Hurricane Katrina, the continued gentrification of relatively flood-safe areas and the failure of subsequent recovery efforts to address the persistent vulnerabilities of the city's impoverished African American communities has left them exposed to future disasters. Efforts to address this through the 2015 Resilient New Orleans Strategy, which proposed various improvements to strengthen the resilience of low-income communities, had the perverse effect of gentrifying some poor, predominantly black neighbourhoods by pushing up housing prices to unaffordable levels.[70]

4.4.3 Participation and inclusivity in urban adaptation planning

Urban climate adaptation is a complex and cross cutting challenge that requires the active participation of different stakeholders. As municipalities undertake climate adaptation planning, many are exploring alternatives to promote broad participation and engage diverse civil society actors. Table 4.2 summarizes the key indicators of inclusivity in urban climate adaptation planning and implementation. This framework can be useful for cities to assess the extent to which they are adequately engaging with multiple voices and experiences when planning, implementing and evaluating adaptation plans.

Man on a wheelchair spending time with friends outdoors/Shutterstock

Table 4.2: Dimensions of social inclusion in urban climate adaptation action

Indicator	Definition	Examples
Consideration of the needs of vulnerable residents	The extent to which the social, economic and political interests of the urban poor, underrepresented minorities and other groups in vulnerable situations are considered in the adaptation process.	▪ Recognizing and prioritizing the needs of the urban poor. ▪ Linking adaptation needs to infrastructure development, service provisions, and livelihood requirements of vulnerable communities. ▪ Recognizing existing community-based adaptation initiatives.
Procedural representation and equity	The degree to which all urban public, private and civil society actors adequately participate in the adaptation process.	▪ Involving the public in framing the most acute climate risks, socioeconomic vulnerabilities, and adaptation priorities. ▪ Addressing existing class, gender, caste, age, and wealth hierarchies in political decision-making.
Just adaptation outcomes	The degree to which formal or institutionalized adaptation projects and programmes achieve just results.	▪ Improving capabilities and capacities for adaptation of the urban poor. ▪ Preventing unequal spatial distribution of losses and damages attributed to climate impacts. ▪ Protecting assets and property of underrepresented communities.

Source: Adapted and modified from Chu et al., 2016, p.376.

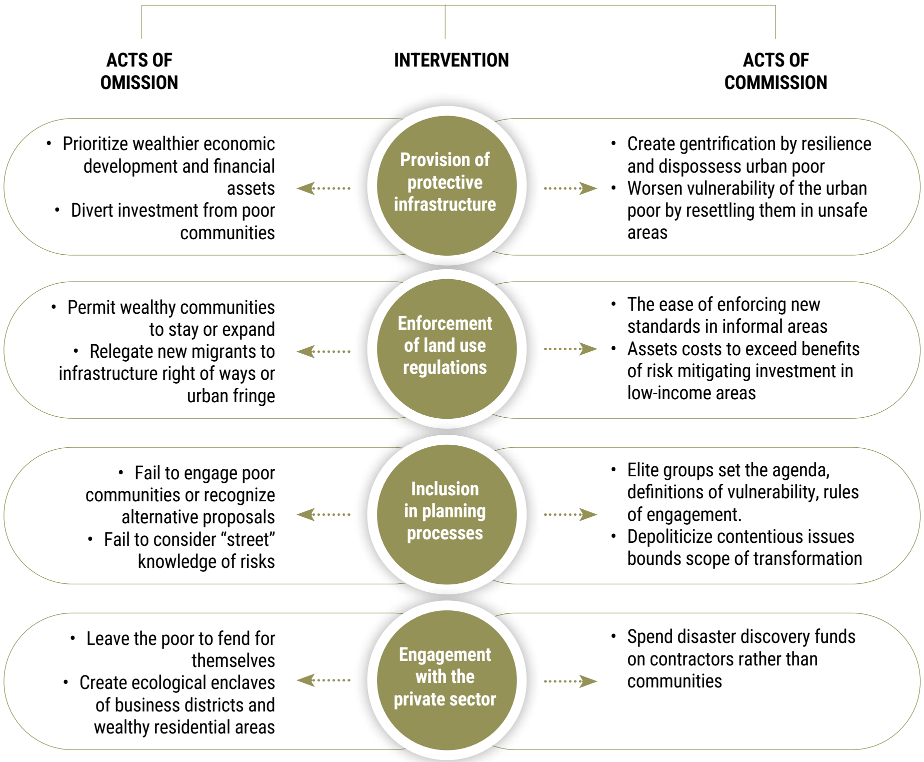
The needs of the urban poor and other socially and spatially disenfranchised populations have historically featured highly in the policy and planning agenda of Quito, Ecuador. The city has tried to facilitate the participation of a wide range of stakeholders to ensure socially inclusive adaptation programmes that adequately reflect local priorities.[71] In Boston (US), too, when producing its 2017 Resilient Boston strategy, the city government involved 11,700 residents who participated in 167 community meetings, 18 workshops and 12 public presentations. In doing this, the city made explicit connections between climate risks and entrenched forms of class-based or race-based injustices.[72]

However, most municipal adaptation planning processes do not engage sufficiently with social justice advocacy groups or the urban poor. It is evident that climate adaptation plans can prioritize the involvement of privileged segments of the population at the expense of the very communities they are intended to support. This can occur through the recalibration of what is considered vulnerable, the selective incorporation of particular groups within these definitions, and the negotiation of problems that may disproportionately affect marginalized populations. Furthermore, planners may at times seek to de-politicize the adaptation process by sidestepping contentious historical development issues and policies that underlie disparities in resource access. However, this avoidance can be counterproductive in addressing the fundamental causes of unequal resource distribution.

Consequently, strategies emerging from adaptation processes often reinforce the vulnerability of urban underprivileged communities, while also giving rise to new disparities in land use. Figure 4.4 shows some of the land use inequities that result from the unequal participation of affected communities in climate adaptation interventions. Therefore, it becomes essential to delve deeper into the intricacies of community engagement and adaptation planning to ensure that the voices and needs of vulnerable populations are not suppressed.

Climate adaptation plans can prioritize the involvement of privileged segments of the population at the expense of the very communities they are intended to support

Figure 4.4: Types of land use planning inequities associated with urban climate change adaptation interventions



Source: Adapted and modified from Anguelovski et al., 2016.

A significant number of cities persist in neglecting equity considerations within their climate and sustainability strategies. In some cases, equity goals are either omitted entirely or relegated to secondary or tertiary status, overshadowed by environmental and economic objectives. This misalignment of priorities poses a challenge to the pursuit of holistic, socially just urban sustainability. Thus, developing climate plans that emphasize equity requires a considerable upfront commitment to building authentic participation from frontline communities and ensuring that it is reflected in implementation. The Barcelona Climate Plan, launched in 2018 following extensive consultations with urban communities and the deployment of a digital platform to increase resident engagement, represents a good example of how cities can generate more informed decision-making through participatory processes involving civil society organizations. Even then, however, the process of its development revealed that local residents and other stakeholders may have conflicting priorities and interests: balancing these differing viewpoints can be challenging and might slow down, or even compromise, the "co-production" processes if local authorities lack the capacity to fully implement equitable participation in practice.[73]

4.5 Towards a Transformative and People-Centred Urban Climate Action Agenda

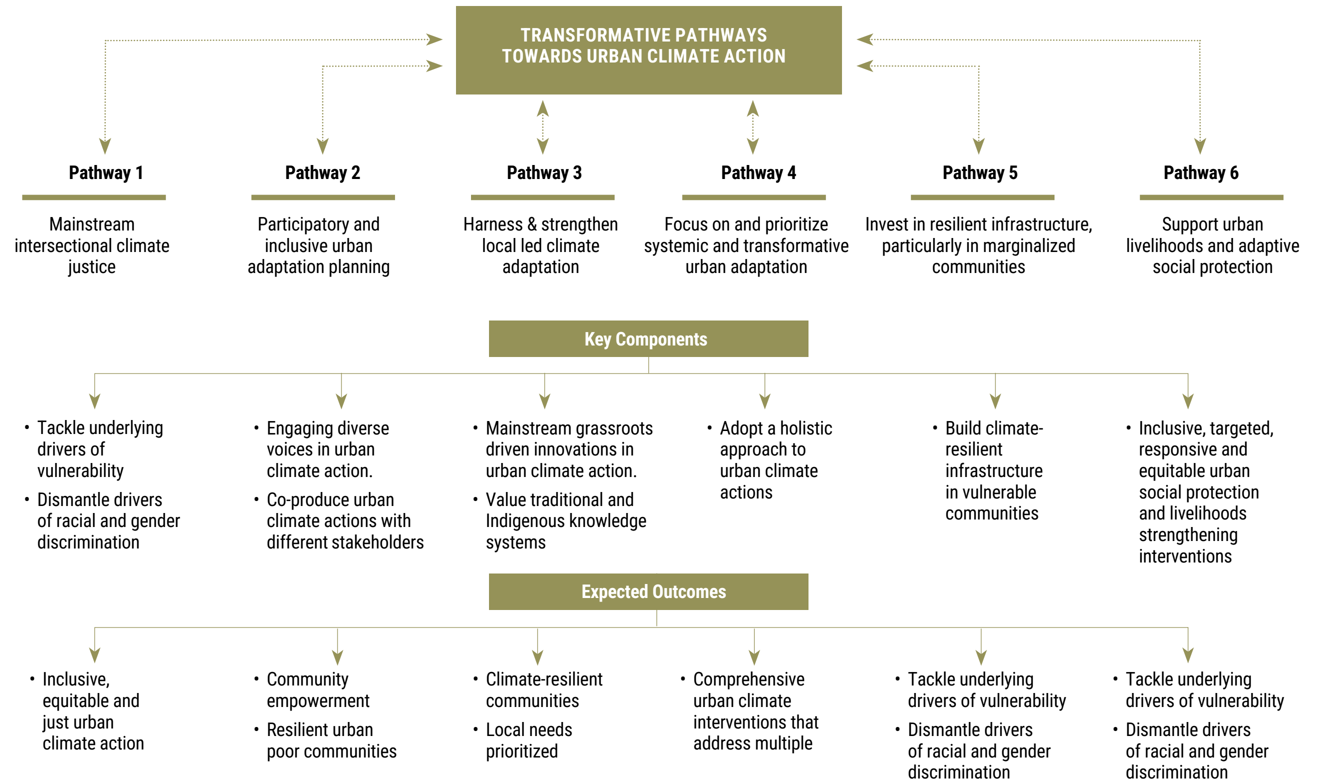
In the face of the escalating challenges posed by the climate crisis, urban areas have emerged as both the epicenters of environmental vulnerability and crucibles for innovative solutions. To address the climate crisis and ensure the well-being of urban populations, a fundamental shift is needed towards transformative and people-centred urban climate action. Such an approach places the experiences, needs and aspirations of residents at its core, recognizing that effective climate strategies must empower communities, prioritize equity and foster resilience in the face of evolving environmental threats.

As highlighted in Chapter 1, a people-centred approach to climate action has the potential to address many of the risks faced by marginalized groups because it adopts an inclusive process, tackles the underlining drivers of vulnerability and in the process unlocks social and economic benefits. A study conducted by Carbon Disclosure Projects (CDP) in 2022 concluded that "cities taking people-centred climate actions identified seven times as many co-benefits from climate actions as other cities", with the large majority reporting an array of social, economic, environmental and public health benefits that made them "happier and more inclusive places to live, work and invest in".[74] With urban communities front and centre of climate action, adaptation and mitigation efforts could support decarbonization in cities whilst creating a more just, equitable and sustainable future for all.

Based on the analysis presented in this chapter, the following transformative pathways are critical to implementing people centred urban climate action: 1) mainstream intersectional climate justice in urban adaptation plans, 2) promote participatory and inclusive urban adaptation planning, 3) harness and strengthen locally-led urban climate adaptation, 4) focus on and prioritize systemic and transformative climate adaptation in cities, 5) invest in resilient infrastructure, particularly in marginalized communities, and 6) strengthen urban livelihoods and adaptive social protection. These components are outlined in Figure 4.5 and explored in more detail in this section.

These interventions collectively should help address current vulnerabilities while building the capacity of poor and marginalized populations to deal with future impacts in the context of the ongoing climate crisis. It is important to reiterate that there is no one-size-fits-all approach to ensuring that climate adaptation efforts have positive results and include the concerns of everyone affected. While these transformative pathways provide a useful foundation for urban leaders, we need to acknowledge that cities and local communities are diverse and thus have differing perspectives on what responses to prioritize. Therefore, cities should consider interventions that might work effectively given their prevailing socioeconomic and geopolitical context, while ensuring that no one is left behind.

Figure 4.5: Transformative pathways towards urban climate action



Urban Biodiversity in Greenwich - People Rest on Stone Benches Next to Wild Plants, with Urban Apartments in the Background/Shutterstock

While investing in resilient infrastructure through green interventions is important, mainstreaming vulnerable urban populations in such initiatives is just as urgent

4.5.1 Mainstream intersectional climate justice into urban adaptation plans

While investing in resilient infrastructure through green interventions is important, mainstreaming vulnerable urban populations in such initiatives is just as urgent. Simply identifying vulnerable populations is not enough; successfully adapting to climate change requires resolving broader societal issues that lead to the systematic vulnerability of certain groups. Therefore, an intersectional climate justice framework becomes a critical tool for promoting inclusive, responsive and just urban climate action.[75] Such a framework would place a central focus on the real-life experiences of individuals facing climate risks, while also critically examining and addressing the deep-rooted legacies of racism and sexism that continue to be felt in cities marked by insecurity, environmental vulnerability and an inequitable economic system whose rewards disproportionately accrue to a privileged few (Figure 4.6).

To effectively implement this approach, it is essential to develop policymaking strategies that not only acknowledge but actively incorporate the intersecting identities, perspectives and unique needs of historically marginalized groups. For instance, cities should strive to adopt and implement intersectional climate mitigation and adaptation plans that explicitly prioritize the protection of the most vulnerable groups of residents (including people who live in slums, women, the elderly, children and people with disabilities).[76] By adopting planning methods that are informed by intersectional, feminist and anti-racist principles, cities can embark on a transformative journey to dismantle oppressive systems and structures that have long perpetuated racial and gender inequalities (Chapter 10).

It is essential to develop policymaking strategies that not only acknowledge but actively incorporate the intersecting identities, perspectives and unique needs of historically marginalized groups

Figure 4.6: Intersectional climate justice framework, drivers of injustice and pathways to achieve intersectional climate justice

Component	Tackle underlying systemic reinforcers of racial and gender inequalities.	Redress drivers of differential vulnerabilities.	Adopt place-based and place-making approaches.	Promote cross-identity climate action and community resilience building.
Drivers of justice	Racial & gendered Capitalism gender and race-blind climate policies.	Historical & structural inequalities, pre-existing risks and urban vulnerabilities Exclusionary land use planning.	Colonial, scientific, technocratic, and expert driven approaches to planning and development.	Limited citizen involvement and engagement in adaptation planning, implementation, and evaluation. Limited or tokenistic civil society participation.
Intersectional climate justice pathways	• Recognize and question economic reinforcers of racial and gender inequalities. • Devise racial and gender equality goals in key regulations, plans and programs.	• Consider historical legacies of social and environmental injustices in adaptation planning. • Address enduring inequality in land use planning. Include the most vulnerable in decision-making.	• Foster decolonial postcolonial approaches to planning and development • Recognize traditional, situated, and local knowledge arising from diverse and often invisible experiences of place and space.	• Foster decolonial/ postcolonial approaches to planning and development • Recognize traditional, situated, and local knowledge arising from diverse and often invisible experiences of place and space.

Resilient, sustainable, inclusive, just and fair urban climate action

Source: Prepared based on information from Amorim-Maia et al. 2022, The intersectional approach requires cities and subnational governments to take bold and proactive measures in confronting the power structures and systems that have historically upheld privilege while disenfranchising vulnerable populations. Therefore, embracing the intersectional approach in urban climate action represents a commitment to fostering inclusive, equitable and just urban environments where the impacts of climate change are mitigated and the benefits are accessible to all, regardless of their gender, race or socioeconomic status. The City of Portland, Oregon (US) has been at the forefront of implementing urban climate initiatives using an anti-racist approach, including the launch of its Five-year Racial Equity Plan in 2017.[77] Designed to address its long history of environmental racism, the programme was followed in 2023 by a US$750 million Climate Action Plan that includes, among other elements, an emphasis on activities that "address climate change while advancing racial and social justice".[78] While commendable, the extent to which Portland can achieve these aspirations will ultimately depend on the comprehensiveness of the plan, ongoing community engagement and a commitment to addressing the issues over the longterm. Encouragingly, other larger North American cities including Boston, New York City and Los Angeles (US) have initiated a significant shift by prioritizing justice within their climate change adaptation plans.[79] In the United Kingdom (UK), meanwhile, the city of Bristol now implements "equalities impact assessments" as a means to determine the impacts of potential policies (including climate programmes) on disadvantaged groups, thereby integrating social and environmental concerns.[80]

The intersection of urban climate action with the equally urgent agenda of slum and informal settlement transformation is also a crucial avenue for simultaneously achieving social inclusion and environmental sustainability. For instance, in Buenos Aires, Argentina, the informal settlement of Villa 20 has been undergoing an ambitious multi-stakeholder programme of participatory slum upgrading. As part of these activities, the organization Transformative Urban Coalitions has been supporting efforts to integrate decarbonization into urban justice strategies by addressing local issues such as UHI effects, air pollution, water quality and run-off.[81] In the context of climate justice, the project demonstrates that it is possible to achieve multiple objectives: reducing GHG emissions, improving the quality of life for marginalized communities and fostering a more inclusive, equitable urban environment.

In addition, city networks, foundations and international development agencies are actively integrating justice into their initiatives—from UN-Habitat's calls for "just urban resilience",[82] to the Rockefeller Foundation's creation of a Climate Advisory Council to "both reduce emissions and enhance opportunities for communities most vulnerable to the effects of a warming world".[83] They are providing valuable resources and practical examples that directly support the development of adaptation plans centred around justice considerations. These and other programmes signal a growing awareness that, if the global community hopes to effectively build resilient cities that leave no one behind, the structural cycle of exclusion and discrimination must be broken.

Communities at the frontline of climate risks should be treated as partners in understanding climate-related impacts and determining adaptation priorities

4.5.2 Promoting participatory and inclusive urban adaptation planning

The success of urban climate action hinges on the ability of city governments to appreciate the lived experiences of those being impacted by climate change. Communities at the frontline of climate risks should be treated as partners in understanding climate-related impacts and determining adaptation priorities. For instance, if complemented with scientific information and innovations, grassroots knowledge systems can enhance adaptation planning and improve the well-being of poor urban residents. One example of a collaborative initiative is the city of Surrey, Canada: the government worked collaboratively with the Semiahmoo First Nation to develop their coastal flood adaptation strategy, which created opportunities to integrate Indigenous priorities into local climate action.[84]

Inclusive urban climate change policymaking goes beyond tokenistic involvement and ensures that marginalized communities have genuine influence and decision-making power

Furthermore, the skills and capacities that cities have at their disposal can only be fully realized through inclusive approaches that overcome barriers to participation. Besides racial injustice, another hurdle to full participation is gender inequality, a problem frequently entangled in cultural norms, discriminatory legislation, institutional exclusion and economic precarity. However, climate programmes can challenge the invisibilization that certain groups experience due to gendered roles and hierarchies, such as women and transgender people, by enabling them to play a leading role in project design and implementation. For instance, recognizing the proven transformative power of women's savings groups, a project in Myanmar led by the non-governmental organization (NGO) Women for the World complemented an ongoing community-driven housing initiative with a project to mitigate extreme heat using strategic building practices and landscape design.[85]

Inclusive urban climate change policymaking goes beyond tokenistic involvement and ensures that marginalized communities have genuine influence and decision-making power. This requires creating spaces for meaningful participation, building capacity among underrepresented groups, and fostering collaboration and dialogue between stakeholders. At the global level, UN-Habitat through its Cities and Climate Change Initiative (CCCI) stands as a beacon, highlighting the crucial importance of participation and stakeholder engagement in shaping and executing urban climate actions. The success of this initiative underscores how involving a diverse range of voices and expertise can lead to more effective, inclusive and sustainable solutions for cities grappling with climate challenges. In Port Vila, Vanuatu, for instance, government officials harnessed the power of the CCCI's climate change vulnerability assessment as a pivotal resource in their efforts to formulate early recovery strategies following the devastating impact of Typhoon Pam in 2015.[86] This example vividly illustrates how the process of gathering and analyzing data, combined with the active participation of local stakeholders, empowers decision-makers to develop timely and contextually relevant interventions in response to climate-related disasters. This approach allowed for the development of recovery actions that not only addressed immediate needs, but also laid the foundation for long-term resilience and sustainability.

The essence of participation lies in its ability to harness the collective wisdom and insights of the communities and individuals directly affected by climate change. By involving residents, experts, and government officials in the process, urban climate action becomes more inclusive, responsive, and, ultimately, effective. In Dosquebradas, Colombia, for instance, co-creating urban resilience strategies with local residents was instrumental in amplifying the voices of vulnerable populations: knowledge exchange between local communities and technical experts was an essential component on this, enabling discussions around the protection of sensitive nature-based assets from urban expansion.[87] The key take-away from these cases in that co-producing adaptation plans with diverse urban groups is critical to creating effective and inclusive solutions that address the needs of all members of society and build their resilience to climate-related shocks and stresses.

By involving residents, experts, and government officials in the process, urban climate action becomes more inclusive, responsive, and, ultimately, effective

4.5.3 Harnessing and strengthening locally-led urban climate adaptation

Top-down climate adaptation initiatives can fail if they ignore grassroots practices and people's lived experiences. Instead, urban governments should harness and strengthen locally-led climate adaptation interventions because this approach recognizes the value of local knowledge and expertise to address climate risks and ensures that local actors on the front lines of climate change have equitable access to power and resources to build resilience. There is emerging evidence that community-driven, incremental solutions can address underlying drivers of vulnerability, boosting household and local resilience while supporting city-wide urban climate action.[88] If cities harness Indigenous and local knowledge, they can generate significant co-benefits for addressing Indigenous dispossession, historical inequities and marginalization of Indigenous values.[89] For instance, in Quito, a deliberate effort was made to integrate local traditional and Indigenous wisdom into the city's climate adaptation policies and plans. The priorities outlined in the Quito Climate Change Action Plan (CCAP) not only align with, but also enrich, traditional practices of biodiversity conservation, urban agriculture, ecosystem protection, water harvesting, and land management. Crucially, youth leaders have emerged as instrumental champions in the identification and revival of traditional Indigenous practices that actively contribute to conservation and the promotion of sustainable agriculture. Their role was pivotal in ensuring the preservation and adaptation of these invaluable practices for the benefit of the city and its residents.[90]

People in slums and informal settlements are resourceful and have for decades demonstrated ingenuity, resilience and agency in face of complex urban challenges

People in slums and informal settlements are resourceful and have for decades demonstrated ingenuity, resilience and agency in face of complex urban challenges. In coping with shortcomings in service delivery and livelihoods, slum dwellers have frequently developed or adopted flexible solutions, such as alternative technologies, urban agriculture and recycling. If acknowledged, coordinated and supported, their bottom-up strategies may effectively complement wider urban climate action.[91] For instance, in slums of Nairobi (Kenya) there are emerging practices of grassroots-driven urban climate adaptation interventions, with children playing a key part in these efforts.[92]

Locally driven initiatives play a crucial role in actively engaging residents and other stakeholders, fostering co-design and co-creation processes

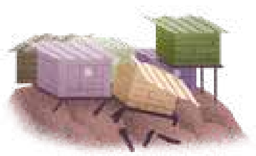
Furthermore, the "Know Your City" campaign run by Slum Dwellers International (SDI) has helped gather and validate climate data at the community level. Beyond data collection, tangible actions include a full range of alternative design solutions, like sustainable or green infrastructure, ecosystem-based approaches to adaptation and nature-based solutions.[93] Another exemplary case that underscores the power of locally-led climate adaptation can be observed through the Mahila Housing SEWA Trust in Ahmedabad (India). This pioneering organization is dedicated to empowering communities by employing innovative strategies to combat the escalating temperatures. One such innovative strategy involves the use of biodegradable polymers to create roofing materials that effectively reduce indoor temperatures. This not only showcases a commitment to environmental sustainability but also highlights the organization's dedication to improving the living conditions of vulnerable populations.[94] Such endeavours serve as a model for how localized solutions can be integrated into the broader framework of urban climate resilience, emphasizing the importance of innovative thinking and community engagement in the face of climate-related challenges. This example also underscores the significant role that NGOs and grassroots initiatives play in the global effort to build climate-resilient communities.

Locally driven initiatives play a crucial role in actively engaging residents and other stakeholders, fostering co-design and co-creation processes in some instances. This not only cultivates a sense of community ownership and buy-in, but also helps mitigate feelings of alienation or dependency. Although the quality and effectiveness of these initiatives may vary, the strong element of local ownership often enhances their sustainability and encourages ongoing maintenance, which can exceed what is typically achieved through conventional local government interventions.[95] One of the key lessons from these cases is that low-cost, locally-led innovations and solutions can boost community resilience while supporting city-wide planning and action. Their effectiveness can be greatly enhanced when implemented through partnerships with local and municipal governments.[96]

Despite being the most well-placed for implementing effective climate adaptation initiatives due to their knowledge of local conditions, needs and customs, community-based organizations are also very limited in terms of resources and political power. Furthermore, their ability to scale-up successful initiatives to the city level is also limited by the impossibility of overriding community boundaries without the involvement of the municipality. Therefore, it is imperative that these bottom-up initiatives are not perceived as mere gap-fillers or substitutes for official urban climate action. Instead, they should be seamlessly integrated with official strategies as part of a comprehensive approach to urban planning (Chapter 5). This integrated approach aims to construct a holistic, multi-stakeholder, cross-sectoral framework for urban resilience, ensuring that both local efforts and government interventions collectively contribute to building resilient cities.

4.5.4 Focusing on and prioritizing systemic and transformative adaptation in cities

Cities are dynamic, characterized by intricate interconnections among diverse communities and sectors. As demonstrated in this chapter, there are multiple channels through which the climate crisis impacts vulnerable urban populations. These channels, at times, reinforce one another, creating a web of challenges that will lead to cumulative vulnerability. These realities have demonstrated that incremental or single-sector urban climate interventions are no longer effective and sustainable (Chapter 7). Therefore, the complexity and uncertainties of the climate crisis and other shocks underscore the urgent need for applying a systems approach to building resilience in cities.[97]



Narrowly focusing on a single sector or intervention can inadvertently heighten overall vulnerability

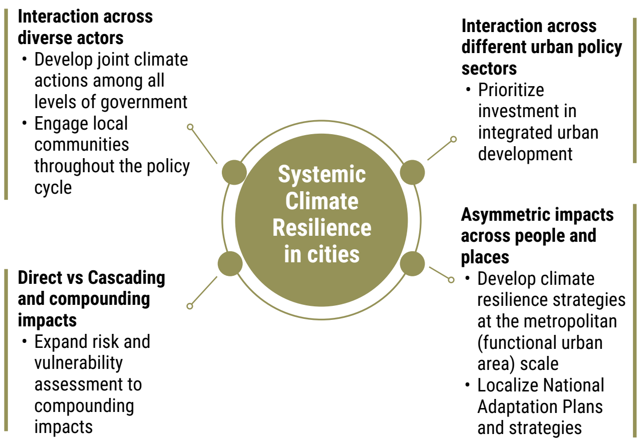
An effective urban climate action should encompass and cater to the entirety of the urban system, rather than isolating individual components. Narrowly focusing on a single sector or intervention can inadvertently heighten overall vulnerability. Systemic climate resilience in cities thus requires a better understanding of the interactions between various dimensions of the urban system, enabling policy instruments to address multiple objectives together through synergies and co-benefits while minimizing trade-offs (Figure 4.7). For instance, cities should explore the interactions between the impacts of climate shocks and other societal challenges such as health, social marginalization or labour productivity. Proper identification of such interactions would allow cities to prioritize climate actions that also benefit other social objectives.

Embracing a more holistic approach to urban climate resilience requires diverse urban actors to collaborate, identify and implement appropriate solutions to address the complex interaction of climate and other economic, social and health systems[98] (Chapter 10). Moreover, by adopting a city-wide perspective and discerning the intricate interrelationships between neighbourhoods and sectors, it becomes more feasible to devise a comprehensive model that addresses the needs of the entire urban system and all its residents. For instance, in 2017, Paris (France) launched its Resilience Strategy, aimed at addressing a spectrum of urban challenges, including climate-related risks such as floods and heatwaves, as well as broader issues like social and spatial inequalities and security. In October 2022, the city initiated a review

Embracing a more holistic approach to urban climate resilience requires diverse urban actors to collaborate, identify and implement appropriate solutions

process to evaluate progress and ensure the strategy's effectiveness in addressing the evolving needs of residents. As part of this process, the city is undertaking various parallel initiatives to gather insights and inform the renewal of the strategy, including studies on the spatial distribution of climate shocks and the socioeconomic consequences of water stress.[99]

Figure 4.7: A framework to understand and enhance systemic climate resilience in cities



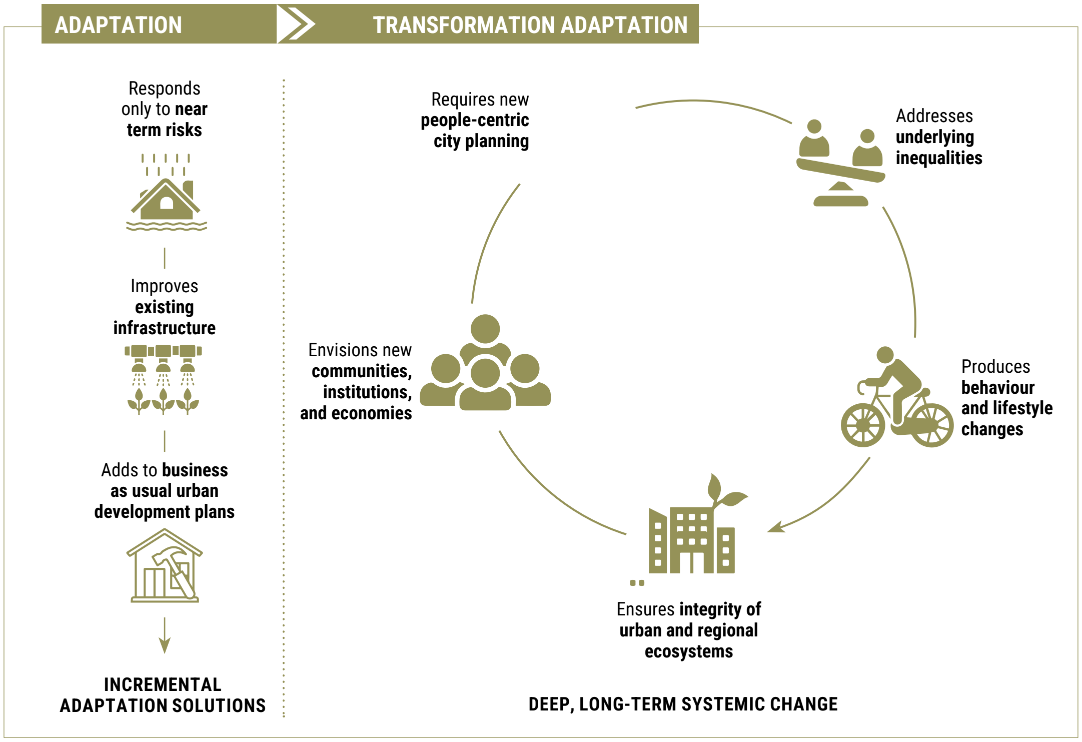
Source: OECD, 2023, p.20.

In urban settings, adopting a systems approach presents a distinctive and valuable opportunity for urban policymakers to gain a comprehensive understanding of the intricate nature of urban climate challenges. By doing so, it enables policymakers to anticipate and mitigate unintended consequences that may arise from climate adaptation and resilience policies. In many cases, well-intentioned policies can inadvertently lead to negative side effects or exacerbate existing urban problems: a systems perspective helps identify and address these unintended consequences, fostering more effective and sustainable urban development. For example, when implementing policies to enhance urban resilience, a narrow focus on one aspect, such as flood control, might inadvertently displace vulnerable communities or exacerbate existing disparities. A systems approach would consider the broader implications, including social, economic and environmental factors, to ensure that the policy aligns with wider sustainability goals and does not unintentionally harm certain populations. In Bangkok (Thailand), the Baan Mankong program has led to systemic change in the city's urban development strategy and relationships between authorities and urban poor communities, enabling the city to build necessary flood prevention infrastructure without disrupting the lives of slum communities.[100]

Cities, subnational governments and other relevant stakeholders should urgently embrace transformative urban adaptation.

Moreover, cities, subnational governments and other relevant stakeholders should urgently embrace transformative urban adaptation. Transformative adaptation reorients urban climate actions around addressing entrenched equity and climate justice challenges (Figure 4.8). It focuses on systemic changes to development processes that improve people's quality of life, enhance the social and economic vibrancy of cities, and ensure sustainable, resilient and inclusive urban futures. [101] In this transformative journey, it is necessary to involve those disproportionately affected by climate change, including women, elderly people, people with disabilities, young people, migrants, and minorities. For transformative urban adaptation to be successful, there are several enabling conditions required. These conditions include strong leadership, finance (Chapter 9) and local capacity, evaluation and learning, and accountable institutions and governance (Figure 4.11).

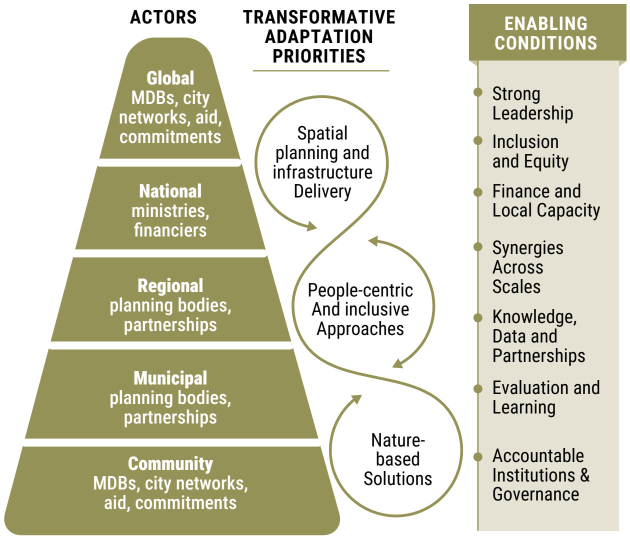
Figure 4.8: Incremental vs. transformative urban adaption to climate change



Source: Chu et al., 2019.

Figure 4.9: Transformative adaptation priorities in cities with enabling conditions and scales of decision-making

Aerial view of Manhattan Central Park, New York City/Shutterstock



Source: Chu et al., 2019.

4.5.5 Investing in resilient infrastructure, particularly in marginalized communities

As highlighted earlier on, slums and informal settlements suffer chronic infrastructure underinvestment, hampering development and putting millions of people at daily risk from climate change. Thus, investing in climate-resilient infrastructure, especially within marginalized communities, is an imperative and forward-looking strategy for cities (Chapter 6). As the impacts of climate change intensify, vulnerable and underserved neighbourhoods often bear the brunt of environmental disasters and infrastructure failures. By directing resources towards the development of resilient infrastructure in these areas, cities can not only enhance the immediate well-being of their residents but also fortify their long-term ability to withstand and recover from climate-related challenges. This approach involves upgrading critical systems like flood defences, sustainable transportation networks, energy-efficient housing and green spaces designed to mitigate urban heat islands.

While most informal settlement upgrading interventions do not have explicit climate adaptation objectives, improving infrastructure has great potential for reducing climate-induced risks such as flooding. If slum and informal settlement upgrading works well, it can greatly increase the resilience of low-income households, buildings, infrastructure and services to extreme weather.[102] Climate action in cities should also start with transformative upgrading of housing to build resilience in marginalized neighbourhoods. Equitable housing, integrated with low-carbon and affordable key services like water, sanitation, energy and accessible transportation, is a crucial entry point to advance climate action and achieve sustainable development.[103] Focusing on marginalized communities ensures that the benefits of resilience extend equitably to all residents, addressing social disparities while fostering a more inclusive and sustainable urban future. This is already being amply demonstrated in cities as diverse as Durban (South Africa) and Rosario (Argentina), where low-income and underdeveloped neighbourhoods are being actively targeted with infrastructural upgrading as part of resilience efforts.[104]

Investing in climate-resilient infrastructure, especially within marginalized communities, is an imperative and forward-looking strategy for cities

4.5.6 Strengthening urban livelihoods and adaptive social protection

Strengthening the financial and social infrastructure of vulnerable urban populations is a critical component of adaptive and transformative capacity. Chapter 1 notes that adaptation must contribute to sustainable livelihood as indicated in the people-centred approach to climate action. Underpinned by a commitment to rights and justice, this approach promotes equitable development and enhances the resilience of livelihoods, ensuring that communities can thrive in the face of environmental and socioeconomic challenges.[105] Cities and subnational governments should adopt a livelihood resilience approach, which emphasizes people's capacity for, and differences in, perceiving risk and taking anticipatory actions, either individually or collectively.

Social protection measures play an important role in building the resilience of marginalized populations to climate change. The Sendai Framework for Disaster Risk Reduction (2015-2030) emphasizes the need to "promote and support the development of social safety nets as disaster risk reduction measures linked to and integrated with livelihood enhancement programmes to ensure resilience to shocks".[106] One policy tool that government could explore in this regard is Adaptive Social Protection (ASP). ASP is a powerful tool to integrate poverty reduction, disaster risk reduction and humanitarian development into climate change adaptation strategies. As a resilience-building approach, ASP combines elements of social protection, disaster risk reduction and climate change adaptation, to break the cycle of poverty and vulnerability of households by "investing in their capacity to prepare for, cope with and adapt to shocks", especially under climate change and other global challenges.[107] Given the escalating climate crisis, ASP holds the potential not only to prevent and reduce loss and damage, but also strengthen resilience by addressing latent structural vulnerabilities (Figure 4.10).

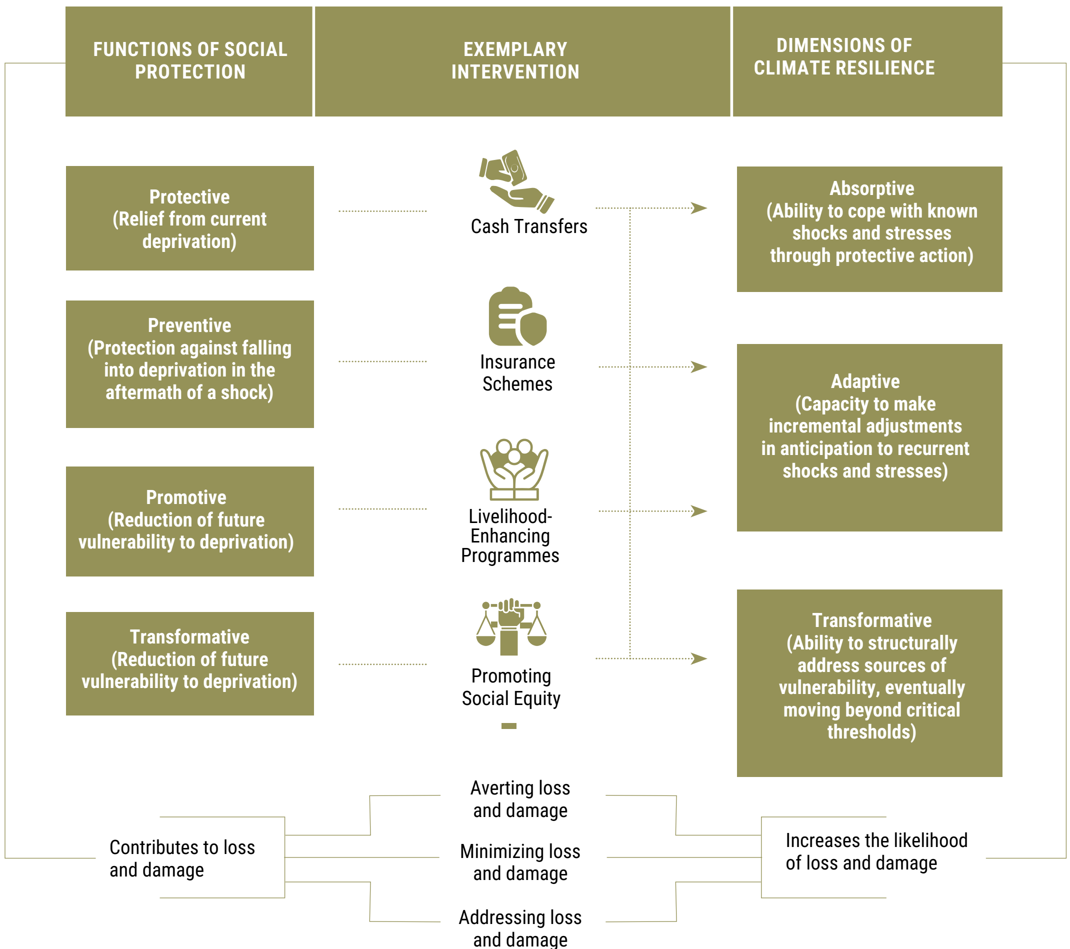
Social protection measures play an important role in building the resilience of marginalized populations to climate change

China provides compelling examples of how social protection measures can significantly enhance the adaptive capacity of urban communities. These measures include social medical insurance, housing subsidies, weather-index insurance, post-disaster construction, relocation planning and livelihood shift strategies.[108] To enhance the effectiveness of social protection programs in their contribution to adaptation, there is a need for improved coordination across various agencies, a deeper integration with climate data to anticipate when vulnerable groups will require support, and a closer alignment with other risk management tools like insurance.[109] Furthermore, when implementing ASP, cities should ensure that such interventions reach the most vulnerable urban

Damage done to trees after a hurricane/Shutterstock

populations and do not lead to maladaptation by disincentivizing risk reduction:[110] for instance, insurance coverage of housing in flood-prone areas, while an important protection for communities exposed to risk, should be calibrated so that it does not at the same time encourage continued settlement in these areas in future.

Figure 4.10: The interconnections between social protection, climate resilience, and loss and damage



Source: Huber & Murray, 2023, p.14.

4.6 Conclusion and Lessons for Policy

As cities across the world continue to grapple with the unprecedented climate crisis, its disproportionate impact on people in vulnerable situations is becoming increasingly evident. From scorching heatwaves to perennial flooding, gruelling water shortages to food insecurity, its effects will compound existing urban vulnerabilities in ways that will make it harder for cities to achieve an inclusive, resilient and sustainable future for all. The cascading effects of these climate-related challenges will exacerbate social and economic inequalities, creating differentiated vulnerabilities that are also shaped by unequal access to infrastructure and services, unresponsive policy and governance frameworks, poorly planned urbanization and various intersectional factors (such as gender, race and ethnicity socioeconomic status). Therefore, for the collective vision of an inclusive, sustainable and resilient urban future to be realized, this chapter has placed emphasis on the following key transformative pathways:

- **Mainstreaming intersectional climate justice in urban adaptation plans:** Unless urgent, people-centred climate action is taken and amplified, climate injustices will escalate, leading to increased loss and damage that will further aggravate the suffering of those who contribute the least to the climate crisis. In implementing climate adaptation measures, cities should prioritize the protection of marginalized populations from the unintended outcomes of processes such as green gentrification.

- **Promote participatory and inclusive urban adaptation planning:** Only through comprehensive and inclusive approaches can cities hope to mitigate the adverse impacts of climate change and foster a sustainable future for all residents. This requires a concerted effort to ensure that consultative and decision-making platforms are accessible to all residents, including informal communities but also women, children, minorities, migrants, people with disabilities and LGBTQ+ groups.

- **Harness and strengthen locally-led urban climate adaptation:** This will require targeted, localized interventions, supported by an understanding of the distinct vulnerabilities that different groups face and the resources that can be used to build resilience at a local level. Furthermore, these interventions should be community-focused, drawing on the unique knowledge, skills and lived experiences of residents themselves.

- **Focus on and prioritize systemic and transformative climate adaptation in cities:** It is imperative for urban leaders and policymakers to integrate equitable and just solutions into their climate adaptation strategies to ensure that marginalized and at-risk groups are protected and supported from growing climate threats. However, to achieve long-lasting and systematic improvement to their resilience, these interventions should involve a multi-pronged approach that combines climate mitigation and adaptation strategies with social and economic policies that prioritize equity and inclusion. For example, investments in social safety nets, healthcare systems and other areas can help address the wider structural challenges that contribute to vulnerability.

- **Invest in resilient infrastructure, particularly in marginalized communities:** Cities and subnational governments should prioritize investing in climate-resilient infrastructure, including improving the quality of housing, drainage and sanitation in informal settlements. Through these commitments, cities and subnational governments not only address the immediate needs of residents, but also build the capacity of these communities to withstand and adapt to the growing challenges posed by climate change.

- **Strengthen urban livelihoods and adaptive social protection:** Targeted interventions on informal livelihoods have the potential to serve as a powerful catalyst for far-reaching urban climate action, particularly when accompanied by a commitment to equitable strategies co-developed in partnership with the workers themselves, including social protection.

The call to action is clear: a collaborative effort from all levels of governments, private sector, multilateral institutions, civil society organizations and communities is needed to ensure that the poorest urban residents are not left behind in the wake of the climate crisis. In the end, a collective urban future founded on resilience, equity and sustainable development is still possible, if we choose it, but it requires urgent, bold and sustained commitment to address the unique challenges faced by the most vulnerable urban populations.

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Chapter 5:

Mapping the Solution Space for Climate Action: The Role of Urban Planning and Design

Quick facts

1. The share of green spaces in urban areas globally decreased from 19.5 per cent in 1990 to 13.9 per cent in 2020.

2. Climate action plans remain either underdeveloped or completely absent in cities of developing countries.

3. Inadequate capacity within local governments and institutional barriers are an impediment to the development and effective implementation of climate-resilient plans.

4. Climate-resilient planning aligns with the broader principles of inclusive, sustainable urban development. Thus, it can be implemented without requiring painful trade-offs when it overlaps with other local development priorities.

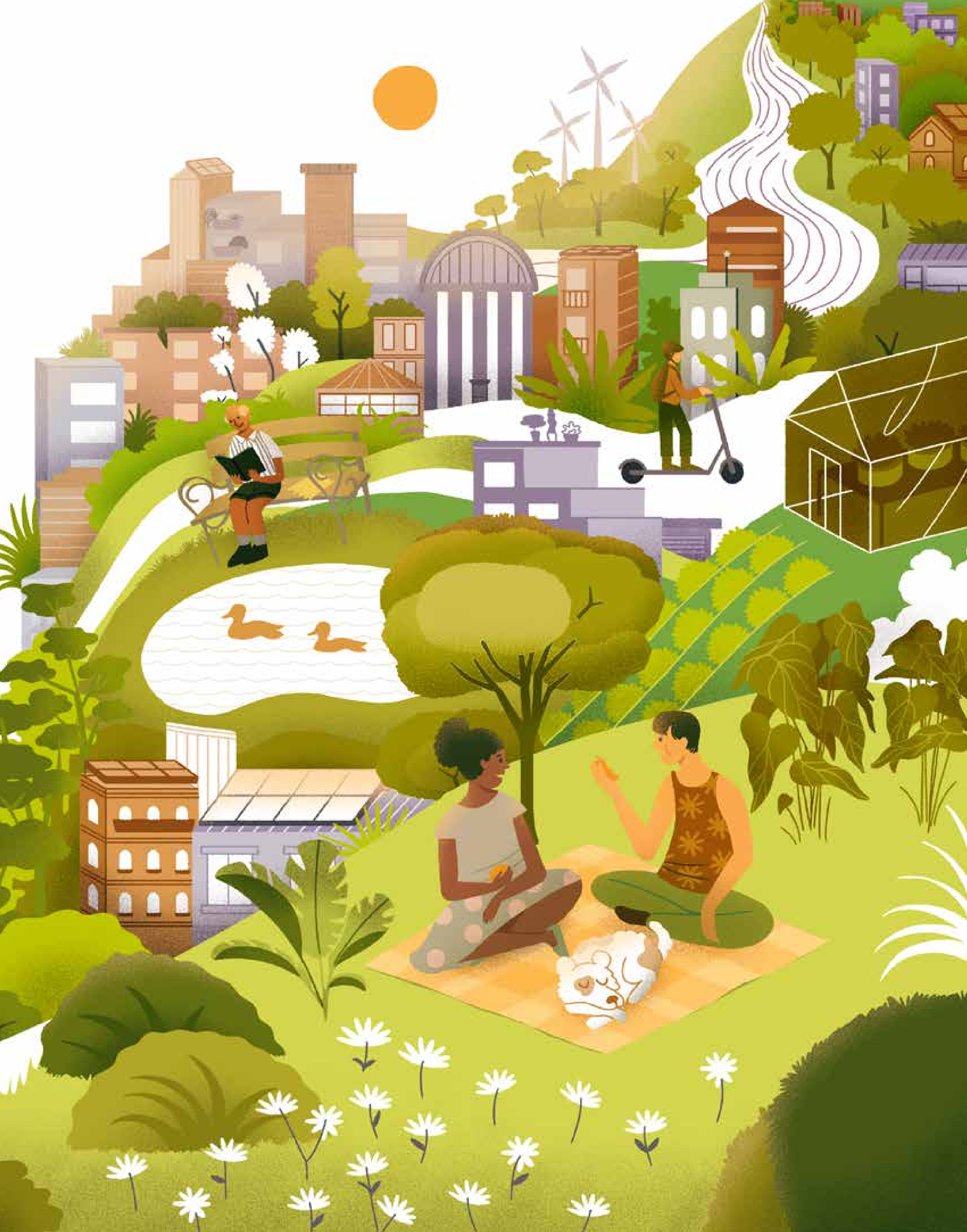
Policy points

1. Integrating climate action into urban planning and design frameworks is essential for a sustainable future.

2. It is imperative to embed climate considerations within urban policies. National urban policies should urgently address mitigation and adaptation.

3. Urban planning and design should promote localized, context-specific climate solutions.

4. Cities should invest in nature-based solutions. For an inclusive and just distribution of their benefits, they should be equitably spread throughout the urban landscape.



Climate change poses one of the most pressing challenges of the 21st century for urban areas. A variety of UN reports and documents, including the New Urban Agenda (NUA), have recognized its unprecedented threat to urban societies, ecosystems and economies. Besides underscoring the necessity of climate action at all levels, from the national to the local, these call for the integration of climate adaptation and mitigation strategies within urban planning and design.[1] With the appreciation that "cities are where the climate battle will largely be won or lost",[2] the role of urban planning and design comes to the fore as a frontline response to climate change.[3]

It is against this backdrop that this chapter begins by delving into the role of urban planning in achieving the Nationally Determined Contributions (NDCs) through National Urban Policies (NUPs), discussing their interplay as well as the causes and consequences of misalignment between them. The chapter then proceeds to focus on urban climate action plans (CAPs) in the second section, offering a snapshot of how climate adaptation and mitigation are mainstreamed into planning frameworks in various regions. Recognizing that the existing urban planning and design capacities to respond to climate change vary significantly across different regions of the world, the third section delves into the multifaceted ways in which planning and design—and their connections to urban management and governance—can deliver climate change action. The last section highlights the obstacles that hinder the effective implementation of otherwise well-thought-out climate-resilient plans, while concurrently discussing measures to overcome them.

5.1 Nationally Determined Contributions (NDCs) and National Urban Policies (NUPs): A Vital but Often Complicated Relationship

In the face of rapid urbanization and escalating climate change, the global community, led by the United Nations, has been at the forefront of advocating for coordinated efforts to mitigate GHG emissions and foster sustainable urban development. As highlighted in previous chapters, central to this endeavour are the NDCs, which outline each country's commitments to reduce emissions and adapt to the impacts of climate change as part of the Paris Agreement.[4] NUPs, meanwhile, provide the needed direction and coordinated course of action—including mainstreaming climate action—to support sustainable urbanization.[5]

Both NDCs and NUPs encompass sectoral and integrated strategies and serve as roadmaps for countries to mitigate and adapt to climate change. Accordingly, NDCs and NUPs shape budgetary allocations and policy priorities at the national and subnational levels.[6] At the heart of these efforts lies the intricate interplay between NUPs and municipal/local CAPs to guide sustainable urban development through various mechanisms laid out in the NUA.[7,] The alignment between NDCs and NUPs is therefore crucial, yet it is often hindered by several barriers that lead to missed climate targets, inefficient resource allocation and exacerbated social inequities.

5.1.1 National urban policies as a roadmap to achieving NDCs

A survey of 86 countries carried out by UN-Habitat, OECD and Cities Alliance in 2020 found that NUPs contributed to advancing the Paris Agreement's commitments in over half of the Member States (53 per cent).[8] The *Global State of National Urban Policy 2021* points to an increasing awareness of the role of NUPs in this regard, particularly in Asia and the Pacific. Generally, past studies by UN-Habitat and partners have shown that NUPs and their processes can play a vital role towards achieving climate goals, through:[9]

- providing regulatory *frameworks and standards* for sectors (transportation, buildings and construction, energy, waste and water management) and financial incentives (grants, subsidies, tax credits and preferential loans) that support climate-friendly urban initiatives.
- supporting *local capacity building* among urban planners, policymakers and other stakeholders to integrate climate considerations into urban development plans and projects.
- facilitating *collaborations and partnerships* (for example, among different levels of government, private sector actors, civil society organizations and academic institutions) to leverage resources and expertise for climate action in urban areas.
- supporting research, development and deployment of *innovative technologies and practices* for urban climate action (such as renewable energy, smart grids, green building materials and urban farming).
- promoting *public engagement and awareness campaigns* to engage citizens in climate action initiatives.
- providing mechanisms for *monitoring, reporting and evaluating* the effectiveness of urban climate action initiatives to track progress, identify gaps, and adjust policies and programs as needed to achieve climate goals.

Ideally, NUPs promote integrated urban planning and design that coordinate action across various sectors including, among others, land, transportation, energy and infrastructure development to reduce GHG emissions and enhance climate resilience. Recognizing the interconnectedness of ecosystems and human settlements, these approaches should also consider the interaction of urban and rural areas to ensure mutually beneficial climate resilience outcomes.[10]

5.1.2 Root causes for misalignment between NDCs and NUPs

Whilst NDCs provide a broad framework for climate action, synergy with NUPs is often lacking. The resulting misalignment of the two hinders comprehensive and effective climate action at the urban level. The root causes of this misalignment centre around a number of factors, discussed below.

Whilst NDCs provide a broad framework for climate action, synergy with NUPs is often lacking

The fragmentation of national level policy frameworks: Often, climate policies and urban development policies are generated and implemented in isolation. This leads to inconsistencies, conflicting objectives and inefficiencies in various dimensions. Yet, there are numerous cross-cutting issues between the national and the urban levels including, among others, ecosystem services and nature-based solutions (NbS), public spaces, circular economy and informal settlements.[11] However, as illustrated in Chapter 2, the NDCs still suffer from glaring gaps with respect to these cross-cutting issues, with far more emphasis placed at the national than at the urban level. These gaps are symptomatic of a lack of integrated approaches that synchronize climate action with urban planning and design.[12] For instance, a country may have ambitious emission reduction targets in its NDCs, but its NUPs may prioritize modes of economic growth that are inconsistent with sustainability and mitigation, resulting in the proliferation of carbon-intensive infrastructure and land use patterns.[13] UN-Habitat encourages consistency between a city's guiding vision and the climate planning objectives.[14]

Underdeveloped NUPs: NUPs, as crucial instruments for sustainable urban development, remain mostly underdeveloped. The failure to prioritize and invest in urban planning and design hampers the potential of cities to contribute meaningfully to NDCs,[15] with only 48 per cent of NUPs in 2020 addressing climate resilience (though this was a significant improvement from just 36 per cent in 2018).[16] In many cases, NUPs lack the necessary depth and specificity needed to address urban areas' unique challenges, particularly with regards to fiscal tools, which hinders effective climate action.[17]

Limited or inadequate representation of urban issues in NDCs: Despite growing urbanization trends, NDCs often focus predominantly on national-level emissions sources, such as energy production and transportation, and overlook the significant contributions of cities to GHG emissions. As illustrated in Chapter 2, more still needs to be done to strengthen the urban content of NDCs. Indeed, 65 (or 34 per cent) of the 195 NDCs submitted to the United Nations Framework Convention on Climate Change (UNFCCC) before 27 June 2023 contained either "low or no" urban content.[18] Moreover, there is need to amplify mitigation responses at the urban level: as discussed in Chapter 2, mitigation responses are more frequently addressed at the national level than at the urban level. It is worth noting that NDCs frequently lack specific targets and strategies to address emissions from urban sectors like buildings,[19] waste management[20] and land use planning,[21] despite the fact that urban areas account for a significant proportion of energy-related CO_2 emissions (69-72 per cent in 2020)[22] and are usually disproportionately affected by climate change impacts.

Neglect of heterogeneous forms of urbanization: Although cities and settlements exhibit diverse forms of urbanization shaped by local contexts, many NUPs fail to acknowledge this heterogeneity. This oversight results in generic policies that may not be suitable for addressing the unique challenges posed by different urban forms—from sprawling metropolises to small, densely populated urban settlements. For effective climate action, the untapped potential of urban areas, regardless of size, should be harnessed through contextualized, integrated and territorial approaches to urban development.[23]

For effective climate action, the untapped potential of urban areas, regardless of size, should be harnessed through contextualized, integrated and territorial approaches to urban development

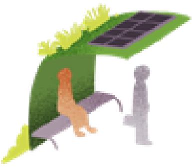
Limited implementation of urban policies: Implementation gaps further compound the challenges associated with NUPs. Even when NUPs exist, their impact is often diluted due to weak enforcement mechanisms, lack of political will, capacity constraints and other institutional shortcomings. There is therefore a need for effective governance structures that ensure the translation of NUPs into tangible actions on the ground.[24]

Bike share system in Masdar City, Abu Dhabi, UAE. © Shutterstock

Limited coordination mechanisms: Lastly, the lack of effective coordination mechanisms between relevant government agencies further exacerbates the misalignment between NDCs and NUPs.[25] Many countries struggle to establish robust coordination mechanisms, leading to disjointed policy implementation and missed opportunities for synergies between climate and urban agendas.[26] Recognizing the need for connecting climate action at the local, national and global levels, COP27 initiated the Sustainable Urban Resilience for the next Generation Initiative (SURGe). Similarly, COP28 initiated the Coalition for High Ambition Multi-level Partnerships (CHAMP) for climate action to further enhance national-subnational collaborations.[27]

5.1.3 The consequences of misalignment between NDCs and NUPs

The misalignment between NDCs and NUPs often results in inefficient allocation of resources that undermine the effectiveness of climate mitigation and adaptation efforts. These gaps may lead to investments in infrastructure that perpetuate carbon-intensive practices and exacerbate climate vulnerability.[28] At the same time, the absence of strategic links between NUPs and NDCs often leads to missed opportunities for allocating support and resources for climate action in urban areas and for scaling up local solutions.



The misalignment between NDCs and NUPs often results in inefficient allocation of resources that undermine the effectiveness of climate mitigation and adaptation efforts

The failure to align NDCs with NUPs also increases the likelihood of missing climate targets set under the Paris Agreement.[29] Indeed, of the NDCs submitted by 2023, the vast majority identify future needs at the national level, mostly for technology (160 NDCs), capacity building (155 NDCs) and finance (141 NDCs). In contrast, only an extremely limited number of NDCs include specific future requests at the urban level, whether it is for finance (26 NDCs), capacity building (9 NDCs) or technology (7 NDCs).[30] This indicates the persistence of gaps between NDCs and NUPs. Yet, as urban areas continue to expand and intensify, their emission trajectories diverge from national projections, making it challenging to achieve emission reduction goals. Meanwhile, inadequate consideration of urban vulnerabilities in NDCs may leave cities ill-prepared to cope with climate change impacts such as extreme weather events (e.g., heatwaves and extreme rainfall) and sea-level rise, leading to adverse social, economic and environmental consequences.[31]

Most importantly, the misalignment between NDCs and NUPs can exacerbate differentiated vulnerabilities and social inequities. Marginalized populations, including Indigenous communities and residents of informal settlements, are disproportionately affected by climate change due to their limited access to basic services, inadequate infrastructure and precarious housing conditions.[32] When NUPs neglect climate resilience and fail to prioritize equitable development, the most excluded communities bear the brunt of environmental degradation and climate-related disasters, further widening existing disparities in cities.[33]

Flooding in Dhaka in Dhaka, Bangladesh © Shutterstock

In sum, urban planning and design play a critical role in achieving NDCs, necessitating stronger NDC—NUP alignment and foregrounding the role of subnational and local levels through integrated policy frameworks, enhanced community engagement, capacity building and knowledge sharing. Planning processes must also recognize the diverse forms of urbanization shaping cities to achieve effective, context-specific strategies.

5.2 Urban Climate Action Plans (CAPs)

With increasing calls to ramp up action on synergies between climate action and the Sustainable Development Goals (SDGs), there is growing awareness that the climate battle will be won or lost in urban areas. The Glasgow Pact has emerged as a critical driver for integrating climate action in planning at all levels to achieve global climate goals while emphasizing context-specific equity considerations.[34] The NUA, meanwhile, recognizes the pivotal role of cities in achieving the SDGs and provides a comprehensive framework to achieve them through integrated, participatory urban planning that promotes synergies between climate action and global development agendas.[35]

5.2.1 A kaleidoscope of CAPs across the globe

More cities are recognizing the important connections between climate resilience and sustainability in their planning processes, including through CAPs.[36] This integration, however, varies widely across cities and depends on each city's unique vulnerabilities and adaptive capacities. There is a dearth of information on the absolute number of cities that have developed CAPs globally. Whilst global networks of cities such as C40 Cities are making efforts to track CAPs among their membership,[37] CAPs remain absent in many countries. In fact, they are only compulsory in a handful of countries like France, Ireland and the UK.[38]

Even when CAPs are in place, data gaps and capacity constraints can lead to mixed results. For instance, in cities across Europe there is need for better indicators and stronger quantitative cost assessments to improve the moderate levels of adaptation and mitigation actions currently integrated into urban policy.[39] As for the content of CAPs, the scant data available reveal a variety of issues in different countries and regions (Table 5.1). In general, it is notable that cities tend to prioritize mitigation over adaptation in their CAPs and frequently lack the necessary data, resources and targets to implement effective climate actions.

Table 5.1: An overview of common barriers to effective CAP implementation

Key challenges	Specific examples
Prioritization of mitigation over adaptation	In **Canada,** a survey of the 63 largest urban areas in Canada found that, in addition to inadequate implementation, monitoring and evaluation mechanisms, "municipal climate change plans prioritize climate change mitigation over adaptation". [40]
Insufficiently ambitious targets	Evidence from 327 small, medium and large cities in **Europe** reveals that although the CAPs address mitigation more than adaptation, with the majority including specific emission reduction targets, these on average would only lead to a 47 per cent decrease: to achieve the Paris Agreement's zero emissions target by 2050, then, cities will need to double these efforts.[41]
Lack of coherence and existing norms	In the **United States,** an assessment of CAPs of 29 major cities shows that successful climate action is being undermined by a lack of coherence and the continued dominance of car-oriented development.[42]
Inadequate data for monitoring and evaluation	In **Latin America**, a study of 74 cities reveals that as of 2022 only 30 have published CAPs. Even these fall short on indicators, however, which reflects gaps between the translation of strategies into action and monitoring the outcomes.[43]
Limited application of CAPs	In some regions, CAPs are still relatively scarce, despite the evident need for urban adaptation and mitigation efforts. For example, although studies highlight the negative impacts of the climate crisis on cities in the **Middle East**,[44] CAPs remain absent for the most part, or underdeveloped where they exist.

5.2.2 Mainstreaming climate action through CAPs

Today, cities are adopting a slew of strategies to mainstream climate action through CAPs. To begin with, they are increasingly *leveraging international agreements* such as the Paris Agreement, the Sendai Framework and the SDGs to guide their climate action efforts. In Denmark, for example, of 98 municipalities, 95 have aligned their CAPs with the Paris Agreement—potentially reducing emissions by 73 per cent by 2030.[45] By aligning with international frameworks for global emissions targets and best practices, cities are accessing technical assistance, knowledge-sharing networks and funding to support their climate goals.[46] Networks like C40 Cities, for instance, are financing investments in the green economy to support climate mitigation.[47]

Concurrently, *leveraging urban policy frameworks* to prioritize climate change considerations is essential for successful climate action. Robust and coherent policy frameworks entail adjustments to existing plans, policies and regulations to align urban CAPs with NUPs and NDCs while integrating new strategies that address emerging challenges. They are vital for mainstreaming climate adaptation and mitigation considerations into all stages of the decision-making process, from project inception to implementation and evaluation, while ensuring coherence among sectoral policies such as energy, transportation, housing and land use. The integrated approach to sustainability in Vancouver (Canada) has ensured stability and predictability for various stakeholders (Box 5.1).

Leveraging urban policy frameworks to prioritize climate change considerations is essential for successful climate action

Box 5.1: A coherent policy approach to Vancouver's energy transition

In Canada, Vancouver's Greenest City 2020 Action Plan, in effect since 2010, focused on the triad of zero emissions, zero waste and healthy ecosystems. The Green Economic Development Policy, central to this plan, transitioned over 3 per cent of the city's employment into green jobs.[48] Furthermore, 93 per cent of the city's energy is from renewable sources, while its building code is considered the greenest in North America.[49] Vancouver has ensured coherence through a phased but coordinated policy approach—including the Renewable City Strategy (2015), the Zero Emissions Building Plan (2016) and most recently, the Climate Emergency Action Plan (2020)—building on shared objectives and avoiding inconsistencies between the various instruments.[50] Notably, Vancouver supports its approach through a robust methodology and rigorous data.[51]

Importantly, this report highlights pertinent issues concerning climate resilience in various chapters that are fundamental for putting people (in particular, marginalized and vulnerable groups) at the centre of climate-responsive urban planning, such as the ability to *cope with hazards* (Chapter 3). Indeed, the ability to cope with hazards from extreme weather events is a crucial aspect of climate-responsive urban planning. In addition to policy frameworks that regulate development in hazard-prone areas and investments in early warning systems, CAPs should contain measures that minimize the impact of climate change and build resilience. Coping measures include disaster preparedness, resilient infrastructure and community-based approaches that reduce the risk of loss and damages and build adaptive capacity. For coastal and low-lying cities, the options range from *protection* (through either engineered structures or soft, ecosystem-based adaptations) to *accommodation* (through advanced planning, land use and building codes changes, ecosystem conservation, insurance policies and strict development requirements) to *planned retreat* (through managed realignment, setbacks or even development prohibitions altogether and the withdrawal of government subsidies).[52] In the US, for instance, dozens of cities in California have been actively engaging with managed retreat from their shorelines in response to sea-level rise and extreme weather events.[53]

CAPs need to *address differentiated vulnerabilities* and the varying adaptive capacity among communities attributed to socioeconomic disparities within cities, as underscored in the previous chapter and in section 5.1.3.[54] For example, flooding hazards in Toronto, Canada, impact the four most vulnerable socioeconomically neighbourhoods (i.e., poor, immigrant communities) more than the rest of the city due to their proximity to flood plains, aging infrastructure, and the proliferation of impervious surfaces.[55] Although Toronto's CAP underscores the need for inclusion, evidence reveals that these communities are still disproportionately exposed to flooding and continue to be excluded from climate adaptive blue-green infrastructure.[56]

Accordingly, in the integration of sustainable infrastructure and design principles—including investments in public transportation systems, compact and mixed-use developments, critical infrastructure and climate-responsive urban design that capitalizes on ecosystem services—an intersectional perspective is vital to ensure that CAPs do not entrench systemic inequities. Indeed, CAPs need to address differentiated vulnerability and climate justice directly through the inclusion of vulnerable and marginalized groups. The engagement of marginalized communities should not be an afterthought: instead, it should be at the core of planning and implementation processes (Figure 5.1).

CAPs need to address differentiated vulnerabilities and the varying adaptive capacity among communities attributed to socioeconomic disparities within cities

Lastly, adopting a more agile and responsive approach that continually monitors, updates and improves the planning process and its implementation to ensure no one is left behind is key. Figure 5.2 illustrates a typical climate action planning process.[57] It is worth noting that such processes are diverse and do vary depending on the urban context.[58] In recent years, C40 Cities has provided a step-by-step guide for cities to develop CAPs that are both consistent with the objectives of the Paris Agreement and holistic to address urban communities' socioeconomic needs.[59]

Figure 5.1: Guiding principles for city climate action planning

City climate action planning should be:

Ambitious
Setting goals and implementing actions that evolve iteratively towards an ambitious vision

Inclusive
Involving multiple city government departments, stakeholders and communities (with particular attention to marginalized groups), in all phases of planning and implementation

Fair
Seeking solutions that equitably address the risks of climate change and share the costs and benefits of action across the city

Comprehensive and integrated
Coherently undertaking adaptation and mitigation actions across a range of sectors within the city, as well as supporting broader regional initiatives and the realization of priorities of higher levels of government when possible and appropriate

Relevant
Delivering local benefits and supporting local development priorities

Actionable
Proposing cost-effective actions that can realistically be implemented by the actors involved, given local mandates, finances, and capacities

Evidence-based
Reflecting scientific knowledge and local understanding, and using assessments of vulnerability and emissions and other empirical inputs to inform decision-making

Transparent and verifiable
Following an open decision-making process, and setting goals that can be measured, reported, independently verified, and evaluated

Source: UN-Habitat, 2015a.

Figure 5.2: Typical climate action planning process

Establish the overall vision for climate change mitigation and adaptation
Cities should consider the challenges faced and their capacity to address them. This will lay the foundation and determine the scope of climate action plans.

Secure political commitments to achieve their vision
Climate action planning needs strong leadership to succeed. In many cities a strong endorsement from the mayor and senior leadership is essential to catalyzing action.

Develop a communications plan
Cities should have a coordinated strategy to engage with the target audience. A good communication plan includes outreach and participation processes during the planning stage, the release of the plan as well as the subsequent implementation of the plan.

Secure multi-stakeholder, cross-sectoral support
Effective planning requires a comprehensive and integrated cross-sectoral approach with actors working across administrative boundaries. Support from key private sector and non-governmental stakeholders can be vital.

Mitigation	Adaptation
Develop citywide greenhouse gas inventories Greenhouse gas inventories determine baseline emissions, and identify key emission sources and reduction opportunities. While complying with local requirements, in order to ensure international compatibility cities are encouraged to use an international reporting methodology based on the Greenhouse Gas Protocol standards, e.g., the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories.	**Conduct a climate change vulnerability assessment** Cities conduct vulnerability assessments to identify current and future risks/impacts to people, community assets, and community functions. A comprehensive vulnerability assessment addresses physical, environmental, economic, social vulnerability, and focus on those most vulnerable to impacts.
Conduct scenario analysis Cities conduct scenario analysis to identify possible future emission trends based on different socioeconomic growth and climate mitigation assumptions or scenarios. The analysis results serve the basis for target setting and identifying actions.	**Conduct scenario analysis** Scenario analysis identities risk levels based on different scenarios of climate impacts, which will inform options to adapt to the potential climate impacts.
Assess the local capacity to reduce emissions Cities assess their capacity to take action and consider how to leverage other existing policies, plans, and actions such as those related to energy, environment, and urban management. This may include policies and programmes that are complementary to mitigation efforts despite being focused on other issues.	**Assess the local capacity to address climate impacts** Cities assess their local capacity to adapt to the climate change impacts. The analysis begins with an inventory of existing community policies, programmes, assets, capacities, and wisdom. This may include policies and programmes that are complimentary to adaptation efforts despite being focused on other issues.
Set greenhouse gas emission reduction goals Based on the scenario analysis and capacity assessment results, cities sets their short-, medium-, and long-term citywide emission reduction goals, and secure political commitment to the goals. Cities are encouraged to refer to the Greenhouse Gas Protocol Mitigation Goal Standard when designing their goals in order to ensure international compatibility.	**Set adaptation goals** Based on the scenario analysis and capacity assessment results, cities set their short-, medium-, and long-term adaptation goals, and secure political commitment to them. The goals should comprehensively cover the physical, environmental, economic, and social impacts of climate change.

Identify and prioritize actions
Effective plans identify comprehensive and integrated actions spanning multiple sectors of urban development and involve action at multiple different scales. Actions are prioritized based on a transparent multi-criteria assessment in coordination with other city planning efforts and institutionalized within all municipal processes and functions.

Develop a plan for implementation
Action plans should include sufficient detail and clearly assign responsibilities so that they are actionable and can be implemented by the appropriate agencies and organizations to achieve the desired goals.

Monitoring, reporting, evaluating, updating and continually improving

Source: UN-Habitat, 2015a.

5.3 The Solution Space for Climate Action

The initial chapters of this report underscore the enormous contribution of urban areas to GHG emissions. Urban planning and design can significantly reduce these emissions and foster sustainability by embedding climate considerations within existing policies, plans and urban governance. For instance, integrating spatial planning (e.g., land use regulations), urban design (e.g., compact, mixed use and transit-oriented spatial layouts), and urban management (e.g., efficient public transportation systems) contribute effectively to mitigation, and consequently, to sustainability.[60]

Simultaneously, this report underscores the value of a people-centred approach to climate action that tackles the underlying drivers of vulnerability. This means recognizing the interconnectedness of climate-resilient urban planning and design with social policy. Public transportation, for example, besides the immediate health and environmental benefits it can bring through reduced emissions, traffic congestion and air pollution, is also key in meeting social objectives: it provides vulnerable populations with improved access to jobs and essential services while simultaneously contributing to mitigation and sustainability efforts.[61] Indeed, integrating social policies within urban planning and design aligns with the broader agenda of creating sustainable, inclusive and climate-resilient cities.[62]

Integrating social policies within urban planning and design aligns with the broader agenda of creating sustainable, inclusive and climate-resilient cities

As discussed in Chapter 4, social policies and measures that address underlying risk drivers, such as poverty reduction strategies, access to affordable housing and universal healthcare, are integral to building adaptive capacity and resilience within urban communities, particularly for vulnerable populations.[63] Minorities and Indigenous Peoples, for instance, are especially vulnerable to climate change due to systemic inequities that exclude them from basic urban services.[64] To reduce these vulnerabilities and enhance resilience, climate adaptation needs to be mainstreamed into city plans.[65] Moreover, the inclusion of diverse voices (e.g., across gender, age, race, ability and cultural backgrounds such as Indigenous knowledge) to develop inclusive and effective climate-resilient urban areas is essential for the successful implementation of mitigation and adaptation strategies and for ensuring equity and justice.[66]

The following subsections delve into the multifaceted ways in which urban planning and design, supported by urban management and governance, can deliver climate change action. Whilst these aspects are interrelated, the following subsection bands the tools/approaches/strategies in the respective fields as it focusses on the "how-tos". Importantly, it is essential to carefully tailor these approaches to align with each context's unique conditions and urbanization patterns.[67] Rapidly urbanizing regions require different strategies compared to established urban centres, so do formally planned areas compared to informally settled urban areas. Simultaneously, it is also imperative to develop urban planning and design strategies at various scales, spanning from the neighbourhood and local community to the urban and regional. UN-Habitat emphasizes the need to identify the most suitable scale for each strategy, recognizing that emissions and climate hazards often extend beyond the administrative boundaries of cities.[68]

Elevated linear park in New York, USA © Shutterstock

Table 5.2: An overview of planning instruments for climate action

Planning instruments for climate action	
The tools	**How the tools work**
Urban legislation and regulations ▪ CAPs ▪ Building codes ▪ Zoning ordinances ▪ Environmental regulations	▪ Set GHG reduction targets ▪ Incentivize energy efficiency (carbon pricing) and transitions (renewable energy and green buildings) ▪ Regulate land use practices
Urban land policies ▪ Smart growth strategies (infill and brownfield redevelopment) ▪ Urban revitalization ▪ Land use planning	▪ Minimize environmental degradation ▪ Conserve natural ecosystems ▪ Restore lost ecosystems
Slum upgrading, urban regeneration, and housing policies ▪ Community-driven approaches ▪ Provide social and physical infrastructure ▪ Upgrade housing	▪ Secure housing tenure ▪ Incentivise climate-resilient housing design features (elevated foundations, flood-resistant materials, and passive cooling) ▪ Locate affordable housing within transit catchments
Urban transport and mobility ▪ Invest in low- to zero-carbon transport infrastructure (such as public transit; walking, cycling, and shared micromobility; electric vehicles; shared mobility) ▪ Adopt universal accessibility measures ▪ Integrate public transit and land use planning ▪ Provide EV charging infrastructure ▪ Invest in intelligent transportation systems (ITS)	▪ Enhance the range, accessibility and convenience of low- to zero-emissions mobility ▪ Concentrate development, employment and social infrastructure around transit hubs ▪ Manage transit and traffic in real-time ▪ Incentivize transitions to zero-emissions mobility
Urban energy systems ▪ Renewable urban energy and storage infrastructure (e.g., solar panels, urban wind turbines, and battery storage systems) ▪ Renewable energy district heating and cooling networks ▪ Intermittent renewable energy sources ▪ Smart grid technologies, advanced metering infrastructure, demand response systems, and grid automation	▪ Facilitate energy transitions ▪ Decrease GHG emissions
Mapping, spatial data, and knowledge sharing ▪ Invest in climate, energy data, and spatial data ▪ Capitalize on innovations (such as AI) ▪ Adopt knowledge sharing approaches and technologies	▪ Steer evidence-based planning, proactive risk management, and climate adaptation ▪ Understand change over time to urban and environmental land cover ▪ Identify vulnerable populations and areas ▪ Empower citizens to participate in data collection

5.3.1 Urban planning instruments for climate action

Urban planning can significantly reduce GHG emissions and foster sustainability by embedding climate considerations within existing policies and plans.[69] The following section provides some practical measures for addressing climate change which are summarized in Table 5.2.

Urban legislation and regulations

Legislation and regulations provide the legal foundation for climate action in cities. They establish mandates, standards and guidelines for addressing climate change and foster sustainable development while promoting social equity and resilience. CAPs, building codes, zoning ordinances and environmental regulations are among the legal instruments that govern urban development and shape the built environment to reduce GHG emissions, adapt to climate hazards and enhance resilience.

Urban legislation should be designed to drive transformative change towards low-carbon, climate-resilient urbanization

Urban legislation should be designed to drive transformative change towards low-carbon, climate-resilient urbanization by setting targets for emission reductions, promoting energy efficiency and regulating land use practices.[70] Moreover, legislation should incentivize climate-friendly behaviours and investments through mechanisms such as carbon pricing, renewable energy mandates and green building incentives. For instance, pricing mechanisms like carbon taxes or emissions trading systems incentivize businesses and individuals to reduce their carbon footprint and invest in clean technologies, hence internalizing the social and environmental costs of emissions. Similarly, subsidies, grants and tax credits stimulate private sector investment in renewable energy, energy efficiency retrofits and sustainable transportation infrastructure.

Robust regulatory frameworks support aligning new developments with stringent environmental standards that reduce GHG emissions (e.g., building codes) and mainstream adaptation (e.g., NbS) for enhanced climate resilience in cities like Oslo (Norway), Copenhagen (Denmark) and Stockholm (Sweden).[71] Today, UN-Habitat, through applied tools such as the Urban Law Module of the Law and Climate Change Toolkit, is supporting countries as diverse as Malawi, Oman, Colombia, India and Tajikistan to improve their legal and governance frameworks for effective implementation of the Paris Agreement.[72]

Urban land policies

While avoiding land use planning inequities highlighted in Chapter 4, urban land policies should guide urban development to prevent environmental degradation and maximize resilience. Accordingly, cities should adopt smart growth strategies that promote infill development, brownfield redevelopment and the revitalization of underutilized urban areas. Also, land policies should concentrate development around transit hubs, employment centres and amenities to minimize urban sprawl and its associated carbon emissions. Collectively, these measures encourage transit use, reduce sprawl, alleviate development pressures on greenfield sites, preserve natural landscapes and promote sustainable development.[73]

Concurrently, cities should develop land policies that incentivize sustainable land management practices such as agroforestry, urban agriculture and sustainable forestry which enhance carbon sequestration, improve soil health and promote equitable local food security. Cities must also develop zoning and land use regulations that promote the conservation of natural ecosystems such as forests and coastal mangroves. Previous World Cities Reports (2020 and 2022)

It is imperative to ensure that ecosystems are sustainably used and effectively conserved, even under pressure for changes in land uses

have emphasized the value of these urban ecosystems and their role in climate change adaptation and mitigation. They provide essential ecosystem services, sequester carbon (mitigation) and protect from extreme weather events (adaptation). For instance, urban natural areas, wetlands and waterfronts provide natural buffers against coastal erosion, sea-level rise, coastal storm surges and inland flooding, hence protecting communities and infrastructure from climate-related risks.[74] It is thus imperative to ensure that ecosystems are sustainably used and effectively conserved, even under pressure for changes in land uses. In the conservation and restoration of ecosystem services, UN-Habitat advocates for a territorial approach that mainstreams urban-rural linkages into planning and development processes.[75] In this regard, NUPs are an important guiding framework.

Additionally, urban land policies should also restore lost ecosystems and develop new ones, especially in cities where blue and green spaces have been declining. Regarding urban green areas, recent data from UN-Habitat reveals their steady decline (see Box 5.8), with severe implications for climate mitigation and adaptation. This feature highlights people-centred measures to enhance the provision of quality urban green spaces. Urban blue spaces are also becoming increasingly rare. To reverse this, urban stream daylighting is an innovative practice for bringing back to the surface and restoring urban streams that previous development has buried in underground culverts. Cheonggyecheon restoration project in Seoul, Republic of Korea, and Zürich, Switzerland's 'Bachkonzept' for stream daylighting are testament to the transformative impact of what such interventions can also achieve on the ground (Box 5.2).[76]

Solar and wind power plant © Shutterstock

Box 5.2: Urban stream daylighting: two different approaches in Zürich and Seoul

Zürich's (Switzerland) *bächkonzept* policy

- Large number of micro-scale interventions since 1986
- 24 kilometres of streams daylighted

Zürich's Bachkonzept

- Improved biodiversity
- Restored infiltration & evapotranspiration
- Ecological connectivity
- Urban connectivity & active mobility

Seoul (Republic of Korea) Cheonggyecheon restoration project

- One mega-scale project between 2003-2005
- 10 kilometres of stream (Cheonggyecheon and Seongbukcheon) daylighted

Seoul's Urban Streams

- Improved biodiversity
- Decreased pollutants
- Urban heat mitigation
- Enhanced mobility & transit

Source: Khirfan, Mohtat & Peck, 2020

Slum upgrading, urban regeneration and housing policies

Importantly, UN-Habitat underscores the necessity of "effective and fit-for-purpose land administration systems" for implementing policies that are both environmentally sustainable and socially inclusive. For instance, climate-resilient land governance is key both for improving tenure security and strengthening community resilience.[77] Cities must prioritize upgrading housing, infrastructure and services in urban slums and informal settlements through community-driven approaches that empower residents to participate in decision-making processes, build social cohesion and strengthen adaptive capacity. UN-Habitat, for instance, through programmes like the Participatory Slum Upgrading Programme (PSUP), has supported countries to mainstream human rights-based approaches to incremental in-situ upgrading, thus building resilience for slumdwellers. Concurrently, based on its experience, UN-Habitat has set out key principles to be applied when considering climate change measures in informal settlements (Box 5.3).[78] Today, examples of innovative approaches slum upgrading abound in cities in developing countries such as Iquique, Chile's inclusive approach to slum upgrading (Box 5.4).[79] A shift toward a transformative, people-centered approach to climate action (see Chapter 4) also necessitates slum upgrading to address the underlying drivers of vulnerability, such as poverty, inequality, inadequate infrastructure and housing tenure, in order to contribute to strengthen urban resilience.

Box 5.3: Principles for action when applying climate change measures in informal settlements

Based on experience, UN-Habitat recommends the following key tenets to be applied when considering and implementing climate change measures in informal settlements:

- Address development deficits with climate action in mind and vice versa
- Downscale vulnerability assessments and responses to city and neighbourhood level
- Incorporate local knowledge in climate change responses
- Strengthen education and training
- Build capacity at the neighbourhood level
- Apply a balanced mix of adaptation options
- Scale up action through co-production and collaboration between actors
- Recognize the opportunities by integrating informality into adaptation and mitigation
- Use recovery processes as an opportunity for low carbon and resilient development

Source: UN-Habitat, 2018a, p.ix

Housing policies should promote climate-resilient housing design features

Likewise, housing policies should promote climate-resilient housing design features, such as elevated foundations, flood-resistant materials and passive cooling, that protect residents from climate hazards while reducing energy consumption and GHG emissions.[80] Incentives should be devised to encourage homeowners and developers to adopt sustainable building practices and technologies (see subsection 5.3.2), including tax credits, subsidies and financing mechanisms (such as EcoCasa in Mexico Box 5.5). At the same time, various levels of government should effectively manage the delicate balancing act between sustainability and affordability of housing. Indeed, sustainable housing should be affordable to ensure social accessibility and equity. Exploring affordable housing models that make sustainable housing more accessible is of essence. Importantly, affordable housing initiatives and subsidized housing should be located close to accessible public transit not only to reduce emissions, but also to enhance social equity and access to essential services.[81]

Box 5.4: Half a House: An integrated approach to informal settlements in Iquique, Chile

The Quinta Monroy project in the city of Iquique, Chile provides a hundred families with "half a house" of 40 square metres each, built on the public land they have been occupying for over 30 years to avoid displacing them. This maintains the families' access to their social networks, public transit and social services. Moreover, the structurally sound new houses are built to withstand natural hazards using recycled material from the original slum, while solar energy provides up to 70 per cent of the household needs. Secured property titles allow owners to incrementally expand their houses and motivate them to invest in energy-efficient appliances, safe in the knowledge that they will not be subjected to evictions in the future. Post-occupancy assessments reveal satisfaction with the thermal comfort, ventilation and natural light of the houses.[82]

Source: Núñez Collado & Wang, 2020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Box 5.5: EcoCasa: Financing low-carbon social housing, Mexico

The residential sector is key to Mexico's commitment of reducing GHG emissions to 50 per cent (below 2002 levels) by 2050. Over the past years, the expansion of Mexican cities—with housing representing at least 60 per cent of this growth—has significantly increased their carbon footprint.

The EcoCasa program is contributing to the supply of environmentally efficient housing in an affordable way, thus improving the quality of life for low-income families. As sustainable housing requires adequate investments, by increasing both the production of low-carbon housing and the supply of mortgages for the same, EcoCasa is helping Mexico reduce its greenhouse gas emissions. The program is part of a multi-pronged approach to help Mexico follow a low-carbon growth path over the medium- to long-term.

Providing financing to build more sustainable houses is contributing to lower energy consumption and spending, cutting greenhouse gas emissions and strengthening government policies and initiatives. In the first seven years the EcoCasa program has helped build over 27,000 houses and finance an additional 1,700 "green" mortgages.

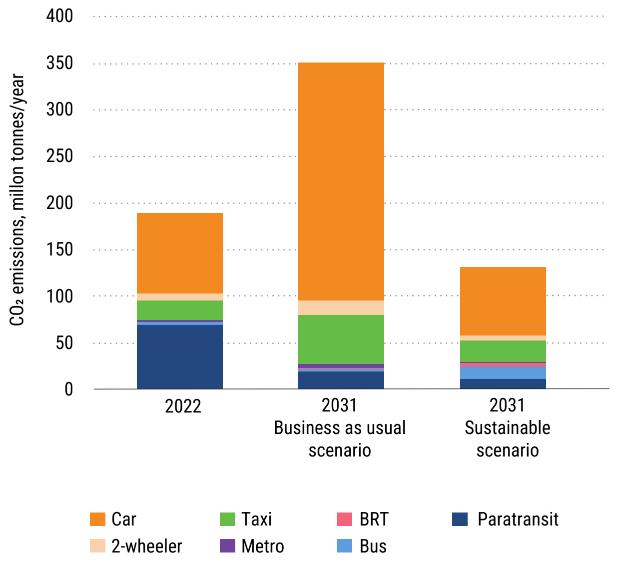
While the immediate outcome of the program is the construction of houses with lower lifecycle GHG emissions, is envisaged that it will provide additional, long-lasting benefits to the housing sector in Mexico (as part of Mexico's Nationally Appropriate Mitigation Action)—contributing to the mainstreaming of sustainability criteria in the housing industry.

Source: UNFCCC, 2023f.

Urban transport and mobility

Given the contribution of urban transport to greenhouse emissions, air pollution and energy consumption, cities should implement sustainable, low-carbon transport solutions (such as public transport, cycling, walking and shared mobility) to reduce emissions, provide equitable access to jobs and services, and encourage sustainable, active travel behaviours that improve public health and urban livability.[83] Previous editions of World Cities Reports have underscored the imperative for investments in public transport infrastructure in cities to promote modal shifts away from private vehicles, reduce traffic congestion, lower GHG emissions and improve air quality. A recent study by ITDP, UNEP and UN-Habitat indicates that to achieve a sustainable transport scenario by 2031 in African cities, the net infrastructure requirements include "21,000 kilometres of footpaths, 6,000 kilometres of cycle tracks, 790,000 bikeshare cycles, 310,000 buses, 3,000 kilometres of BRT and 250 kilometres of metro".[84] As illustrated in Figure 5.3, this scenario would cut CO_2 emissions by 220 million tonnes per year, or about 63 per

Figure 5.3: CO_2 emissions by scenario for African cities

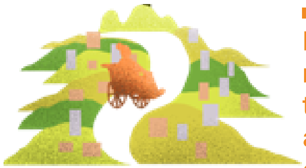


Source: ITDP, UNEP and UN-Habitat, 2022

cent, from the 351 million tonnes projected by 2031 in a "business as usual" scenario (to 131 million tonnes in the "sustainable" scenario).[85] Importantly, well-designed and inclusive public transport also provides equitable access to jobs and urban services.

Public transit measures should be integrated with land use planning through transit-oriented development (TOD) to promote compact, mixed-use urban environments that further reduce the need for long-distance commutes and private vehicle travel.[86] This integration should be accompanied by investments that encourage sustainable travel behaviour and reduce the reliance on fossil fuel-powered vehicles including pedestrian, cycling and shared micromobility infrastructure such as bikes, e-bikes and e-scooters. It is important that cities adopt universal accessibility measures (e.g., for wheelchairs, roller skates and skateboards) that enhance safe and equitable access to non-motorized modes of transport for children and individuals living with disability.[87] Equitably distributed multi-modal mobility that is accessible to people with various (dis)ability levels ensures social equity in access to employment, social infrastructure and critical services during climate emergencies.[88]

Furthermore, to accelerate emission reductions from the transport sector, various levels of government should embrace and support technology advancements and innovations in transport, such as intelligent transportation systems, shared mobility and electric vehicles. Intelligent transportation systems (ITS) and smart mobility solutions, including traffic management technologies, real-time transit information and ride sharing for trips not well covered by existing public transport networks, optimize traffic flow, reduce congestion and facilitate efficient multimodal transportation options. ITS solutions help minimize idling times and optimize route choices, so reducing fuel consumption and vehicular emissions.



Equitably distributed multi-modal mobility that is accessible to people with various (dis) ability levels ensures social equity in access to employment, social infrastructure and critical services during climate emergencies

Importantly, these innovative approaches to transportation should be linked to integrated long-term planning and policy-making processes. With regard to e-mobility, for instance, Rwanda is a model of a rapidly urbanizing country accelerating its adoption through the deployment of a fleet of shared and electric bicycles and scooters, accompanied by accessible docking stations and a single app that facilitates convenient use.[89] In Norway, meanwhile, Oslo's successful transition to electric vehicles (EVs) (including battery operated and plug-in hybrid models) ensued from providing EV charging infrastructure combined with transitions to renewable energy sources.[90] Various levels of government should also develop incentives (subsidies, tax credits) to support the transition to zero-emissions mobility systems and enhance their range, accessibility and convenience for urban residents.[91] As e-mobility is key to decarbonizing the transport sector and cannot be envisaged without improved urban planning or wider investments in shifting transport towards improved public transport and active mobility, UN-Habitat outlines 10 principles for its successful implementation:[92]

i. Integrate electric mobility in the context of improved urban planning and in a balanced "Avoid-Shift-Improve" framework

ii. Prioritize people and public transport over private cars

iii. Plan and design to accommodate a rich mix of electric mobility options integrating active and high-capacity modes of transport

iv. Identify opportunities for multimodal transit hubs through the strategic location of electric mobility charging infrastructure

v. Design an integrated transport policy approach seeking synergies between national and local measures

vi. Build cross-cutting institutional cooperation

vii. Engage with all relevant stakeholders across multiple sectors, strengthen public-private partnerships, and create co-ownership of the transition

viii. Promote equity and inclusion in the deployment of electric mobility

ix. Increase the share of renewable energy sources and move towards a zero-emission future

x. Provide adequate access to information on electric mobility to users.

Box 5.6:The transition of Pakistan's public transit to EVs

In 2019, Pakistan approved its first National Electric Vehicle Policy. In addition to climate change concerns, Pakistan's policy seeks to decrease urban air pollution and oil imports.[93] To support this policy, planning measures include investments charging infrastructure and financial incentives, such as reduced customs and sales taxes. Pakistan's ambitious target is that by 2030, 30 per cent of all new sales of cars and trucks will be EVs, rising to 90 per cent by 2040. For bikes and rickshaws, the policy aims even higher, with a target of 50 per cent new vehicles to be electrified by 2030, reaching 90 per cent in 2040. The policy has already helped incentivize domestic electric vehicle manufacturers to invest in e-buses and the production of electric motorcycles.[94]

Urban energy systems

Given that the energy sector is a major contributor to GHG emissions, it is essential to develop urban planning strategies that facilitate the transition to clean, renewable energy sources and improved energy efficiency. Initiatives like ICLEI's 100% Renewables Cities and Regions Roadmap project, among others, support cities and regions in developing strategies and action plans toward renewable energy transition.[95] These plans should prioritize renewable urban energy infrastructure, such as solar photovoltaic (PV) panels on rooftops, wind turbines in urban areas, community solar projects, hydroelectric systems and geothermal power.[96] They should also include district heating and cooling networks that integrate renewable (e.g., geothermal) and waste heat sources for efficient energy distribution and utilization, particularly in densely populated urban areas. In addition to mitigation, renewable and district energy systems reduce the reliance on centralized power plants, thus strengthening adaptive capacity by avoiding an all-out system failure in the case of extreme weather events.[97]

It is essential to develop urban planning strategies that facilitate the transition to clean, renewable energy sources and improved energy efficiency

Urban planning should also facilitate the integration of intermittent renewable energy sources into urban grids through innovations in energy storage technologies, such as pumped hydro storage, flywheel systems and battery storage systems. These systems store excess energy generated during periods of low demand and supply it during peak demand hours, so enhancing grid stability and reducing the reliance on fossil fuel backup power.[98] Concurrently, urban planning should integrate smart grid technologies (e.g., advanced metering infrastructure, demand response systems and grid automation) to optimize energy distribution, reduce transmission losses and enhance grid efficiency. Smart meters enable real-time monitoring of energy consumption patterns, thus empowering community members to adjust their behaviour and optimize their energy use, while automated grid controls and sensors improve grid reliability and responsiveness to fluctuations in supply and demand.[99] Overall, the following timeless key attributes of sustainable energy action planning, outlined by UN-Habitat, UNEP and ICLEI in 2009 remain relevant today: a "whole system" approach designed first and foremost around carbon mitigation and energy needs, flexible enough to adapt to changing conditions and cognizant of the different social and economic costs involved.[100]

Mapping, spatial data and knowledge sharing

Robust monitoring, reporting and verification mechanisms that track progress, measure impacts and ensure accountability are key to achieving equitable and just climate action.[101] Cities should harness data from sources such as energy consumption, transportation patterns and waste generation to develop targeted interventions and policies to reduce GHG emissions and transition to low-carbon energy systems. Likewise, cities must invest in climate data to enable evidence-based, proactive risk management and climate adaptation. For instance, geographic information systems (GIS) integrate layers of demographic, land use, transportation networks and environmental hazards data. Similarly, remote sensing technologies, such as satellite imagery, aerial drones and Light Detection and Ranging (LiDAR) provide valuable insights into urban land cover, vegetation, water resources and environmental changes over time.[102]

Cities must invest in climate data to enable evidence-based, proactive risk management and climate adaptation

As illustrated in Chapter 3, these tools facilitate mapping vulnerability indicators (e.g., socioeconomic factors, infrastructure vulnerabilities and environmental hazards) to identify areas and populations that are most at risk from climate change impacts, such as flooding, heatwaves and sea-level rise. This in turn can inform decision-making around urban planning, infrastructure design and emergency response to protect vulnerable urban communities. For example, cities in the Netherlands (e.g., Delta Programme) and Japan (e.g., Tsurumi River Multipurpose Retarding Basin) use advanced modeling techniques and risk assessment methodologies to identify vulnerable areas, manage flood risks and prioritize investments in infrastructure and land use planning for coastal protection. Their data-driven, forward-looking approaches demonstrate exemplary disaster risk reduction and resilience-building efforts.[103]

Cities should also capitalize on innovations in data collection, namely artificial intelligence (AI). For instance, AI can help improve efficiency in water resource planning and management, particularly in contexts of water scarcity, through more accurate data that combines annual use, locational constraints and vulnerability assessments.[104] Equally important, cities much empower citizens to participate in data collection themselves, for instance through crowd-sourced mapping and on-line engagement platforms that leverage technology to foster transparency, accountability and community resilience.[105]

5.3.2 Urban design solutions for climate resilience

As the global community grapples with the urgent need to address climate change, urban design should serve as a catalyst for emission reductions and enhanced adaptive capacity. Through sustainable urban form regulations, low-carbon building materials, energy-efficient design and inclusive public spaces, urban design can support adaptation and mitigation efforts. Several misconceptions, however, have provoked public resistance to climate-responsive urban design.

Table 5.3: An overview of urban design solutions for climate resilience

Urban design solutions for climate resilience	
The tools	**How the tools work**
Urban and built form regulations ▪ Compact, intensified, mixed-use, and transit-oriented development patterns ▪ Balance compactness and open spaces ▪ Harmony with nature ▪ Building codes (e.g., minimum elevations, stormwater management, structural codes)	▪ Contribute to mitigation and adaptation ▪ Facilitate prompt response during/after climate hazards ▪ Foster healthy and safe communities
The building sector ▪ Retrofit grants for low-income communities ▪ Contextualized passive design principles and survivability features ▪ High performance building envelopes, efficient HVAC systems, and energy management systems ▪ Bioclimatic architecture principles ▪ NbS measures ▪ Circularity and sustainable, eco-friendly materials ▪ Embodied carbon building codes (local building materials) ▪ Repurpose existing buildings	▪ Incentivize energy efficiency retrofits (e.g., insulation, lighting, heating, ventilation) ▪ Incorporate Indigenous and traditional knowledge ▪ Ensure habitable conditions during extreme events ▪ Minimize energy consumption, lower operational costs, and reduce emissions ▪ Avoid emissions through circularity, shift to sustainable materials, and improve extractive materials' production ▪ Decrease emissions and costs ▪ Foster local economic development ▪ Extend buildings' lifespan ▪ Reduce the need for new construction ▪ Minimizes resource consumption ▪ Support local economy development ▪ Preserve cultural heritage
The design of public urban spaces ▪ Prioritize public transit and active mobility ▪ Adopt universal accessibility principles ▪ Preserve natural habitats and protect biodiversity ▪ Mandate urban reforestation and NbS	▪ Improve urban livability and reduce environmental impacts ▪ Facilitate equitable access to public spaces, transit, active mobility, employment and social infrastructure ▪ Reduce automobile reliance and lower emissions NbS: ▪ Protect coastal communities and infrastructure from coastal erosion, sea-level rise, and storm surges ▪ Sequester carbon and improve air quality ▪ Manage stormwater runoff and alleviate inland and coastal flooding risks ▪ Increase biodiversity ▪ Enhance aesthetic appeal ▪ Provide educational opportunities ▪ Harvest rainwater and increase water and food security ▪ Provide shade, enhance thermal comfort and mitigate the UHI effect ▪ Enhance water infiltration and recharge groundwater
Water and sanitation infrastructure ▪ Design WRM ▪ Retrofit water and sanitation infrastructure ▪ Conduct climate risk assessments ▪ Mandate engineering standards and adaptive design features ▪ Implement community-based adaptive management strategies	▪ Enhance water and sanitation systems resilience ▪ Ensure continuity of service during extreme events ▪ Balance competing water demands and environmental needs ▪ Address climate change impacts on water availability, quality, and resilience sanitation
Nurture climate responsive forms of living ▪ Designated bike storage spaces ▪ Recycling and composting facilities ▪ Complete communities, the 15-minute city, and intensification policies	▪ Encourage cycling over car use ▪ Encourage circularity ▪ Balance water and environmental demands ▪ Avoid sprawl and car-dependency ▪ Foster social equity and environmental justice ▪ Create inclusive, accessible, resilient and self-sustaining communities

Urban form regulations

Urban form regulations and densification policies should be designed to contribute to net-zero targets through compact, mixed-use and well-connected development patterns that reduce automobile dependency, increase public transit and promote active mobility options, fostering healthier, more livable communities and reduced air pollution. Given the decline of urban green areas (see Box 5.8), urban form regulations should balance intensification with blue-green infrastructure, as these spaces contribute to both mitigation (through carbon sequestration) and adaptation (for example, by absorbing excess stormwater runoff, replenishing underground aquifers and alleviating the urban heat island (UHI) effect). The balance of compact and connected urban form with open spaces also facilitates prompt response and action during (e.g., evacuation) and after (e.g., reconstruction) both rapid and slow onset climate hazards.[106]

Additionally, urban and built form regulations should set minimum elevation requirements for structures in flood-prone areas and mandate stormwater management systems to ensure flood resilience. Building codes should also ensure structural integrity against extreme weather events like hurricanes. Adhering to urban form regulations protects lives, livelihoods, property and infrastructure from the impacts of climate change.[107]

The building sector

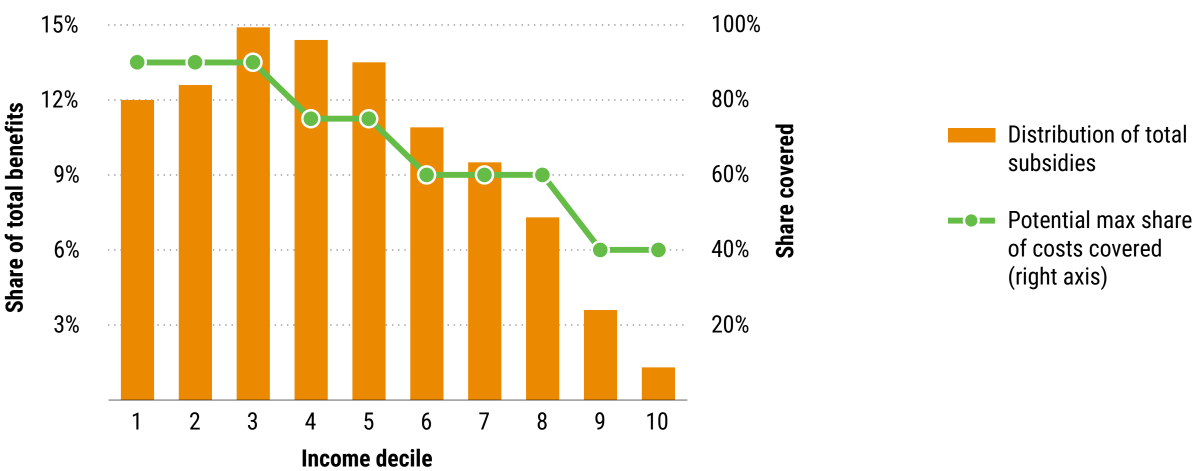
The building sector is responsible for 37 per cent of GHG, rendering it among the largest source of emissions.[108] These comprise both *operational* (those generated by the everyday heating, cooling and powering of the buildings) and *embodied* (those produced by the construction, renovation and eventual demolition of the building, including the sourcing of building materials) emissions. At present, the majority of emissions generated are still operational, a situation reflected in the fact that decarbonization efforts have tended to prioritize reductions in this area through energy-efficient building design. Firstly,

People-centred and inclusive approaches are key to ensure vulnerable low-income households are not left behind through targeted support in form of grants and subsidies

energy efficiency retrofits —including insulation upgrades, light emitting diode (LED) installations, and heating, ventilation, and air conditioning (HVAC) system optimizations—enhance buildings' energy efficiency, comfort, and lower utility bills and operating costs.[109] Unfortunately, not all households can afford these retrofits as they require significant upfront costs. People-centred and inclusive approaches are therefore key to ensure vulnerable low-income households are not left behind through targeted support in form of grants and subsidies. As examples, *Better Energy Warmer Homes Scheme* and *Warmth and Well-being Scheme* in Ireland and in France's *MaPrimeRénov'* (whose distribution of allocation is illustrated in Figure 5.4) ensure fairer distribution of retrofit grants.[110]

Secondly, *high performance building envelopes* (i.e., that integrate solutions for temperature control, airflow regulation, moisture control), efficient HVAC systems and energy management systems (e.g., building automation systems, smart thermostats, automated controls, sensors, and energy-efficient appliances) minimize energy consumption, lower operational costs and reduce emissions. Likewise, building codes should require well-insulated walls, roofs and windows that minimize heat transfer, to improve thermal comfort and reduce the reliance on mechanical heating and cooling systems powered by fossil fuels.[111] Particularly for cities in the tropics, UN-Habitat offers detailed guidance on minimizing buildings' energy demand in the *Energy and Resource Efficient Urban Neighbourhood Design Principles for Tropical Countries: Practitioner's Guidebook*.[112] Overall, in addition to emission reductions, these measures also result in significant cost savings for building occupants over time.

Figure 5.4: Distribution of allocations of MaPrimeRénov' grant and maximum share of retrofit costs covered by household income, 2020-2022, France



Source: International Energy Agency, 2024, p.122

Thirdly, *passive design principles* that are foundational to Indigenous and traditional building practices, such as optimized building orientation, maximized natural daylighting and shading devices, reduce the need for artificial lighting, heating, and cooling, thus lowering energy demand and emissions associated with electricity generation while addressing the unaffordability of more expensive systems.[113] Accordingly, cities should develop contextualized passive design standards, energy-efficient features and renewable energy systems. For instance, green building certifications, such as Leadership in Energy and Environmental Design (LEED) or Building Research Establishment Environmental Assessment Method (BREEAM) are becoming increasingly prevalent in cities in both developed and developing countries, showcasing a shift towards low-carbon building practices and sustainable urban development construction.[114] They also provide frameworks for assessing and recognizing sustainable building practices, thus incentivizing developers to adhere to higher environmental standards. Passive survivability features like robust building envelopes, redundant systems and natural ventilation strategies ensure that buildings maintain habitable conditions during power outages or extreme heat events, so reducing the risk to occupants' health and safety.[115]

Fourthly, building design should integrate *NbS measures* such as blue and green roofs, green walls, permeable pavements and rain gardens. For example, tropical cities like Singapore have implemented green roof strategies to sequester carbon, cool buildings and alleviate the UHI effect, decreasing energy consumption by up to 63 per cent.[116] NbS also provide multiple co-benefits, such as enhanced aesthetic appeal, increased biodiversity, educational opportunities and improved air quality.

Lastly, building design should incorporate measures for indirect emissions reductions through behavioural change toward sustainability, including designated bike storage spaces that encourage cycling over car use[117] and recycling and composting facilities that encourage circularity.[118]

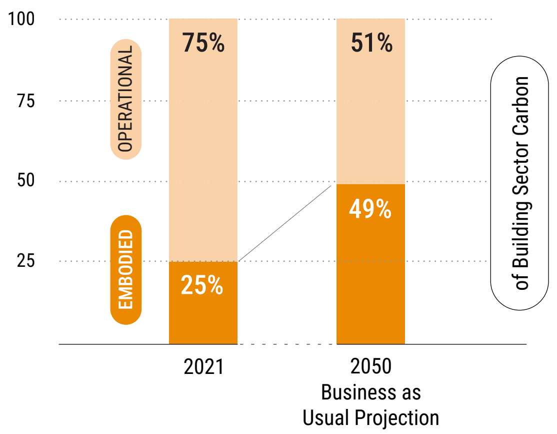
However, the past few decades have witnessed a steady rise in the share of global emissions associated with the production of various materials such as metal, cement, plastic and wood. While in 1995 this accounted for 5 gigatonnes of emissions, amounting to 15 per cent of the total of 35 gigatonnes worldwide, by 2015 this had more than doubled to 11.5 gigatonnes—almost a quarter (23 per cent) of all global emissions—with the construction sector responsible for around 40 per cent.[119] Despite this, climate adaptation and mitigation efforts have generally prioritized enhancing the energy efficiency of building through these measures, in part because significantly more emissions are generated through the operation of buildings at present than their construction. However, this is likely to change in the near future. While embodied emissions are estimated to comprise just a quarter (25 per cent) of emissions associated with buildings as of 2021, by 2050 the proportion is projected to rise to almost half (49 per cent) (Figure 5.5).[120] Consequently, the area of embodied emissions is likely to become a greater priority in the near future. Accordingly, the building sector can effectively contribute to emission reductions through decarbonatization of materials and the adaptive reuse of buildings.[121]

While embodied emissions are estimated to comprise just a quarter (25 per cent) of emissions associated with buildings as of 2021, by 2050 the proportion is projected to rise to almost half (49 per cent)

In this regard, the selection of *appropriate building materials* can significantly reduce embedded carbon and contribute to adaptation and sustainability. To achieve this, UNEP identifies a triad of actions: "*avoiding* emissions through circularity, *shifting* to sustainable materials, and *improving* the production of extractive materials".[122] Accordingly, cities should develop building codes that encourage circularity (for example, through designing for deconstruction and reuse) to allow materials to be salvaged and repurposed at the end of a building's life cycle. Further, cities should mandate embodied carbon building regulations that encourage the use of local building materials sourced from nearby or regional suppliers to minimize embodied carbon emissions. Doing so helps foster local economic development and reduces dependency on imported materials, thereby enhancing community resilience to economic shocks and disruptions.[123] Also, as illustrated in the case of Sana'a (Yemen) in Box 5.7, local building materials leverage traditional and Indigenous knowledge in adapting to local environmental conditions, so enhancing resilience to climate change impacts.

Green facade in Singapore © Shutterstock

Figure 5.5: Projected contributions from embodied and operational carbon within the building sector



***Embodied emissions** are all the emissions associated with the construction (and deconstruction) of a building.*
***Operational emissions** are the emissions generated through the function and maintenance of the building.*

Source: UNEP, 2023b.

Finally, the *adaptive re-use of buildings* involves repurposing existing buildings to extend their lifespan, reducing the need for new construction and the additional resource consumption this would bring. Additionally, it contributes to the local economy through job creation, sense of place and aesthetic appeal (for residents, businesses and cultural tourism), giving rise to artisanal activities while also contributing to cultural heritage preservation.[124] It also enhances collaboration and community engagement.[125]

Box 5.7: Traditional building materials in Sana'a, Yemen

Sana'a's unique mud high-rise buildings are inscribed on UNESCO's World Heritage List. The combination of mud bricks (for the walls) and locally procured wood (for the ceilings) minimize construction emissions and costs while offering remarkable resilience to extreme weather events. Moreover, the building materials, orientation and the location, size and placement of the stained glass (*qamariya*) and wood covered windows (*mashrabiyyah*) provide natural light and passive cooling in the summer and heating in the winter. Urban agriculture takes place in the backyards and contributes to food security, while the wells offer a much-needed water supply.[126] Old Sana'a's vernacular urban form has proven to be more sustainable than its contemporary neighbourhoods particularly when considering urban form metrics around compactness and density; walkability and connectivity; and thermal comfort.[127]

The design of public urban spaces

Public spaces should encourage walkability and cycling and incorporate blue-green open spaces to contribute to mitigation, adaptation, improved urban livability and reduced environmental impacts.[128] The design of public urban spaces should also align with sustainable land use planning to preserve natural habitats and integrate NbS, whether through green infrastructure (e.g., green roofs and walls, trees, community gardens, and permeable pavements) and/or blue infrastructure (e.g., rain gardens, bioswales, bioretention systems, and naturalized stormwater management systems). NbS contribute to mitigation, adaptation and overall urban sustainability through a range of functions. Besides sequestering carbon, they provide shade, enhance thermal comfort and mitigate the UHI effect, hence minimizing heat-related risks[129]—as green spaces within cities are on an average 0.94°C cooler than built up areas without greenery.[130] They also manage stormwater runoff, alleviate inland and coastal flooding risks, enhance water infiltration and recharge groundwater, thereby contributing to integrated water resource management.[131]

The design of public urban spaces should align with sustainable land use planning to preserve natural habitats

In addition to improved air and water quality, NbS's co-benefits include increased food security, enhanced aesthetic appeal, increased biodiversity, ecological resilience and recreational opportunities. Therefore, ecosystem-based adaptation (EbA) and NbS present a unique opportunity to integrate and mainstream climate adaptation and mitigation within urban design to support the development of more liveable urban environments. Singapore's Active, Beautiful, Clean Waters and Landscaping for Urban Spaces and High-Rises initiative is an exemplar in this regard: through an extensive programme of "naturalizing" its riverways, it has successfully reduced its flood-prone area from 3,200 to 32 hectares, generated savings of approximately US$390 million every year and returned much of the city's waterways to community use.[132] Similarly, Laos PDR is currently building climate resilience among local communities in the riverine cities of Vientiane, Paksan, Savannakhet and Pakse through an integrated approach to flood management. The project marks a shift in urban flood management in Laos from grey (hard engineered) infrastructure towards integrated urban EbA.[133]

Ecosystem-based adaptation (EbA) and NbS present a unique opportunity to integrate and mainstream climate adaptation and mitigation within urban design to support the development of more liveable urban environments


Lumphini Park, Bangkok city, Thailand © Shutterstock

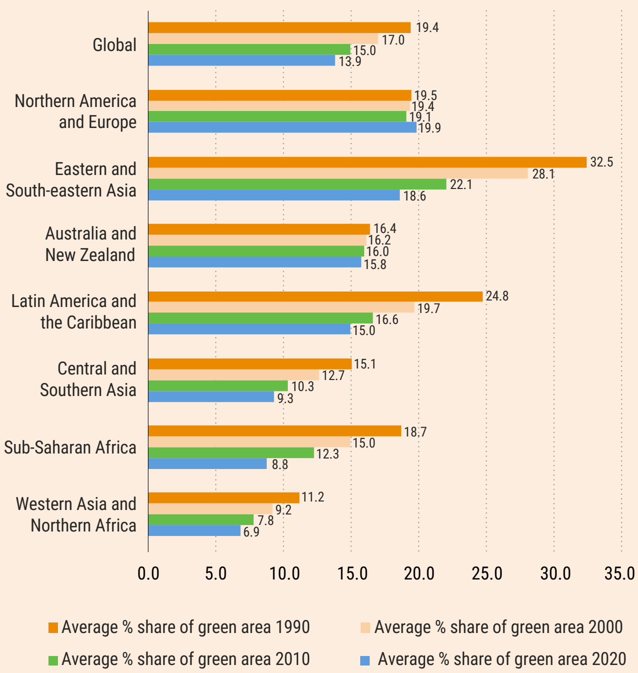
Box 5.8: Reversing the global decline of urban green areas

Green spaces play a number of critical roles in cities, boosting biodiversity, enhancing human well-being and aiding both adaptation and mitigation of climate change.[134] Despite the clear need for urban green spaces, however, new data produced by UN-Habitat across 660 cities from across the world regions shows that, between 1990 and 2020, urban green areas recorded a steady decline. The global average share of green spaces in urban areas – encompassing forests, individual trees, forests, shrubs, perennial grasses and other types of long-term vegetation - decreased from 19.5 per cent in 1990 to 13.9 per cent in 2020. This overall decline was consistent in all regions, except North America and Europe, and was most pronounced in Eastern and South-eastern Asia, Sub-Saharan Africa and Latin America and the Caribbean (Figure 1).

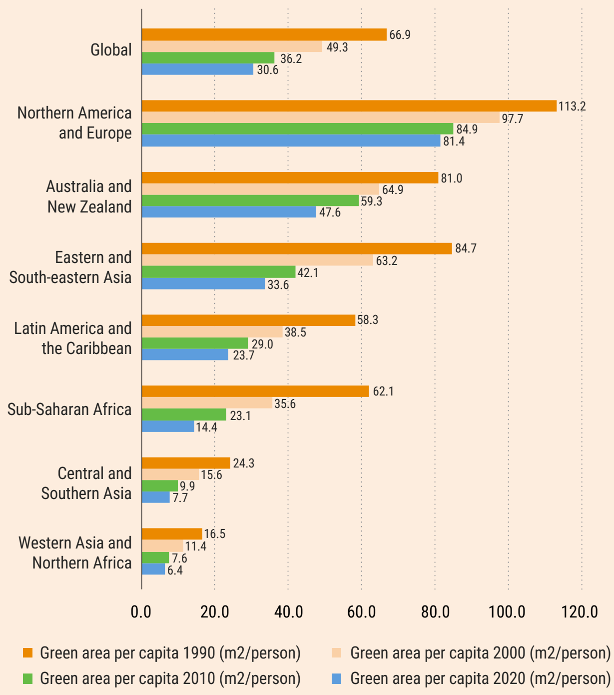
The declining shares of urban green areas, coupled with growing urban populations, have translated into a 54 per cent decline in the global average green area per capita: from 66.9 square metres per person in 1990 to 30.6 square metres per person. The decrease in green area per capita was observed in all world regions, with the highest declines observed in Sub-Saharan Africa, Central and Southern Asia, Western Asia and Northern Africa and Eastern and South-Eastern Asia. In absolute numbers, Northern America and Europe recorded the highest average green area per capita, estimated at 81.4 square metres per person in 2020, more than double the global average (30.6 square metres/person) and 12 times more than the average in Northern Africa and Western Asia (6.4 square metres/person) (Figure 2).

As illustrated in the statistical annex of this report, these variations become even more extreme when comparing specific urban centres in different climatic zones, be they in the same country or across regions.[135] At the same time, despite the overall decline in the share of urban green areas across different regions between 1990 and 2020, many cities have made deliberate efforts to either maintain their greenery or even establish new green areas.

Average percentage share of green area in cities and urban areas 1990—2020



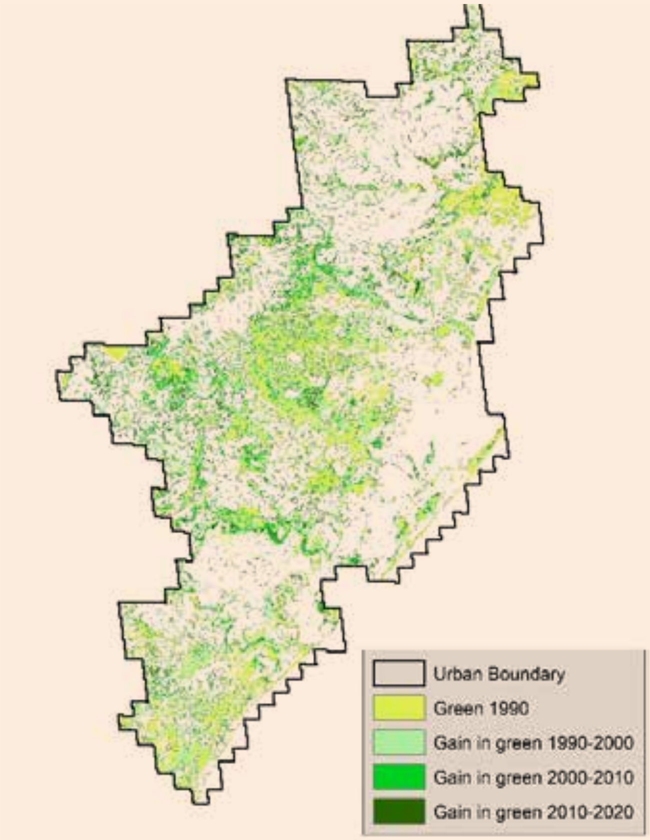
Average green area per capita per region 1990—2020 (m2/person)



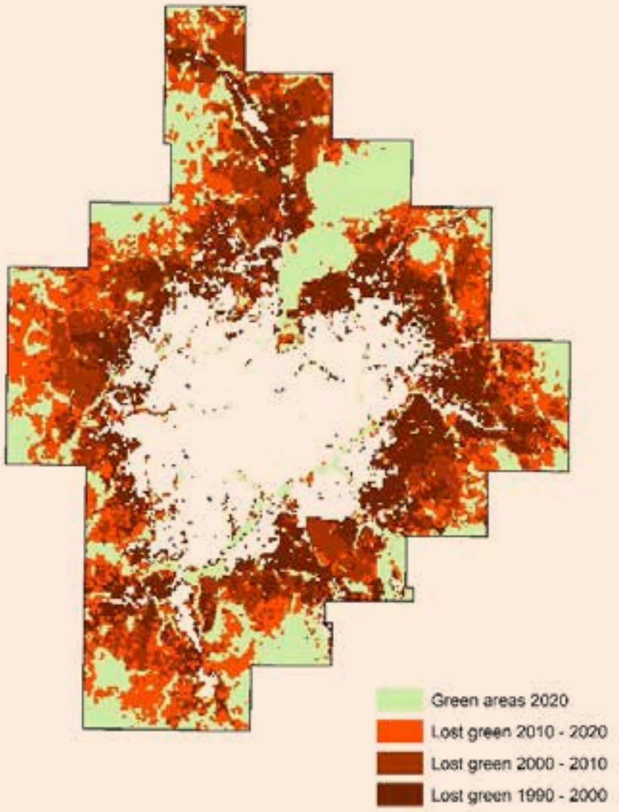
Source: UN-Habitat, 2024d.

Note: Methodology and city specific data points available at: https://data.unhabitat.org/pages/open-spaces-and-green-areas

Area increase in Durban, South Africa (left) and decrease in Nzérékoré, Guinea, 1990-2020



Increasing green areas in Durban, South Africa



Decreasing green areas in Nzerekore, Guinea

While the proportion of green areas in Nzérékoré, Guinea, declined—from 70 per cent of the total urban area in 1990 to 16.6 per cent in 2020—Durban, South Africa, saw a rise (from 14.7 per cent to 25.1 per cent) during the same period.[136]

How can cities add green spaces?

It is important for cities to not just be concerned about the quantity of green spaces, but also about their quality and integration with the rest of the urban fabric. Rather than focusing solely on meeting aggregated targets, planners should promote city-wide greening strategies that include qualitative standards and social policies about their use, access and social effects. A human-centered approach takes into account the social function and necessary diversity of public green spaces, from smaller neighbourhood parks close to homes, to larger urban parks connected by public transport, as well as even larger nature reserves on the edge of cities.

Importantly, cities should ensure their green spaces are not fragmented, but part of an interconnected blue-green network: green spaces that are connected with waterbodies typically have greater impact on lowering urban heat island effect.[137] Cities need to apply ecological principles when choosing vegetation type and promote plants that are appropriate for the local climate,[138] which can endure and flourish without excessive support, in particular in drier climates or seasons when water in scarce. Additional irrigation to plants should try to use recycled grey water as much as possible.

Meeting standards on adequate green space in cites is not an easy task, as past and current modes of urban development have led to high rates of built-up and impervious area. However, cities can promote trees and vegetation on private land by mandating green standards, as well as enhance existing public spaces by retrofitting greenery into their design. Furthermore, through the adaptive use of underutilized land or urban infrastructure, including rail corridors, underutilized back alleys and brownfield sites, extensive greening of cities can be achieved.[139] Cities are encouraged to explore low-hanging fruit when it comes to greening, such as reduction of lanes for traffic to allow for tree-lined streets, before resorting to more expensive and maintenance-intensive options.

Water and sanitation infrastructure

Water and sanitation infrastructure are essential for enhanced urban resilience and reduced vulnerability. Cities should design integrated water resource management and retrofit water and sanitation infrastructure to withstand climate change impacts, such as sea-level rise, extreme weather events and prolonged droughts. Cities also need to incorporate climate risk assessments, engineering standards and adaptive design features into infrastructure planning and investment decisions to ensure that water and sanitation systems can continue to provide essential services to urban populations in the face of future climate shocks.[140] A variety of resources are available to support policymakers, planners and service providers in this process, such as UN-Habitat's *Climate Proofing Toolkit for Basic Urban Infrastructure, with a Focus on Water and Sanitation*. The toolkit offers useful technical steps for integrating climate change risks and opportunities into the design of water and sanitation infrastructure, as well as key principles for making such infrastructure more resilient.[141] Knowledge exchange and capacity sharing can also make a vital contribution for cities seeking to make their water and sanitation systems more resilient. For example, through the Global Water Operators' Partnerships Alliance (GWOPA), UN-Habitat is providing expertise on water-related solutions for impactful climate action. Through Water Operators' Partnerships (WOPs), the alliance is strengthening capacities for building climate-resilient infrastructure for water and sanitation in Gabès (Tunisia), among other places.[142]

Cities should design integrated water resource management and retrofit water and sanitation infrastructure to withstand climate change impacts, such as sea-level rise, extreme weather events and prolonged droughts

Citizen involvement, particularly of marginalized communities in informal settlements, is essential at every stage of these processes. The benefits of community engagement are demonstrated by the Lima Ecological Infrastructure Strategy (LEIS), developed in peri-urban areas of Lima, Peru, based on water-sensitive urban design principles. The programme, combining integrated spatial planning with granular micro-level interventions, included the establishment of a water treatment plant and children's water park in a poorly connected, insecure area in the northern periphery of the city. A central feature of the programme was its participatory approach to the design and implementation of its activities, ensuring its outputs aligned with local needs. This in turn helped build the foundation for the facilities to be community-managed after their completion.[143]

Climate responsive forms of living: 'Sustainable proximities'

It is important to recognize that urban design can modify human behaviour, in addition to modifying urban form, to achieve climate responsive, sustainable and equitable outcomes. UN-Habitat thus advocates for the application of urban design principles to achieve a people-centred built environment that is compact, connected, inclusive, vibrant and resilient.[144] Notions like "complete communities"[145] and the "15-minute city" paradigm[146] have recently re-emerged as transformative ideas for the built environments that envision neighbourhoods where residents can access essential services, amenities and job opportunities within a short walk or bike ride from their homes.[147] Thus, they minimize the need for long commutes and reduce the reliance on private automobiles, resulting in cleaner, safer urban environments. They also reduce the dependence on long-distance supply chains and promote local businesses, markets and services. Accordingly, these urban development models, if implemented in line with the principles espoused in key design resources such as UN-Habitat's *MY Neighbourhood*,[148] not only promote social cohesion by creating more inclusive, accessible and vibrant communities but also foster resilient, low-emission communities. Moreover, decentralized energy systems, such as rooftop solar panels and district heating networks, further reduce their reliance on centralized fossil fuel-based energy sources, further lowering their emissions and enhancing their energy security, particularly during extreme weather events.[149]

Urban design can modify human behaviour, in addition to modifying urban form, to achieve climate responsive, sustainable and equitable outcomes

Navigating public contestation and related pitfalls

Navigating contestations that may arise due to multiple reasons is essential. This is because the effective implementation and enforcement urban design regulations require collaboration among policymakers, developers, builders and local communities to achieve meaningful progress in addressing climate change. Some of the key challenges and controversies are discussed below.

While pushing for climate responsive and sustainable urban design solutions, cultural sensitivity is crucial to respect local traditions and cultural identities

The tension between innovation and tradition: While pushing for climate responsive and sustainable urban design solutions, cultural sensitivity is crucial to respect local traditions and cultural identities.[150] Striking a balance between innovation and tradition ensures that urban design solutions resonate with the unique characteristics of each city. For example, adopting traditional and Indigenous passive cooling techniques in low-income housing projects, such as natural ventilation and shading to reduce energy consumption, may not be sufficient for improving indoor comfort during extreme heatwaves and may warrant the support of thermal insulation and/or mechanical support.[151] Most importantly, in line with the design justice principles outlined in Chapter 8 of this report, participatory design approaches should engage local communities in the co-creation of climate-responsive urban spaces and empower them to contribute to design solutions that address their specific needs and vulnerabilities. Tagum City in the Philippines, for instance, promotes social cohesion, environmental stewardship and climate adaptation through community-led design for hazard-prone areas.[152]

Equity concerns: While compact, mixed-use developments can promote walkability, reduce emissions and enhance social interaction, they have been criticized for their focus on physical proximity as the primary

Jakarta, Indonesia © Shutterstock

determinant of accessibility, overlooking the role of social and economic factors in shaping urban mobility patterns. Critics argue that simply reducing travel distances may not address underlying inequalities in accessing opportunities and resources, particularly for marginalized communities who face barriers such as income inequality, discrimination or lack of affordable housing. Therefore, to avoid exacerbating spatial segregation and gentrification, notions like complete communities and the 15-minute city model must be accompanied by social policies that ensure equitable access to public services and affordable housing to protect vulnerable communities from displacement. Moreover, they should be accompanied by adequate infrastructure investments and urban design interventions to avoid overcrowding and pollution, as well as ensure equitable access to blue-green infrastructure.[153]

Resistance to change: Various urban design interventions often require context-specific adaptations and modifications to ensure their relevance and effectiveness. This requires a nuanced understanding of local contexts, collaborative governance approaches and a genuine commitment to inclusive, participatory urban design processes: [154] otherwise, resistance will often emerge. In the case of complete communities and the 15-minute city, opposition may arise for a number of reasons, including concerns over the enormous cost of retrofitting urban environments and skepticism about their applicability in other contexts. There may also be significant social and cultural factors in negative attitudes towards them: for instance, the perceived threat they pose to other lifestyles (in particular, the "freedom" of private car use)[155] and the potential for homogenized solutions that disregard the diverse needs, preferences and living conditions of different urban areas. [156]

Thus, engaging the public from the inception of urban design projects helps address concerns, ensures equitable development and fosters community ownership. In addition to avoiding public contestation, inclusivity also promotes social equity through urban design and development, recognizing that resilient cities are those that cater to the needs of all residents by addressing issues of accessibility to all, affordability and equity. Thus, urban development can actively promote social justice through the adoption of disability-inclusive, gender-sensitive and child-friendly design.[157]

5.3.3 Urban management for resilience and resource efficiency

Effective urban management is essential for translating climate-sensitive urban planning and design into tangible actions on the ground. However, evidence from across the globe reveals that all too often, urban management systems remain "rigid and technocratic".[158] In this context, it is essential for cities to adopt more inclusive approaches to planning and decision-making, such as participatory budgeting and citizen science projects, that foster a sense of ownership and collective responsibility for addressing climate change impacts at the local level. Boston's Youth Lead the Change and the European Commission's Urban Water Atlas for Europe are examples of such initiatives.[159]

Effective urban management is essential for translating climate-sensitive urban planning and design into tangible actions on the ground

Table 5.4: An overview of urban management measures to enhance resilience and resource efficiency

Urban management	
The tools	**How the tools work**
Integrated waste management ▪ Phase out conventional waste disposal methods ▪ Adopt sustainable ISWM strategies (reduce, reuse, recycle) ▪ Engage communities	▪ Increase resource recovery and energy production ▪ Enhance urban hygiene ▪ Reduce emissions and environmental problems ▪ Save natural resources ▪ Support urban and peri-urban agriculture
Water and sanitation ▪ Develop IWRM programs (sustainable stormwater management like BGI, EbA, NbS, permeable pavements, and rainwater harvesting) ▪ Wastewater reuse and recycling systems (greywater reuse and treated wastewater) ▪ Water conservation and efficiency measures (low-flow fixtures, water-saving appliances, and drought-tolerant landscaping) ▪ Public awareness campaigns and incentives	▪ Promote circular urban water management ▪ Reduce urban runoff and alleviate flooding ▪ Replenish and improve underground water quality ▪ Conserve freshwater resources ▪ Reduce energy consumption for water treatment ▪ Reduce water demand and enhance urban water security ▪ Encourage responsible water use behaviour and foster a culture of water stewardship
Circular economy initiatives ▪ Circular economy policies (closed-loop economy: product reuse, repair, remanufacturing) ▪ Incentivize circular economy practices ▪ Extended producer responsibility (EPR) policies and product stewardship programs	▪ Minimize waste generation ▪ Conserve resources ▪ Reduce GHG emissions ▪ Incentivize eco-design and product innovation

The ongoing maintenance of critical urban infrastructure is vital for climate resilience. While cities in developed countries benefit from well-established institutions and access to financial resources and technical expertise, they face significant urban management challenges in relation to the retrofitting of existing infrastructure to meet evolving climate threats. For instance, legacy critical urban infrastructure—whether in small or large cities like Charlottetown (Canada) and New York (the US)—requires significant investments to withstand rising sea levels and extreme weather events.[160] In contrast, although many cities in developing countries grapple with institutional fragmentation and governance challenges that undermine their urban management efforts, a significant portion of their infrastructure has yet to be built. Consequently, cities in developing countries have a unique opportunity to integrate sustainable and resilient practices into their infrastructure development from the outset.

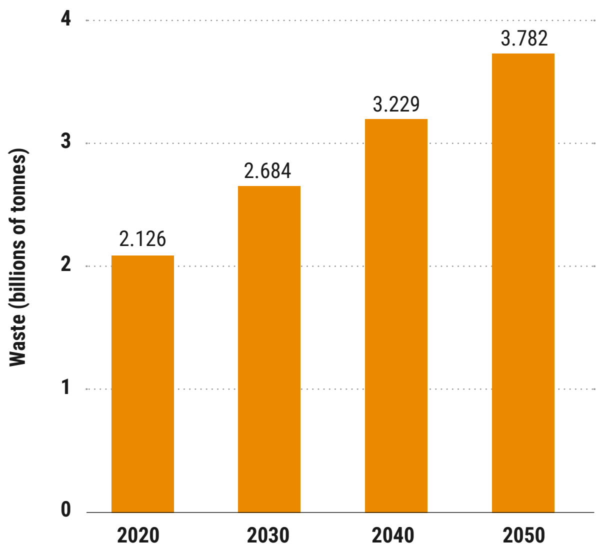
Integrated solid waste management (ISWM)

Effective management of municipal solid waste is integral to sustainable urban planning and design. Already, if urgent action is not taken, global municipal solid waste generation is predicted to grow from around 2.1 billion tonnes annually (as of 2020) to almost 3.8 billion tonnes by 2050 (Figure 5.6).[161] This portends negative outcomes for the climate, ecosystem and human health, particularly in developing regions where there uncontrolled waste disposal practises such as open burning and dumping are commonplace (Figure 5.7).[162] Cities should thus phase out such conventional waste disposal methods that pollute air and soil, contaminate groundwater and contribute to GHG emissions.[163]

UN-Habitat's Waste Wise Cities initiative, supporting 55 cities to date across the world, offers a variety of lessons on to tackle urban waste

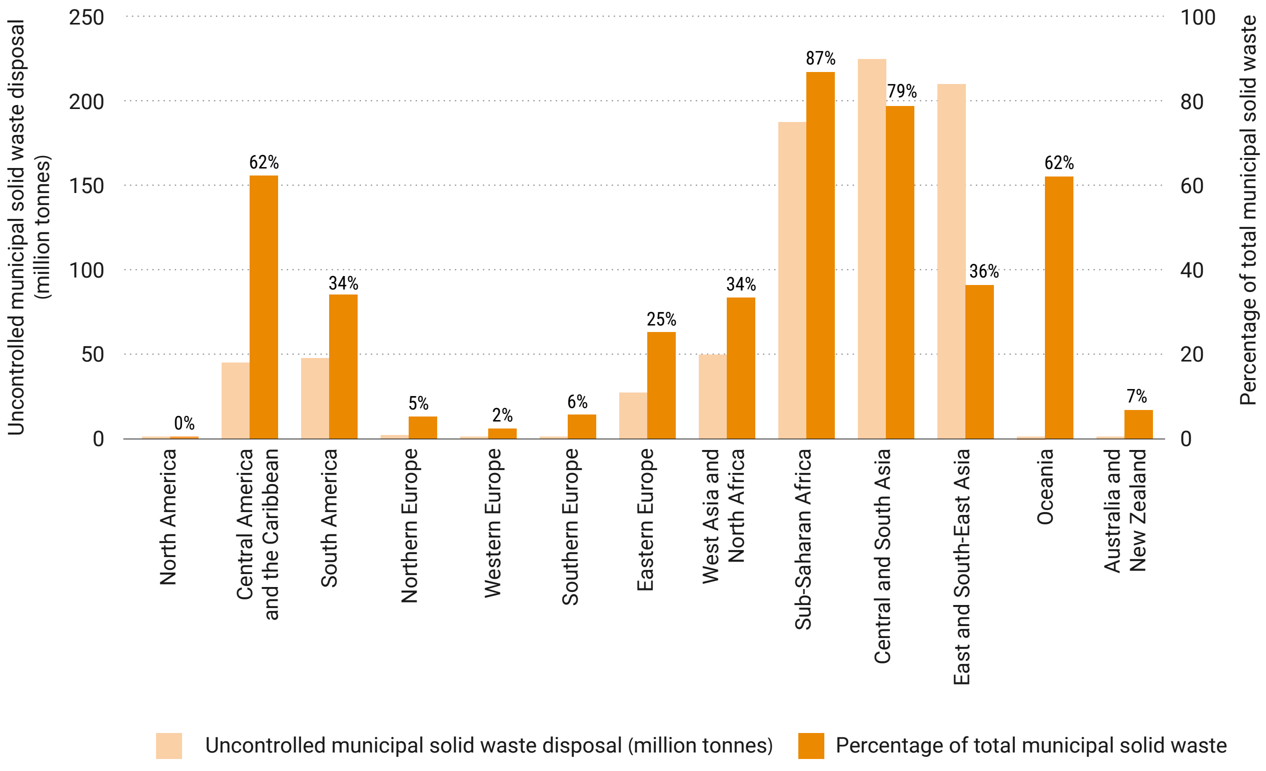
If urgent action is not taken, global municipal solid waste generation is predicted to grow from around 2.1 billion tonnes annually (as of 2020) to almost 3.8 billion tonnes by 2050

Figure 5.6: Estimated global municipal solid waste generation, 2020–2050



Source: UNEP, 2024, p.18

Figure 5.7: Uncontrolled disposal of municipal solid waste (MSW) by region, in million tonnes and percentage of total MSW (2020)



Source: UNEP, 2024, p.28

management problems.[164] Among other activities, in 2021 UN-Habitat launched the Waste Wise Cities Tool, a methodology based on SDG indicator 11.6.1, to assess a city's municipal solid waste management performance.[165] The approach is underlined by the so-called "5Rs": rethink, reduce, reuse, recycle and refuse of single-use items.[166] For instance, composting and recycling divert organic waste and recyclable materials from landfills, thereby reducing emissions and conserving natural resources. In Yangon (Myanmar), UN-Habitat improved solid waste management by supporting the implementation of the innovative "Fukuoka Method", leading to faster decomposition of waste and lower methane gas emissions in Htein Bin open landfill.[167] The same low-cost method has been applied in Addis Ababa and Bahir Dar (Ethiopia) and Kiambu County (Kenya).[168]

ISWM should entail such waste audits as well as environmental and economic assessments of the impacts of waste management options. These are critical in guiding cities to design and implement effective waste reduction and resource recovery programs that contribute to climate change mitigation and sustainable development. Throughout, it is essential for ISWM strategies to optimize the management of solid waste through community engagement, including waste generators from all sectors, service providers, regulators, multi-level governments and local communities.[169]

Water and sanitation management

Effective water and sanitation management is critical for addressing climate change impacts on urban water resources and infrastructure. Therefore, cities should develop integrated water resource management (IWRM) programs that connect water supply, wastewater treatment, stormwater management and ecosystem conservation for a circular and sustainable approach to urban water management. For instance, cities must adopt sustainable stormwater management practices (such as NbS, permeable pavements, and rainwater harvesting systems) that reduce urban runoff and alleviate flooding while also replenishing and improving the underground water quality in cities.[170]

Cities should also develop wastewater reuse and recycling systems, such as greywater reuse for non-potable, irrigation and industrial uses. These systems conserve freshwater resources, reduce energy consumption for water treatment and enhance urban water security. Advanced wastewater treatment technologies and decentralized reuse infrastructure also maximize resource recovery, minimize environmental impacts and promote sustainable water management practices.[171] Importantly, water conservation and efficiency measures should also be implemented at the building scale, such as low-flow fixtures, water-saving appliances and drought-tolerant landscaping, to collectively reduce water demand and energy consumption for water treatment and distribution. These measures should be paralleled by water conservation policies, public awareness campaigns and incentive programs to encourage responsible water use behaviour and foster a culture of water stewardship among residents and businesses. As illustrated by efforts in Cape Town and São Paulo (Box 5.9), these measures are integral in the quest to transition into a water-sensitive city.

Box 5.9: Coping with water scarcity: São Paulo, Brazil and Cape Town, South Africa

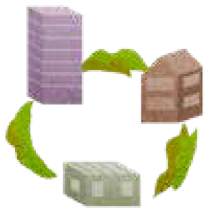
Across the world, the threat of water scarcity in cities is rising against the backdrop of climate change, with some projections suggesting that more than 1 billion urban residents could soon be facing inadequate supplies.[172] Some cities, however, when confronted with severe water scarcity, have been able to convert their rapid-onset hazards into opportunities by transforming their water management systems through more efficient water use, recycling and the protection of water sources. To achieve this often requires not only the adoption of new technologies and the restructuring of existing management systems, but also behaviour change, governance reform and partnership building.

In São Paulo (Brazil), the combined effects of drought and inadequate management of the city's water distribution culminated in 2015 in chronic water shortages. With reservoir supplies close to depletion, the crisis provoked protests and ultimately brought to light a number of underlying challenges that needed to be addressed, including significant water loss from leakages, protracted under-investment by the authorities and the urgent need to diversify existing water sources. Ultimately, the crisis prompted the city to adopt more integrated water management strategies and promote water-saving technologies to ensure more sustainable supplies in future.

Similarly, between 2017 and 2018, Cape Town (South Africa) was also experiencing severe drought, with only a fraction of its normal water reserves to draw on. This led it to implement a combination of context-specific approaches to transition into a water-sensitive city. This included demand-side management measures that involved the local communities in climate action (for example, through public awareness and trust building campaigns to cultivate prudent water usage and water usage restrictions) and supply-side interventions to address future risks (including infrastructure upgrades, stormwater management and aquifer recharge).[173]

Circular economy initiatives

Circular economy initiatives, such as product reuse, repair, remanufacturing and sharing platforms, minimize waste generation, conserve resources and reduce the GHG emissions associated with virgin material extraction and production processes.[174] Cities should develop circular economy policies that foster a closed-loop economy to maximize resource efficiency and minimize environmental impact. Cities should also develop policy measures, regulatory frameworks and economic incentives to create a conducive environment for businesses, industries and consumers to engage in sustainable consumption behaviours. For instance, extended producer responsibility (EPR) policies and product stewardship programs hold manufacturers accountable for the entire lifecycle of their products, from production to end-of-life disposal, so incentivizing eco-design, product innovation and waste reduction. Cities that adopt EPR policies and programs shift the responsibility and cost burden of waste management back to producers, thus encouraging more sustainable consumption patterns upstream to reduce the environmental footprint of consumer goods.[175]



Cities should develop circular economy policies that foster a closed-loop economy to maximize resource efficiency and minimize environmental impact

5.3.4 Multi-level governance and collaboration: Leaving no one Behind

Governance structures are essential for coordinating, implementing and managing climate action and creating a feedback loop across multiple levels, sectors and partners. Accordingly, and as discussed in Chapter 7, multi-level governance frameworks should engage national, regional and local authorities to align policies, resources and priorities toward addressing climate change at different scales. Simultaneously, urban governance mechanisms should ensure the effective collaboration, coordination and accountability in climate planning and implementation among local government agencies, private sector actors, academia, civil society organizations and community groups. Many cities, for instance, establish dedicated climate agencies or task forces to coordinate efforts across various departments and partners: this can help streamline decision-making processes and ensure a coherent approach to urban planning and design. Moreover, effective urban governance requires institutional capacity-building, knowledge-sharing and technical assistance. Among other opportunities, local governments can strengthen their capacity by partaking in city networks like C40 Cities and ICLEI (Local Governments for Sustainability).[176]

Importantly, cities should adopt inclusive and intersectional governance processes, such as community consultations, citizen engagement platforms and participatory budgeting, to ensure that climate policies and projects that directly affect residents are community-led.[177] Inclusive policies and programs should prioritize marginalized groups, including low-income communities, ethnic and racial minorities, LGBTQ+ individuals and people living with disabilities. Indeed, "access-ability" and disability-inclusive urban planning can only be achieved through

"Access-ability" and disability-inclusive urban planning can only be achieved through engagement with people living with disabilities to understand their worldview and accessibility needs, particularly in relation to emergency response and resilience building

engagement with people living with disabilities to understand their worldview and accessibility needs, particularly in relation to emergency response and resilience building.[178] In the same vein, gender-responsive approaches to climate planning and design recognize and address the differentiated impacts of climate change on women, men and gender-diverse individuals.

Likewise, youth have a vested interest in shaping climate policies and initiatives, making it all the more important that they are engaged and championed as agents of change.[179] Youth-led initiatives such as Fridays for Future and Youth Climate Summits mobilize young activists to advocate for climate action, raising awareness in their communities and holding governments to account. Accordingly, intersectional methods should acknowledge the diverse social identities within urban populations and work towards equitable and inclusive climate action, fostering transparency, accountability and legitimacy while building social capital and trust among diverse parties.

At the same time, inclusive planning and design for climate change demands incorporating multiple forms of knowledge, including traditional and Indigenous perspectives. Indigenous communities possess valuable insights into local ecosystems and climate patterns, making their inclusion crucial for effective climate responsive planning.[180] Indeed, as discussed earlier in this chapter, urban planning and design rooted in traditional and Indigenous knowledge have historically responded well to local climatic conditions. Many communities developed sustainable and climate-resilient urban forms that align with their context and cultural practices. Known as vernacular architecture, these traditional settlements are well-suited to their local climates by virtue of their usage of local materials, orientation, and passive cooling and heating.[181] For instance, traditional architecture in hot and humid climates developed a range of innovative solutions to alleviate local conditions, including building orientation, solar loading, cross ventilation and water retention, strategies among others.[182]

Rapid urbanization, land use changes and external pressures, however, pose threats to traditional and Indigenous planning knowledge systems. Therefore, these practices should be urgently integrated within contemporary climate mitigation, adaptation and sustainability urban planning and design strategies.[183] However, while traditional approaches to the built environment can provide natural and locally appropriate solutions to climate change impacts, it is sometimes the case that they can be complemented or enhanced with the use of modern techniques or materials. For instance, while vernacular housing in Vietnam adopts various climate-responsive strategies that render it adaptable to the local conditions, it nevertheless requires contemporary insulation and ventilation to enhance its indoor thermal comfort during extreme heat.[184]

5.4 Planning for Climate Resilience: Current Challenges and Future Opportunities

Although cities across the world are increasingly developing climate-resilient urban plans to mitigate and adapt to the climate crisis, many face numerous obstacles that hinder their effective implementation. The discussion below delves into the current challenges and opportunities they present for the future.

5.4.1 Institutional barriers

Institutional barriers undermine the ability of cities to implement timely climate actions, leading to a disjointed and fragmented approach to climate action that hinders the adoption of integrated, cross-cutting climate strategies.[185] The complex challenges posed by climate change require seamless coordination across various city departments and collaboration across different sectors and levels of government. Yet, bureaucratic silos and processes often delay the formulation and implementation of climate policies and impede prompt, effective climate action. Meanwhile, rigid planning approaches struggle to keep pace with the rapidly changing climate scenario, leading to loss and damages that could have been mitigated with more proactive measures. This is exacerbated by risk-averse decision-making—often attributable to fear of legal repercussions, political fallout and/or financial mismanagement—that favours conservative, less impactful solutions, thus hindering the ability of cities to address the dynamic challenges presented by climate change.[186]

It is imperative for cities to adopt more agile, well-coordinated, flexible and responsive urban planning frameworks and mechanisms that facilitate swift adjustments to emerging climate risks

Therefore, it is imperative for cities to adopt more agile, well-coordinated, flexible and responsive urban planning frameworks and mechanisms that facilitate swift adjustments to emerging climate risks and embed climate considerations into every stage of urban planning and development.[187] This involves incorporating climate risk assessments into planning processes, establishing climate-responsive and decentralized urban governance structures, and investing in innovative climate-resilient urban infrastructure. Equally important is the establishment of cross-sectoral collaborations,[188] such as interdisciplinary task forces, that contribute to capacity building and knowledge transfer, foster an understanding of the interconnected nature of climate change impacts, and facilitate the development and implementation of integrated climate adaptation and mitigation measures.[189]

5.4.2 Data availability and management challenges

Data gaps are among the most common challenges facing many cities across the globe and hinder effective planning and management responses to climate change. Robust data systems are essential to inform evidence-based decision-making in urban areas. Lack of data and inconsistent data formats, for instance, can be major hurdles in taking climate action, meaning there is a lack of reliable information to guide interventions.[190] Therefore, municipal and local governments need to enhance their capacity in data gathering and analysis, with indicators and assessment methods to facilitate the development of climate responsive policies and action.

Access to information and data can be increased through experimentation and knowledge exchange. Local testing, such as through pilots or demonstration sites, plays a crucial role in illustrating the potential impact of innovative solutions. Moreover, facilitating knowledge sharing among cities is important, as urban leaders are more likely to embrace new solutions when they witness successful implementations elsewhere. International cooperation through initiatives like C40 Cities supports the building of urban planning and management capacities globally, helping to bridge disparities between cities and countries through knowledge exchange, partnerships and technical assistance.[191]

Furthermore, innovation and technological advancements that facilitate access to accurate and up-to-date monitoring, evaluation and learning empower planners to make data-driven and timely decision-making. These tools include GIS and LiDAR mapping, smart city technologies, data analytics, remote sensing tools and climate modeling. The use of these tools should aim for equitable and just outcomes, whether through the inclusion of social vulnerability indicators[192] or through direct engagement of local stakeholders in the collection, interpretation and application of the data. In Vancouver, Canada, for instance, authorities have actively sought to disseminate the data collected through their Greenest City programme to other organizations to use in their own work.[193]

5.4.3 Financial hurdles

One of the foremost challenges hindering the implementation of urban climate-resilient plans is limited and/or inadequate financial resources. As noted in Chapter 9, a significant financing gap exists. In many parts of the world, municipal finance primarily relies on intergovernmental transfers and on property taxes.[194] The cumbersome nature of bureaucratic budget approval processes leads to delayed budget allocations on climate action projects.[195] Moreover, local governments often face budget constraints and competing financial priorities that divert resources away from financing climate adaptation to address impending risks. Also, many cities are confronted by insufficient or inadequate quantitative mechanisms to assess the costs and funding schemes for implementing adaptation and mitigation interventions.[196] Many local governments struggle to secure sufficient financing to fund just and equitable climate-resilient interventions such as public transit and flood-adaptive NbS. These financial hurdles exacerbate existing inequalities as vulnerable communities often bear the brunt of climate impacts.

As discussed further in Chapter 9, innovative financing mechanisms decentralize and transfer financial resources from the national level to subnational levels and create opportunities for public-private partnerships. Furthermore, international cooperation and innovative global funding mechanisms enable cities in low- and middle-income countries to overcome financial bottlenecks through access to climate finance, capacity building and technology transfer. These innovative financing mechanisms, like the Loss and Damage Fund, offer promising avenues for mobilizing resources and accelerating climate adaptation efforts.[197]

5.4.4 Inadequate capacity

Inadequate capacity within local governments and institutions poses a critical barrier for the effective implementation of climate-resilient plans. Insufficient knowledge, skills and expertise within local planning agencies hinder the formulation and execution of robust CAPs. Furthermore, failure to engage with local residents to understand their needs and values jeopardize the trust between planners and communities.[198] For instance, in both New York City, United States and Copenhagen, Denmark, well-intentioned climate interventions were implemented without a nuanced understanding of local vulnerabilities: this led to adverse outcomes, including eco-gentrification and displacement, that exacerbated rather than decreased the insecurity of the affected communities.[199]

Insufficient knowledge, skills and expertise within local planning agencies hinder the formulation and execution of robust CAPs

Investments in capacity-building programs present an opportunity to enhance the technical skills of urban planners, particularly in cities in developing countries, to empower them with the skills and knowledge necessary to integrate climate considerations into urban planning, design and urban management practices. Capacity building includes training programs, knowledge-sharing platforms and collaboration with academic institutions. Furthermore, peer-to-peer learning networks and partnerships facilitate the exchange of best practices and lessons learned among different municipalities.[200]

5.4.5 Competing priorities and fragmented approaches

The clash of priorities presents a pervasive obstacle in the effective implementation of climate-resilient plans at the local level. As mentioned before, urban areas are often faced with a multitude of challenges, such as poverty, housing shortages and social infrastructure needs, that divert attention and resources away from climate action. Rather than siloed and fragmented approaches, these challenges should further emphasize the need for an integrated approach to urban planning and design that aligns climate resilience, social planning and societal needs.[201] Such integration was recommended in "The future we want"—the United Nations Conference on Sustainable Development which was held in Rio de Janeiro, Brazil, between 20 and 22 June 2012[202]—and is further emphasized, based on strong evidence, in the UN-Habitat's International Guidelines on Urban and Territorial Planning.[203]

5.4.6 Lack of political will

Political considerations, driven by short-term electoral cycles and vested interests, may impede the adoption of stringent climate policies. Political will and leadership are essential for driving transformative change toward climate action. A study of cities across the province of British Columbia, Canada, found that political interests constitute the foremost barrier to implementing transformative climate action due to

Political will and leadership are essential for driving transformative change toward climate action

leadership swings with electoral cycles, the lack of coordinated action across governance scales, and policy incoherence across governance levels.[204] Likewise, evidence from cities across Switzerland attributes implementation gaps to a lack of political commitment at multiple levels (national and cantonal/municipal)—a situation that also leads to policy fragmentation across governance levels.[205] Therefore, increased awareness and advocacy for climate action among politicians demands long-term perspectives that prioritize sustainability and resilience over immediate political gains.[206] Furthermore, civil society organizations, grassroots movements, and environmental activists play a crucial role in holding policymakers accountable and fostering a culture of climate consciousness.

5.4.7 Polarity between planning and development regimes

The perceived tension between planning-led regimes that prioritize the collective good and development-led regimes that focus on economic growth and expansion represents a significant obstacle to the implementation of climate-resilient plans. The perception of dichotomy between these approaches often leads to conflicts and compromises that undermine the effectiveness of climate action initiatives. Recent experiences in New York City, United States demonstrate the potential for an "infrastructure-first" approach to generate tensions with the local communities (Box 5.10). Instead of a dichotomy, a harmonized approach that integrates both planning and economic development goals is essential for climate action, whereby urban and territorial planning serves as a "catalyst for sustained and inclusive economic growth" concurrently with "social development and environmental sustainability".[207]

A harmonized approach that integrates both planning and economic development goals is essential for climate action

Box 5.10: The "Big U" shift, New York City

New York City's experience with Hurricane Sandy in 2012 highlighted the urgent need for coastal climate resilience measures. In response, the BIG U project, designed through several rounds of community engagement, aimed to create a ring of bermed parkland as flood protective NbS around Lower Manhattan. Although over US$335 million in national and municipal funding was secured, the project was subsequently amended in 2018 when city authorities announced that the plan would be significantly altered. Major changes to the design disposed of the berms, replacing them with infill that would raise the low-lying areas and add significantly to the cost.

This seemingly unilateral decision, announced after years of consultation with local residents, resulted in a breakdown of trust between communities and the city government. There were also concerns that the proposals seemed to be triggering several luxury housing towers, which not only indicated a business-as-usual approach, but also the dominance of development-led planning that triggers green gentrification. Although work is now progressing on a different plan that will for the time being provide greater protection from further flooding, a development that some locals have welcomed, others lament the destruction of the park's existing ecosystem to accommodate it. Furthermore, the abandonment of previous plans to treat the riverside areas as a "sponge" that could absorb extreme flooding when it did occur in favour of hard engineering was criticized as short-sighted, given the possibility that continued climate change could render the new protection redundant in future.[208]

Flooded tunnels, damaged steeples, uprooted trees in Manhattan and Brooklyn, the aftermath of Hurricane Sandy © Shutterstock

5.4.8 Conflict and migration

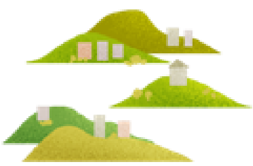
Regions facing conflicts and high rates of migration experience additional challenges in implementing climate-resilient plans. Climate change and environmental degradation exacerbate existing social, economic and political vulnerabilities and contribute to displacement. The number of refugees and asylum seekers fleeing from highly climate-vulnerable countries continues to rise exponentially: 70 per cent of all refugees and asylum seekers in 2022, a significant increase from 56 per cent in 2012. In many instances, conflict and environmental disasters "interact and overlap as triggers and drivers of displacement".[209]

In addition to derailing climate action in the countries of origins, conflict often also negatively impacts the host cities due to strains on their resources that complicate both the development and execution of CAPs. This renders host communities also vulnerable and facing a severe lack of resources to withstand or address climate risks. Even international organizations' ongoing relief efforts to the refugee crisis contribute to GHG emissions.[210]

5.4.9 Limited public awareness and participation

Common challenges across all contexts include a lack of inclusive and just governance.[211] As discussed in the previous section, inclusive governance empowers diverse sub-communities in shaping their urban environment, fosters a sense of ownership, and promotes sustainable practices. Likewise, limited public awareness and apathy or skepticism toward participation and engagement hinder the implementation of climate initiatives. Examples abound of the need to cater for the public's demands for better evidence of the benefits of climate action and for demonstrating that climate action complements, rather than compromises, other important urban agendas like social, health or economic development. In Rio de Janeiro, Brazil, while communities were satisfied with the construction of Madureira Park, the city has reportedly faced difficulties in convincing the community of the benefits of proposed green spaces ahead of their construction. This was despite the evident benefits, from recreational areas to lower temperatures in local neighbourhoods, that these brought once completed.[212]

Therefore, it is essential for climate action to combine evidence-based decision-making with inclusive planning processes that engage the perspectives, experiences and knowledge of diverse urban populations. Evidence shows that perseverance in inclusive governance and citizen participation in climate action ultimately enhances the legitimacy and effectiveness of climate action initiatives in the longterm.[213] Also, leveraging the power of civil society organizations for public education campaigns, community-based initiatives and transparent communication channels all contribute to building public awareness and fostering community engagement.[214]



Inclusive governance empowers diverse sub-communities in shaping their urban environment, fosters a sense of ownership, and promotes sustainable practices

5.5 Concluding Remarks and Lessons for Policy

While integrating climate change adaptation and mitigation into urban planning and design undoubtedly poses challenges, it also presents opportunities crucial for sustainable urban development. As cities increasingly face the impacts of climate change, it is imperative to embed climate considerations within existing policies and plans. This requires promoting coherence across different policy domains and fostering cross-sectoral collaborations. The chapter demonstrates that urban planning and design play a pivotal role in achieving NDCs as outlined in the Paris Agreement. Whilst NDCs and NUPs serve as roadmaps for countries to mitigate emissions and adapt to climate change, this chapter discusses the causes and implications of their misalignment. Consequently, effective climate action in urban areas necessitates integrated approaches, enhanced community engagement, and strengthened coordination mechanisms.

This chapter shows that CAPs are instrumental in mainstreaming climate action at the local level. In mapping the solution space, it highlights the diverse range of planning instruments for climate action within CAPs. Urban design solutions play a vital role in climate change mitigation by reducing emissions while also reducing vulnerabilities and enhancing communities' adaptive capacity. In discussing the design strategies, this chapter notes that challenges like public contestation will inevitably arise: in these contexts, policymakers should balance innovation with cultural sensitivity, engage communities early to address socioeconomic concerns, and adapt strategies to local contexts to foster inclusive, equitable urban development.

This chapter also brings out the critical role urban management plays in promoting urban circularity and sustainable consumption. Lastly, in the solution space, the chapter underscores the importance of collaborative governance, noting that multi-level governance frameworks and community engagement mechanisms foster collaboration, coherence and accountability in climate planning and implementation. Indeed, this chapter illustrates that whilst varying challenges exist in both developing and developed countries with respect to climate-resilient urban planning and design, innovative participatory and community-led approaches offer many promising solutions.

In discussing the present challenges and future opportunities in planning for climate resilience, this chapter underscores the imperative for enhancing institutional capacities; the necessity to integrate climate action with other priorities; the need for political goodwill and effective leadership; the importance of harmonized planning and development goals; the urgency to address social vulnerabilities to ensure inclusive and equitable climate action (noting the intersectionality of climate change with social, economic and political vulnerabilities); and the need for enhanced public engagement.

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Chapter 6:

Resilient Infrastructure as an Accelerator of Transformative Climate Action in Cities

Quick facts

1. Resilient infrastructure is a critical element of urban climate action to achieve the Sustainable Development Goals, the Paris Agreement, the Sendai Framework and the New Urban Agenda.

2. Infrastructure around the world is being affected by climate change, and the costs resulting from damaged assets, expensive repairs, service disruptions and loss of life are expected to increase.

3. The world still faces a glaring infrastructure gap, leaving the majority of people in developing countries vulnerable to climate change.

4. Most urban infrastructure needed to achieve resilience has yet to be built, offering the possibility to build it more sustainably and inclusively.

5. Investing in resilient infrastructure construction, operation and maintenance can generate long-term financial benefits to cities and national economies.

Policy points

1. Infrastructure needs to be resistant to the effects of climate change, but this in itself is not sufficient to accelerate effective climate action.

2. Transformative infrastructure should build the social and economic resilience of inhabitants to climate change, address both the drivers of climate change and vulnerability, and be delivered in a way that contributes to broader and positive lasting societal change.

3. Community-led service provision models and other forms of participation empower communities to shape urban infrastructure and adapt more effectively to the challenges of climate change.

4. By recognizing and incorporating informally built and managed infrastructure, cities can harness their potential to contribute to sustainability goals while enhancing their own resilience.

5. Blue-green infrastructure and nature-based solutions can be transformative accelerators of climate action in cities.

Infrastructure plays a critical role in shaping the ways in which human activities drive climate change, and in turn the ways in which climate change impacts on humans. How the various infrastructures associated with cities—including housing, basic services, transportation systems or energy production—are constructed, maintained and operated has major implications for mitigation and adaptation.

The use of buildings are responsible for 17.5 per cent of global greenhouse gas (GHG) emissions, while transport and waste account for 16.2 per cent and 3.2 per cent respectively.[1] When the embodied emissions from construction are added to this, the use and construction of buildings alone is responsible for 37 per cent of emissions.[2] Thus, planning and developing infrastructure in these sectors are pivotal in mitigating global warming. Urban infrastructure networks are already experiencing the severe physical impacts of climate change, affecting economic productivity, human well-being and health. This takes place in a context in which current infrastructure is inadequate to meet the basic needs of urban residents in many cities around the world.

Yet, resilient infrastructure provides significant opportunities to achieve effective people-centred climate action in cities and urban areas. Not only can well-designed and managed infrastructure accelerate pathways to net-zero urban futures, but it can also protect communities from the inevitable negative impacts of climate change. Moreover, infrastructure can play a transformative role in reshaping the relationships between urban residents and their surroundings in ways that contribute to lasting and climate-resilient development.

As a large share of urban infrastructure remains to be built, meeting future infrastructure needs will be paramount for reducing global emissions and building both human and ecosystem resilience to climate change. Current investments in infrastructure, fall far short of the US$3.7 trillion required every year until 2040.[3] The global infrastructure deficit affects millions of people in rapidly expanding cities, particularly in low- and middle-income countries, where residents lack access to basic infrastructure services such as energy, water and sanitation, waste management and transportation.

Climate-resilient urban infrastructure that addresses drivers of vulnerability can enhance adaptive capacity and improve the quality of life of urban populations while safeguarding against climate risks

Climate-resilient urban infrastructure that addresses drivers of vulnerability can enhance adaptive capacity and improve the quality of life of urban populations while safeguarding against climate risks. Strategies such as integrating low-carbon informal livelihoods into city-wide service provision models, designing culturally appropriate and energy-efficient housing, and engaging diverse groups in participatory planning processes for infrastructure projects can enhance resilience and contribute to global sustainability goals.

This chapter begins by providing a typology of resilient infrastructure that accelerates effective climate action, followed by an exploration of the state of global infrastructure, how it is contributing to GHG emissions, and how it is being damaged by climate-related impacts. The following sections subsequently examine the different categories of infrastructure in more detail: infrastructure that is *climate-resistant*, infrastructure that contributes to *resilience*, and infrastructure that is *transformative*. The final section of the chapter focusses on mechanisms for delivering transformative infrastructure, with a particular focus on the planning, policy, governance and financing conditions that are necessary to enable this.

6.1. The Role of Urban Infrastructure

Urban infrastructure is directly or indirectly responsible for a significant proportion of GHG emissions, yet it is also key in building the resilience of urban areas to environmental shocks. As a result, urban infrastructure and urban responses to climate change "both configure and are configured by" each other.[4] The New Urban Agenda (NUA) commits to the promotion of "equitable and affordable access to sustainable basic physical and social infrastructure for all", and recognizes the significance of infrastructure in driving resource efficiency and resilience—a point reinforced by the recently adopted 2023 United Nations Habitat Assembly Resolution on Urban Planning and Sustainable Infrastructure.

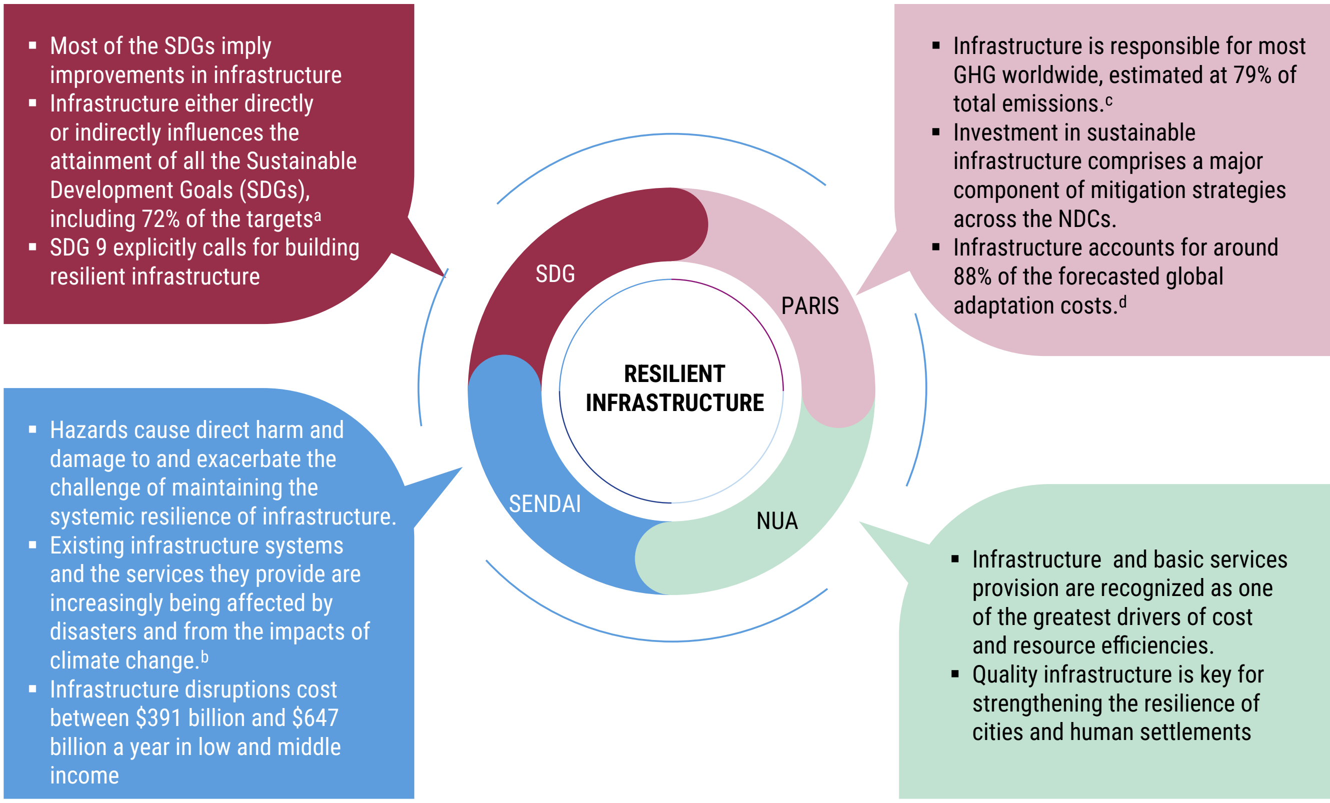
6.1.1. The impact of inadequate urban infrastructure

Inadequate or outdated physical infrastructure and service delivery mechanisms can have dramatic effects on human well-being, the economy and the environment,[5] with particularly deleterious effects for issues of equity and sustainability. This is a global challenge, but is particularly evident in developing countries. The lowest levels of provision can be found in Sub-Saharan Africa, where only 22 per cent of the urban population have access to piped water,[6] and South Asia, where only 23 per cent have access to safely managed sanitation.[7]

These averages mask huge differences between and within cities, with low-income neighbourhoods and secondary cities being particularly disadvantaged. For example, though globally the percentage of people living with inadequate sanitation provision is declining, the improvement is not equally distributed: countries with little or no access to wastewater treatment infrastructure in the year 2000 were also those most likely to show no improvement (or even a deterioration) in coverage by 2015.[8]

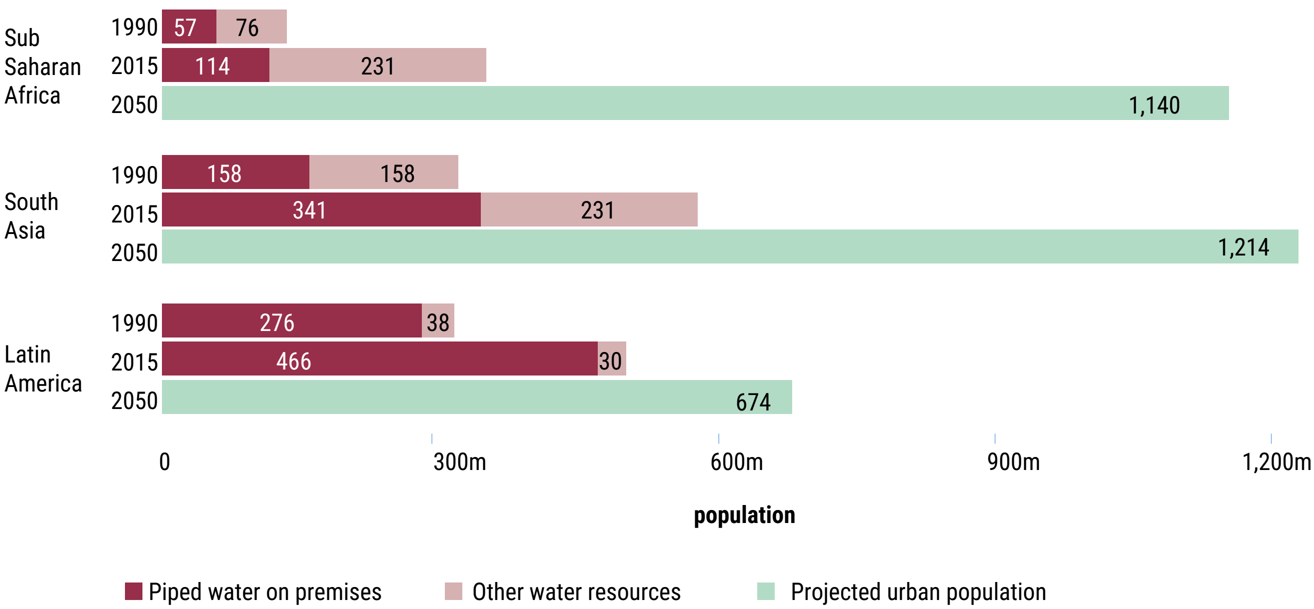
It is also the cities of the developing world where 90 per cent of all population growth is now taking place,[9] placing still further pressure on already inadequate infrastructure systems. Close to 1.1 billion people worldwide reside in slums and informal settlements: in effect, "the world is producing new slum dwellers faster than it can address existing slums".[10] In informal settlements, as well as in many planned neighbourhoods in low-income countries, access to basic public infrastructure can be inadequate or non-existent.

Figure 6.1: The connections between resilient infrastructure and major global sustainability frameworks



Source: [a.] Thacker et al., 2019; [b.] Thacker et al., 2021, p. 12.; [c.] Thacker et al., 2021, p. 13; [d.] Hallegatte et al., 2019b, p. 2.

Figure 6.2: Access to water in developing countries



Source: Mitlin et al., 2019; WHO & UNICEF, 2017; UN DESA, 2017.

Sidewalk repair in Jakarta, Indonesia © Shutterstock

6.1.2. Barriers to inclusive infrastructure access

In many cases, it is not only the physical absence of infrastructure that precludes inhabitants from accessing basic services. As Chapter 4 explained, institutional factors such as lack of access to social and financial services, exclusion from city-wide development plans, and limited access to information act as multipliers of risk.[11] These can serve to exclude populations based on socioeconomic features such as income-level, ethnicity, legal status, and gender.

These institutional factors can severely hinder people's ability to respond to climate-related shocks. For example, water supplies are frequently contaminated by solid and human waste, leading to serious public health issues that are particularly dangerous for children.[12] Many informal settlements are situated in areas that are exposed to natural and geographic hazards such as flooding, landslides, subsidence and local air pollution, for example from nearby industries.[13] The risks associated with the increased incidence of natural disasters caused by human-induced global warming are exacerbated in informal settlements by overcrowded living conditions, unsafe housing, poor health and inadequate infrastructure.[14]

In cities of developed countries, the most pressing infrastructure challenges tend to relate to upgrading and modernizing ageing infrastructure. Still, certain places experience higher levels of relative poverty, where often already marginalized and minority groups live in areas characterized by underinvestment in urban infrastructure. Characteristics like current urban form (dense or sprawling), the level of inequality, average and per capita income level, the city's economic base (industry- or service-oriented), the presence of corruption in government, and the power of those with vested interests such as incumbent firms, vary greatly from city to city. For example, it has been shown that higher levels of corruption strongly correlated to lower overall infrastructure quality.[15] As a result of these different characteristics and development pathways, the infrastructure needs and challenges of cities and urban areas can vary significantly, as shown in Table 6.1.

In cities of developed countries, the most pressing infrastructure challenges tend to relate to upgrading and modernizing ageing infrastructure

Table 6.1: Infrastructure challenges in different types of urban areas

City type	Definition	Infrastructure challenges	Examples
Megacity	A city with a population of 10 million people or more	Severe traffic congestion, high energy consumption, high pollution levels, housing shortages, gentrification and high cost of living	Tokyo, Japan Sao Paulo, Brazil Cairo, Egypt New York, USA London, UK
Medium city	A city with a population of between 1 million and 10 million people	Balancing growth with infrastructure expansion, economic diversification, scaling infrastructure and social services	Cape Town, South Africa Melbourne, Australia Rome, Italy
Small city	A city with a population of less than 1 million people	Limited budgets, attracting and retaining businesses and talent, modernizing infrastructure	Heidelberg, Germany Wellington, New Zealand Gaborone, Botswana
Low-income	Cities in countries with a low GDP per capita	Limited financial resources, often rapid urbanization, high number of informal settlements, inadequate city-scale infrastructure	Dhaka, Bangladesh Kathmandu, Nepal Port Moresby, Papua New Guinea Kinshasa, DRC
High-income	Cities in countries with a high GDP per capita	Ageing infrastructure, high environmental impact, technological integration	Oslo, Norway Sydney, Australia Vancouver, Canada Osaka, Japan
Coastal	Cities located on or near a coastline	Climate change and sea-level rise, environmental degradation, disaster preparedness	Miami, USA Shanghai, China Rio de Janeiro, Brazil Barcelona, Spain
Inland	Cities located away from coastlines, possibly in landlocked regions	Overcoming geographic isolation, resource management, economic diversification	Denver, USA Vienna, Austria Urumqi, China Asunción, Paraguay
Fast growing	Cities experiencing rapid population and/or economic growth	Managing urban sprawl, strain on infrastructure services, high environmental impact	Bangalore, India Nairobi, Kenya Lima, Peru Houston, USA
Stable	Cities with stable, moderate growth rates	Balancing growth and sustainability, avoiding economic stagnation	Munich, Germany Kigali, Rwanda Calgary, Canada
Shrinking/ declining	Cities experiencing population loss and economic decline	Reduced tax base, maintaining (outdated) infrastructure with limited funds	Detroit, USA Leipzig, Germany Yokohama, Japan Valparaiso, Chile
Centralized	Cities where decision-making is highly concentrated at the national or central government level	Potential lack of local fiscal, human, and/or technical capacity, limited responsiveness	Paris, France Moscow, Russia Bangkok, Thailand Riyadh, Saudi Arabia
Decentralized	Cities with significant local autonomy in decision-making	Coordination with higher levels of government, funding limitations when reliant on central transfers	San Francisco, USA Berlin, Germany Curitiba, Brazil
Elected local government	Cities governed by elected officials with high levels of public participation	Balancing diverse interests, efficient decision-making	Copenhagen, Denmark Toronto, Canada Stockholm, Sweden
Selected local government	Cities governed by appointed officials or leaders with centralized, often top-down decision-making	Limited public participation, potential for discontent with large-scale infrastructure projects	Dubai, UAE Beijing, China Hanoi, Vietnam

Yet no matter the specific urban circumstances, every city stands to benefit from investing in green and climate-resilient infrastructure. Where this is done in an inclusive manner, it can support poverty reduction, address inequalities and cultivate more participatory, non-hierarchical relations between governments and citizens, opening up possibilities for more just and sustainable futures.[16]

6.1.3. A framework for accelerating climate action through infrastructure

While significant resources are now being channelled towards urban infrastructure that responds to climate change impacts, the approaches to these often exist on a continuum that can be broadly categorized as follows (see Figure 6.3):

- *Climate-resistant* infrastructure withstands climate shocks and continues to provide the services with which it is associated in situations of natural disaster or crisis. Though it can bring significant benefits in reducing physical damage to assets, its solutions may privilege technical priorities over socioeconomic concerns, potentially ignoring or even reinforcing inequalities.

- *Resilience-building* infrastructure delivers health-promoting or other basic services that help urban residents to develop their adaptive capacity so that they are better able to respond to climate-induced shocks. Typically, recognizing that vulnerability to climate change impacts is determined by social as well as environmental factors, communities will be actively engaged in the design and development of infrastructure to align with local needs and minimize negative impacts.

- *Transformative* infrastructure addresses the drivers of both GHG emissions and vulnerability in a way that leads to wider and more structural reform as part of the transition towards inclusive and sustainable cities. Its approach goes beyond conventional participatory approaches in that it actively seeks to reconfigure social and economic exclusion, with infrastructure seen as a tool to deliver broader justice-based outcomes.

Conversely, poorly planned and implemented, or badly maintained infrastructure can actively erode the resilience of cities, particularly of low-income residents. This framework is illustrated in Figure 6.3. While these approaches often exist on a continuum and the distinctions between them may at times be blurred, Table 6.2 demonstrates the differences in how these various infrastructures respond to key vulnerabilities.

Figure 6.3: A typology of resilient infrastructure in the context of climate change

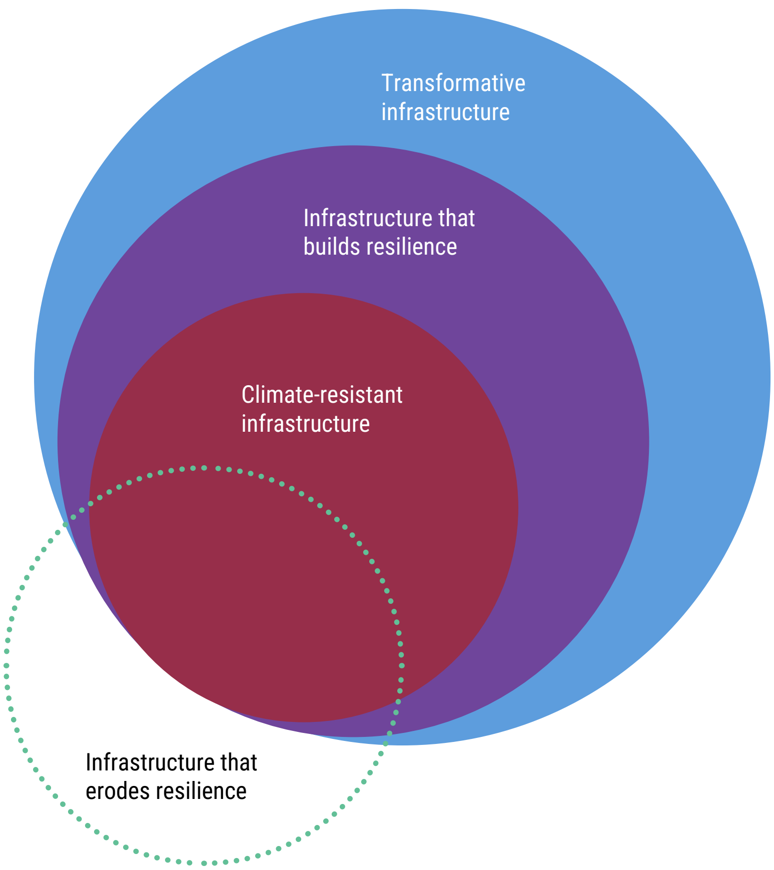


Table 6.2: How different types of resilient infrastructure can impact non-climate-related drivers of vulnerability

Driver of vulnerability	Infrastructure that erodes resilience	Climate-resistant infrastructure	Resilience-building infrastructure	Transformative infrastructure
Informal livelihoods	Replacement of informal with formal livelihoods (that many informal workers cannot access)	Provision of infrastructure that is capable of withstanding climate-related shocks and stresses, but which is implemented without specific concern for how it will affect vulnerable or marginalized groups and low-income or informal settlements	Integration of informal livelihoods in service provision models	Integration of low-carbon informal livelihoods into city-wide service delivery models
Poor quality housing and overcrowded living conditions	Gentrification of existing neighbourhoods		Community-led upgrading that supports incremental design	Low-carbon, culturally appropriate housing that enhances residents' access to urban services and social networks
Inadequate access to basic services	Improved service access that only serves certain groups		Improved service access for those who need it most	Participation in planning, design and delivery of low-carbon service models
Insecure land tenure	Eviction of those without land titles (often without fair compensation)		De-facto tenure rights recognized	Legitimization of informal and communal land rights
Environmental stresses	Local environmental degradation		Community-based management of the local environment	Enhancement of local environment and contribution to global environmental goals
Social protection	No social protection for (informal) workers		Improved access to non-contributory social protection schemes	Universal social protection (contributory and non-contributory) schemes extended to all formal and informal workers

This framework provides the central point of reference for much of the analysis that follows in this chapter. While the next section takes a step back to describe global infrastructure trends more generally and their contribution to GHG emissions and climate change, later sections will describe in greater detail the distinct challenges and opportunities of the different approaches (climate-resistant, resilience-building and transformative). In particular, it will highlight the importance not only of building current and future climate change impacts into infrastructure as a minimum, but also the unique pathways to deeper change that inclusive, socially informed policies can bring.

This chapter does not focus on infrastructure that erodes resilience, but it is important to acknowledge that experiences of maladaptation are widespread. Examples certainly exist of infrastructure that is planned and implemented by private developments, municipal authorities, and national governments without regard for whether or not it is fit for purpose in relation to current and anticipated climate threats. A common characteristic of maladaptation is that vulnerabilities are shifted from one community to another.

For example, the recent construction of seawalls in Fiji to protect people from rising sea-levels has inadvertently made those living close to the new infrastructure more exposed to flooding, as it is now more difficult for stormwater to drain into the sea. Changes in sediment deposits from the seawall intervention also shifted vulnerability to communities further along the coast.[17] The implementation of adequate environmental safeguards—as a minimum standard—should increasingly prevent construction of infrastructure that is likely to fail when exposed to hazards. Similarly, the adoption of appropriate social safeguards should prevent the development of infrastructure that impedes the well-being or livelihoods of urban residents.

6.2 Infrastructure and Climate Change

Cities are engines of economic growth, sites of innovation, and spaces for social transformation and political inclusion. These achievements are in large part possible due to the availability and quality of urban services and infrastructure.[18] This section identifies the types of infrastructure that exist in urban areas, examining its contribution to GHG emissions and the extent to which it in turn is negatively affected by disasters and climate change. Sustainable, inclusive urban service provision is fundamental for ensuring the living standards of all citizens and residents, managing a city's ecological footprint, and harnessing opportunities for prosperity.

6.2.1 Types of urban infrastructure

Urban service delivery encompasses the physical systems that make a city, as well as the totality of interactions, rules, norms and values that govern those infrastructures. It is increasingly recognized that "green" (or natural) infrastructure, as well as "blue" (related to water) infrastructure also plays a critical role in climate action. Taken together, physical and natural infrastructure "form the foundation on which human settlements are built and function" and include water and sanitation, waste collection and management, transport and energy.[19] Information and communications technology (ICT) is also increasingly recognized as a separate category of infrastructure. Housing can also be considered an infrastructure (see Box 6.5), since it is the primary means by which citizens access other basic urban services[20] and exercise their right to citizenship.[21] Finally, protective infrastructure (such as stormwater drainage, seawalls and dykes) is a subset of the built environment with the specific purpose of reducing risks to people and other infrastructure.

Infrastructure exists and is used at various scales—from appliances and utilities within the household, to transnational distribution networks. The focus of this chapter is primarily on neighbourhoods (community infrastructure) and cities (trunk infrastructure), as these have the most direct bearing on urban lives, well-being and productivity—and are closely linked with and dependent on each other. The main elements of this infrastructure are shown in Table 6.3.

Table 6.3: Neighbourhood and urban infrastructure

Sector	Actual or Potential Examples	
	Neighbourhood (community infrastructure)	Urban (trunk infrastructure)
Energy	Distributed renewable energy sources, including rooftop solar panels or small wind turbines	Large-scale power generation and distribution systems, often involving centralized power plants and extensive grids
Transport	Local cycling lanes, pedestrian pathways, and community-based transportation initiatives	Major road networks; railways and airports; centralized public transportation systems
Water and Sanitation	Individual or community-level rainwater harvesting; decentralized wastewater treatment; local well-based or groundwater sources	City-wide water storage and reticulation networks; city-wide sewage collection and treatment plants
Waste Management	Household composting, recycling initiatives and community clean-up programs	Large-scale collection systems; incinerators; landfills
ICT	Household and community networks	City-wide networks, servers, etc.
Protective infrastructure	Micro-drainage; small-scale river or coastal protection.	Stormwater drains; sea walls; river embankments; dykes.
Housing	Individual homes, including self-built and informal housing	Whole neighbourhoods, including apartment blocks
Health facilities	Neighbourhood public health facilities (e.g. community clinics, maternity and neo-natal clinics)	Large-scale health facilities (e.g. general hospitals)
Education and other social services	Early childhood and primary schools that serve local neighbourhoods; community halls, religious facilities, etc.	Secondary and tertiary institutions that serve city/ national scale; other large public institutions

Box 6.1: Informal infrastructure and climate change

A significant proportion of the built environment in cities in low- and middle-income countries is both constructed and managed informally. Where public services often fall short, alternative providers step in to meet the demand. While some operate within formal legal frameworks, many function semi-formally or informally, and by doing so fill gaps in crucial services such as transportation and water provision.

This is notable for various reasons. First, informal settlements have been described as "perhaps the most striking representation of a global infrastructure crisis that has beset an increasingly resource-constrained world",[22] highlighting the extreme inequality both within and between cities in access to basic services. Second, informal infrastructure is often not accounted for in official infrastructure-related inventories. Third, informal infrastructure usually falls outside of formal (i.e. authority-led) building, planning and occupational health regulations, meaning it can be unreliable or unsafe, both for those who work in providing it as well as for consumers. Fourth, those working in—as well as relying on—informal infrastructure and services are disproportionately excluded groups, subject to intersectional vulnerabilities such as those around gender and caste.[23] All these issues are exacerbated by the fact that informal settlements are disproportionately located in low-lying or disaster-prone areas that are especially exposed to climate change risks: furthermore, their residents are typically poor and marginalized, undermining their social resilience to negative impacts.

These alternatives often come at a high cost, disproportionately affecting low-income residents who have little choice but to rely on them. Furthermore, the quality and safety of these alternative services can be compromised: for example, water from informal vendors may be unsafe as well as expensive, while informal transport services can be unreliable and contribute to congestion and pollution. At the same time, the attitude of local authorities can exacerbate these challenges: alternative service providers are frequently stigmatized and often face obstacles such as harassment from authorities. This hostility persists despite their significant contributions, such as informal waste pickers who can play a vital role in recycling and reducing GHG emissions (see Box 6.3). As argued later in this chapter, a key element in building transformative urban climate action is for greater integration between formal and informal infrastructure systems—something that can only occur if national and local governments are willing to recognize informal operators.

Alternative service providers range from private operators like minivan drivers to community-based organizations and small businesses. Frequently seen examples of informal infrastructures include water kiosks, where residents can access clean water from communal taps or standpipes, and small-scale renewable energy systems such as rooftop solar panels. Informal waste management systems, such as community-based recycling initiatives and makeshift waste collection points, play a crucial role in managing solid waste in areas where formal waste disposal services are limited or non-existent. Informal ICT networks, from community-run internet cafes to mobile phone charging stations, facilitate communication. Informal transport options, including shared minibus taxis and motorcycle taxis, provide affordable and flexible mobility solutions for residents in areas underserved by formal public transportation networks.

6.2.2 Blue-green infrastructure

An increasingly significant sub-category of infrastructure falls under the broad definition of "blue-green infrastructure". This refers to the network of natural and nature-based elements integrated into urban areas to provide a range of ecological, social and economic benefits. These features can be designed to mimic or incorporate natural processes to reduce risk of flooding, regulate urban temperatures and improve air quality, among other gains. Through the restoration and regeneration of natural ecosystems, networks of green areas can generate co-benefits for climate change mitigation and adaptation as well as human physical and mental health.[24] Their integration into wider urban planning can also be an effective way to enhance the flexibility and multi-functionality of urban spaces.

Blue-green infrastructures can help achieve effective climate action through both mitigation and adaptation, leveraging natural processes that enhance water infiltration and regulate temperatures. Vegetation can sequester carbon dioxide and aid temperature reduction through evapotranspiration, contributing to reduced energy demands by enabling passive cooling and insulation. Meanwhile, natural buffer zones like mangroves help reduce the risk of coastal flooding and erosion. Furthermore, investing in the protection of ecosystem services through the development of green infrastructure is a cost-effective and sustainable way to build urban climate resilience, while also generating employment opportunities. One study found that ecosystem restoration creates 3.7 times as many jobs per dollar as oil and gas production.[25]

Besides strengthening resilience to environmental shocks, these forms of infrastructure offer substantial social benefits as spaces for recreation, community gathering, food production and biodiversity. Encompassing a wide range of approaches, including urban agriculture, street trees, green roofs, parks, community gardens, bioswales, retention ponds and the restoration of floodplains and watersheds,[26] they can also be combined with conventional "grey" infrastructure. While these hybrid "green-grey" approaches may be more effective than either strategy applied in isolation, they are not yet widely used.[27]

Box 6.2: Social, secondary or soft infrastructure

As well as the predominantly physical, engineered systems that make up a city's built environment, a wider host of institutions must exist in order for a city to function. Though less visible, this infrastructure is equally important in building resilience to climate change as it is the foundation for economic activity and human well-being. Variously referred to as "social", "soft" or "secondary" infrastructure, this mostly spans the policies, resources and services that allow citizens to participate in productive social and economic activities. This includes social services, public education, healthcare, welfare and adequate income. Though this chapter focuses primarily on the role of hard (both physical and green-blue) infrastructure in building urban climate resilience, where relevant it also draws out connections with soft infrastructure.

Soft solutions can play a crucial role in responding to environmental challenges, as demonstrated in Jodhpur, India, where the revival of traditional practices has helped strengthen local resilience to rising temperatures and drought. While climate-sensitive approaches such as rainwater harvesting have been passed down from generation to generation for centuries, since the advent of piped water this knowledge has slowly been eroded. However, recognizing the value of these tried and tested approaches, the authorities in Jodhpur incorporated elements into the development of the city's Heat Action Plan. The implementation strategy involved culture-based climate action that integrated the preservation of cultural heritage, such as traditional water systems and historic sites, as a tool to build climate resilience while also safeguarding the rich cultural identity of the city. The initiative also advocated for integrating traditional architectural practices into modern buildings to reduce energy consumption and mitigate the effects of urban heat islands. Furthermore, women—who are disproportionately impacted by extreme heat and other climate change—are recognized as crucial bearers of local climate knowledge.

Consultation for Jodhpur's heat action plan © Siddhartha Das/GRRID Corps

Source: Madapala & Kanji, 2024; RGUKT Srikakulam & GRRID Corps, WCR Case Study submission.

6.2.3 Global distribution and trends in infrastructure

As the world has rapidly urbanized, it has increasingly been covered by infrastructure in all its forms. This is illustrated by the growing prevalence of "anthropogenic mass", comprising manmade materials such as concrete, aggregates, bricks, asphalt, processed metals and plastics. At the beginning of the 20th century, anthropogenic mass was equal to only 3 per cent of global biomass—but by 2020 it exceeded biomass for the first time.[28] Much of this infrastructure is in urban areas: indeed, "to the extent the twenty-first century is the 'urban century', its material expression appears likely to be an 'infrastructure century'".[29]

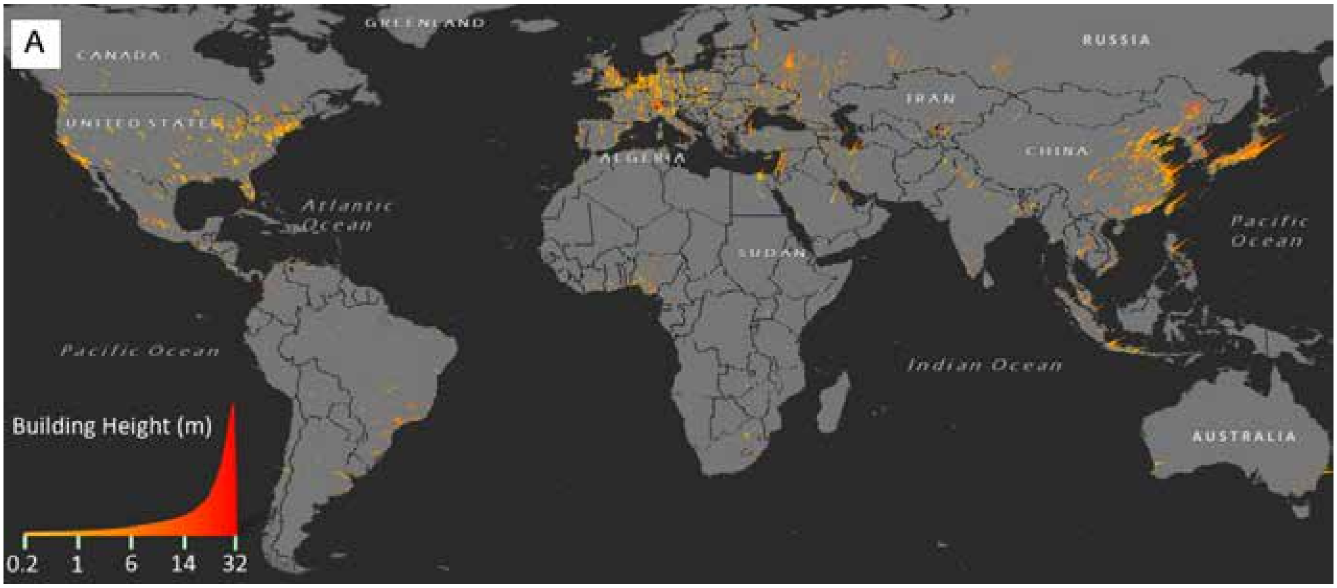
This infrastructure is distributed highly unevenly around the world. The top three countries with the largest amount of urban built-up infrastructure—China, the United States, and Japan—together account for approximately 50 per cent of the global total.[30] The gaps between high- and low-income countries are stark: the built-up infrastructure in 45 developed countries (home to 16 per cent of the global population) is roughly equivalent to that of 114 developing countries where 74 per cent of the global population reside.[31] This is vividly illustrated in Figure 6.4, which clearly shows the concentration of built-up height in North America, Europe and East Asia.

It is estimated that a further 30 billion tonnes of anthropogenic mass is added each year on average, with wide implications for natural hazards, biodiversity, and various climatic and biogeochemical cycles.[32] This is particularly notable in emerging economies: the total floor area of buildings globally is expected to double by 2060, with most of this growth expected in Asia and Africa.[33] The need for further investment in infrastructure is therefore significant, with one estimate suggesting that US$6.3 trillion is required each year between 2016 and 2030 to sustain growth and meet basic needs.[34] Given that urban infrastructure generally lasts between 30 and 100 years, whatever countries and cities choose to construct now will have profound economic and environmental repercussions—for better or worse—for many years to come.[35]

The past two decades have seen major shifts in infrastructure developments. Across Asia, particularly in East, South and Southeast Asia, rail and metro infrastructure has been growing at an accelerated rate. Of the 89 new metro systems that have opened since the year 2000, around two thirds were built in Asia.[36] A significant trend in Europe has been in the recommitment for long-distance train routes: while some of this is associated with the expansion of high-speed networks, institutional arrangements such as the European Green Deal's emphasis on rail travel as a component of achieving climate goals, along with greater cross-border collaboration, are at least as significant. Similarly, improvements in solar photovoltaic technology (and associated reductions in cost) have been instrumental in making this available across South Asia—but government initiatives (such as India's National Solar Mission), institutional innovations (such as the Net Metering Policy in Bangladesh) and other incentives have also contributed to the rapid expansion of this infrastructure at both large scale and in micro-grid / off-grid settings.

There are also emerging qualitative trends in infrastructure, including a shift towards "infrastructure decentralization".[37] Decentralized infrastructure can be more resilient through in-built redundancies, and by limiting the places in the network that can lead to a "single point of failure". In the face of climate change, cities that rely on a single or limited number of places for energy generation or wastewater processing are highly susceptible to climate shocks.

Figure 6.4: Global urban built-up heights derived from satellite observations [the colour and height of the bar represent built-up heights in each 500m grid]



Source: Zhou et al., 2022

A distributed infrastructure network is a particular form of decentralization, where a large diversity of providers and consumers are connected with each other.[38] Nature-based solutions (NbS) to infrastructure exemplify a distributed system, and much of the resilience of NbS is derived from the dispersed yet interconnected aspect of these ecological services. These shifts will require infrastructure designers and developers to incorporate connectivity and whole-systems thinking in their plans. Indeed, infrastructure provision in informal settlements often emerges in a decentralized and distributed manner. In many cases, these systems are providing lessons for governments to reconsider conventional approaches: for example, in Trivandrum, India (see case 12 in the Case Study Annex), the city's centralized waste management was reconfigured around "micro-composting centres" for higher collection and recycling rates.

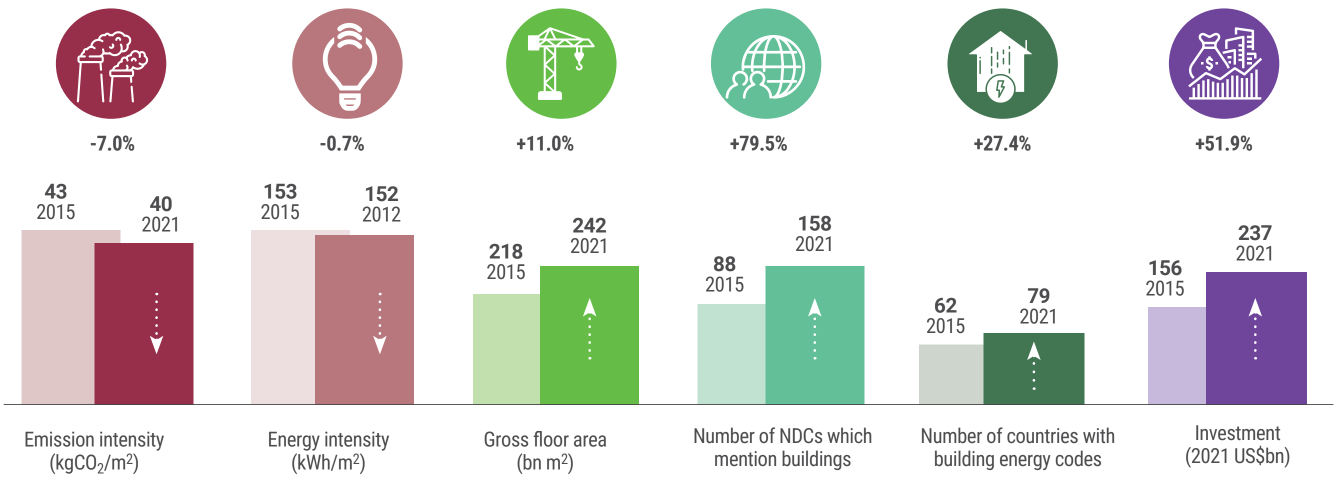
6.2.4 Infrastructure and emissions

As highlighted in Chapter 1, the urban share of global GHG emissions is substantial and continues to increase. While not all of these urban emissions are associated with infrastructure, the IPCC concludes—with very high confidence—that "the construction of new, and upgrading of existing, urban infrastructure through 2030 will result in significant emissions".[39] Infrastructure contributes to GHG emissions through its entire lifecycle, from construction to its use and disposal. For a subset of major cities globally (members of the C40 climate network), emissions from building and infrastructure construction are expected to form the single largest category of consumption-based emissions (21 per cent) between 2017 and 2050, with 60 per cent of these being associated with the production and delivery of building materials.[40]

Annual emissions from buildings operations have reached an all-time high of 12 billion tonnes of CO_2e.[41] These emissions have grown significantly over time: non-residential buildings generated 54 per cent more CO_2 in 2019 than in 1990, with residential buildings generating 32 per cent more CO_2 during the same period.[42] When including estimated CO_2 emissions from producing buildings materials, buildings represented around 37 per cent of global CO_2 emissions in 2021.[43] Although incremental improvements are being made in reducing emissions intensity and energy intensity per unit of building area, the gross floor area is increasing at a more rapid rate—meaning that the overall trends are of increased emissions from buildings (Figure 6.5). Indeed, as the total floor area of buildings is expected to double between 2025 and 2065, primarily in Asia and Africa[44] – given the lack of stringent energy codes in many countries in these regions, this presents a significant opportunity for improved alignment with net-zero goals.[45]

The UNEP Global Buildings Climate Tracker confirms that despite progress at the policy level, such as expanded building energy codes, there must be greater efforts to reduce emissions overall and to improve building energy performance, given this trend of increasing floor area: it concludes that there is "a growing gap between the actual climate performance of the sector and the necessary decarbonization pathway".[46] Data from the Global Infrastructure Hub estimates that only 60 per cent of infrastructure projects currently have a GHG emissions target that is aligned to net-zero: of these, only one third have a target that is firmly science-based (Figure 6.6).[47] In this regard, the extent to which the emissions generated are fully accounted for, can be as significant as the targets themselves. For instance, while Asia is leading the way in net-zero targets for infrastructure assets, Europe has the most comprehensive net-zero targets that also typically include so-called "Scope 3" emissions—those linked to all used and imported goods and services needed to build the infrastructure.

Figure 6.5: Global buildings and energy trends (2015 and 2021)

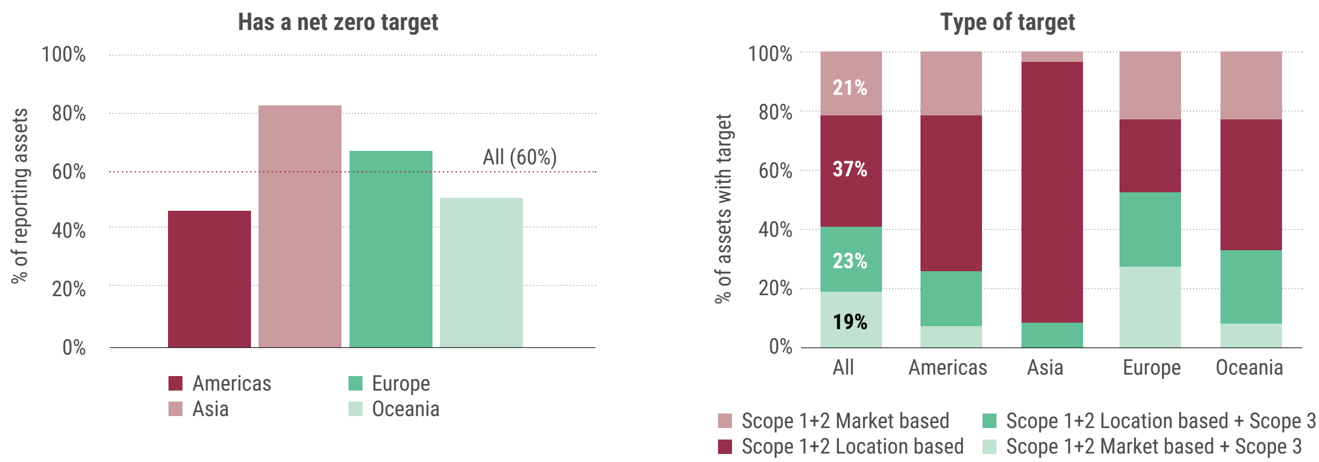


[1]Values included for the baselines have been updated from previous versions of the Buildings-GSR due to both historic input data updates for emissions and floorspace, and also deflation factors for US$. The proportional changes between previous years remains similar.

Source: UNEP, 2022b.

Damage to infrastructure caused by natural disaster, Durban, South Africa © Shutterstock

Figure 6.6: Net-zero targets of infrastructure assets



Source: Global Infrastructure Hub, 2023.

The way in which infrastructure is operated and maintained throughout its lifecycle also has a significant impact on its performance in relation to climate change. As well as direct reductions in emissions through more efficient performance, appropriate maintenance can extend the lifespan of infrastructure assets, reducing the need for additional construction and its associated costs and emissions.[48] This can also help to ensure that infrastructure remains able to cope with different shocks and stresses associated with climate change.

6.2.5 Infrastructure losses from disasters and climate change

Infrastructure is already being adversely affected by disasters and climate change. The Coalition for Disaster Resilient Infrastructure estimates an average annual loss of approximately US$700 billion in infrastructure and buildings, of which 70 per cent can be attributed to climatic hazards.[49]

A World Bank assessment estimated that power generation and transport infrastructure alone incur losses of US$30 billion a year on average from natural hazards, with low- and middle-income countries shouldering about US$18 billion of the total amount.[50] These losses are expected to increase significantly as a result of climate change: the Economist Intelligence Unit estimates present losses of US$4.2 trillion by 2100 under a 2°C scenario, rising to US$13.8 trillion in a 6°C scenario.[51] While most infrastructure is currently still concentrated in the global north, as low- and middle-income countries are more vulnerable, they are expected to incur the highest infrastructure losses. While they only account for about one third of the total exposed value of infrastructure, they represent 54 per cent of the risk to climate change.[52] These infrastructure losses can be disaggregated by types of infrastructure, as illustrated in Table 6.4.

Table 6.4: Observed and expected climate impacts on different infrastructure sectors

Infrastructure Sector	Examples of Observed and Expected Impacts
Energy	Current annual damages of €0.5 billion per year in Europe; projected to increase 1612 per cent by the 2080s 33.9 per cent of Chinese population vulnerable to electricity supply disruptions from floods or droughts Power system costs in USA expected to increase by US$50 billion by 2050
Transport	7.5 per cent of road and railway assets exposed to 1-in-100 year flood events each year, with total global expected annual damages of US$3.1 to 22 billion (mean of US$14.6 billion) Damage to transport infrastructure in Europe could rise from €0.5bn per year to over 10 billion by the 2080s Increased failure of transport infrastructure (e.g. melting of asphalt, inundation of underground systems, bridge failures, flooding of ports and airports in coastal zones)
Water and sanitation	Substantial climate risks expected from droughts, flooding and storm surges
Waste	Potential damage to landfill sites and other waste processing infrastructure Disruption to collection schedules
ICT	Damage to key ICT assets (cables, masts, pylons, data centres, telephone exchanges, base stations, switching centres) Damage to underground ICT infrastructure from ground shrinkages arising from droughts and heatwaves
Protective infrastructure	Sea walls, flood protection and other infrastructure damaged by events that exceed their capacity
Housing	Negative effects on housing stock (including physical damage and loss of property value), from climate impacts including flooding, heat, and wind
Health	Increasing damage to healthcare facilities (hospitals, clinics, residential homes)
Education and other social services	Increasing damage to educational and other social services facilities; disruption to education through use of schools as emergency shelters

Source: Dodman et al., 2022.

Table 6.5: Impacts of infrastructure disruption on firms and households

Sector	Direct Impacts	Coping Costs	Indirect impacts
Energy	Reduced utilization rates (US$38bn/year) Sales losses (US$82bn/year) Lower productivity of family firms Diminished well-being	Other sources of generation (initial investment and operating costs)	Service disruption Higher barriers to market entry Inability to provide on-demand services and goods Constrained access to jobs, markets and services Health impacts on individuals and households (including medical costs, lost income)
Transport	Reduced utilization rates (US$107bn/year) Congestion and loss of time Higher fuel costs	Increased inventory to cope with disruptions	
Water (and Sanitation)	Reduced utilization rates (US$6bn/year) Diminished well-being and loss of time	Costs for other water sources	
Tele-communications (and ICT)	Reduced utilization rates Diminished well-being	Reliance on more expensive temporary alternatives	

Source: Hallegatte et al., 2019b (based on tables 0.1 and 0.2 of reference).

Beyond the direct costs of damage, the effects of disrupted infrastructure services have multiple impacts on both urban firms and urban households. Indeed, the "indirect losses associated with service disruption are often greater than the value of asset loss and damage."[53] These range from reduced utilization rates, to asset damage or dysfunction, to requirements for alternative investments to cope with damage, and to lower individual productivity and well-being, as illustrated in Table 6.5. Sub-standard and poorly maintained infrastructure assets are particularly at risk of causing disruption to essential services and interlinked indirect losses.

Infrastructure can also be affected by compound risks. These occur when a single hazard causes impacts across multiple sectors: for example, when urban flooding from extreme precipitation disrupts transport infrastructure and networks, ICT networks and energy generation. These can also lead to cascading risks, whereby failures in one system (for example, electricity generation and distribution) directly lead to failures in other systems set up to manage potential threats (such as stormwater pumping stations).

6.3 Climate-resistant Infrastructure

As discussed in the introductory section, this chapter proposes a framework for infrastructure development that exists on a continuum between *climate-resistant*, *resistance-building* and *transformative* approaches to infrastructure development. This section begins by examining the particular opportunities and challenges surrounding climate-resistant infrastructure.

Climate-resistant urban infrastructure is planned, designed, built and operated in ways that take into account future climate-changed conditions,[54] enabling it to withstand and recover rapidly from natural disasters, extreme weather events and other environmental shocks and stresses. It can enhance a city's overall resilience to climate-related disaster by minimizing disruptions to essential services during disasters while reducing economic losses by minimizing damage to critical infrastructure. By being responsive to the increased frequency and intensity of climate-related disasters, it also enhances the ability to recover quickly and adapt to changing conditions. Besides incorporating sustainable design principles to reduce its carbon footprint, it encourages responsible land use planning to minimize vulnerability to climate impacts.

6.3.1 Opportunities: improved security and investment potential

Investing in climate-resistant infrastructure can lead to long-term cost savings. For example, by preventing damage to critical infrastructure such as water supply systems, transportation networks and power grids, measures like improved construction standards and flood protection will reduce the financial burdens associated with frequent repairs and upgrades.

Climate-resistant infrastructure projects also have the potential to attract investment and spur wider economic development. Investors are increasingly drawn to cities that demonstrate a commitment to safeguarding their assets against climate-related risks. Resilience measures can create jobs and stimulate local economies during both construction and operation, attracting commerce and innovation organizations that are drawn to the services on offer after completion. There will also be knock-on positive effects: improved infrastructure can in turn enhance public health, minimizing the associated healthcare costs and likely also preventing additional disaster recovery costs.

Climate-resistant infrastructure offers significant opportunities for enhancing the safety and well-being of urban populations during extreme climate events. In the face of climate change and an increasing frequency of natural disasters, such as hurricanes, floods and wildfires, cities with climate-resistant infrastructure are better equipped to protect their inhabitants and allow them to recover more quickly. As highlighted in Chapter 3, robust disaster response mechanisms, early warning systems and resilient building designs can significantly reduce the risks associated with these events. A proactive approach minimizes the displacement of affected communities and can prevent loss of life.

6.3.2 Challenges: unintended consequences and overlooked local realities

Infrastructure projects, even when designed to be climate-resistant, can have environmental consequences, such as the altering of natural drainage patterns or disruption of ecosystems. These negative environmental externalities can reduce or even reverse any mitigation or adaptation gains achieved by the project in the first place. Responses to the challenges of climate change have generally focused on technological efficiency and innovation, sometimes at the expense of ensuring equitable access to climate-resistant infrastructure for all community members. Urban adaptation and resilience-building interventions can also be "financially speculative, economically exclusive, and socially discriminatory".[55] Investment in climate-resistant infrastructure that helps close the infrastructure gap but leads to environmental externalities and greater exposure to risk is "ultimately self-defeating".[56]

The issue of equitable access to the benefits of climate-resistant infrastructure and its services are a key challenge. Infrastructure that is implemented using a business-as-usual approach, without concern for local circumstances and affected stakeholders, can exacerbate existing disparities or create new ones.[57] For example, green infrastructure and nature-based solutions may lead to gentrification if implemented without proper consideration of the social, economic and environmental needs of the most vulnerable or at-risk communities.[58] Unequal access to infrastructure and its services, regardless of the resilience of that infrastructure, perpetuates a vicious cycle of poverty and deprivation that becomes increasingly difficult to escape.

Such consequences are in part brought about by increasing systems complexity. Infrastructure policies often remain confined within silos, hindering holistic and integrated approaches to resilience-building. This compartmentalization limits the capacity to address interconnected challenges effectively. In particular, a reliance on technological solutions as a panacea for building resistance to climate change risks overlooking the critical socio-political dimensions of infrastructure development. Inflexibly built infrastructure is also likely to result in institutional or technological lock-in, providing little leeway to integrate more sustainable practices in future or adapt in the face of changing environmental conditions.[59]

Innovations in service delivery are often evaluated based on their economic value and potential opportunities for wealth creation, rather than on the public value they create.[60] The urgency of climate change may be able to leverage greater investment for green and climate-resistant infrastructure where returns are expected, but taken alone this may serve to legitimize technocentric ecological engineering approaches that can be exclusionary,[61] rather than contributing to the "radical rethinking of current infrastructure models" that is needed.[62] More attention should therefore be paid to putting in place transformative governance structures around physical and engineering systems.[63]

6.4 Resilience-building Infrastructure

In many cases, the delivery of infrastructure projects has occurred at the cost of certain groups of urban residents, often entrenching existing inequalities and vulnerabilities. In response, global agendas have been increasingly foregrounding justice in their principles. Such approaches highlight the need to align social and environmental goals with urban planning priorities, as set out in the SDGs and the NUA (see Figure 6.1). If designed and implemented appropriately, infrastructure can build the social and economic resilience of citizens and communities, making them better prepared to respond to the impacts of climate change. Improving the provision of infrastructure and services particularly in deprived urban areas is crucial for addressing poverty and inequality, which in turn is necessary for the development of inclusive, resilient cities. Following on from the previous section on climate-resilient infrastructure, this section explores the second category of infrastructure discussed in the framework earlier in this chapter (6.1.3.): *resilience-building* infrastructure.

6.4.1 Opportunities: more inclusive and sustainable provision for all

Low-carbon urban infrastructure can enhance resilience for all urban residents by reducing inequalities within and between cities. For example, by investing in sustainable public transit networks and the integration of non-motorized transport infrastructure such as cycling lanes and pedestrian zones, cities can improve mobility options for residents of all income groups. This, in turn, reduces traffic congestion and air pollution, promoting cleaner air and better health outcomes for vulnerable communities. By prioritizing low-carbon urban infrastructure, cities can create more inclusive and sustainable environments, ensuring that the benefits of a cleaner, safer and healthier urban life are accessible to all.

To address the existing infrastructure deficits in informal settlements requires significant investment in climate-resilient trunk infrastructure to which community-led service provisions models can then connect. This in turn requires financial and political partnerships between local authorities and informally settled communities—a considerable challenge in contexts where governments have refused to recognize these groups. However, besides the compelling moral justification for inclusive interventions, targeting infrastructure in ways that reduces poverty and inequality is often more economically attractive.

As argued in Chapter 1 of this report, cities must not overlook the role that urban informality plays in building sustainable and just urban futures, particularly in developing countries. This is particularly true with regard to resilience-building urban infrastructure. In cities of the Global South, "heterogeneous infrastructure configurations" and a variety of non-uniform modes of service delivery have long existed.[64] In such situations, a host of initiatives of varying degrees of formality and with varying levels of state support have evolved to fill delivery gaps.[65] For the majority of residents in fast-growing cities in developing countries, most if not all urban services and infrastructure are accessed via such decentralized and often informal channels.

Cities must not overlook the role that urban informality plays in building sustainable and just urban futures

Even though many of these decentralized systems have functioned efficiently for years, often serving populations who would otherwise have no alternatives, they are often cast aside as a nuisance. This is despite the fact that many "alternative" infrastructure systems have arisen in response to specific place-based needs and can generate new capacities for providing and governing urban infrastructure and its associated services. If they are considered at all, it is through discussions on how to formalize informal service delivery mechanisms or how to replace decentralized, low-tech operations with uniform, state-of-the-art systems. Going forward, cities should seek to harness the potential of informality to provide services, create jobs and contribute to poverty alleviation, whilst ensuring that necessary social protections and appropriate regulations are in place.[66]

Escalators in an informal settlement in Medellin, Colombia © Julius Mwelu/UN-Habitat

Box 6.3: The vital role of informal waste collection in India

Cities in the Global South are uniquely positioned to adopt "disruptive, innovative yet practical" low-carbon measures.[67] One example is the opportunity to develop economic structures that promote the recovery, recycling, reuse and repair of so-called waste materials. In many cities, informal waste collection not only plays a vital role for low-income communities excluded from official municipal services, but also serves as an important livelihood source for thousands of waste pickers. Various estimates suggest that between 0.5 and 2 per cent of the global urban population currently work in the informal waste economy.[68]

A case in point is India, where the thriving informal waste economy currently employs more than 1.5 million people in its cities alone.[69] Waste pickers are responsible for collecting a substantial portion of the country's recyclables, saving them from landfill, yet their valuable contribution is all too often overlooked. Indeed, working conditions for informal waste collectors can be extremely challenging, characterized by unsanitary environments, health hazards, lack of access to basic equipment and official harassment. Like other forms of social infrastructure that play a crucial role in promoting sustainability and resilience, the effectiveness of informal waste collection networks is heavily influenced by the willingness of authorities to support their work.

With this in mind, in 2004 the Self-Employed Women's Association (SEWA), a trade union for working women in Ahmedabad, established a ground-breaking partnership with Vejalpur municipality to deliver door-to-door collection services to 45,000 households. While the local authorities provided items such as handcarts and gloves along with a monthly salary, SEWA provided technical training on safety protocols and client engagement. The project proved a success: the income of female waste pickers quadrupled, health outcomes improved and as much as 70 per cent of all waste was recycled through the initiative.

Such partnerships with the informal waste sector offer alternatives to more expensive investment in solid waste infrastructure while generating larger social and economic benefits. Nevertheless, despite their demonstrated value, informal waste collectors depend on the continued engagement and openness of governments to maintain these arrangements. Following the incorporation of Vejalpur with Ahmedabad Municipal Corporation (AMC), the work was ultimately tendered to a private contractor. This shift reflected a wider preference, in India and elsewhere, for privatized, technology-intensive solutions over informal solutions. To support marginalized informal workers and improve environmental outcomes, however, cities in India and elsewhere should engage with the positive elements of the SEWA initiative to inform future collaborations.

Source: Oates et al., 2018; Oates et al., 2023.

6.4.2 Challenges: trade-offs and competing objectives

Implementing resilience-building infrastructure is not invariably straightforward. In many cases, trade-offs need to be navigated: greater urban density can lower infrastructure development costs, for instance, but potentially increase vulnerability to urban heat island effects. Another key challenge is that the integration of both socioeconomic and climate objectives into infrastructure projects may demand higher upfront costs. This can deter investment, especially in resource-constrained environments where it is often important to have a clear and profitable business case to attract private capital. Public-private partnerships and governance structures can sometimes favour private interests over public welfare. As discussed earlier in this chapter, such projects must also consider equity concerns. Effective community engagement is crucial in this regard, as insufficient involvement can lead to projects that do not align with the needs and desires of local residents. However, communities are themselves not homogeneous and some stakeholders (particularly those with access to more resources) may be more vocal than others.[70]

Combining multiple objectives in infrastructure projects increases complexity and uncertainty. It may be challenging to quantify and measure the success of these projects, making it harder to secure funding and support. Determining the appropriate metrics to evaluate the success of integrated projects can be challenging. Climate resilience and socioeconomic equity indicators may not always align or may require trade-offs. Policy and regulatory barriers may also prevent the optimization of synergies between climate and development goals. When not explicitly aligned and integrated with goals of climate and socioeconomic resilience, a lack of policy coherence can lead to contradictory outcomes.

Integrated infrastructure requires careful urban land use planning to ensure that land use decisions complement the infrastructure's objectives. Poor planning can result in unintended consequences, such as sprawl or increased vulnerability. A more sprawled urban form can make for highly inefficient land use, which tends to drive up costs of infrastructure: by one estimate, up to six times more than infrastructure in more compact urban forms.[71] Where formal land systems cannot keep pace with urban growth, infrastructure provision becomes a greater challenge, but retrofitting infrastructure is both more expensive and socially and technically challenging.

6.5. Transformative Infrastructure

Ensuring that infrastructure is resilient to climate change should be seen as "a means to achieving more resilient societies, rather than an end in itself".[72] As was highlighted in the World Cities Report 2022, "equitable access to urban services is a necessary, but not sufficient condition. Cities must be transformed at a deeper level in their governance and decision-making structures, planning approaches, institutions and priorities of political leaders".[73] Resilient infrastructure can be a vehicle through which to achieve these and other—transformative—human development goals. In this regard, urban infrastructure can be a useful tool for addressing structural vulnerabilities, thereby building equity and social justice.

Transformative infrastructure—the final, and most far-reaching, of the approaches discussed in the introductory framework (6.1.3.)—is frequently derived from rights-based approaches that focus on capacity-building, meaningful participation of the most vulnerable groups, and their access to basic services and key resources, including financing.[74] Infrastructure that addresses the drivers of both climate change and vulnerability, delivered in a way that contributes to broader and positive lasting societal change—for example, by institutionalizing meaningful participation—can be considered transformative.

6.5.1 Integrating the informal sector into city-wide service delivery models

Informal, self-organized or community-based initiatives have the potential to be more participatory than conventional top-down service provision. They often serve populations that might otherwise be marginalized or excluded from formal, regulated service delivery, and many are also low-carbon. For example, scalable, modular and renewable energy technologies reduce the need for larger centralized power stations and grid connections for the fast-growing population of urban households in Africa. The environmental benefits as especially evident when these decentralized solutions displace polluting fuels such as paraffin and charcoal.[75]

At the same time, it is essential to recognize that the informal economy also faces significant challenges and limitations that, if unaddressed, could limit and even reverse infrastructural resilience. Many informal service providers operate outside of formal regulations and standards, which can result in substandard or unsafe infrastructure that may not withstand and could even worsen climate impacts. In addition, informal workers and businesses frequently face challenges in accessing physical and technical resources, such as land, financing and training. They are also likely to be more vulnerable to the adverse effects of climate change than others: their precarious livelihoods, lack of social protection and weak or non-existent health and safety regulations all limit their capacity to respond to shocks such as extreme weather events.

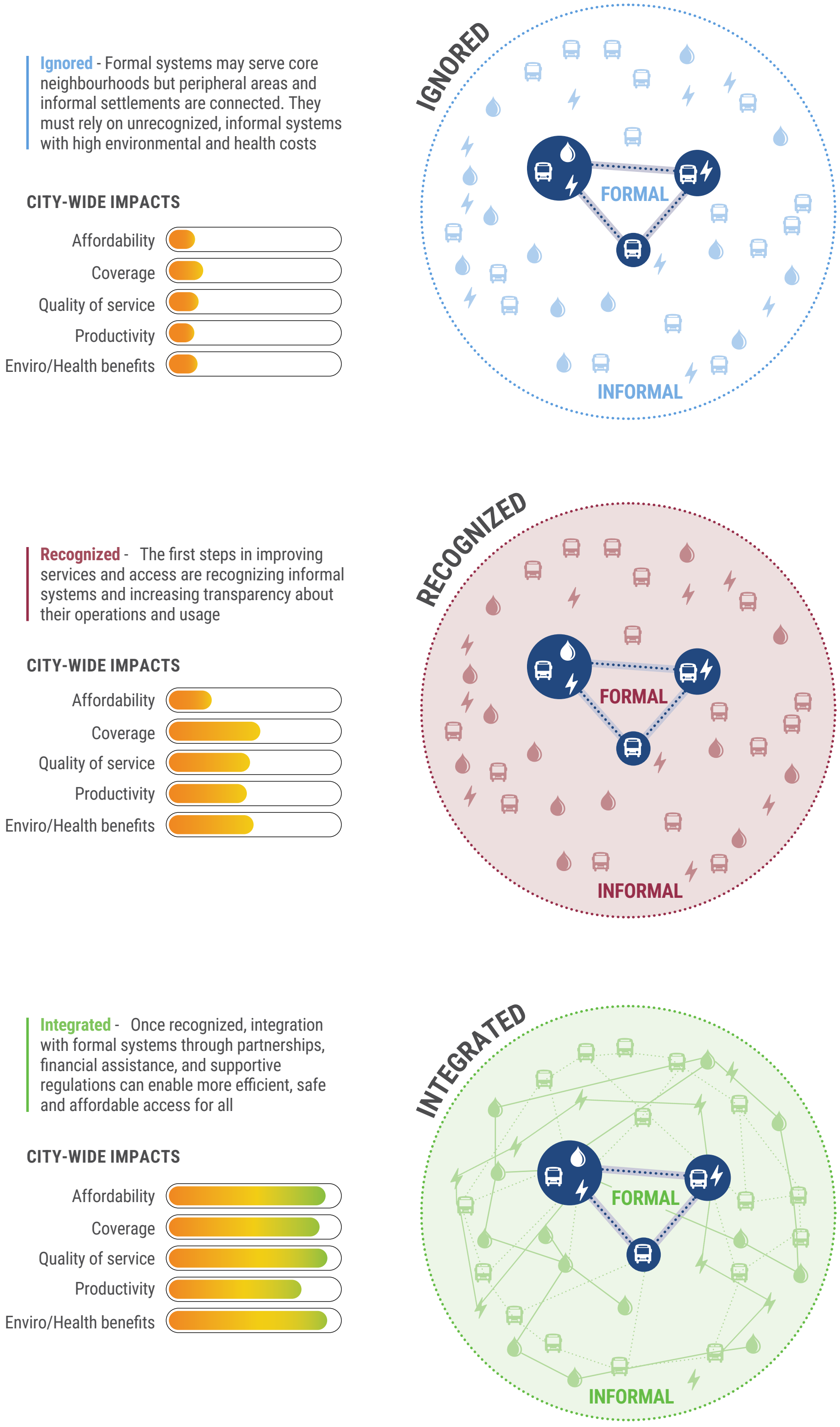
An effective transformative approach will not only focus on integrating informal systems into formal systems but also help address the systemic issues that contribute to their exclusion and poor functioning

While climate-resilient approaches to infrastructure development may seek to identify and incorporate informal systems, an effective transformative approach will not only focus on integrating informal systems into formal systems but also help address the systemic issues that contribute to their exclusion and poor functioning. This includes, in particular, the widespread reluctance of local and national governments to recognize informal operators. However, fostering partnerships with alternative providers can facilitate rapid and cost-effective service delivery to marginalized communities, avoiding the replication of carbon- and capital-intensive Global North development trajectories. Partnerships across sectors, exemplified by initiatives like Slum/Shack Dwellers International federations,[76] empower communities to address collective needs, improve infrastructure and engage with local authorities, which can lead to more substantive and meaningful collaboration.[77] As Figure 6.7 illustrates, the process of including informal service provision in cities begins with their recognition, but ultimately should be fully integrated with formal systems through collaborations, partnerships and institutional support.

Alongside the necessary long-term efforts that focus on enhancing large-scale city-wide infrastructure networks, place-based and decentralized solutions may also prove effective in certain contexts, such as informal settlements or peripheral areas with low population density. To expand access to essential services in an inclusive and climate-resilient way, cities could integrate existing low-carbon alternative service providers into a comprehensive city-wide system—rather than displacing them in favour of formal or conventionally modernist services. Working with local businesses, informal operators and community-based organizations, city authorities could establish regulatory frameworks to ensure basic service quality, safety and affordability for underserved populations. In sectors like transport, water and sanitation, the public sector is ideally positioned for planning and oversight, assisting alternative operators to meet mutually agreed quality standards and regulatory frameworks to ensure accountability and scalability.

Hybrid service delivery models, blending conventional networks with alternative services, can be implemented to cater to diverse income levels and address specific local needs. Particularly in cities with limited resources and capacity, gradual improvements of informal services can enhance productivity and quality without immediate formalization. For example, initiatives such as fleet renewal programs, coupled with institutional support, have succeeded in modernizing and greening informal transport in various cities.[78]

Figure 6.7: Costs of ignoring/benefits of integrating informal sector service providers



Source: Mahendra et al., 2021.

Box 6.4: The transformative impact of streetlights in Jinja, Uganda

Jinja in eastern Uganda is one of five cities included in the Government of Uganda's Transforming the Settlements of the Urban Poor in Uganda (TSUPU) programme. As part of TSUPU, a municipal development forum (MDF) was established in the city, with the intention of bringing together local government, the urban poor and other stakeholders to align urban development priorities.

Together with the National Slum Dwellers Federation of Uganda (NSDFU), the MDF conducted participatory enumeration in the informal settlement of Kibugumbata, home to 6,000 people. The mapping exercise generated discussions about the settlement's challenges with both income generation activities and safety after dark, prompting deliberations on the solar streetlights that were being rolled out in the centre of Jinja. Despite initial reluctance from Jinja Municipal Council (JMC) to implement solar streetlights in a less central location, the MDF was able to earmark 20 solar streetlights for Kibugumbata, with financial contributions from Slum/Shack Dwellers International and JMC itself.

The project spearheaded capacity building for a green transition by training five local youths as solar technicians and led the project installation in March 2018. Since then, local residents report feeling safer, and business owners are able to operate for up to five hours more every day. The solar technicians receive a stipend from JMC for maintaining the streetlights, and have also found work with domestic clients elsewhere in the city. The municipality's willingness to invest in the informal settlement has generated a perceived increase in tenure security.

Cities can maximize the co-benefits of transitions, by looking beyond the environmental aspects of sustainability to trigger wider organizational and institutional change. The spillover effects of the energy transition can go far beyond emissions reductions: linking distributed technologies to new forms of social organization can offer new ways of meeting energy demand, whilst simultaneously empowering marginalized groups and creating meaningful multistakeholder partnerships to tackle urban development challenges. This case is particularly relevant for Ugandan cities since the devolution of service delivery to city authorities has led to irregularities in electricity supply, meaning municipalities must look for new ways to both meet the basic needs of residents and power municipal infrastructure.

Source: Gillard et al., 2019.

6.5.2 Nature-based solutions as a transformative accelerator

Urban infrastructure should of course not generate adverse ecological impacts. This means incorporating the principles of ecosystem protection and restoration into infrastructure provision. Ecosystem-based Adaptation is recognized internationally under the Convention on Biological Diversity (CBD14/5), while the related concept of NbS includes a broader range of approaches. Through the associated social, environmental and economic co-benefits that NbS can generate, up to 115 of the 169 SDG targets can be accelerated.[79] A wide range of NbS to resilience have been implemented, ranging from increasing tree cover and green spaces to address the heat island effect (in Barcelona and Durban), increasing permeable surfaces and wetlands (as in China's sponge cities programme), and mangrove restoration to support coastline regeneration and disaster risk reduction (as seen in Semarang, Indonesia).[80]

Many of these interventions—particularly ones which include community planning and participation—are a common feature in resilient infrastructure, yet when integrated into a broader strategy encompassing complex city-wide ecosystems, they have the potential to be transformative. NbS are also cost-effective. One estimate placed the typical costs for a nature-based intervention on average to be only half the cost of conventional grey infrastructure of the same capacity.[81]

Despite the co-benefits and cost reduction potential, however, only 0.3 per cent of all infrastructure investments is currently aimed at NbS

Despite the co-benefits and cost reduction potential, however, only 0.3 per cent of all infrastructure investments is currently aimed at NbS.[82]

Nature-based infrastructure can also be a vehicle through which to challenge dominant knowledge paradigms and contribute to knowledge diversity. Transformative processes that link scientific, Indigenous, local, practitioner and other forms of knowledge are more effective, sustainable, and contextually appropriate, and are more likely to generate legitimate, relevant and effective climate action.[83] In addition to more conventionally accepted forms of knowledge, philosophies from Indigenous movements like *buen vivir (sumak kawsay)* and *ubuntu* could provide insight into ways to develop more equitable, culturally sensitive and contextually appropriate solutions. They emphasise harmony with nature, community well-being, a holistic understanding of development and collective responsibility. Incorporating these Indigenous knowledge principles into urban infrastructure planning could leverage the capacity of infrastructure to stimulate new social and economic orders, transforming human-nature relations in the

Modern street, green urban sustainable development, bike ways and sponge garden system in modern neighbourhood in Estonian capital city, Tallinn, Estonia © Shutterstock

process. This must go beyond the rhetorical mobilization of Indigenous discourses[84] and instead embrace the possibility of rethinking the relationship between humans, infrastructure and nature. Infrastructure should be seen not as having a single purpose but rather as contributing to a range of social, environmental and economic objectives that represent multiple values.

6.5.3 The value of justice-based approaches to infrastructure implementation

As discussed earlier in this chapter, infrastructure projects can actively harm local populations if imposed without proper consideration of their needs and realities. The intersection of environmental risk and social vulnerability is why resilience-building infrastructure must acknowledge and reflect the variety of challenges that communities, particularly in low-income or informal settlements, face. However, though participation is a crucial and powerful tool, transformative approaches to infrastructure typically go further by adopting a justice-based lens. This approach aims to rectify entrenched social and economic inequalities through infrastructural interventions that not only do not reinforce these issues or even factor them into their development, but actively seek to resolve them by catalysing lasting change.

Transformative approaches to infrastructure typically go further by adopting a justice-based lens

The concept of justice is often used to assess whether policy interventions—whether in the realm of urban development or climate change—are achieving desirable outcomes. Considering different forms of justice is essential when considering the transformational potential of resilient urban infrastructure. The most common framings that are used are distributional and procedural justice or equity. Distributional justice ensures inclusive and sustainable outcomes of an infrastructure project, for example promoting equal access for all stakeholder groups to the infrastructure and the services it offers. Distributional outcomes might also involve a fair and sustainable contribution to climate mitigation or adaptation goals, for example ensuring vulnerable communities have fair access to any services the infrastructure offers, like protection from extreme weather or access to clean energy.

Procedural justice involves inclusive and transparent processes, where all—including marginalized groups—are actively enabled to participate in decision-making.[85] Strong political commitment ensures meaningful involvement in project design and implementation. As well as being more procedurally fair, infrastructure projects that have incorporated diverse viewpoints in design and planning stages tend to better meet community needs, enhance social cohesion, and to be more likely to contribute to climate goals.

More recent analysis has highlighted the significance of other forms of justice when assessing climate change responses.[86] Corrective justice responds to historical wrongdoing and addresses the needs of people who have been negatively affected by actions in the past. In relation to infrastructure, this could include an explicitly "redistributional" agenda in ensuring that under-served groups are prioritized in the provision of new infrastructure. Transitional justice recognizes that policies need to be sequenced over time to achieve desired outcomes (e.g. net-zero emissions) and that the steps towards this also need to be taken in a way that they do not produce less just intermediate outcomes. Finally, recognitional justice[87] expands the focus on procedures to explicitly highlight the historical, cultural, and regional factors and circumstances driving injustice, and the need to recognize these throughout planning and implementation of all urban activities.

Box 6.5: The transformative potential of connecting resilient urban infrastructure to adequate affordable housing

Housing is seldom seen as a core element of urban infrastructure, but is more usually identified and treated as a distinct sector for policies, planning and interventions. Despite this, housing is inevitably and intimately linked with urban infrastructure systems. Decisions made about housing ripple through the broader urban landscape, influencing energy use, transportation patterns, water management, waste generation, community resilience, and overall urban sustainability.

The framework proposed in this chapter for assessing the resilience of infrastructure can also be applied to housing. Poorly built or maintained structures actively detract from the resilience of their residents, increasing their susceptibility to harm from climate-related events. Climate-resistant structures address this direct issue, by providing shelter that can withstand climate impacts—but unless they simultaneously address issues such as accessibility and affordability, they are unlikely to contribute to the overall resilience of inhabitants.

There is also the potential for housing to be transformative: through incorporating sustainability principles (including low-carbon construction and operation) and inclusive design in ways that contribute to broader societal and urban change. Several factors are key:

- *Construction and materials*: the use of robust materials (climate-resistant) and the inclusion of water and energy efficiency features (resilience/transformation).
- *Location*: the positioning of housing in relation to infrastructure and other services, livelihoods, and social networks (contribution to resilience). Housing situation in close proximity to public transit, employment centres and amenities reduces the need for private transportation; while including planning for basic services (water, sanitation, waste management, energy) in settlement design generates efficiencies and improves resilience of households.
- *Urban form*: liveable urban density can improve the efficiency and quality of service provision, leading to more efficient energy use, transportation and delivery of services and hence reducing the overall carbon footprint of urban areas (transformation). Mixed-use development projects enable residents to access essential services and amenities within their communities (transformation).
- *Governance of design and implementation*: engaging residents in the process of planning, design and construction of housing (and associated infrastructure such as disaster / emergency shelters) can ensure that housing meets their specific needs, while also incorporating local knowledge about hazards, vulnerabilities, and responses to these (transformation).

In conclusion, while climate-resistant housing can provide significant protection from the physical impacts of natural disasters and environmental shocks, a transformative approach goes far beyond this. By integrating climate concerns with wider challenges around poverty, social precarity and exclusion, it not only fosters greater resilience but also helps address fundamental inequalities within the housing sector. A great example of housing as a form of climate action can be seen in the La Borda Cooperative Housing project, included in the Case Study Annex of this report.

6.6 Financing Transformative Urban Infrastructure

There is a global deficit in infrastructure, and the way in which this infrastructure is provided and managed will have profound implications for global emissions and resilience. Millions of people, especially in fast-growing cities in low- and middle-income countries, are facing the consequences of substandard infrastructure, often at significant social and economic cost. Though the construction of new urban infrastructure is necessary to meet growing demand, underfunding and poor maintenance of existing infrastructure are also key factors resulting in inadequate electricity, water, sanitation and transport systems.[88]

6.6.1 The business case for investing in transformative urban infrastructure

There are significant opportunities for savings generated by low-carbon cities. Low-carbon urban actions could generate a stream of savings equivalent to US$16.6 trillion by 2050.[89] At the city level, improved and inclusive access to resilient infrastructure can yield cascading benefits for the entire city and even beyond.[90] For example, costs associated with healthcare and lost productivity due to inadequate sanitation are estimated to be around US$223 billion per year.[91] Conversely, every US$1 invested in water and sanitation on average yields an economic return of US$5.5 in time savings, better health and productivity.[92]

One distinctly urban opportunity capitalizes on the concentration of people and land uses in urban areas that enable the compact city-public transport nexus as a tool to lower emissions.[93] Given that the transport

Given that the transport sector represent the fastest-growing source of global emissions, shifting national transport budgets from building road infrastructure to support public transport can have a transformative impact

sector represent the fastest-growing source of global emissions,[94] shifting national transport budgets from building road infrastructure to support public transport can have a transformative impact.[95] While public transit is included a key policy measure in 39 per cent of NDCs,[96] its global take-up has been too low. Unless this changes, transport may remain a key hurdle in efforts to mitigate global warming.[97]

The incremental costs of designing more resilient assets in the power, water and sanitation, and transport sectors are relatively low: the World Bank estimates that these are only 3 per cent greater than overall investment needs. Perhaps more significantly, the same report concludes that investing in more resilient infrastructure is beneficial in almost all scenarios, with every US$1 invested in middle- to upper income countries delivering an average of US$4 in benefits over an infrastructure's entire lifetime. Paradoxically, the expected impacts of climate change mean this investment in resilience is "even more necessary and attractive: on average, it doubles the net benefits from resilience".[98] As Chapter 3 highlighted, data on the location and potential impact of climate hazards is important, as the maximum benefits can be realized if investments are made where they are most needed.

6.6.2 Future needs and costs

Figures on the future costs of infrastructure vary considerably, but there is consensus that current investment is insufficient to meet the demands of constructing new infrastructures and maintaining existing assets. The Coalition for Disaster Resilient Infrastructure estimates the annual investment needed to not only address infrastructure deficits, but also achieve the SDGs and net zero targets by 2050, could be as high as US$9.2 trillion.[99] Other estimates from the World Bank show that developing countries need to invest approximately 4.5 per cent of GDP annually to deliver "ambitious" and "high efficiency" infrastructure in different sectors.[100] In Asia alone, the Asian Development Bank has estimated that US$1.7 trillion needed to be invested annually until 2030 to maintain the region's growth momentum and respond to climate change.[101]

Most of these estimates also stress the significant gap in what is needed to meet demand. According to one calculation, there is an annual global demand for infrastructure investment of US$3.7 trillion, but only US$2.7 trillion is being expended—amounting to an annual "infrastructure gap" of US$1 trillion.[102] The Global Infrastructure Outlook estimates

Box 6.6: Calculating infrastructure returns: Direct, indirect, induced and catalytic impacts

To fully capture the value that transformative infrastructure can bring, whether at the planning phase or during subsequent monitoring and evaluation, it is important to account for all the returns. This means recognizing not only the immediate and readily identifiable benefits it brings, but also the wider ripple effects it may bring to local residents and economies in its wake. According to the World Bank, these can be separated into four broad categories, listed below:

- *Direct impacts*: "those generated by the infrastructure itself, through initial construction and ongoing operations and maintenance of the infrastructure". For instance, the development of the TransMilenio Bus Rapid Transit (BRT) system in Bogotá, Colombia, created thousands of construction jobs, including roles for engineers, construction workers and planners, while ongoing operations provide employment for drivers, maintenance staff, and administrative personnel.
- *Indirect impacts*: these encompass "the employment and economic activity supported by the supply chain impacts following the initial investment in the infrastructure". In the case of the BRT, these include the economic activity generated in the supply chain, such as through the production of buses and the sourcing of construction materials.
- *Induced impacts*: "the knock-on effects of increased household spending of those employed in the direct and indirect jobs, often in the local area but also reaching outside the local catchment". These are seen through the boost in local economies as incomes earned by those employed in direct and indirect roles, leading to increased spending in retail shops, restaurants, and service providers near the BRT lines. In addition, improved access to public transport has enabled more people to access employment opportunities, contributing to higher household incomes and improved living standards.
- *Catalytic impacts:* "where the investment supports longer term changes or spill-over effects which impact productivity in other parts of the economy". These can include significant environmental benefits. The BRT system has reduced traffic congestion and emissions by offering a reliable public transport alternative, leading to better air quality and lower GHG emissions, while also contributing to improved public health outcomes.

Viewed together, these various impacts draw out a picture of complex, mutually interacting benefits that can be characterized as transformative. Urban development around BRT stations has spurred new residential and commercial properties, promoting urban regeneration. The system has reduced travel time, made transportation more accessible and affordable for low-income populations especially, enhancing social equity and inclusion. All these impacts have boosted overall economic productivity by increasing connectivity between businesses and a larger workforce, and by reducing the time and money required for logistics.

Source: World Bank, 2021a.

that a global infrastructure investment of US$93.7 trillion is required between 2016 and 2040 for both new and replacement infrastructure, equivalent to 3.5 per cent of GDP—based on current trends, this is a gap of US$14.0 trillion.[103]

Given these resource constraints, ensuring efficient and cost-effective investments in infrastructure is paramount. Data on expenditure on maintenance are less readily available than that on the construction of new assets, but it is clear that renovating or extending the lifespan of infrastructure assets both saves money and reduces the use of new, virgin materials.[104] For example, in the Netherlands the estimated cost to producers and consumers of an asset failing is ten times that of the cost of repair.[105]

Ensuring access to the necessary funding, particularly in regions where the need is most acute, poses enormous difficulties. In developed countries, debt and equity financing instruments are already being deployed to fund ambitious infrastructure projects. But even financing “business-as-usual” infrastructure is a huge challenge in many parts of the world. While 55 per cent of public investment is undertaken by subnational governments in OECD countries,[106] subnational governments in developing countries face severe barriers in accessing finance due to unreliable intragovernmental transfers, creditworthiness, reliance on intergovernmental transfers, and limited own-source revenue systems (see Chapter 9). Most cities in low- and middle-income countries have lower credit ratings than their national government’s international rating, with the result that commercial investors tend to concentrate urban infrastructure financing in high-income countries.[107] While as much as US$384 billion of climate finance has been invested in urban areas annually, this is barely 8 per cent of what is required globally, with shortfalls especially evident in developing countries in Sub-Saharan Africa and the Middle East and North Africa.[108]

More positive trends can be observed in private investment, such as the observable, albeit slow, shift towards investment in cleaner energy sources. The share of green private investment in infrastructure has increased significantly over the past decade, though there has been a slight dip since 2020, and non-green investments in infrastructure still outweigh those in green infrastructure.[109] There is also strong growth in the use of sustainable instruments such as green bonds and green loans to finance infrastructures.[110]

Financing transformative infrastructure faces many of the same challenges as financing other forms of urban climate action, as is explored in greater detail in Chapter 9. However, the high upfront costs and the long timeframe of many transformative infrastructure projects can further exacerbate these challenges. It is worth noting that a wide range of broader socioeconomic and environmental impacts can accrue over an infrastructure’s lifespan that go beyond the purely financial costs and benefits of infrastructure investment: as illustrated in Box 6.6, these can contribute to transformative urban change. Investment in infrastructure for renewable energy generation alone could lead to more than 38 million new green jobs by 2030.[111] Accounting for these wider impacts can help to better identify possible returns to investment, and can help to build the business case for leveraging private sector finance.

A wide range of broader socioeconomic and environmental impacts can accrue over an infrastructure’s lifespan that go beyond the purely financial costs and benefits of infrastructure investment

6.6.3 Integrating climate resilience and mitigation into asset management

Effective public infrastructure asset management is a key component of resilience infrastructure. It enables governments to increase their financial viability, creditworthiness and public confidence by anticipating future costs, demonstrating accountability for expensive assets and enhancing transparency. Over an infrastructure’s entire lifecycle, upfront investment in infrastructure may only account for 15 to 30 per cent of expenditure, while the remainder is attributable to operations and maintenance.[112] As a result, a long-term approach to infrastructure planning is essential, integrating these various operational costs and updating capital plans throughout the lifecycle.

Sustainable asset management also involves factoring in climate change considerations, ensuring that the construction, operation and maintenance are resilient and do not aggravate its negative impacts. This does not mean that no new infrastructure can be built on account of embodied GHG emissions, but that it should be done in a way that supports transformative change and works to lower climate vulnerability in the long run. It also requires a holistic approach to the range of assets in a city, integrating its physical, engineered systems with its blue-green infrastructures.

It is important, too, to consider how system redundancy can be increased by increasing the diversity of approaches taken to infrastructure service provision, rather than only striving for monolithic technical solutions. Should one component of the system fail, well planned redundancy can minimize disruption of essential services and interlined indirect losses. Infrastructure asset management can integrate considerations of climate resilience by adopting an adaptive approach that allows the original design to be modified over time to address different climate change scenarios: for example, by implementing modular construction methods or even including a plan in case of relocation or abandonment. This may also include adapting existing byelaws, codes, regulations, policies, development plans and operational protocols, such as the mandating of waterproof or heat resistant materials where flooding or wildfires are likely to occur.

There are challenges and trade-offs to this approach, including the lag time between costs and benefits (meaning that the bulk of benefits of increased climate resilience will occur beyond the budget-cycles typically considered by decision-makers), as well as the uncertainty of future climate impacts. While most maintenance in local governments tends to be reactive, this can hinder the building of resilience across an interdependent asset management system. Proactive and preventative asset maintenance can reduce the likelihood of infrastructure failure by strengthening capacity to respond to climate shocks and stresses.

Overall, managing assets with climate resilience in mind can generate a range of benefits, including more reliable service provision, increased asset life and reduced cost.

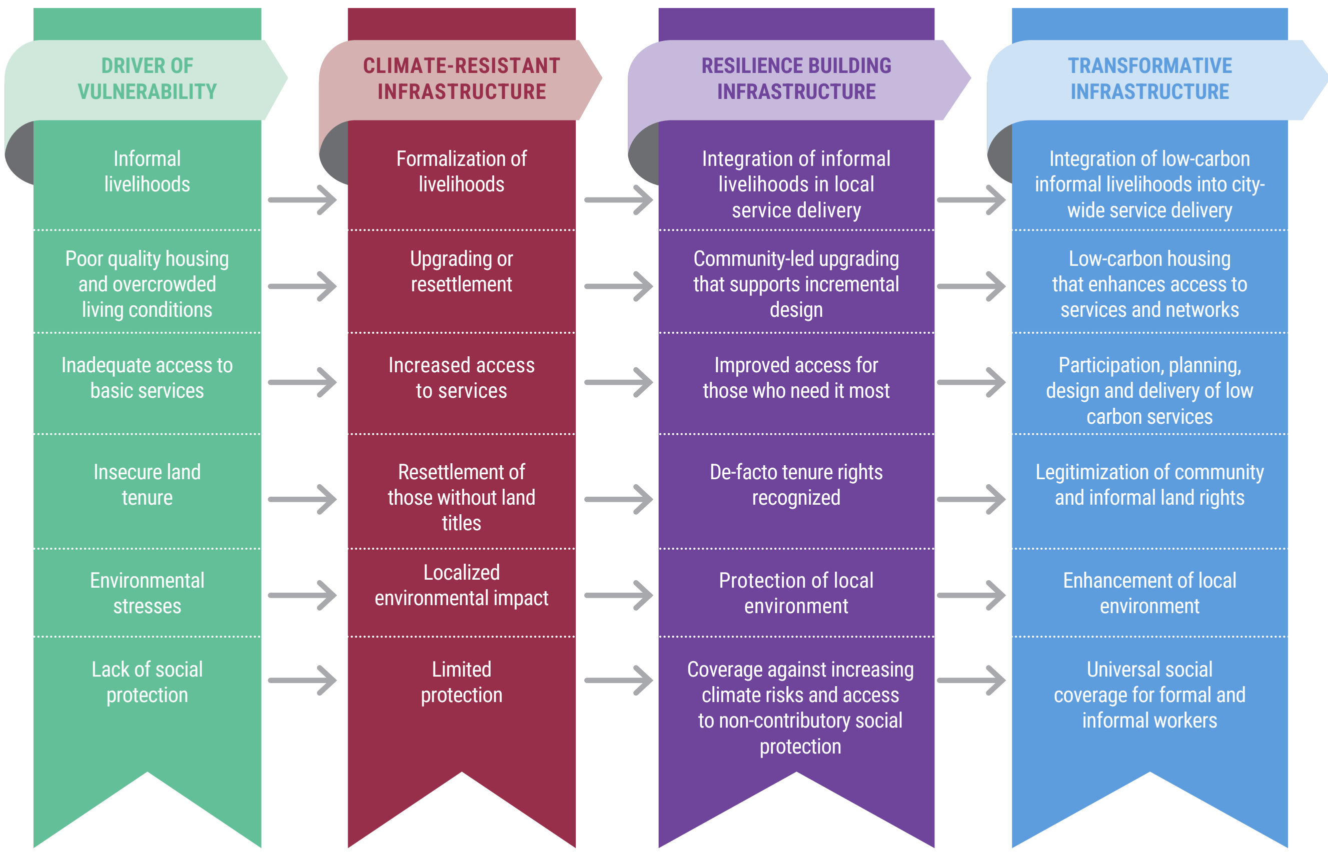
6.7 Policy lessons for Delivering Transformative Infrastructure

Infrastructure plays a fundamental role in shaping the sustainability, prosperity and well-being of cities and their residents. The way in which infrastructure has developed in recent years—whether through formal planning or through informal processes—is a key determinant in the level of risk that cities face from climate change, and the contributions that they make to GHG emissions. Moreover, given the rapid and ongoing growth in infrastructure and the associated transformation of the built environment, patterns of infrastructural development in the coming years and decades will be among the main factors shaping the extent to which effective climate action can take place.

This chapter has so far identified three components of climate responsive infrastructure: namely, infrastructure that is *climate-resistant*, infrastructure that contributes to *resilience*, and infrastructure that is *transformative*. These roles of infrastructure are in many ways successive, in the sense that it is difficult to realize transformative infrastructure without it also being climate-resistant and contributing to building resilience. This concluding section offers action-oriented policy guidance that can enable local governments to achieve transformative infrastructure. The framework demonstrates that meaningful activities can be taken in all urban settings, and that these can range from initial starting points to more advanced and ambitious plans and programmes.

Perhaps the most important conclusion from this analysis is that approaches to infrastructure that accelerate effective climate action in cities do not need to be undertaken sequentially. Indeed, it may be possible for cities which currently lack "resilient urban infrastructure" to consider the development of infrastructure in ways that immediately achieves more transformative goals. The frameworks of city-wide service delivery and NbS demonstrate how transformative approaches to infrastructure can address basic human needs, urban economic priorities and the imperatives of climate change even in resource-constrained settings. Finally, the specific examples around livelihoods, housing, social protection and local environmental actions show how this can be implemented in ways that achieve people-centred climate action in cities.

Figure 6.8: Main drivers of climate vulnerability and the ways these are addressed by different types of resilient infrastructure



6.7.1 Pathways towards transformative infrastructure

Integrate low-carbon informal livelihoods into city-wide service provision models. By recognizing and incorporating the diverse economic activities of informal workers into the broader urban fabric, cities can harness their potential to contribute to sustainability goals while *enhancing their own resilience*. This integration into city-wide systems can expand access to essential services, ensuring quality, safety and affordability while supporting the livelihoods of marginalized communities. Partnerships between city governments and informal communities can facilitate more rapid and efficient infrastructure improvements, at the same time creating jobs and supporting local economic development.

Integrated service delivery models can be realized by supporting and regulating localized, on-site infrastructure solutions and ensuring the cost of these is not borne by vulnerable communities. This can be achieved through the provision of direct fiscal support, such as by offering subsidies or tax breaks to local initiatives or paying for community/household connections to central systems. Non-fiscal support can be equally valuable, such as providing land or premises, equipment, training, and technical and business expertise to service providers who are contributing to resilience-building activities. In addition, the reform of procurement procedures can ensure that informal and community-based actors who are contributing to sustainable service delivery are able to participate in tender processes.

Promote low-carbon, culturally appropriate housing that enhances residents' access to urban services and social networks. Traditional, vernacular and informal forms of housing are often already low-carbon and adaptive to prevailing climatic conditions in a way that is *climate-resistant*. Prioritizing sustainable and, where appropriate, vernacular building practices can deliver housing solutions that both respond to the needs of residents and reduce carbon emissions.[113] Such housing initiatives enhance the quality of life for residents whilst *contributing to the overall resilience* of urban communities. Adopting supportive building codes and standards can help guide people and construction companies towards more sustainable options. To ensure building codes remain accessible and affordable to low-income residents, it is important to leverage local knowledge systems. To be truly *transformative*, scientific, Indigenous, local, and practitioner knowledge in resilience-building processes should be used to develop contextually appropriate and sustainable solutions, and building regulation.

Facilitate participation in the planning, design and delivery of low-carbon service models. Encouraging community-led service provision models and other forms of participation in the planning, design and delivery of low-carbon service models empowers communities to shape their own urban environments and adapt to the challenges of climate change. By meaningfully involving residents—including representatives from all relevant stakeholder groups, such as formal and informal workers, women and men, youth, people with disabilities, migrants, people from different religious backgrounds—in decision-making processes, cities can leverage local knowledge and expertise to develop innovative infrastructure solutions that builds resilience of diverse populations.

Rights-based, participatory approaches generally lead to more successful infrastructure outcomes. They should be part of wider efforts to improve the inclusivity and efficacy of governance structures, including by encouraging inter-agency cooperation and collaboration to enhance policy coherence. These activities should be accompanied by adequate fiscal transfers to, and technical support for, local governments and other actors involved in infrastructure delivery processes, particularly in informal settlements. Governments should establish mechanisms for continuous community involvement, feedback and decision-making throughout the infrastructure lifecycle.

Leverage inclusive land use planning, including through the recognition of informal and communal land rights. Cities can improve access to basic services for marginalized communities by recognizing customary tenure and the rights of informal settlements and communal land users, thereby both reducing their vulnerability to climate change impacts and increasing their right to the city. This can both strengthen social cohesion and facilitate greater investment in sustainable infrastructure and services, for example by increasing the ability of residents to make changes that advance mitigation and adaptation action.[114] Such recognition and integrating is a critical enabling factor for developing integrated urban land use plans that *build resilience* by complementing infrastructure objectives and prevent unintended consequences such as urban sprawl. Inclusive and effective land use planning can also help unlock access to sustainable and innovative financing mechanisms such as land value capture.

Minimize exposure to climate exposure through land use planning that avoids or discourages development in high-risk areas such as floodplains and coastal zones. Zoning regulations and incentives can help to identify priorities, for example by designating areas for green space and highlighting areas that are especially vulnerable to climate risk. Infrastructure investment should be prioritized in marginalized areas. Where informal settlements are located in low-risk conditions, in-situ upgrading can be carried out to simultaneously enhance the security of tenure, increase access to basic services and amenities, and reduce inequality. *Transformative* upgrading programmes must be part of integrated urban land use plans that complement infrastructure objectives and prevent unintended negative consequences such as urban sprawl, particularly in fast-growing cities. Such integrated land use planning can only reach its maximum potential when governments at all levels strive for policy coherence by aligning climate resilience and socioeconomic equity goals across different levels of government and sectors.

Prioritizing blue-green infrastructure and eco-system-based adaptation enhances local environments and contributes to global sustainability goals. By prioritizing blue-green infrastructure and eco-system-based adaptation, cities can improve air and water quality, mitigate the urban heat island effect, enhance biodiversity, and reduce vulnerability to flooding. Urban infrastructure that offers new forms of relationships between humans and nature can be achieved by integrating diverse forms of knowledge including scientific, Indigenous, local, and practitioner knowledge. Doing this in a *transformative* way that ensures all urban dwellers have access to these facilities and the services they offer—for example, by ensuring local communities are involved in the planning and delivery of nature-based infrastructures—can benefit local residents by providing recreational and ecological amenities. A lack of community participation in the implementation of NbS can lead to technocratic pitfalls and *erode* resilience. Incorporating blue-green infrastructure into the upgrading of informal settlements, as well as into wider urban development, can enhance socio-cultural connections and deliver environmental and economic benefits that support local livelihoods.[115] Alignment of infrastructure development with the goals set out in global agendas, including the SDGs and the NUA, will help to achieve global sustainability objectives, such as the reduction of GHG emissions and the conservation of natural resources.

Provide protection against existing climate risks through access to universal social coverage for formal and informal workers. Labour rights, healthcare, housing benefits, income support and other forms of soft infrastructure ensure that all residents, regardless of their formal employment status, have the resources and support they need to withstand and recover from climate impacts. In addition to centralized funding, this can be done by supporting initiatives that bring together low-income urban residents in savings groups, federations and other associations that empower communities in addressing their collective needs. Including considerations around accessible social protection for informal and formal workers in infrastructure service provision enhances the adaptive capacity of urban communities. These protections are essential components for meeting any sustainable development goals.[116]

Conduct risk assessments that include different forms of justice. As highlighted in Chapter 3, making infrastructure *climate-resistant* requires comprehensive risk assessments that consider the interaction between climate hazards, asset locations and vulnerabilities, which may use advanced data analytics and modelling to identify potential impacts of climate change on urban infrastructure, accounting for both current and future conditions. Such risk assessments can help *build resilience* by guiding effective disaster response mechanisms that include evacuation plans, emergency shelters, and rapid deployment of resources during and after extreme events. These risk assessments and disaster risk assessment can become increasingly advanced and nuanced, by integrating the principles of just transitions into urban infrastructure projects, ensuring that they support both social justice and environmental sustainability. Risk assessments based on the principles of just transitions can be *transformative* if they help to inform decisions about prioritization of infrastructure for communities that have been negatively affected by urban development processes.

Monitor and evaluate performance. A fundamental component to ensure infrastructure is *climate-resistant*, but also *builds wider resilience,* is to establish systems for ongoing monitoring and evaluation of infrastructure performance under climate stressors. Monitoring needs to inform continuously improvements to infrastructure resilience through regular preventative (as well as reactionary) maintenance that ensures it is adaptive to changing conditions. To measure the way in which infrastructure contributes to wider community resilience, it is important that metrics and indicators are set up that are able to capture these impacts. Infrastructure that *builds resilience* and *is transformative* can have higher upfront costs than infrastructure that is merely climate-resistant, so the societal benefits of resilience-building and transformative infrastructure need be well accounted for, to make evident why the higher upfront costs are justified. This requires a reconsideration from infrastructure as an engineering question, to a societal and environmental one, which requires that engineers and planners liaise with and work in close collaboration with other disciplines.[117]

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Micromobility in Warsaw, Poland © Shutterstock

Chapter 7:

Multi-level Governance for Inclusive Climate Action

Quick facts

1. Addressing the climate crisis calls for a "whole of society" approach, requiring the participation and collaboration of multiple layers of authority and cooperation across different jurisdictions.

2. There is an urgent need to develop and strengthen the capacities of local and regional governments to implement climate solutions, particularly in developing countries.

3. Networked, bottom-up movements led by cities are increasingly playing a key role in global climate governance.

4. Hybrid governance approaches, characterized by multi-stakeholder and cross-sectoral collaboration, offer a powerful alternative to conventional top-down approaches to climate action.

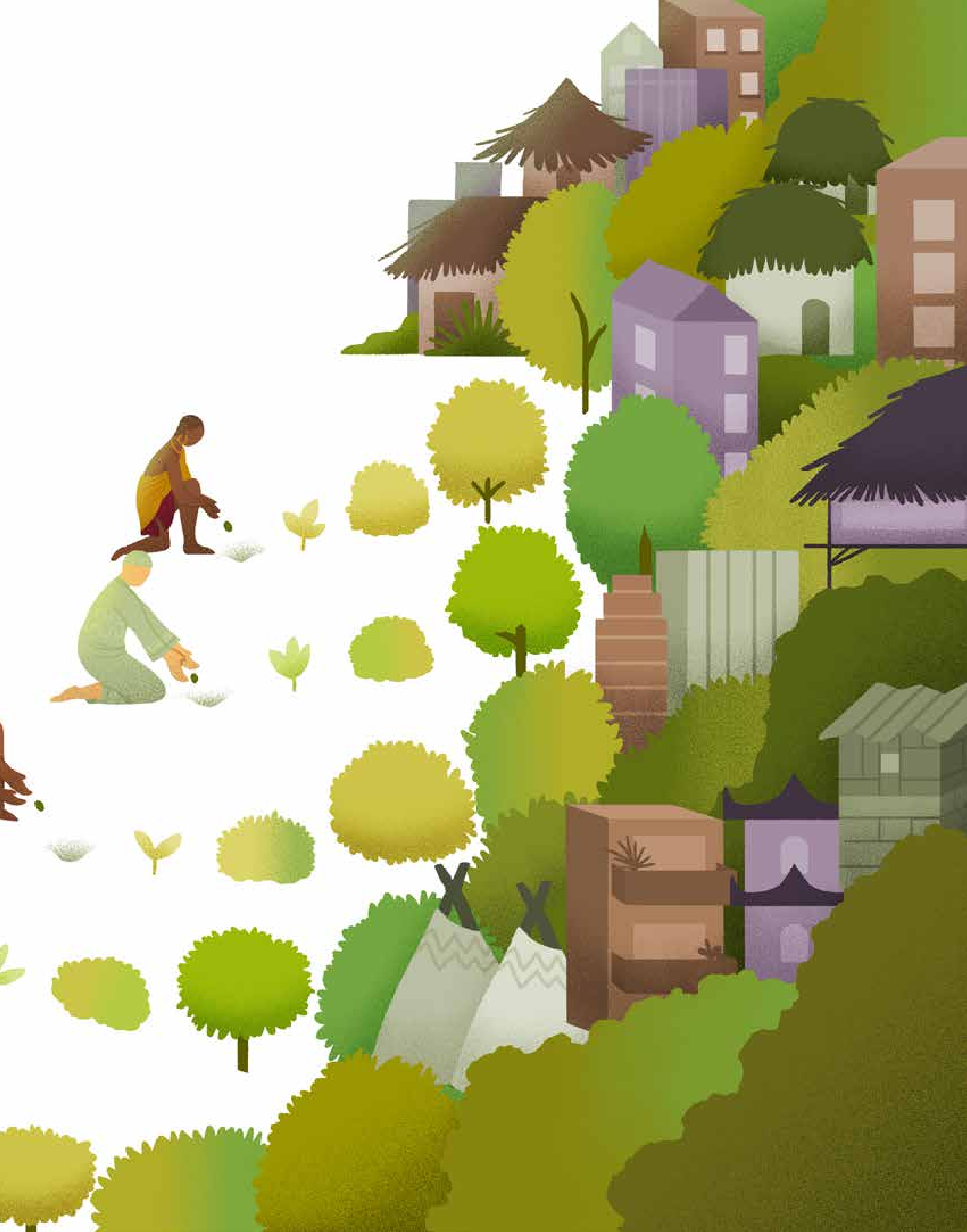
Policy points

1. Effective climate action requires multi-level governance and collaboration across different scales.

2. Localization of Sustainable Development Goals, including Goal 13 ensures that the global development agenda is not just a set of distant goals, but an implementable framework that is impactful at the local level.

3. To unlock the transformative potential of locally-led climate action, increasing local capabilities to facilitate and manage adaptation initiatives is vital.

4. Strengthening the co-existence of formal and informal governance systems offers valuable opportunities to accelerate climate action.



The world is teetering at a point of no return: in the words of the United Nations (UN) Secretary-General, “the battle for 1.5ºC will be won or lost in the 2020s – under the watch of leaders today”.[1] Whilst the previous chapters have underscored the important role of cities to potentially mobilize strong and ambitious climate action, all this depends on decisions taken by policymakers to spur action at various levels of governance. Climate change is indeed a global emergency that requires international cooperation and coordinated solutions at all levels.[2] Yet, stuck in a rut of inaction in the face of this emergency, the global community is still grappling with ways to convince various levels of governments to make the climate crisis a priority.

UN Member States have called for the widest cooperation and participation of all countries in an effective and appropriate international response to climate change.[3] Increasingly, there are calls for urgent and concerted international effort to make good on commitments made at various UN Framework Convention on Climate Change (UNFCCC) Conference of Party (COP) meetings. However, much still needs to be done to get to the point where the threat of climate change has been adequately addressed. For this to happen, governments should not only make greater commitments with respect to their Nationally Determined Contributions (NDCs), but also work with cities to achieve more ambitious targets.

Indeed, Sustainable Development Goal 13 (SDG 13) focuses on combating climate change and its impacts, calling for urgent action to mitigate climate risks, enhance adaptive capacity and integrate climate measures into national policies, strategies and planning. While the previous chapters have underscored that cities are the arenas for this climate battle, achieving SDG 13 requires coordinated efforts across various levels of governance. Further, as climate change is a complex and multifaceted issue that transcends borders and sectors, the concept of multi-level governance becomes essential in this context, involving multiple layers of authority: from international and national bodies to local and regional governments, as well as civil society and communities, among other stakeholders.

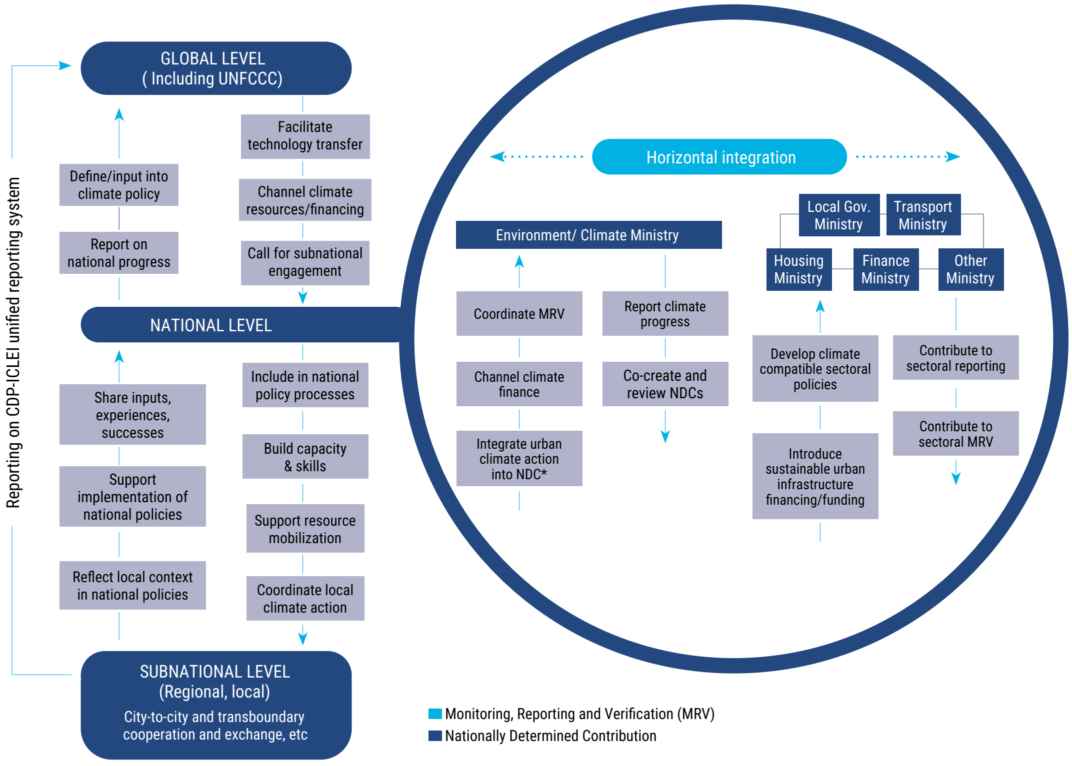
It is against this backdrop that this chapter explores the role of multi-level governance in achieving SDG 13, emphasizing the significance of multilateralism. It examines how different levels of governance interact, the importance of cooperation among countries and local governments, and the ways in which multilateralism can enhance climate action. Through the lens of multi-level governance, this chapter highlights the interconnectedness of global, national and local efforts in addressing climate change and achieving sustainable development. Lastly, the chapter explores how governance, through modes of co-production with relevant stakeholders, can facilitate climate-resilient services in urban areas.

7.1 Understanding Multi-level Governance and Its Relevance to Climate Action

The concept of multi-level governance, which emphasizes “the connections between vertical tiers of government and horizontally organized forms of governance”, offers a valuable framework for understanding how environmental problems are governed both within and across different scales.[4] This system encompasses diverse actors who represent different forms of authority and competencies. In the context of climate adaptation and mitigation, decision-making processes have been dispersed upward to international organizations and transnational networks, downward to cities and regions and outward to non-state actors. The vertical dimension of multi-level governance recognizes that national governments cannot effectively implement national climate strategies without working closely with regional and local governments as frontline drivers of change. Cities, in turn, are integrated into national political administrative systems: for better or worse, these shape the ability of local governments to act on climate change. In the horizontal dimension, connections are forged between different ministries and sectoral agencies (such as housing, transport and the environment). Transnational city networks—such as C40 Cities, Local Governments for Sustainability (ICLEI), United Cities and Local Governments (UCLG) and US Mayors Climate Protection, among others—are also important in strengthening horizontal connections, supporting local governments in their efforts to address climate change.[5] Figure 7.1 illustrates the vertical and horizontal dimensions of multi-level governance for climate change.

Clean up following hurricanes Helene and Milton, Treasure Island, Florida USA. © Shutterstock

Figure 7.1: The vertical and horizontal dimensions of multi-level governance for climate change



Source: UN-Habitat, 2022g.

As Figure 7.1 clearly demonstrates, even though the climate battle will be won or lost in cities, the climate emergency cannot be effectively addressed by cities alone. At the same time, climate change is not solely a national issue, but a challenge that requires cooperation across different jurisdictions and sectors. The complexity of the climate crisis and its multidimensional social, economic, political and environmental implications calls for a well-coordinated response across scales (Chapter 2), tackling social vulnerabilities (Chapter 4), investing in resilient infrastructure (Chapter 6), fostering innovation (Chapter 8) and supported by adequate financing (Chapter 9). Battling climate change requires significant resources, political will and technical capacities from the global to national and subnational levels.[6]

7.1.1 The complexity of climate change and the need for multi-level governance

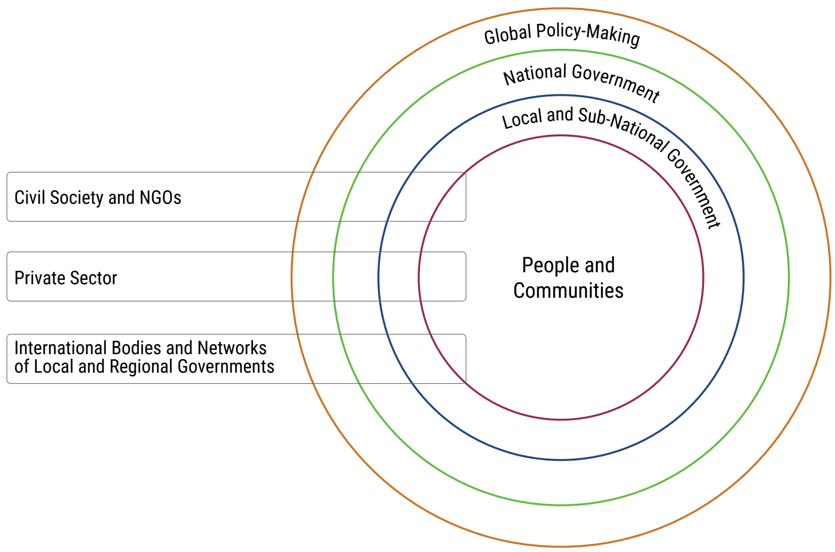
Climate change presents a unique challenge due to its global nature, requiring responses at various levels. Global warming, rising sea levels and extreme weather events affect countries differently, necessitating tailored strategies at the national and subnational levels. At the same time, international cooperation is crucial for setting common goals, sharing resources and addressing transboundary issues. Given that the impacts of climate change transcends jurisdictional boundaries, no single stakeholder and no single level of government can keep the Paris Agreement target of a 1.5°C increase within reach alone.

Even though the climate battle will be won or lost in cities, the climate emergency cannot be effectively addressed by cities alone

As illustrated in Figure 7.2, there are complex interactions and relationships among various actors involved in climate governance—from international bodies to national, subnational and local governments and their networks, as well as civil society, the private sector (Chapter 2) and financial institutions (Chapter 9), all of whom play pivotal roles in climate governance. As highlighted in Chapters 2 and Chapter 8, the private sector can be a valuable source of expertise, innovation and resources under multi-level governance approaches for supporting urban climate interventions. Private sector actors, including multinational corporations and industry associations, influence climate policy through lobbying and the adoption of sustainable practices. These entities interact with governments at all levels with respect to regulatory compliance. Non-governmental organizations (NGOs) and civil society organizations play a vital "watchdog" role, advocating national governments and multilateral processes for better climate policies while shaping public opinion. These organizations engage with all levels of government to ensure accountability and promote sustainable practices.

As discussed in the next sections of this chapter, networks of local and subnational governments advocate on behalf of their members in international processes and collaborate with research institutions to conduct studies and share best practices. These networks play a critical role in aligning policies and providing support across different levels of government, ensuring a cohesive approach to climate governance as well as advocacy through multilateral processes. Understanding these relationships is key to creating and implementing effective people-centred climate policies and measures.

Figure 7.2: A "whole of society" approach toward people-centred climate action



Notes:

- Climate change science should inform action.
- International financial architecture should enable people-centred climate action.
- Coordination and integration through both formal and informal processes is key to effective climate action.

7.1.2 The role of national governments in multi-level governance

Multilateral processes, mainly driven by the United Nations Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC), play a central role in shaping global climate policy. They influence national governments by providing policy guidelines to follow through with decisions, scientific assessments and technical support. National governments, in turn, are pivotal in implementing their internationally agreed climate goals through national policies by crafting their NDCs. National governments are also responsible for translating international guidelines into actionable policies, which—when including local and subnational governments in their design as a key lever—can then be implemented effectively at the city level. National legislative bodies then formulate regulations that enforce these policies across all territories. National governments also have the mandate to regulate the private sector to ensure compliance and foster sustainable practices.

The existence of national regulation has a significant impact on local climate planning. Cities in Denmark, France, Slovakia and the UK, where local climate plans are compulsory, are about 1.8 times more likely to have a mitigation plan, and five times more likely to have an adaptation plan, compared to cities in other countries where it is not mandatory.[7] In Slovakia, for example, local authorities are required to develop Action Plans for Sustainable Energy, such as the *Akčný plán trvalo udržateľnej energie mesta Nitra do roku* 2020 (Action Plan for Sustainable Energy of the City of Nitra until 2020). These strategic framework documents focus on climate change mitigation efforts: the mandate for their creation is established by the National Energy Policy and the National Framework and Energy Strategy of the Slovak Republic.[8] In some cities, climate policies are not solely the product of national or international requirements (i.e. top-down). Helsinki, for instance, has been proactive in initiating and developing its own climate agendas.[9]

Adequate financing for adaptation actions such as early warning systems, disaster response and recovery systems, and adaptive social protection is also urgently needed (Chapter 9). As illustrated in Figure 7.1, national governments have a key role to play in the mobilization as well as the allocation of resources for climate adaptation and mitigation. However, this must be in coordination with other levels of governments—as the complexity and scope of climate change require the involvement of local and regional governments, particularly given their proximity to the communities and ecosystems most affected. It is thus imperative that national policies are integrated with local actions and regional strategies. Moreover, in emergencies, for instance, the coordination advantage of centralization can diminish and needs to be complemented by more agile mechanisms that empower decentralized government entities.[10]

Complexity and scope of climate change require the involvement of local and regional governments, particularly given their proximity to the communities and ecosystems most affected

Through national emergency funds, however, the national governments can act as a guarantor of safety during climate crises by internalizing the knowledge in territorial inequalities when a rapid response is needed. At the same time, financing a pool of aggregated projects through clearinghouses managed by networks of local and subnational governments could also serve as a lever to mitigate financial risks. This could ensure effective allocation of financial resources to support grassroots climate initiatives, making local and subnational governments essential actors in the overall climate governance framework. All in all, the differentiated capacities to respond to such a global responsibility through a subsidiarity scheme must be recognized.

7.1.3 The role of local and regional governments in climate action

Local and regional governments are at the forefront of climate action. As they are directly responsible for implementing many of the policies and measures needed to achieve SDG 13, local and regional governments are the most appropriate arena in which climate action should be implemented for different reasons. First, as highlighted in previous chapters of this report, cities are significant contributors of greenhouse gas (GHG) emissions and high energy consumption. Consequently, they have a great responsibility to engage in climate mitigation and adaptation—but also, with the right policies in place, the potential to deliver transformative change in both these areas.[11]

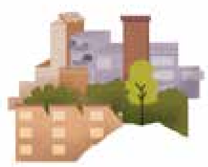
Second, local and regional governments facilitate action in response to climate change by fostering partnerships with relevant stakeholders, encouraging public participation, and lobbying national governments. They work closely with NGOs and civil society organizations to implement projects and educate communities about climate action. In the same vein, local governments leverage their networks for knowledge dissemination and collaboration: in the United Kingdom (UK), for instance, UK100—a consortium of local representatives committed to achieving net zero by 2050—is providing cities with a platform to exchange experiences on their green transition activities and lobby the national government to allocate more resources to achieve this.[12]

Third, some local governments have gained considerable experience in addressing environmental problems, particularly in energy management, transportation, waste management, disaster risk reduction and urban planning (see Chapter 5). Through climate action plans, they manage these critical areas that have significant implications for climate change mitigation and adaptation. In the OECD, for instance, local and regional governments oversee almost two-thirds (64 per cent) of environment- and climate-related public investment.[13] Local and subnational governments play a critical role in bridging the gap between national policies and local implementation, often in innovative ways: they adapt national guidelines to fit regional and local contexts, ensure policy alignment across different levels of government, and enforce these policies within their jurisdictions. On the front lines of climate action, these governments engage with communities, enforce local regulations that align with higher-level policies, and drive local climate initiatives.

Urban planning and climate resilience

Within the vertical dimension of multi-level governance, local governments play a central role in planning for urban climate resilience, thereby contributing to SDG 11 (inclusive, resilient and sustainable cities). Cities are "at the interface of local action and national and international level climate change adaptation and mitigation commitments".[14] As elaborated in Chapter 5 of this Report, local governments have a direct influence on building climate adaptive cities when they make intentional decisions to mainstream climate change into their city plans. However, there are significant discrepancies in the ability of local and regional governments in developed and developing countries to integrate climate resilience into urban planning frameworks (see Chapter 5). Cities in developed countries often have a well-established track record of incorporating climate considerations into their urban planning processes. These cities have integrated strategies that address both mitigation and adaptation measures, leveraging advanced technologies, robust financial resources and extensive institutional capacities to build resilient urban environments.[15]

In contrast, cities in developing countries face numerous challenges in embedding climate resilience within their urban planning frameworks. In developing countries, some spatial strategies have limited actions to address climate change, and fail to integrate its implications into planning processes effectively. These challenges stem from limited financial resources, inadequate technical expertise, and often fragmented institutional structures. As a result, the capacity of these cities to systematically address climate risks and integrate resilience measures into urban planning is significantly constrained. Additionally, the lack of data, weak governance structures and competing development priorities further hinder their ability to implement comprehensive climate strategies. Moreover, most local governments in developing countries lack devolved power and authority,[16] which can limit their capacity to innovate.



Local governments have a direct influence on building climate adaptive cities when they make intentional decisions to mainstream climate change into their city plans

At the same time, the potential for climate action at the city level is often overlooked, with a focus on national and supranational scales dominating.[17] Therefore, within the multilateral framework, this centralization of authority can lead to a disconnect between the needs and potential of cities and the broader national and state-level policies. Additionally, the focus on national and supranational scales often overshadows the significant role that cities can play in climate action. Therefore, it is important to strengthen multi-level collaboration and ensure that climate action is delivered at different scales through the involvement of all levels of government.

It is important to strengthen multi-level collaboration and ensure that climate action is delivered at different scales through the involvement of all levels of government

This includes strengthening collaboration between local, state and federal governments, and this could be achieved through the establishment of intergovernmental task forces or committees that bring together representatives from different levels of government to develop and implement coordinated climate action plans. UN-Habitat champions collaborative climate governance as it "leads to more effective, longer-lasting solutions towards a low-carbon and climate-resilient future."[18] The Coalition for Urban Transitions also notes that transition to zero-carbon cities depends on meaningful partnerships among different tiers of government, with national governments actively enabling and supporting climate action at the local level.[19] In this regard, it is important to note that initiatives such as Coalition for High Ambition Multi-level Partnerships (CHAMP) for climate action have emerged in recent years to enhance cooperation between national and subnational governments.

However, there is also an urgent need to develop and strengthen the capacities of local and regional governments to implement climate solutions, especially in developing countries. Too often solutions to address the challenges associated with climate change are proposed, but the follow through in terms of implementable action is missing or non-existent because of the absence of the required capacity or technical knowhow to implement such solutions. For example, policy proposals relating to compact cities should be made with due consideration of the technical ability on the ground for implementation. In many cities, this may require retrofitting of existing land use, changes in planning regulations and the adoption of mixed land uses: all this has the potential to cause significant disruptions, particularly in contexts where local authorities lack the expertise to undertake these activities themselves.

Additionally, local and regional governments' role in urban planning and fostering climate resilience faces considerable financial barriers. As discussed in Chapter 9, these levels of government face several barriers in accessing urban climate finance: regulatory and policy barriers; project preparation barriers; and implementation and financing barriers. They need to access predictable funding flows for local climate projects and be recognized by international financial institutions as worthy of credit or subsidies. As mentioned above, national and subnational governments could work together to establish risk-sharing mechanisms to mitigate financial risks on projects.

Disaster risk reduction and adaptation

As articulated in Chapter 3 of this Report, disaster risk reduction, resilience building and disaster preparedness are at the core of socioeconomic development. Local governments are often the first responders to climate-related disasters, such as floods, storms and heatwaves. They play a crucial role in disaster risk reduction by implementing early warning systems, building resilient infrastructure as well as supporting vulnerable communities. Many local governments have already undertaken comprehensive vulnerability assessments and established mitigation and adaptation strategies, including early warning systems for floods, landslips and droughts.[20]

Local and regional governments, as key players within the multi-level governance framework, possess significant opportunities to influence disaster risk reduction, accelerate disaster response and enhance recovery efforts. Through their control over land use planning, building codes and regulations, these governments can reduce exposure to hazards and ensure that new developments are resilient to potential disasters. As discussed in Chapter 5, enforcing stringent building codes in flood-prone areas can prevent the construction of vulnerable structures, while promoting the use of flood-resistant materials can mitigate the impact of flooding on existing buildings.

Moreover, local governments have the responsibility to conduct regular risk assessments, monitor environmental conditions and establish robust early warning systems. These systems are essential for detecting early signs of disasters, such as rising river levels or the likelihood of landslides, and communicating these risks to the public. By doing so, local governments can facilitate timely evacuations and other preventive measures, thereby reducing the potential for loss of life and property in the face of climate hazards.

Local governments, often the first responders to climate-induced disasters, play a crucial role through their local civil protection offices. They often lead efforts in declaring climate emergencies, making executive decisions in areas where they possess fuller control, as well as providing important information in support of greater intervention by higher levels of governments.[21] In the same vein, as climate change and natural disasters do not stop at administrative boundaries, regional governments, with their broader jurisdictions, are well-positioned to coordinate climate action across multiple municipalities. This coordination is vital for addressing transboundary risks and issues that cross administrative boundaries, such as watershed management, air quality and regional transportation networks.

First responders in a flooded residential area. © Shutterstock

Even though the principle of subsidiarity is still valid and valuable, some decisions are most effectively implemented at a regional or metropolitan level when the scale of the action requires a degree of coordination to ensure consistency and harmonization.[22] As observed during the COVID-19 pandemic, the risk of fragmentation of public policies significantly increases with ad-hoc decision-making at the local level, as opposed to coordinated approaches across jurisdictions.[23] By working together, local and regional governments can develop integrated strategies that address the unique challenges of their areas while contributing to national and global climate goals.

7.2 Multilateralism in Climate Governance

Effective and inclusive multilateralism, supported by transparent and accountable institutions, can facilitate more coherent and comprehensive responses to global challenges.[24] In the context of climate change, multilateralism has been integral to the establishment of global agreements, setting standards, and facilitating the flow of finance, technology and knowledge. The global nature of this emergency calls for its effective global governance, and the existing multilateral agreements have been a step in unlocking this governance.

7.2.1 The role of multilateral institutions

At present, within the UN system and outside, several bodies work on climate change. Within the UN system, as highlighted in previous sections and Chapter 2, UNFCCC's COPs are the leading global forums for multilateral discussion of climate change matters. Other UN System bodies leading the work on climate change include IPCC, the UN Environment Programme (UNEP), Green Climate Fund (CGF), the UN Office for Disaster Risk Reduction (UNDRR) and the World Meteorological Organization (WMO), among others. Besides the UN, and as discussed in the next sections, international city networks such as C40 Cities are playing a leading role through networked urban climate action, while the Global Commission on Adaptation (GCA) is catalyzing adaptation efforts across the world. The UNFCCC, GCA and the IPCC, for example, serve as platforms to accelerate, coordinate and support climate adaptation initiatives by providing scientific assessments, policy recommendations and strategic frameworks that guide international and national actions.[25]

UN-Habitat has been active in multilateral engagement and international cooperation on a range of urban and housing issues, including the localization of the SDGs. Through its Cities and Climate Change Initiative, for instance, UN-Habitat has been supporting cities in emerging and developing countries to address climate change. Concurrently, in the face of current global crises, UN-Habitat has been championing inclusive and effective multilateralism as a lever to realize urban resilience. At the Second Session of the UN-Habitat Assembly in 2023, the Ministerial Declaration titled *A Sustainable Urban Future through Inclusive and Effective Multilateralism: Achieving the Sustainable Development Goals in Times of Global Crisis,* countries reaffirmed their commitment to the New Urban Agenda (NUA) and its implementation plan and endorsed the role of UN-Habitat as the United Nations' focal point for sustainable urbanization and human settlements.[26]

Cities and regions around the world are increasingly engaging in multilateral initiatives to advocate for stronger climate action

Besides UN-Habitat, and aforementioned bodies leading work on climate change within the UN System, various other UN agencies and international organizations such as the World Bank Group, and philanthropic organizations like the Bloomberg Philanthropies and the Bill and Melinda Gates Foundation, among others, are instrumental in assisting national governments climate action efforts. For example, they provide financial resources, technical expertise, and capacity-building support to help countries develop and implement effective climate adaptation strategies. By bridging the gap between global commitments and local actions, these organizations ensure that adaptation efforts are aligned with broader sustainable development aims and are responsive to the needs of vulnerable populations (see Chapter 4). Together, these supranational and international organizations foster collaboration across borders, enhance knowledge sharing and mobilize resources to address the complex, interconnected challenges posed by climate change.

7.2.2 Multilateralism at the local and regional levels

Cities and regions around the world are increasingly engaging in multilateral initiatives to advocate for stronger climate action. This has largely been through city and subnational networks that are engaged in transnational climate governance. Table 7.1 provides examples of some of these, their scope of operations and impacts of their activities. For example, through C40 Cities, members collaborate on initiatives such as sustainable transportation, energy efficiency and climate resilience, demonstrating the power of multilateralism at the subnational level. Similarly, the Regions4 network (formerly known as NRG4SD) brings together regional governments to collaborate on sustainable development and climate action. These multilateral initiatives enable local and regional governments to amplify their impact by pooling resources, sharing knowledge and expertise, and influencing global climate policy. They also provide a platform for cities and regions to showcase their achievements and learn from the experiences of others, fostering innovation and accelerating progress towards SDG 13.

In influencing global climate policy today, two key alliances represent the local and regional governments constituency: The Global Task Force of Local and Regional Governments (GTF), coordinated by UCLG, that advocates towards the UN; and the Local Governments and Municipal Authorities (LGMA), coordinated by Local Governments for Sustainability (ICLEI), that advocates towards the UNFCCC, serving as the voice of cities and regions. Both have been advocating for a multi-level governance approach for a long time through their efforts in implementing the global development agendas at local level. The Global Covenant of Mayors for Climate and Energy (GCoM) acts as a significant alliance in this context, bringing together the expertise of the city networks and the national Covenants of Mayors to find innovative solutions for cities to achieve their climate targets.

A municipal truck uses anti smog gun to spray water on the road for dust suppression to reduce air pollution in Delhi, India. © Shutterstock

The Glasgow Climate Pact, arising from the rigorous negotiations of COP26, represented a pivotal moment in global climate action. The Pact holds considerable significance for local and regional governments, and their advocacy efforts through LGMA. The Pact acknowledges in its preamble "the urgent need for multi-level action" in combating climate challenges.[27] By recognizing local and regional governments as essential stakeholders, the pact validated their authority and capacity to implement tangible solutions on the ground. Additionally, its provisions around multi-level and cooperative action underscored the importance of collaboration between national and subnational entities, emphasizing the interconnectedness of efforts across all levels of governance. As discussed in Chapter 2, subsequent COP meetings have produced key milestones and outcomes on climate action, with significant implications for urban areas.

7.2.3 The synergy between multi-level governance and multilateralism

The synergy between multi-level governance and multilateralism is critical for achieving SDG 13 and other SDGs. While *multi-level governance* ensures that climate action is implemented at all levels—from global agreements to local initiatives—*multilateralism* facilitates the coordination and cooperation needed to align these efforts and scale up their impact. As highlighted in Chapter 2, the implications of various COP meetings for cities clearly call for enhanced multi-level governance. Noteworthy, significant urban initiatives focused on multi-level governance have been launched alongside recent COPs, such as the Cities Race-to-Zero and Cities Race-to-Resilience campaigns at COP 26. The SURGe Initiative launched at COP 27 aims to accelerate local and urban climate action through multi-level governance, engagement and delivery through five integrated tracks, contributing to achieving the Paris climate goals and SDGs. CHAMP, recently launched in COP 28, supports the unlocking of climate action through multi-level partnerships.

Localizing the SDGs, including SDG 13, is a way of ensuring that the global agenda is not just a set of distant targets, but a practical framework that directly impacts people's lives at the local level

It is evident that the synergy between multi-level governance and multilateralism lies in their complementary strengths. Multi-level governance allows for a more granular approach, where local and regional authorities can implement policies that are closely aligned with the unique needs and conditions of their constituencies. This bottom-up perspective is crucial in ensuring that global policies are effective at the ground level, where their impact is most directly felt. Multilateralism, meanwhile, provides the platform for collective action, enabling countries to pool resources, share knowledge and coordinate efforts on a global scale. It facilitates the development of international norms and standards, which can then be adapted and implemented through the structures of multi-level governance. Oftentimes, national policy developments are "frequently inspired, driven and necessitated by international negotiations and agreements" that then inform policy making at the various regional, national and local levels.[28] Indeed, for this synergy between multi-level governance and multilateralism to work effectively, there is a need to align global, national and local efforts.

Aligning global, national and local efforts

To achieve SDG 13, it is essential to align global, national and local efforts. This means fostering strong communication channels between global institutions, national governments and local authorities, as well as encouraging horizontal collaboration among countries and regions.

Formally institutionalizing SDGs into planning and policy processes at both national and local levels is an essential means of mainstreaming the principle of localization into every level of government

While multilateral pacts such as the Paris Agreement set the framework for global action, their success depends on national governments translating these commitments into actionable policies in Member States. Local and regional governments, in turn, must implement these policies in ways that reflect their unique circumstances and needs. The European Union (EU), for instance, has adopted a multi-level approach to climate governance, where member states are required to develop national energy and climate plans that contribute to the EU's overall climate targets. These plans are then implemented by local and regional governments, ensuring that climate action is coordinated across all levels of governance.[29]

It is also vital to ensure that climate actions at all levels are inclusive and equitable, addressing the needs of the most vulnerable populations, who are often disproportionately affected by climate change (as noted in Chapter 4). By aligning efforts across these levels, synergies can be created that enhance the effectiveness of climate action, ensuring that global commitments translate into tangible results on the ground. A fundamental approach advanced by UN-Habitat for the alignment of global, national and local efforts is *SDG localization*: this involves adapting and implementing the global goal to fit the specific contexts, priorities and needs of local communities. Localizing the SDGs, including SDG 13, is a way of ensuring that the global agenda is not just a set of distant targets, but a practical framework that directly impacts people's lives at the local level.[30] Today, on-the-ground delivery of SDGs is being supported by the Local2030 Coalition—a multi-stakeholder platform designed to facilitate cooperation across the UN and to support the localization of the Goals—whose secretariat is hosted by UN-Habitat.

SDG localization requires a "whole of government" and "whole of society" approach.[31] Formally institutionalizing SDGs into planning and policy processes at both national and local levels is an essential means of mainstreaming the principle of localization into every level of government.[32] In Germany, for instance, the State Secretaries Committee for Sustainable Development oversaw the revision of the National Sustainable Development Strategy to align it with the SDGs, as well as facilitated the integration of SDG initiatives across all government departments, including the Department for Regions and Local Government.[33] This top-down approach is complemented by bottom-up engagement by German association of cities (DST) through the German Municipal Charter for the Future.[34]

In Europe, cities have become deeply embedded in European multi-level climate governance frameworks.[35] European cities are not only implementing local climate policies but are also actively engaging with national and supranational institutions to shape broader climate agendas. In the UK, Bristol—among other distinctions, the first city in the country to declare a climate emergency[36]—has been a leading example of localization of SDGs in cities. A key important highlight from Bristol's leadership in SDG localization is that the process has largely been driven by city dwellers and other stakeholders, whose collective efforts and resources facilitated local government engagement with the goals (Box 7.1).[37] Other cities have also embraced the opportunities of localization. In Japan, Kitakyushu City set up a SDGs Council to advice on the implementation of the SDGs through the engagement of various stakeholders Box 7.2).[38] In Italy, SDG localization is supported by the creation of a "community of intentions" (a network of civil servants, specialists and other stakeholders) who engage in dialogue and partnerships across all regions, autonomous provinces and metropolitan cities.[39]

Box 7.1: Localization of SDGs in Bristol, UK

Bristol's leadership in SDG localization in the UK is unique. The process was first initiated by a dedicated group of citizen campaigners who engaged local authorities, NGOs and businesses on the value of the SDGs as a framework for action in the city. Through sustained "embedded advocacy" and political support from Bristol's elected Mayor, the SDGs became a critical platform to bring different stakeholders together towards shared goals. Through concerted efforts, Bristol integrated SDGs into its ambitious One City Plan to synchronize its objectives with the global aspirations enshrined in the SDGs. In July 2019, Bristol released its first ever Voluntary Local Review (VLR), which was widely circulated through international city networks and served as an important mechanism for building inter-city relationships and sharing practical lessons on SDG localization. At the onset of the COVID-19 pandemic in 2020, the SDG framework became an important anchor in Bristol's recovery planning. In 2021, Bristol initiated a new program of citizen engagement to strengthen awareness of the SDGs in the city through the multi-stakeholder "SDG Alliance".

Source: (Fox & Macleod, 2023).

Effective localization of global agendas is often hampered by lack of technical and financial capacity, especially among municipalities.[40] In many cities around the world, there has been limited support from central governments for the localization of SDGs, particularly in terms of funding and policy guidance. Funding is crucial to the effective implementation of SDG localization. While some large and wealthy cities, like New York City (US) or Singapore, have the capacity to allocate financial and human resources to engage with the SDGs,[41] many urban dwellers live in small- and medium-sized cities that face significant resource constraints—even in wealthy countries.

SDG localization may also be constrained by a lack of policy guidance from national governments, which can hinder the effective implementation of global goals at the local level. Without clear national directives, local governments may struggle to interpret how the SDGs relate to their specific contexts and how to integrate these goals into their existing frameworks. As a result, cities and regions may develop fragmented or inconsistent approaches to SDG localization. This often leads to gaps and disparities in progress across different areas, with some cities advancing rapidly as others lag. For example, a city might prioritize certain SDGs that align with its immediate needs, like infrastructure development, while neglecting others that are equally important, such as reducing inequalities or tackling climate change.[42]

It is thus critical for central governments to develop national SDG localization frameworks that provide clear policy guidelines and best practices for cities to follow. Such frameworks would include step-by-step guidance on how to integrate SDGs into local planning processes, as well as templates and toolkits that cities can use to develop their own strategies. Moreover, the Ministerial Declaration of the Second Session of UN-Habitat Assembly encourages Member States and relevant stakeholders to use inclusive and effective multilateralism and international cooperation to, among other actions, "strengthen SDG localization and empower local and regional authorities and governments as central actors to accelerate action to fulfil the 2030 Agenda for Sustainable Development".[43]

Box 7.2: Localization of SDGs in Kitakyushu, Japan

The City of Kitakyushu, Japan, has a rich history of community-led activism that stretches back to the 1960s, when a number of women's associations collectively mobilized to call for the city's industrial pollution to be more strictly regulated. Their campaign led to partnerships between the city government, civil society and the industries that ultimately led to improved air quality and a cleaner ocean. More recently, continuing this tradition in response to contemporary challenges, the city has established a Kitakyushu City SDGs Council. The council, comprising eight experts from various environmental, economic and social fields, offers guidance on policies to support the implementation of the SDGs through multi-stakeholder partnerships. At the same time, the Kitakyushu SDG Club was also set up to provide an inclusive space for anyone in the city to join: it soon gained more than 800 members.

Source: UN-Habitat, 2022d.

It is critical for central governments to develop national SDG localization frameworks that provide clear policy guidelines and best practices for cities to follow

Kitakyushu, Japan. © Shutterstock

The role of partnerships and networks

Partnerships and networks play a crucial role in bridging the gap between different levels of governance and facilitating multilateral cooperation. Initiatives like GCoM and the Cities Climate Finance Leadership Alliance (CCFLA) have been instrumental in driving multilateral cooperation towards effective urban climate responses. The failure of national governments to directly confront the challenge of climate change has necessitated the emergence of networked bottom-up movements of climate governance by cities, upholding the goals of the Paris Agreement.[44]

Over the past few years, various cities across the globe have joined national and transnational city networks, from national-level associations (such as the US Mayors Climate Protection Agreement) to global consortiums (such as C40 Cities). Table 7.1 provides an overview of city networks and their operational mandates as they relate to transnational climate governance. These provide a platform for cities and regions to share knowledge, collaborate on projects and advocate for stronger climate policies at the national and international levels. Notably, the IPCC acknowledges the central role played by city networks in spearheading public engagement on climate change responses and in catalyzing the diffusion of climate policies throughout the world.

Table 7.1: Examples of city and subnational networks engaged in transnational climate governance

Name	Describe themselves as:	Scope of operation	Significance and impact
ICLEI (Local Governments for Sustainability)	"The leading global network of more than 1,500 cities, towns and regions committed to building a sustainable future"	They work directly with members, local governments in improving local practices and influencing policy globally.	Since its formation in 1990, ICLEI has been instrumental in championing sustainability agendas.
C40 Cities	"A network of the world's megacities committed to addressing climate change"	Coordinates processes of collaboration and knowledge sharing, as well as developing city-based metrics.	Formed in 2005, the network has raised the profile of the cities and climate change agenda.
The World Mayors Council on Climate Change	"An alliance of committed local government leaders concerned about climate change"	The Council brings together Mayors, former Mayors and Council Members who make a personal commitment to political action for climate change.	Since its formation in 2005, the Council has worked to deliver politically savvy initiatives that have put climate change on local policy agendas.
United Cities and Local Governments (UCLG)	"UCLG represents and defends the interests of local governments on the world stage, regardless of the size of the communities they serve"	UCLG's mission is to advocate democratic self-governance…and represent local governments and develop policy- many of which relate to climate change.	Since its inception in 2004, UCLG has had a strong voice in shaping international agendas, with a clear pro-democratic governance advocacy agenda, which has also promoted key climate change policy.
Region4 (formerly known as NRG4SD)	"Regions4 is a global network representing subnational governments (states, regions, and provinces) before UN processes, European Union initiatives, and global discussions in the field of sustainable development"	Region4's mission is to empower regional governments by enabling the strongest connections inside and outside the network and translating them into impactful action.	Region4 have worked in partnership with UN organizations, linking climate change objectives with SDGs.
Energy Cities	"The European Association of local authorities in energy transition"	The Association develops proposals to advance a transition, to help their members directly.	Created in 1990, the network represents more than 1,000 local governments in Europe, mainly municipalities.
EU Covenant of Mayors	"Signatory local authorities share a vision for making cities decarbonized and resilient where citizens have access to secure, sustainable and affordable energy"	By signing the Covenant, local governments commit to deliver a Sustainable Energy and Climate Action Plan and establish a monitoring process.	Over 6,000 "democratically constituted local governments" have signed the covenant since 2005, shaping both local and European Policy.
Asian Cities Climate Change Resilience Network (ACCCRN)	"A multi-year initiative to strengthen the capacity of over 50 rapidly urbanizing cities in Bangladesh, India, Indonesia, the Philippines, Thailand and Vietnam to survive, adapt, and transform in the face of climate-related stress and shocks"	Works directly with members, mainly individual practitioners, to support the development of partnerships and provide access to a shared knowledgebase.	The ACCCRN has had a strong influence in collaborative approaches to urban resilience, and has raised the profile of its national partners, such as the Mercy Corps Indonesia.
Japan, the Coalition of Local Governments for Environmental Initiative (COLGEI)	Is a network of members representing local governments in Japan.	Members include local governments but also other organizations, such as universities or concerned members of the public.	Since the early 1990s, COLGEI holds an annual conference for sharing practices and experiences; works in partnership with ICLEI.

Source: Adapted from Castán Broto, 2017.

Since the ratification of the Paris Agreement, advocacy by such city networks has strongly supported multi-level governance and the overall increasing prominence of cities and subnational governments in COP negotiations and international fora addressing climate change. The increasing prominence of city networks in global climate governance indicates a significant shift from the traditional state-centric, multilateral approach underpinning the UNFCCC to a transnational framework characterized by the active participation of subnational and non-state actors.[45] For instance, European cities are key participants in EU-led initiatives such as the EU Covenant of Mayors for Climate and Energy. This initiative brings together thousands of local governments committed to implementing EU climate and energy objectives, including reducing GHG emissions by at least 40 per cent by 2030.[46] Through these and other networks, members can share best practices and influence EU climate legislation, such as the European Green Deal, which aims for climate neutrality by 2050.[47] Cities like Paris, Barcelona and Copenhagen have themselves set ambitious local targets aligned with EU goals, demonstrating how urban actions contribute to broader European climate policies.[48] Many cities across Europe are also members of global city networks like the C40 Cities and ICLEI, which work closely with the European Commission and other EU bodies, as well as Eurocities (Box 7.3).

Box 7.3: The integrative governance vision of the Eurocities network

Eurocities—the 200-strong membership network of major cities in Europe—has been a vocal advocate for the adoption of an ambitious European Green and Social Deal as the centrepiece of a Europe-wide transformation. In particular, it has called for the development of an "enabling framework" of tailored policy and finance to support investments in renewables, energy-efficient construction and low-carbon transportation. Importantly, it emphasizes the need to place cities and local government front and centre of this process, including the promotion of a Green Deal Industrial Plan to promote collaboration between businesses and local authorities. This call for empowered city-level action aligns with Eurocities' advocacy for "a local Europe with the capacity to act".

Source: Eurocities, 2023.

City networks and alliances have also been powerful tools for cities in developing countries to create synergies and attracting funding. In Mali, the national Association of Municipalities was able to deploy EU funding to strengthen SDG localization in 100 municipalities. In Ghana, similarly, the National Association of Local Authorities of Ghana (NALAG)—with financial assistance from the Commonwealth Local Government Forum—has initiated a number of programmes to enhance the ability of local, provincial and district governments to adapt the SDGs to their local realities.[49]

In recent years, city diplomacy is increasingly being leveraged to drive climate action. The Urban20—a city diplomacy initiative bringing together mayors from major G20 cities to inform the discussions of national leaders at the G20—is facilitating engagement between the G20 and cities, raising the profile of urban issues in the G20 agenda. It is a forum for cities to develop a collective message and perspective to inform G20 negotiations. The works undertaken by the Urban20 constituency result in a Communiqué on which the member cities agree upon, to advocate on the local perspective and solutions regarding the priorities of each G20 Presidency.[50]

The influence of city diplomacy in enhancing ambition on urban climate action has also been seen in the enhanced international engagement and bilateral cooperation between Australian and Chinese stakeholders. This was achieved through the "Shared Pathways to COP28" program, a bilateral exchange and capacity-building program focused on strengthening urban climate action in both countries that was facilitated by Melbourne Centre for Cities at the University of Melbourne.[51] Indeed, such city-university partnerships have been proven to catalyze and support effective urban sustainability transformations.[52]

Working jointly towards effective climate action

Collaboration and knowledge sharing play a crucial role in both mitigation and adaptation. Regional climate alliances are formed with neighbouring municipalities to tackle climate issues collectively, sharing resources and best practices, as well as integrated approaches that offer significant co-benefits. By addressing multiple objectives simultaneously, integrated climate actions provide a more sustainable and resilient future for communities. [53]

As highlighted in previous sections and various chapters of this report, a coordinated and integrated approach to the complex interactions and relationships across various levels of governance and actors, as shown in Figure 7.2, is key to effective climate action. Ireland, for instance, ensured policy coherence and smooth coordination across different levels in its first Climate Action Plan in 2019 (see Box 7.4). Since then, the country has fostered national engagement through National Dialogue on Climate Action (NDCA)—a mechanism for facilitating social dialogue on climate action and ensuring wider public consultation and engagement for its annual climate action plans.[54]

The increasing prominence of city networks in global climate governance indicates a significant shift from the traditional state-centric, multilateral approach underpinning the UNFCCC to a transnational framework characterized by the active participation of subnational and non-state actors

Box 7.4: Ireland's multi-level governance approach in tackling climate change

In 2019, the Irish government launched its first all-of-government Climate Action Plan. The purpose of the plan is to provide the details of how the state intends to meet its EU target of reducing its carbon emissions by 30 per cent between 2021 and 2030 to create a resilient, vibrant and sustainable country. The plan outlines 183 actions within 13 different policy areas that extend to all sectors of Irish society and its economy: for each action, the plan sets out the steps necessary for delivery, a realistic timeline and the actor/s responsible for ensuring implementation. Progress can therefore be readily tracked and measured.

It is a cross-sectoral plan in that it includes measures across the sectors responsible for the country's GHG emissions. The plan takes a multi-level governance approach, by including local, regional, national and international actors and detailing their roles in implementing the actions in the plan. The plan also sets out a clear monitoring, evaluation and accountability framework to ensure policy coherence and smooth coordination across different levels of government and scales.

Source: Wagner et al, 2021.

7.2.4 Challenges and opportunities in multi-level governance and multilateralism

While multi-level governance and multilateralism offer significant opportunities for advancing climate action, they also present challenges. Multi-level governance involves multiple layers of decision-making across local, regional, national and international levels. While this decentralized approach can be more adaptive and responsive to local contexts, it often leads to policy fragmentation. The absence of a coherent policy framework can result in overlapping or conflicting regulations, making it difficult to implement effective climate action. For instance, a national climate policy might emphasize renewable energy, while local regulations could still support fossil fuel industries due to economic dependencies, leading to a lack of policy coherence. Local governments might prioritize immediate climate adaptation needs, such as flood control, while national governments focus on long-term mitigation strategies. Without proper coordination, these differing priorities can lead to inefficient use of resources and missed opportunities for synergistic action.

Limited powers, resources and capacity also hamper climate action by cities in developing countries. Oftentimes, cities lack sufficient responsibility or resources to autonomously implement urban climate initiatives themselves. Even in instances where there is a high level of overall devolution and a relatively high degree of fiscal decentralization, there may still be strong centralization in the energy sector—leaving urban authorities constrained with respect to meaningful role in energy transitions.[55] In the US, recent years have seen tension between state and federal governments on climate policies, as well as multiple obstacles to robust subnational climate policy.[56] These competing institutional and jurisdictional interactions can hamper effective climate action.[57] Therefore, ensuring that different levels of government work together towards common goals is essential for achieving SDG 13.

Flooding aftermarth, Chiang Rai, Thailand. © Shutterstock

Flooding following Cyclone Idai, Mozambique. © Shutterstock

Multi-level governance processes are also characterized by complex power relations among different actors, which may serve to exclude marginalized stakeholders, thereby reinforcing existing vulnerabilities.[58] Ensuring inclusivity requires deliberate efforts to engage disenfranchised groups, such as Indigenous communities, women and low-income populations, in governance processes. While multilateralism offers a global platform for collective action towards climate change, developed countries often dominate the agenda-setting process, potentially sidelining the concerns of developing nations, which are disproportionately affected by climate change. This imbalance can lead to inequitable climate agreements that fail to address the needs of the most vulnerable populations. Multi-level governance must involve all relevant stakeholders, including marginalized communities, Indigenous Peoples, and vulnerable groups, who are often disproportionately affected by climate change. Multilateralism should also address the needs of developing countries, which may lack the resources and capacity to implement effective climate action.

7.3 Governance and Co-Production for Climate-Resilient Services in Urban Areas

The urgency of climate change requires robust, inclusive and adaptive governance frameworks that can facilitate climate-resilient services, particularly in urban areas. Effective multi-level governance and hybrid approaches are essential for supporting urban resilience by fostering collaboration, coordination and synergies across different stakeholders, sectors and levels of government. Past editions of this report underscore that addressing complex challenges such as climate change require coordinated action across all scales.[59] The IPCC also notes that transformative capacity—that is, the capacity required to deliver adaptation action—"extends across multiple agency levels or geographical locations, as well as various domains".[60] At the same time, as discussed in the previous sections, it is important to recognize that local governments are at the forefront of multi-level governance, given the increasing emphasis on localization of global agendas and the critical role of cities in this process.[61]

Hybrid approaches, which integrate top-down policies with bottom-up initiatives and participatory processes, have considerable potential to enhance the effectiveness and legitimacy of resilience efforts by incorporating diverse perspectives, local knowledge and innovative solutions. However, much of the literature in this area has tended to focus on generic recommendations for improving governance rather than context- and place-specific insights for fostering change on the ground.[62] It is important to note, though, that institutions such as C40 Cities have often provided valuable local insights. For example, in advancing 10 factors that underpin good climate governance in cities (see Box 7.5), C40 Cities has developed a series of case studies from cities across the world. These highlight the varied and innovative approaches cities are adopting to ensure alignment of city priorities and development objectives with the goals of the Paris Agreement.[63]

In the quest for inclusive and adaptive frameworks, hybrid governance approaches are especially critical in developing countries, where formal governance structures often operate in parallel with informal and traditional forms of governance. The IPCC highlights the significant role that aspects of informal governance, such as Indigenous and local knowledge, informal learning and neighbourhood associations, can play in building resilience to climate impacts.[64] This section therefore explores how governance, through modes of co-production with relevant stakeholders, can facilitate climate-resilient services in urban areas, with a particular focus on the context of developing countries. It examines how local practices can be effectively scaled up, as well as the challenges and opportunities of co-existing formal and informal governance systems.

The urgency of climate change requires robust, inclusive and adaptive governance frameworks that can facilitate climate-resilient services, particularly in urban areas

Box 7.5: Factors underpinning effective climate governance in cities

Good governance is crucial for cities to deliver on their climate targets. C40 Cities has identified 10 factors that underpin good climate governance in cities:

- *Institutional arrangements:* The institutional architecture outlining roles and responsibilities within, and across, a city's governance structure is central to carrying out the city's climate action plan.
- *Legal frameworks to support climate action:* The various legislation assisting a city's climate action plan and the degree to which it strengthens horizontal and vertical climate action.
- *Mainstreaming climate policy:* Integrating climate action across the city through governance structures and systems, policy frameworks and political support.
- *Cross-departmental arrangements and action:* Implementation of integrated city-wide actions through, for instance, dedicated multi-departmental climate committees.
- *Vertical integration:* City climate action and ambition that is integrated or aligned with both higher and lower levels of government.
- *Budgetary mainstreaming:* Including climate priorities into the wider city budget processes general financial management.
- *External governance:* Setting up structures that facilitate long-term engagement with external stakeholders, including devolving actions and responsibilities.
- *Monitoring and transparent reporting systems.* Implementing systems to track progress (including monitoring emissions and implementation of climate actions) and create accountability.
- *Communication and engagement:* The local government engagement with the public, civil society and other stakeholders such as the private sector, as well as making information accessible to them to foster broader support for a city's climate action plan.
- *Innovative solutions to capacity and resource challenges:* Innovative measures to overcome challenges related to staff capacity and resourcing.

Source: C40 Cities, 2021c.

7.3.1 The role of governance in facilitating climate-resilient services

Effective governance involves the participation of various stakeholders, including governments, civil society, the private sector and local communities, in the decision-making process. Such co-production ensures that climate strategies are not only technically sound, but also socially inclusive and responsive to local needs.

Co-production as a mode of urban climate governance

Co-production allows for the integration of diverse knowledge systems, including scientific expertise, local knowledge and Indigenous practices, into the development of climate-resilient services (see Chapter 4). As World Cities Report 2022 notes, co-production can strengthen local capacities, draw attention to environmental injustice, and enhance awareness and transparency.[65] As an approach, co-production transcends the limits of conventional participation by expanding the scope not only of *who* can engage in decision-making processes, but also *how* they can do so: by fostering accessible "activity spaces" open to an array of different stakeholders, it provides participants with the opportunity to "collectively shape discourses, imaginaries and solutions".[66] Therefore, in co-producing climate solutions, new relationships are built and community actors are empowered to take active roles in tackling climate change.

As underscored in Chapter 6, engaging residents in the process of planning, design and construction of housing (and associated infrastructure such as disaster emergency shelters) can ensure that the finished product meets their specific needs. Furthermore, incorporating local knowledge about hazards, vulnerabilities and responses into these processes can prove transformative. In Ulaanbaatar, Mongolia, the involvement of communities in the co-design of the Flood Resilience in Ulaanbaatar Ger-Areas (FRUGA) project brought multiple benefits: while the incorporation of local knowledge into the design ensured it aligned with the needs of residents, their active participation also generated a greater sense of commitment and ownership. The adaptation measures implemented in the project "include reduction of flood risk through resilient urban development and land use management, recycling and treatment of used water, and implementation of comprehensive flood prevention measures such as a flood retention wall, drainage channels, and suitable latrines".[67] In Genk (Belgium), co-production was used to transform the Stiemer valley from an unloved and underutilized area of the city into a mixed-use, blue-green public space. In this context, the spatial masterplan was developed through the involvement of multiple city departments and regional governmental institutions, with residents engaged through a range of activities, including bicycle tours and neighbourhood consultations.[68]

The development of the Climate Justice Charter for South Africa exemplifies a participatory approach to regulation—engaging civil society organizations, grassroots movements and individuals in the drafting process. Initiated by the Co-operative and Policy Alternative Centre (COPAC) and the South African Food Sovereignty Campaign (SAFSC), the drafting process emerged from years of advocacy for food sovereignty and climate justice, involving assemblies in workplaces, communities and faith-based spaces to deepen grassroots input. The movement plans to develop an economic model for the charter, a just transition plan, enabling constituents to develop their own strategies for systemic alternatives and socio-ecological restructuring.[69] Involving local-level actors and communities is a key factor in building trust and legitimacy for such processes.

Although most cities in both developing and developed regions have been actively adopting co-production as an approach to urban climate

Successfully embedding co-production requires a focus on sustaining it beyond isolated interventions by fostering long-term relationships and ensuring ongoing support for engagement activities and local communities

governance, the majority still face limited political capacity, conflicting stakeholder interests, silo mentalities and a structural lack of resources.[70] One of the ongoing challenges in integrating co-production into urban climate governance lies in the mismatch between co-production practices and existing formal governance structures and processes. For city policy officers, engaging in co-production often involves navigating its complexities and diversity, while constantly needing to allocate time, develop skills and secure support for these initiatives.[71] Successfully embedding co-production requires a focus on sustaining it beyond isolated interventions by fostering long-term relationships and ensuring ongoing support for engagement activities and local communities. Without this long-term perspective, co-production risks leading to negative outcomes, such as disempowerment, participation fatigue and diminished trust between city governments and urban communities.

The importance of inclusive governance

Inclusive governance is essential for building climate resilience, particularly in urban areas where diverse populations are often exposed to varying degrees of risk. Ensuring that all stakeholders, including marginalized groups, have a voice in the governance process helps to create more equitable and effective climate strategies (as articulated in Chapter 4). At the local level, stakeholder engagement increases adaptive capacity by enhancing knowledge about climate change and local responses, increasing their willingness to be involved in management. In Sierra Leone, for instance, the Federation for Urban and Rural Poor (FEDURP)—a women-led network of more than 3,000 people—is contributing to vulnerability assessments. Besides being a savings group, network members take on other tasks: undertaking detailed data surveys to identify high-risk areas, for example, or building capacity and awareness among local residents on flood prevention.[72]

In Indonesia, the Bangkit Berdaya program in Jambi City showcases an innovative approach to fostering a green economy through community-based efforts and participatory governance. With the primary objective of accelerating infrastructure development at the grassroots level, the program encourages cooperative community participation to address local environmental and infrastructure challenges. The program streamlines the selection process of small-scale community development proposals and engages residents in the construction process through the Indonesian tradition of *gotong-royong* or community action. Through multi-level collaborative efforts between government, communities and the private sector, the program not only accelerates infrastructure development but also fosters a sense of solidarity and ownership among residents.[73]

Inclusive governance, when combined with strong institutions, leads to interventions that are well-aligned with local contexts and needs—thus enhancing adaptive capacity.[74] In Brazil, through the Roadmap Making Barcarena a Resilient City, the municipality engages in a participatory approach involving government and society to co-create solutions aligned with global agendas like the SDGs, the NUA, Paris Agreement and Sendai Framework. The city's resilience strategy, developed in collaboration with UNDRR, considers various factors such as socioeconomic vulnerability, gender, disability and inequality—aiming to address not only disaster risk reduction but also broader societal vulnerabilities (as discussed in Chapter 4). Through this integrated vision of resilience, Barcarena's Resilience Committee is fostering an enabling institutional ecosystem that includes representatives from various public policy councils and international organizations, among others, to ensure a coordinated and holistic approach to risk reduction across all sectors of government and society.[75] In Nepal, the National Disaster Risk Reduction and Management Authority has been proactive in engaging persons with disabilities, thus serving as an example to advocate for disability-inclusion in climate action.[76]

Mitigation efforts can be enhanced by inclusive governance. Meaningful participation by stakeholders bolsters efforts by governments to adopt and implement more ambitious climate policies and enhances political support, improves transparency and supports just climate mitigation outcomes. Additionally, inclusive governance fosters solidarity in community groups and networks, increasing social awareness and willingness to accept trade-offs while reducing conflict and corruption.[77] Given that governance and institutional structures determine the allocation of resources, implementation of policies and overall adaptive capacity, this is especially important. All too often, climate action is impeded by inadequate institutional frameworks. Yet, effective, accountable and inclusive institutions at all levels, as envisioned by SDG 16, are integral to effective climate action and mainstreaming resilience. Strong institutions with clear, inclusive and forward-looking policies can enhance resilience.

Today, the public sector's role in addressing societal challenges and fostering inclusive and sustainable development is pivotal—a people's response is largely shaped by it. In an era characterized by increasingly complex and inter-connected global challenges, it is imperative that public institutions evolve to anticipate future development needs and be more responsive to the communities they serve.[78] As noted in Chapter 2, building trust and legitimacy of institutions is critical for urban climate governance and action. In Bangladesh, for example, a study on adaptation pathways for flood-affected households found that improving the efficiency and effectiveness of local governments and institutions was crucial for enhancing livelihood resilience.[79]

Inclusive governance, when combined with strong institutions, leads to interventions that are well-aligned with local contexts and needs

Transforming the public sector also calls for adoption and operationalization of the Principles of Effective Governance for Sustainable Development (Figure 7.3). These 11 principles were prepared under the auspices of the UN Committee of Experts of Public Administration and endorsed by UN Economic and Social Council in 2018, to help countries build effective, accountable and inclusive institutions at all levels of governance. *Effectiveness* is viewed through three principles: competence, sound policymaking and collaboration. With respect to *accountability*, the principles are integrity, transparency and independent oversight. *Inclusiveness* encompasses the following principles: leaving no one behind, subsidiarity, non-discrimination, intergenerational equity and participation.[80]

Figure 7.3: Principles of Effective Governance for Sustainable Development

Source: Based on United Nations Economic and Social Council, 2018.

In conclusion, in contexts where formal governance structures may be weak or under-resourced, informal and traditional forms of governance often play a critical role in service delivery and community organization. These informal systems, as discussed in the next section, often provide valuable insights and resources that formal governance mechanisms may overlook, particularly in areas such as disaster risk reduction and water resource management. Inclusive climate governance also implies recognition of the contribution of informal governance.

7.3.2 The role of informal governance in climate resilience

The previous edition of this report (World Cities Report 2022) notes that formalized relationships between government and the plurality of various stakeholders in urban governance, especially civil society, strengthens communities and those who are underrepresented.[81] At the same time, the reality is that informal arrangements have become another useful mechanism to provide solutions to crises plaguing the world. Climate governance today is already permeated by all sorts of informal governance systems, ranging from the international level (for example, the networking at climate policy events such as UNFCCC's COP or the G20 summits)[82] to local-level arrangements within communities providing home-grown solutions. In this section, informal governance refers to the non-codified practices, norms and institutions that operate outside formal structures but still play a significant role in governing communities. In many developing countries, informal governance is often context-bound: as it is usually deeply rooted in local culture and traditions, with social relationships playing crucial roles, it is generally more accessible and responsive to the needs of local populations than formal governance structures.

All in all, informal governance has created an "innovative space" to explore new possibilities and develop trust between critical actors.[83] This is evidenced, for instance, in the customary governance and practices by which Indigenous Peoples and local communities contribute to environmental governance across scales—even though they are yet to be fully recognized in conservation and development policies, let alone society at large.[84] It is also demonstrated by the vital role that informal learning and knowledge exchange, facilitated by informal networks, play in motivating actions on climate change mitigation and adaptation on the ground. Finally, it is also evident in the role played by neighbourhood associations and other community-based organizations engaged in informal governance in building local resilience.

Indigenous and local knowledge and climate resilience

Indigenous Peoples and local communities contribute to territorial management and environmental stewardship through customary governance and practices that create and maintain biodiversity.[85] As highlighted in Chapter 5, Indigenous knowledge systems carry ancient and intergenerational wisdom that is vital to climate resilience, particularly in regions where communities have had a harmonious relationship with their natural environment over centuries. As this ecological knowledge both evolves from and responds to the natural world, it is increasingly recognized as ideal for developing and advancing meaningful climate solutions.[86]

Informal governance has created an “innovative space” to explore new possibilities and develop trust between critical actors

Indigenous and local knowledge is “context-specific, collective, informally transmitted and multi-functional, and can encompass factual information about the environment and guidance on management of resources and related rights and social behaviour.”[87] This knowledge encompasses practices related to agriculture and water resource management as communities are more directly reliant on the environment for subsistence. It also touches on approaches to disaster preparedness that have been passed down through generations and are often more sustainable and adaptive, considering gaps in policy and practice in disasters risk reduction.

Chapter 5 also highlighted Indigenous urban design and building practices that are attuned to local conditions and that minimize emissions while being adaptive to local climate conditions. By integrating Indigenous and local knowledge into formal climate strategies through co-production, inclusive governance can enhance the resilience of urban areas to climate impacts. For example, in Honiara, the Solomon Islands, Indigenous knowledge systems played a vital role in community-selected tree varieties used in flood mitigation (see Box 7.6). [88] Similarly, local knowledge played a significant role in species selection and choice of planting methods in the implementation of tree planting in Lilongwe, Malawi.[89] In Gorakhpur, India, residents' historical knowledge of past floods and their impacts was integral to flood risk mapping.[90] In Shumar, Bhutan, a community of mostly older persons has used their years of experience in managing the impacts of landslides to design a specially adapted water delivery system suspended from the branches of large trees.[91] Fostering such local niches and other forms of innovation (Chapter 8), as well as scaling up their successes, can significantly contribute to broader climate resilience efforts.

Indeed, such engagement enhances the positive impacts of adaptation and minimizes the likelihood of maladaptation. Whilst Indigenous and local knowledge is a valuable resource and can be integrated with modern climate change adaptation strategies for more effective, context-specific responses, barriers persist. In Africa, for instance, current national adaptation policies on the continent show serious gaps in effectively integrating Indigenous and local knowledge systems within the legal frameworks to reduce vulnerability.[92] In Latin America. the perspectives, knowledge and rights of Indigenous People are often ignored, necessitating their legal empowerment to sway climate action. [93] It is thus vital for the knowledge, perspectives and practices of Indigenous Peoples across the world to meaningfully inform transformative, evidence-backed climate action.[94] Moreover, as underscored in Chapter 8, the inclusion of multiple knowledge and perspectives is central to “a just urban transition.” At the multilateral level, this journey of inclusion culminated with the establishment of the Local Communities and Indigenous Peoples Platform, which offers Indigenous Peoples and local communities across the world an avenue for knowledge exchange and experience sharing. It also builds their capacity and facilitates their engagement in the UNFCCC process.[95]

Box 7.6: Leveraging Indigenous knowledge in flood prevention measures in Honiara, the Solomon Islands

Honiara struggles to cope with the growth of informal settlements, particularly against a backdrop of climate change-induced environmental stress. Many homes in informal areas near the riverbanks have already been destroyed by flash flooding, while many more located on the hillside have been affected by landslides. Other vulnerabilities that have been exacerbated by climate change impacts include constrained water shortages, inadequate drainage, inaccessible roads, inadequate waste disposal and overcrowding.

UN-Habitat's multilayered approach to vulnerability mapping, overlaying climate change and urban spatial vulnerabilities, identified an informal area in Koa Hill, located along the Mataniko River in Honiara, as a climate vulnerability hotspot. Flood mitigation measures such as slope stabilization along the riverbank and on top of the hill, using community-selected tree varieties, were implemented by UN-Habitat in collaboration with local communities. These measures have moderated the impacts of extreme rainfall and landslides, strengthening the resilience of informal settlements in Koa Hill. The project also included an urban garden and nursery with a safe space for propagating seedlings for future use.

Source: UN-Habitat, 2023f.

Informal learning and knowledge exchange

Climate change education cannot and should not stay limited to formal education.[96] Informal learning and knowledge exchange play a vital role in motivating actions on climate change mitigation and adaptation. In cities, public communication and awareness campaigns by various levels of government as well as other stakeholders have often offered informal learning opportunities—playing a key role in raising awareness, shaping public understanding and changing behaviour. An analysis of climate actions taken by the 96 cities which make up C40 Cities found that awareness and educational campaigns were the third most common action taken by cities to combat climate change.[97] While a variety of strategies and media may be employed, such awareness campaigns have the net effect of strengthening public engagement in climate change policy and building resilience.[98]

Further, the capacity of local communities can be enhanced through awareness-raising and training activities that allow them to effectively participate. In this regard, community members should have the opportunity not only to benefit from information flows, but actively contribute to its dissemination as educators and communicators themselves. Informal networks, such as neighbourhood associations and community-based organizations, are vital in such capacity enhancement, facilitating the sharing of information and best practices related to climate adaptation and mitigation. In slums and informal settlements, for instance, community meetings, social networks and local leaders can play a crucial role in presenting knowledge about climate risks and adaptation strategies in ways the community can relate to. By supporting and leveraging these informal learning mechanisms, governance at various levels can ensure that climate information reaches all segments of the population, including those who are most vulnerable. At the same time, this can be useful in tackling misinformation and disinformation campaigns seeking to undermine climate action.

Neighbourhood associations and local resilience

In localizing the SDGs and responding to climate change, the neighbourhood scale cannot be an afterthought. Their unique scale, located at the intersection of the city and the individual building, affords them with multiple opportunities to stir collective climate action.[99] For example, UN-Habitat considers climate-responsive urban design to be most effective when applied at this scale, where urban morphology, geometry of spaces and street orientation can be manipulated for resilience to climate change.[100]Also, the proximity and tangibility of participating in climate action encourages neighbourhood residents to collectively address mitigation and adaptation challenges.[101]

In most cities, both in developed and developing countries, neighbourhood associations and other community-based organizations often play a vital role in building local resilience to climate change at this scale. These groups, which are often formed in response to specific local needs or challenges, can mobilize resources, coordinate community efforts and advocate for the interests of residents in the face of climate risks. In many urban areas, particularly in developing countries, neighbourhood associations have taken the lead in organizing disaster preparedness initiatives, managing local resources and advocating for infrastructure improvements. These associations can serve as key partners in the co-production of climate-resilient services, leveraging local knowledge and social capital that can enhance the effectiveness of formal governance efforts.

7.3.3 Scaling up local practices for climate resilience: Challenges and opportunities

While local practices and informal governance mechanisms play a crucial role in building climate resilience, there is often a need to scale up these initiatives to have a broader impact. Scaling up involves expanding successful local practices to a wider audience or integrating them into formal governance frameworks to ensure that they contribute to broader climate resilience efforts. One of the main challenges of scaling up local practices is the potential loss of context-specific knowledge and the risk of oversimplification. Many local practices are deeply rooted in the specific environmental, cultural, and social contexts of the communities in which they have developed. When these practices are scaled up or replicated in different contexts, there is a risk that their effectiveness may be diminished or that they may not be as easily accepted by other communities.

Another challenge is the potential resistance from formal governance structures, which may view informal practices as being at odds with established regulations or standards. Entrenched structural and systemic factors like historical power relations, or political agendas that prioritize technocratic approaches and scientific knowledge over Indigenous Peoples, traditional or local knowledge can reinforce existing barriers and ensure that these valuable perspectives continue to be sidelined from mainstream adaptation efforts.[102] For instance, Indigenous Peoples and local communities have often been excluded or even displaced by formal conservation efforts such as the creation of protected areas. Even though they increasingly engage in environmental governance across scale, they still face numerous participation barriers in regional and global governance.[103]

Oftentimes, conflicts between formal and informal governance systems do arise, particularly when there is a breakdown of communication or loss of trust. Indigenous Peoples, for example, being on the frontlines of ecosystem conservation, often find their efforts to halt activities that degrade the environment penalized through intimidation, criminalization and violence, including assassinations.[104] Even where formal structures or national policies do recognize the vital importance of community-based or locally-led practices, legislative, administrative or conceptual challenges can still arise. Studies have shown that efforts to upscale locally-led adaptation can be obstructed by a limited understanding of the concept of community-led adaptation at the local government level as well as lack of coordination between nodal ministries and implementing bodies responsible for adaptation interventions, leading to poor implementation.[105] Notwithstanding the central role local authorities have to play, reinforcing and scaling these activities requires awareness and coordination at all levels of government, while civil society actors can help ensure accountability and the flow of information.[106] Additionally, sustainability and scalability is closely linked to institutional and technical capacity building tailored to different contexts, including increasing local capacities to access and manage finance.[107]

Despite these challenges, there are significant opportunities for scaling up local practices to enhance climate resilience that can contribute to global impact. One approach is to integrate successful local practices into formal governance frameworks through the process of co-production. Involving local communities in the design and implementation of climate policies is essentially devolving and developing climate governance at the local level. This ensures that these policies are informed by local knowledge, practices and experiences, increasing their likelihood of being effective. At the same time, building local leadership and local government capacity, as well as supporting effective monitoring, evaluation and learning, is key.[108] Empowering local stakeholders to lead in adaptation efforts, in line with the Principles for Locally Led Adaptation Action outlined in Box 7.7, should be prioritized.

Sustainability and scalability is closely linked to institutional and technical capacity building

Partnerships between local communities, various levels of governments and international organizations, among other stakeholders, is providing much needed resources and support to scale up successful local practices. The Global Environment Facility Small Grants Programme (GEF SGP), for instance, has provided financial and technical support for the development and implementation of innovative local actions that address global environmental issues. The mobilization of bottom-up actions has encompassed numerous projects that integrate Indigenous knowledge into climate resilience initiatives, helping to scale up these practices to benefit larger populations.[109] The Global Center on Adaptation acts as "a solutions broker" for scaling up locally-led adaptation action, linking efforts on the ground to funding from international financial institutions and donors as well as facilitating local organizations peer-to-peer and South-to-South learning.[110] European Commission's initiative Communities for Climate (C4C) is empowering local action against climate change by supporting community-led projects—promoting a culture of resilience and sustainability, serving as a model for broader change across Europe."[111] The aforementioned global city networks, such as C40 Cities, have also been effective platforms for transforming and scaling up pilot experiments.[112]

Lastly, dissemination of local knowledge and practices more widely through a variety of media and platforms is essential. In scaling local practices to have impact across many levels (including the global), it is important to harness the potential of digital technologies. These can promote or make way for more reflexive, inclusive governance systems that address the complexity of climate change and help meet climate goals.[113] Also, a great opportunity lies in leveraging technology and digital platforms for wide dissemination of local knowledge and practices. Already, the digital space is rife with information about successful climate adaptation strategies. It is also connecting communities with similar challenges, as well as facilitating peer-to-peer learning through various online portals, such as the GCA's "Global Hub on Locally Led Adaptation" and UNFCCC's "Local Communities and Indigenous Peoples Platform Web Portal".

Involving local communities in the design and implementation of climate policies is essentially devolving and developing climate governance at the local level

Volunteers engage in beach cleaning and tree planting, Yogyakarta, Indonesia. © Shutterstock

Box 7.7: Principles for Locally Led Adaptation Action

The Global Commission for Adaptation developed the following set of eight principles as a guiding framework to enable more effective and sustainable adaptation at the local level. They ensure that bottom-up climate action is inclusive, informed, adequately resourced and impactful:

1. *Devolving decision-making to the lowest appropriate level:* Giving local institutions and communities more direct access to finance and decision-making power over how adaptation actions are defined, prioritized, designed, implemented; how progress is monitored; and how success is evaluated.

2. *Addressing structural inequalities faced by women, youth, children, disabled and displaced people, Indigenous Peoples and marginalized ethnic groups:* Integrating gender-based, economic, and political inequalities that are root causes of vulnerability into the core of adaptation action and encouraging vulnerable and marginalized individuals to meaningfully participate in and lead adaptation decisions.

3. *Providing patient and predictable funding that can be accessed more easily:* Supporting long-term development of local governance processes, capacity, and institutions through simpler access modalities and longer term and more predictable funding horizons, to ensure that communities can effectively implement adaptation actions.

4. *Investing in local capabilities to leave an institutional legacy:* Improving the capabilities of local institutions to ensure they can understand climate risks and uncertainties, generate solutions and facilitate and manage adaptation initiatives over the longterm without being dependent on project-based donor funding.

5. *Building a robust understanding of climate risk and uncertainty:* Informing adaptation decisions through a combination of local, traditional, Indigenous, generational and scientific knowledge that can enable resilience under a range of future climate scenarios.

6. *Flexible programming and learning:* Enabling adaptive management to address the inherent uncertainty in adaptation, especially through robust monitoring and learning systems, flexible finance and flexible programming.

7. *Ensuring transparency and accountability:* Making processes of financing, designing and delivering programs more transparent and accountable downward to local stakeholders.

8. *Collaborative action and investment:* Collaboration across sectors, initiatives and levels to ensure that different initiatives and different sources of funding (humanitarian assistance, development, disaster risk reduction, green recovery funds, etc.) support one another, and their activities avoid duplication, to enhance efficiencies and good practice.

Source: Global Commission on Adaptation, 2021.

7.3.4 The co-existence of formal and informal governance

The co-existence of formal and informal governance systems presents both challenges as well as opportunities for realizing effective climate action. During crises, as was the case with the COVID-19 pandemic, UN-Habitat underscores the urgent need to work directly with communities, connecting formal and informal governance mechanisms and supporting self-organization in communities, recognizing their social and cultural diversity.[114] While formal governance structures provide the legal and institutional frameworks necessary for large-scale climate initiatives, informal governance systems—as illustrated above—enhance legitimacy and inclusiveness while at the same time offering the flexibility and responsiveness to local conditions.

Understanding informal institutions is crucial for adapting to climate change, advancing technological adaptation measures, achieving comprehensive disaster management and advancing collective decision-making

Involving local communities in the design and implementation of climate policies is essentially devolving and developing climate governance at the local level

It is not enough just to have different levels of government complementing and strengthening each other in formal arrangements: a people-centred, inclusive climate action, as illustrated in Figure 7.2, demands the co-existence of formal and informal governance. One of the primary challenges of co-existence is the potential for conflicts between formal and informal governance systems that may arise due to differences in priorities, values, and approaches to governance. As highlighted in previous subsections, formal governance structures (often backed by legal systems) may prioritize standardized solutions and regulatory compliance; informal systems, on the other hand, may emphasize local knowledge and adaptive practices that may not always align with formal regulations. Furthermore, formal institutions might hamper or undermine informal institutions, while informal institutions can also subvert or replace formal institutions.[115]

Another challenge is the potential for power imbalances between formal and informal governance systems. In many cases, informal governance systems may lack the resources, authority or recognition needed to effectively influence formal decision-making processes. This can lead to a situation where informal systems are marginalized or overlooked, even when they offer valuable insights or solutions. As IPCC notes, addressing climate change will require governance that goes beyond notions of formal government or political authority, and integrates other actors including informal institutions and communities. Understanding informal institutions is crucial for adapting to climate change, advancing technological adaptation measures, achieving comprehensive disaster management and advancing collective decision-making.[116] Furthermore, “enabling transformative capacity requires novel governance arrangements based on broad participation.”[117]

Positive synergies that enhance climate resilience can be realized from the co-existence of formal and informal governance systems, as the ability to combine the strengths of both systems can create more effective and adaptive governance structures. For example, formal governance systems can provide the resources, authority and coordination needed to implement large-scale climate initiatives, while informal systems can offer the flexibility, responsiveness and local knowledge needed to tailor these initiatives to specific contexts. By working together, formal and informal governance systems can create more holistic and adaptive approaches to climate resilience. In Montreal (Canada), for example, the Metropolitan Agora is a fundamentally informal arrangement that allows the public to learn, exchange, debate and propose ideas for the implementation of the Metropolitan Land Use and Development Plan.[118]

Another opportunity lies in the potential for mutual learning and capacity building. Formal governance systems can learn from the adaptive practices and local knowledge of informal systems, while informal systems can benefit from the resources, expertise and institutional support provided by formal governance structures. This mutual learning can help to build more resilient and adaptive governance systems that are better equipped to address the complex and dynamic challenges of climate change. Some informal arrangements are often used in a complimentary manner to address gaps in the formal governance systems. Besides catalyzing innovative grassroots solutions to the specific challenges of slums, “there are varying degrees of ability to demand accountability from policymakers, service providers and governance actors within these communities”:[119] informal governance structures frequently interact with elements of the formal system, such as local councillors, to negotiate concessions around service access and other needs.

Positive synergies that enhance climate resilience can be realized from the co-existence of formal and informal governance systems

Walk for Your Future climate march, Brussels, Belgioum. © Shutterstock

7.4 Concluding Remarks and Lessons for Policy

Owing to the unique and global nature of the climate emergency, this chapter has underscored the imperative for responses at various levels. For instance, as climate change requires robust, inclusive and adaptive governance frameworks that can facilitate climate-resilient services in cities, this chapter notes the vital role of hybrid governance approaches—supported by effective, accountable and inclusive institutions at all levels—in supporting urban resilience. It has also highlighted the challenges of integrating co-production into urban climate governance, such as the misalignment between co-production practices and existing formal governance structures and processes. More broadly, the chapter outlines a number of key recommendations for international, national and local stakeholders to bear in mind:

- *Strengthen multi-level collaboration and ensure that climate action is delivered at different scales* through the involvement of all levels of government. As multi-level governance ensures that climate action is implemented at all levels, this chapter foregrounds the urgent need to develop and strengthen the capacities of local and regional governments to implement climate solutions, particularly in developing countries.

- *Align global, national and local efforts to ensure effective climate governance:* In this regard, multilateralism has a key role to play in facilitating the coordination and cooperation needed to align these efforts and scale up their impact. The localization of global development agendas is a fundamental way to align these efforts, in particular by formally institutionalizing the SDGs into planning and policy processes at both the national and local levels.

- *Engage partnerships and networks to bridge the gap between different levels of governance* and facilitating multilateral cooperation, given the increasing prominence of city networks in global climate governance. These horizontal structures—frequently diverse and transnational in nature—offer enormous potential to disrupt traditional and entrenched governance hierarchies that in many cases obstruct effective, inclusive climate action.

- *Extend climate action beyond mainstream governance frameworks to include informal, traditional and Indigenous systems:* All too often, particularly at the national level, climate policies are not only poorly integrated between different formal actors, but also wholly disconnected from the complex informal structures that are often the primary source of authorities, knowledge and consensus building in slums and informal settlements. This includes valuable Indigenous knowledge, often developed over centuries, that could strengthen urban resilience strategies.

- *Scale up local practices and learning to enhance climate resilience at the global level:* While it is vital to ensure adequate support and technical assistance is channelled down from the international and national levels, where resources are typically concentrated, it is also important that there is a two-way process of exchange. Through inclusive platforms and knowledge exchange, there are significant opportunities to replicate successful approaches at scale.

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Mangrove planting to protect the environment in Suratthani Province,Thailand © Shutterstock

Chapter 8:

Fostering Innovation for Inclusive Climate Action in Cities

Quick Facts

1. Technological innovations like renewable energy sources and electrified vehicles cannot, on their own, break the dependencies on unsustainable economic pathways.

2. Social innovation, which drives behavioural change and promotes broader participation in climate action, plays a critical role in the transition to more inclusive and resilient cities.

3. Urban innovation is not well integrated or clearly framed in Nationally Determined Contributions.

4. Ignoring inequalities and injustices in existing city structures risks reproducing worsening conditions for vulnerable groups, especially those with limited resources to recover from climate-related events.

Policy Points

1. Policy and planning at all levels should address integrated and coordinated approaches to innovation, bringing together technological, social, and nature-based innovations.

2. In revising Nationally Determined Contributions in 2025, national governments should strengthen their focus on urban innovation.

3. National governments should lead in setting appropriate institutional and regulatory frameworks that address injustices associated with climate innovation and adopt national and regional policies to ensure just urban transition.

4. Local governments should actively foster inclusive innovation ecosystems that broaden the range of innovation actors and knowledge perspectives.

Innovation—representing both the creation of something "new" and the process of distributing it—is central to the ability of cities to deliver effective climate action. While businesses tend to define innovation in terms of the development and marketing of breakthrough products and services,[1] the true scope of innovation extends far beyond this towards solving societal challenges, regardless of economic value. In the context of climate change, "transition innovation" refers to the framework of creating "new" ways of adapting to environmental impacts and reducing carbon emissions, including the overarching structural and institutional processes needed to move towards a more resilient future.

Innovation in cities is particularly important for climate action because many feasible responses have some level of dependence on urban settings, such as the concentration of skills and capacities, as well as access to the built environments in which many innovations happen. UN-Habitat's *World Cities Report 2022: Envisaging the Future of Cities* highlighted the central role of urban areas in fostering innovation, noting the rise of digitalization as an important tool to deliver the transition to net zero.[2] However, digitalization and the Internet of Things (IoTs) that find expression in the "smart city" are on their own insufficient to deliver climate-resilient futures and may even, in some cases, be counterproductive. For instance, analysis suggests that smart cities may reinforce technocratic approaches to urban management that, on the whole, prevent rather than advance sustainability.[3] While recent advances in artificial intelligence (AI) and automation offer promising innovations to scaling up climate action, translating these innovations into ready-to-use urban solutions is not straightforward and often results in unintended consequences.[4]

Climate-resilient urban futures can only be achieved if no one and no place is left behind

In this area as in others, climate-resilient urban futures can only be achieved if no one and no place is left behind. This demands a different perspective on transition innovation—not only to create 'new' ways of responding to climate change challenges, but to do so in such a way that collective resilience is strengthened rather than weakened, especially for those most vulnerable. A people-centered approach to transition innovation is therefore crucial for effective urban climate action and a broader shift towards a just urban transition.

The chapter begins by defining approaches to transition innovation and how they reflect urban dynamics in Section 8.1, highlighting the centrality of just urban transition and inclusive innovation for effective urban climate action. Section 8.2 situates transition innovation within the global trends and policies developed in Nationally Determined Contributions (NDCs). This leads to a diagnosis of the need for integrative approaches to transition innovation. Section 8.3 explores the domains and strategies for these integrative approaches, highlighting examples and key opportunities. Section 8.4 reflects on the ethical dilemmas of transition innovation that are analytically distinct from the already captured negative unintended consequences of innovation. Finally, Section 8.5 reflects holistically on how a people-centered approach to transition innovation can help foster low-carbon, climate-resilient cities of the future.

8.1 Approaches to Transition Innovation

By its very nature, innovation disrupts established ways of doing things. This is certainly the case with the transition to climate-resilient, net zero cities: at a fundamental level, it demands a move from an extractive to a regenerative economy, where cooperation, democracy, ecological health and social well-being are prioritized over profit. Furthermore, as the climate crisis and rapid urbanization raise new uncertainties, old certainties are no longer tenable. Today's innovators find themselves navigating a rapidly changing landscape with implications that are not yet fully understood.

The transition is also being shaped by existing structures of privilege, which influences transition priorities and how they are implemented.[5] The challenge is that many innovations for climate action fail to confront the inequalities and injustices that underpin an unsustainable economic system, meaning that new forms of climate urbanism have the potential to reproduce or exacerbate existing injustices.[6] These injustices are themselves the product of both *omission* (where insufficient action has been taken) and *commission* (when the action taken is detrimental to the most vulnerable groups).[7] In these regard, policy has shifted more focus on the how innovation impacts on people, including the justice and equity questions raised by the transition to a climate-resilient society.[8]

A justice-centered approach to transition innovation is therefore central for effective urban climate action. Such a perspective seeks to deliver innovations that respond to climate change-related challenges at the required scale and speed without causing further harm to people, especially those most vulnerable. As discussed in the context of urban infrastructure in Chapter 6, adopting a justice lens moves beyond *sensitive* or *responsive* approaches to urban marginalization and exclusion, aspiring instead to be *transformative*: that is, actively challenging the structural drivers and historical injustices that shape inequalities (see Table 8.1). A justice perspective further acknowledges the diverse ways in which place-based innovation takes shape and works to connect these innovations to people's needs. Additionally, this approach promotes learning across different contexts and domains of innovation that together work to accelerate the process of transition.[9]

Los Angeles illuminated cityscape downtown at night, California, USA with Hologram of Artificial Intelligence concept/Shutterstock

Table 8.1: Approaches to marginalization and exclusion in urban innovation

Approaches that are:	
Sensitive to marginalization and exclusion	Diagnose differences in access to innovation processes and technologies that lead to marginalization and exclusion
Responsive to marginalization and exclusion	Actively meet the needs of people who are marginalized or excluded
Transformative for marginalization and exclusion	Challenge marginalization and exclusion by putting marginalized people at the center of the innovation process

8.1.1 Just urban transition

A long history of environmental justice activism and thought has demonstrated that social and environmental injustices are interconnected and ought to be simultaneously addressed. A case in point is the rising demand for cars in many African cities, which is increasing pollution and GHG emissions while at the same time deepening the divide between those who are mobile and those who are not.[10] Sometimes climate action may itself even lead to negative social consequences: for example, in Bengaluru, India, beautification programs to restore riverside areas are often delivered at the expense of vulnerable communities that live on their banks.[11]

The drivers of injustice lie beyond specific projects and actions, deeply entrenched in dynamics that reproduce unsustainable political, economic, socio-ecological and technological relations. There are plausible responses to counter these drivers, such as: enabling plural and dissenting dialogue; promoting community economies and social infrastructures for the exchange of knowledge and innovation; facilitating forums for co-creating future visions; and engaging with alternative proposals emerging from activist networks. The common thread in these approaches is their focus on how knowledge is produced – a key point of intervention for a just urban transition.

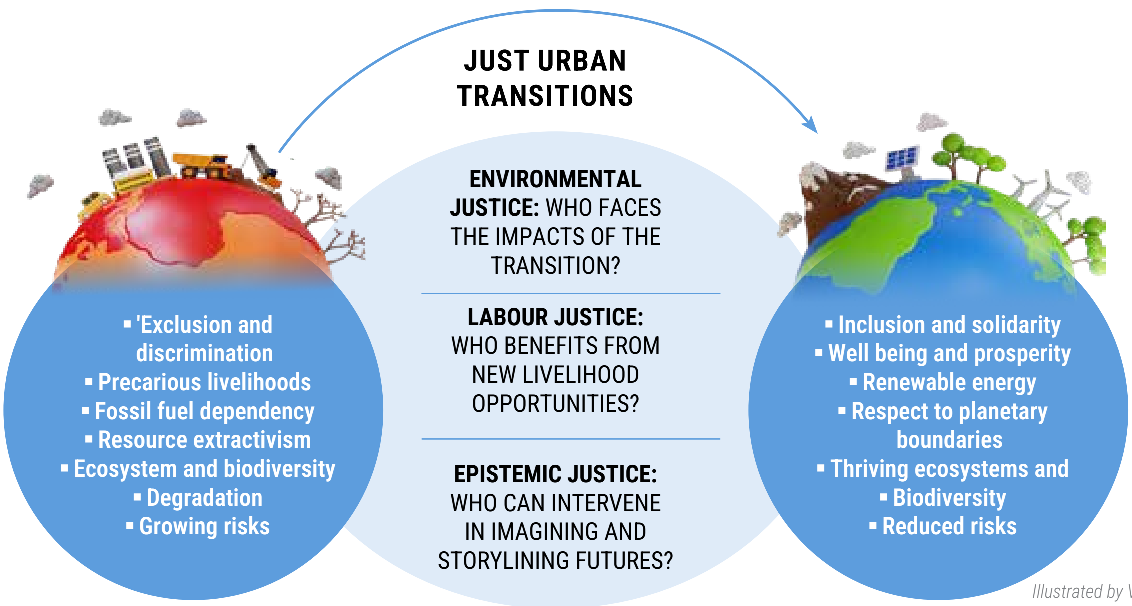
Box 8.1: Defining just urban transition

Just urban transition refers to policy and planning agendas that anticipate and mitigate the unequal distribution of risks and benefits, ensuring that climate action does not disproportionately burden marginalized groups. Central to a just urban transition is the democratization of governance and decision-making and the inclusion of multiple knowledge systems and perspectives, with the overall objective of redressing historical legacies of exclusion and injustice.

Source: Hughes & Hoffmann, 2020.

Figure 8.1 represents the magnitude of change required in a just urban transition from a fossil fuel-dependent urban economy to a climate-resilient one. Such a jump will require multiple forms of innovation to adapt people's lives and work to the new context. However, such adjustments may be particularly taxing for the most disadvantaged groups. At the same time, there have been calls to innovate in climate policy and planning to redress historical legacies of exclusion and injustice.

Figure 8.1: Magnitude of change in a just urban transition and the questions it raises



Illustrated by Vanesa Castán Broto

There are three main challenges pursued by a just urban transition (Figure 8.1):

- First, *climate action may disproportionately impact disadvantaged groups*. A just urban transition must include measures to ameliorate or avoid those impacts (*environmental justice*).

- Second, *economic restructuring will directly impact current labour conditions*. A just urban transition requires innovation to facilitate the integration of workers into the new economy (*labour justice*).

- Third, a transition requires imagining and creating responses for the future, but *only certain actors in society are legitimately able to drive the process of innovation* and design visions to shape the future. A just urban transition requires reevaluating the sources of knowledge and integrating multiple knowledge into transition innovation (*epistemic justice*).

A just urban transition is therefore not a superficial change that can solely be achieved by introducing new technologies. Rather, it demands a profound transformation in contemporary societies, a shift in values, and a rethinking of our relationship with the environment.[12] Transition innovation should therefore not only address what innovations are developed, but also how they are developed. What knowledge comes to matter in the transition process is also crucial to identifying and addressing inequalities and injustices.[13] For that reason, the just urban transition strongly depends on creating inclusive forums for the development of innovation, whether this is done in practical urban labs, ongoing consultations or through specific forums to target the concerns of marginalized social groups.

Transition innovation should not only address what innovations are developed, but also how they are developed. What knowledge comes to matter in the transition process is also crucial to identifying and addressing inequalities and injustices

8.1.2 Inclusive innovation: lessons and models

Inclusive innovation models take a normative approach to innovation as a social good. They move beyond the economic and industrial development concerns of mainstream approaches, to consider the broader contribution of innovation to social and environmental benefits (see Figure 8.2).[14] Inclusive innovation policies challenge mainstream narratives of innovation by broadening the range of actors, providing different strategies for recognition and access to innovation arenas, and centering the understanding of how particular innovations impact daily lives.

In the context of urban climate action, inclusive innovations are needed to palliate the negative impacts of the transition to net zero and address the needs of the most vulnerable groups of people to ensure a resilient city. The requirements for inclusive innovation will naturally depend on the context of need. For example, many transition innovations relate to food production and distribution in cities: inclusive innovations in urban agriculture must therefore ensure that the new knowledge generated meets the needs of small-scale farmers.[15] This could include access to supply chains, innovative tools for organizing and aggregating produce, or knowledge exchange and labor-saving technologies.

Inclusive innovation mobilizes wider sectors of the population to find responses to the climate crisis within their environment, especially those most disadvantaged. It can lead to surprising interactions between cultural life and developing a place-based, locally relevant economy. For example, research in 23 provinces of China found that spiritual beliefs motivated villagers to develop place-based innovations to adapt local resources to ongoing challenges.[16] However, inclusive innovation depends on creating opportunities for marginalized groups and civil society associations to speak for themselves in a free and fair environment, without any top-down impositions or expectations.[17]

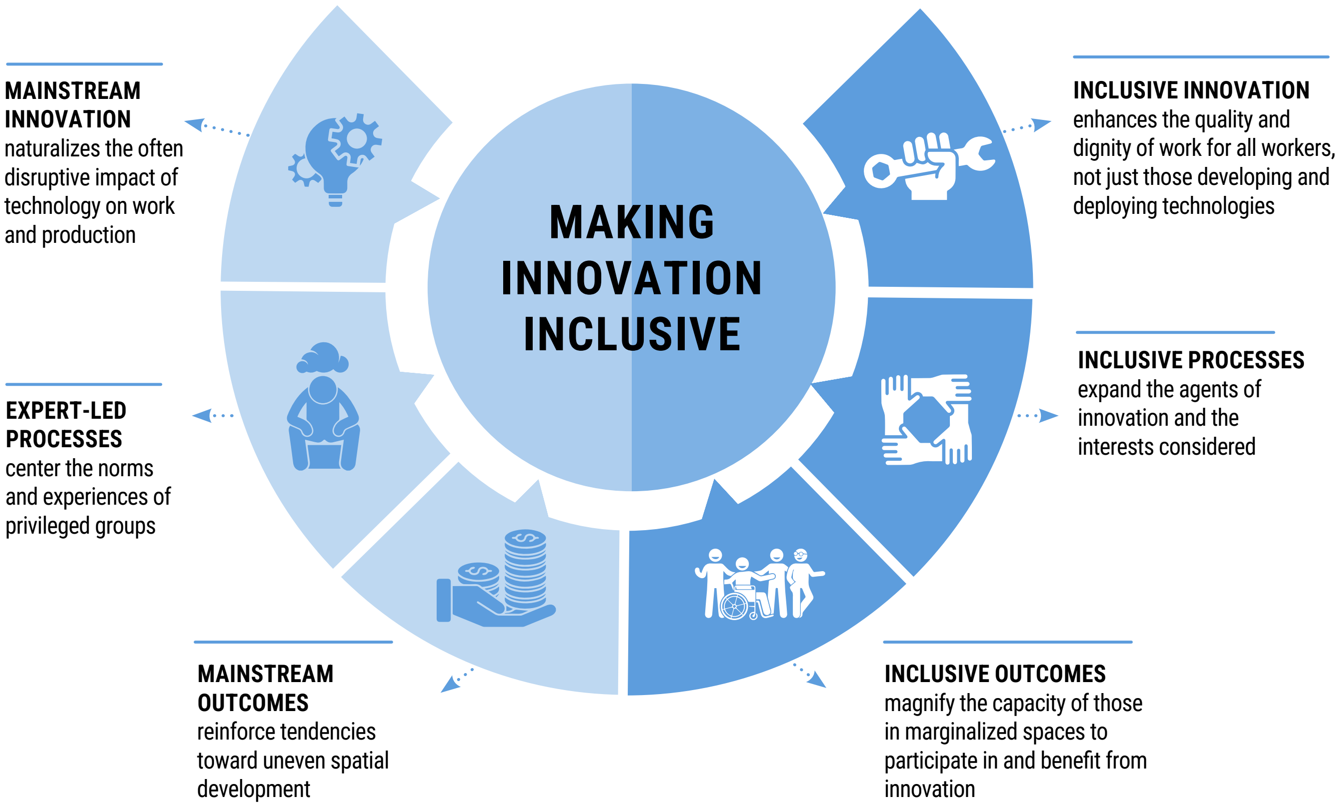
International support for innovation and technology transfer has long been part of the Conference of Parties (COP) climate negotiations but seems not enough to palliate current deficits

There are, however, obstacles to the development of inclusive innovation. International support for innovation and technology transfer has long been part of the Conference of Parties (COP) climate negotiations but seems not enough to palliate current deficits. Countries with weaker institutional systems struggle to generate, exchange and collaborate on ideas, leading to lower rates of innovation. At the same time, they often face barriers to accessing traditional financing mechanisms to advance their capacity to innovate.[18]

In contexts where public resources are unavailable, international aid programs may promote inclusive innovation. For example, the United Kingdom (UK) Department for International Development (DFID), now integrated into the Foreign Commonwealth and Development Office) delivered place-based innovations to improve women's safety in cities like Nairobi.[19] However, critical research showed that such programs are transformative only when they directly tackle existing drivers of discrimination, for example by facilitating the visibility of women in electoral processes.[20]

Global aviation © Shutterstock

Figure 8.2: Mainstream innovation vs inclusive innovation



Illustrated by Vanesa Castán Broto based on the discussion in Schrock & Lowe, 2021.

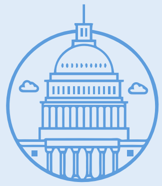
Neither public support nor international aid can substitute for dynamic networks of innovators able to link existing technological developments with specific social and environmental outcomes to respond to climate change. In practice, inclusive innovation is not well integrated into development programs.[21] The spread of the internet and digital technologies facilitates knowledge spillovers that benefit smaller companies with less access to research and development (R&D),[22] but those seem insufficient to accelerate inclusive innovation. The private sector is often slower in taking up inclusive innovation programs articulated in development programs.[23] Limited resources and time, alongside a poor understanding of innovation processes, hinder inclusive innovation. [24] Fostering diversity within private sector companies, for example through gender-diverse boards, tends to foster inclusive innovation.[25]

Even when the conditions are appropriate, there are risks in delivering inclusive innovation. First, inclusive innovation tends to generate place-based forms of practical knowledge that, without reaching scale, may not receive further support or funding within existing markets. Second, when inclusive innovation provides scalable solutions, powerful companies or other stakeholders may appropriate them as commercial products at the expense of their inherent public value. Further, those trajectories also depend on dominant ideas about knowledge production and the concentration of innovation resources in certain locations and sectors of the population that are formally sanctioned as "knowledge producers", influencing policy and planning practices.[26] Expanding the range of actors engaged in innovation helps direct resources to people who are already making efforts to deliver it and challenge established innovation trajectories.

Policy strategies must deliberately address the concepts of inclusive innovation to reach vulnerable populations. A supportive national agenda for inclusive innovation can catalyze and integrate inclusive innovation into large-scale actions. However, local institutions also provide additional momentum and support, particularly when inclusive innovation is closely tied to local development agendas. For example, since 2016 the Design Tech Academy in the city of Saint-Etienne, France, has provided digital skills to low-income immigrant youth through the combination of the local government's prioritization of urban design, the availability of national funding and the participation of intermediaries such as Telecom Saint Etienne.[27] Other cities have also established similar examples of integrated, inclusive innovation strategies (Box 8.2).

Policy strategies must deliberately address the concepts of inclusive innovation to reach vulnerable populations

Box 8.2: Integration of inclusive innovation in urban development strategies in large cities



WASHINGTON DC

In Washington, DC in the United States (US), the mayor adopted the 2016 Pathways to Inclusion Strategy to diversify the tech economy and established an Innovation and Technology Inclusion Council. An inclusive innovation incubator provides disadvantaged groups access to tech-entrepreneurship.

PITTSBURGH, PA

Pittsburgh (US) has branded itself as an "inclusive innovation city" and in 2015 adopted an inclusive innovation roadmap. Action areas: improving city operations, closing the digital divide, connecting citizens to local governance, supporting local businesses and clean technologies, and championing open data.

LONDON, UK

In London, UK, inclusive innovation is integrated into existing strategies for economic development, such as the local enterprise partnership London LEAP. Specific "inclusive innovation districts" include the Olympic Park site and the Borough of Camden's inclusive innovation network.

Source: Lee, 2023.

Beyond public policy and urban development planning, local governments can further facilitate inclusive innovation for just urban transitions. One way to do this is to tie inclusive principles to the actual practices of innovation that occur in urban environments through models that redefine the agents of innovation in climate action, bringing forward the role played by citizens and communities. These are below-the-radar, citizen-oriented approaches to inclusive innovation that can play a crucial role in development and urban climate action.[28]

Involvement in *innovation platforms* is one way that city governments have gained a presence in innovation processes at the local level.[29] Innovation platforms consist of nodes of encounter for multiple stakeholders to work together to respond to a shared challenge. For example, a case study of four municipal-led innovation platforms in Sweden showed that the presence of embedded municipal institutions served to establish clear normative frameworks and create opportunities for knowledge exchange and development. They intervened in a range of areas, from accelerating

Sustainable neighbourhood in Almere, The Netherlands. The city heating (stadswarmte) in the district is partially powered by a solar panel island (Zoneiland) © Shutterstock

the adoption of technologies for a bio-economy to developing large-scale sustainable regeneration projects, as well as delivering material improvements in the environment of deprived districts.[30]

Sometimes, strategies focus on *cluster innovation*. Cluster innovation refers to instances where a process is created which then makes it possible for the innovation to emerge: participants may have different roles, but it is the process, rather than the activities of any one actor, which makes a difference. International development assistance programs in countries like Bolivia have emphasized the potential of cluster innovation to manage polluting industries, such as the leather industry. Still, the emphasis on business innovation sometimes distracts from the potential inclusive effects of these programs, which depend heavily on having intermediary institutions, such as universities or NGOs, capable of mediating such inclusion.[31]

While activist-led networks routinely play an important role in delivering grassroots innovations, their maintenance over time depends on maintaining sustainable partnerships with local governments and institutions

Grassroots innovation refers to bottom-up solutions generated by networks of activists and organizations in ways that respond directly to the local context of action and include the interests and values of the communities involved.[32] Local governments can work with intermediaries and other interlocutors that help mobilize communities in planning and implementation of the just urban transition. For instance, organizations such as the Climate Justice Network [33] and the Voices for Just Climate Action[34] actively work to deliver grassroots innovations. However, while activist-led networks routinely play an important role in delivering grassroots innovations, their maintenance over time depends on maintaining sustainable partnerships with local governments and institutions. Box 8.3 elaborates on two examples of how community-led organizations in Kenya and the Philippines have engaged in climate innovations through partnerships with local governments and other actors.

Box 8.3: The role of community-led partnerships in catalyzing innovative climate action

Community partnerships, particularly with those traditionally excluded from decision-making such as informal settlements, have enormous potential to drive innovation. Besides strengthening the rights and opportunities of marginalized groups, these collaborations also tap into local skills, perspectives and knowledge that all too often are overlooked during the development of climate actions. Local governments, businesses and other city residents can benefit enormously from such alliances through grassroots engagement, participatory data collection and other activities.

This is illustrated by an array of initiatives in developing countries across the world that have brokered community-led collaborations. For instance, the Philippines Alliance, a network of NGOs that support the Homeless Peoples Federation of the Philippines, has worked since the 1990s to facilitate access to housing and manage disasters among the poorest communities in the country. In 2023, one of the Philippines Alliance partners, the Technical Assistance Movement for People and Environment, Inc. (TAMPEI), launched the project "Resilience of informal communities in rapid urbanization" (RURBANISE) to increase the resilience of informal settlement dwellers across the country.[35] Working in collaboration with the University of the Philippines and other partners, the project aims to introduce a variety of risk management innovations, such as advanced spatial analysis and the co-production with communities of 3D maps with 3D printers. The project demonstrates innovative ways to combine technology and forms of collaborative knowledge production to deal with the immediate challenges in vulnerable communities.[36]

In Kenya, the Kisumu Waste Pickers Welfare Association (KIWAPWA) - a collective of 15 groups, comprising 250 waste pickers dedicated to innovating waste management solutions – has made significant contributions in advancing locally – led climate action. Their efforts have improved environmental hygiene in Kisumu and enhanced public health by reducing the prevalence of communicable diseases like diarrhea and cholera. As one of the networks of Muungano wa Wanavijiji, a federation of slum dwellers in 21 counties in Kenya, KIWAPWA has successfully partnered with the Kisumu County government. Through this collaboration, they advocate for the construction of waste recovery centres in every ward and collaborate with the city government and other stakeholders to promote household-level waste segregation.[37]

Source: University of Sheffield, Urban Institute, 2024, and Muungano Wa Wanavijiji, 2024.

Frugal innovation is innovation that aims at reducing the input in economic and social activities to achieve sustainability. Since the objective is minimizing the use of resources (such as raw materials, energy, fuel, water, waste and finance), frugal innovations tend to be affordable and accessible, making them ideal for large-scale transformations in rapidly growing urban areas where resources are scarce.[38] Frugal innovations recognize the role of simple, accessible alternatives. Examples in the energy sector include electricity-free clay fridges, lights made with plastic bottles and the adoption of traditional construction techniques to improve house ventilation. Local institutions may play a fundamental role in helping replicate some of these frugal innovations, sometimes simply through information-sharing campaigns.

Mundane innovation relates to all the above categories but focuses on the innovations that address routine day-to-day contexts without aiming to disrupt existing regimes. Mundane innovations emerge from the observation of routine activities. Anyone can lead them, but it is increasingly evident that when innovation programs at any level of governance engage with mundane challenges, those innovations have greater relevance and may lead to social change of the kind required for a just transition. These ideas of innovation provide insight into how to do newness differently. They start by putting people's ideas and interests at the core of the process, at the same time ensuring that those interested in innovation are themselves leading the innovation process. In doing so, inclusive innovations can advance the interests of groups of people who may otherwise be excluded from the just urban transition. Table 8.2 summarizes the different models that local government can engage to further advance inclusive innovation.

Table 8.2: Models to deliver inclusive innovation

Models	Mechanisms	Benefits
Innovation platforms	Mechanisms whereby multiple stakeholders work together to respond to a shared challenge	Creation of multi-stakeholder arenas for the discussion of collective challenges
Cluster innovation	Collective forms of innovation in which the innovation can only be attributed to the collaborative process	Co-design studios in which facilitators catalyze innovation processes
Grassroots innovations	Innovation generated by citizens' groups or communities.	Support and mobilization of activists fighting for a common cause.
Frugal innovation	Innovation directed to simplify and reduce production processes, especially at the local scale	Active engagement with challenges about reducing the local use of resources and energy
Mundane innovation	Innovation that emerges within the needs of specific life practices	Connecting knowledge generation to routine experiences of living in the city

In summary, local governments can foster inclusive innovation through a variety of approaches, including policy, urban planning and models for generating inclusive innovation. Table 8.3 provides an overview of strategies that support an inclusive innovation ecosystem capable of routinely generating locally relevant and just transition innovation.

Table 8.3: Approaches for local governments to foster inclusive innovation ecosystems

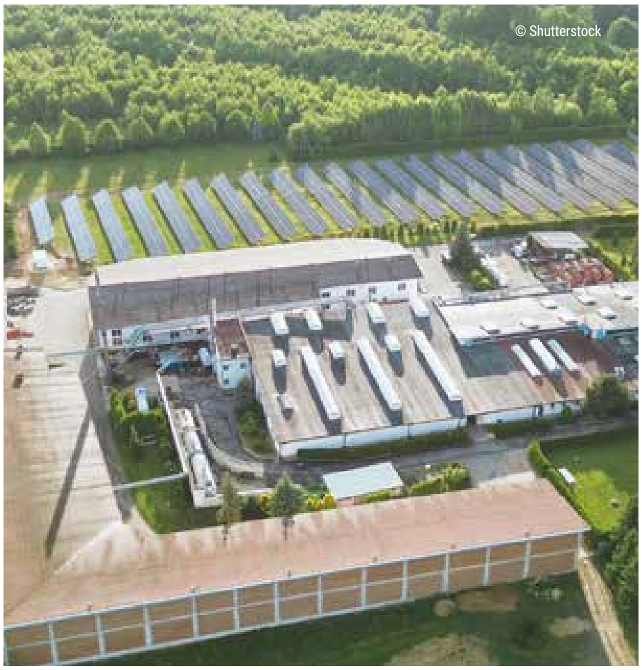
Areas of action	Policy	Objective	Examples
Strategy and policy making	Participation in innovation policy	Facilitate the inclusion of diverse perspectives in the development of innovation policies	Citizen boards or councils that provide advice on innovation policy
	Prioritization of sectors that favor inclusion	Shifting innovation funding to foundational or mundane sectors	Prioritization of key sectors in national innovation strategies
	Diversification of innovation	Facilitate the development of an innovation environment in low-innovation regions	Regional development policies
	Innovation for inclusion	Invest in innovation in the areas of concern for disadvantaged populations	Focus on innovation in public and social services
Participation and access	Participation in entrepreneurship	Provide access to disadvantaged groups to entrepreneurial resources and skills	Business incubators for disadvantaged groups
	Participation in the innovation workforce	Provide access to disadvantaged groups to jobs in STEM	Employment programmes and fairs in STEM sectors
	Participation in education	Provide access to disadvantaged groups to STEM education	Educational policies to promote STEM
Impact and outcomes	Minimizing impacts of innovation	Ensure that innovations have minimal impacts on disadvantaged populations or provide remedial action	Technology impact assessments
	Specific inclusive innovations	Focus on a particular innovation that favors disadvantaged groups	Solar lamps designed for informal settlements
	Innovation for inclusive development strategies	Tie in specific innovations to wider development objectives	Innovation-focus development programmes
	Innovation diffusion	Policies that facilitate access to new technologies	Policies addressing the digital divide

8.2 Implications of Global Development Agendas for Urban Transition Innovation

Policy and strategies for urban transition innovation occur within the broader context of global agreements aimed at fostering innovation. The Sustainable Development Goal 9 (SDG 9) seeks to "build resilient infrastructure, promote sustainable industrialization and foster innovation". SDG 9 recognizes the relationship between knowledge production and innovation capacities, seeking to increase public and private R&D spending. The last progress report explains that investment in R&D has increased globally, alongside advances in mobile connectivity that enhance research and knowledge production infrastructures.[39] However, this progress is uneven.

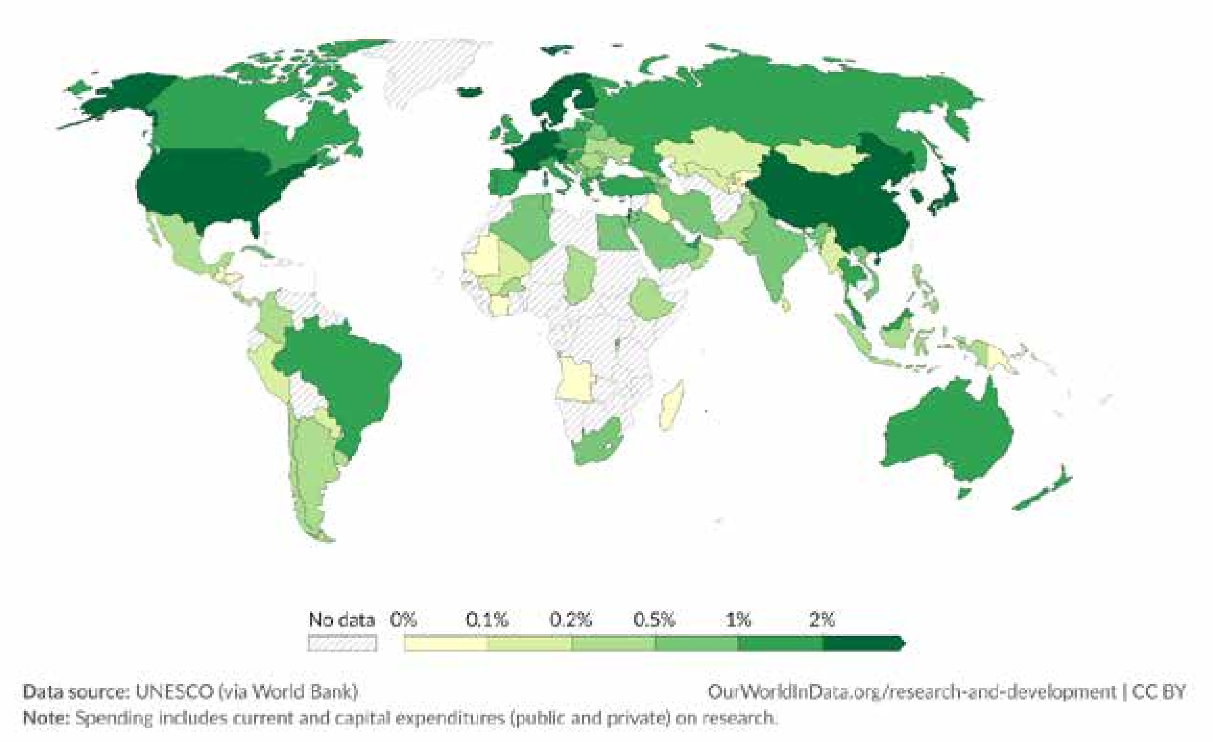
8.2.1 Analyzing innovation indicators from SDG 9

Investments in R&D as a share of Gross Domestic Product (GDP), as reflected in SDG indicator 9.5.1, suggests wide disparities between countries in the investments available for innovation (see Figure 8.3). Furthermore, within countries innovation also tends to concentrate spatially, though it is unclear to what extent geography and the level of urbanization are significant determinants in themselves of the pattern innovation takes.[40]



Sustainable Industrial Facility with Solar Power Plant

Figure 8.3: R&D spending as a share of GDP, 2021



Source: Our World in Data, 2024a.

Rather than concentrating only in the largest urban centres, innovation appears to emerge in diverse locations and settings, although in countries such as Republic of Korea and the United States (US), patents are concentrated in large metropolitan areas.[41] The focus on patents has generated a discussion about how urban areas provide opportunities to grant higher returns on innovation, for example, facilitating the rapid patenting of new ideas to bring to markets.[42] However, the indicator of patents does not reflect the diversity of innovation. Many innovations for climate-resilient development, especially nature-based and social innovations aimed at lifestyle changes and adaptation, are not easily formalized or marketable. Their success in promoting transitions depends more on the quality, adequacy and direction of innovation than on their quantity.[43] Secondary cities, overlooked regions, rural locations or remote areas may provide the conditions for the diversification of entrepreneurship, generating latent or unpublicized innovations that - while often ignored in dynamic urban economies – are nevertheless crucial to building resilience.[44] This underscores the urgency and significance of approaches to innovation policy that emphasize regional balance across the different dimensions of innovation.

Table 8.4 shows an overview of conventional economic policies to stimulate innovation at different geographical levels and across sectors. The specialization of certain cities, for example, in the creative industries may provide an innovation advantage that policymakers may wish to support through targeted policies.[45] Fostering innovation in a particular location and sector, for example, may require concentrating resources in particular areas. However, imbalances in access to knowledge and resources may also generate structural inequalities in access to knowledge resources. Such policies therefore may not be sufficient to stimulate the broader range of innovations required for resilience.

Table 8.4: Conventional policies to stimulate innovation across different geographical levels and sectors

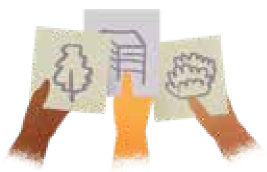
Levels Of Governance	General Policies	Industry And Sector Policy	Firms
National State	Tax Code Patent Policy Non-Compete Clauses	Industry-Specific Tax Support or Subsidies	Loans and Guarantees
Local Government	City-Wide Taxes and Business Regulations Supporting Infrastructures (E.g., Mobility)	Industry-Specific Support for Specific City- Based Sectors	City-Level Tax Breaks City-Tied Contracts
Neighbourhood	Empowerment Zones Local Infrastructures	Innovation Clusters Targeted Infrastructures	Specific Infrastructures and Labour Force Support

Source: Adapted from Chatterji et al., 2014.

Innovations are, however, driven by people. Hence, another indicator of innovation is the presence of an "innovation class" capable of driving innovation forward. The SDG indicator 9.5.2 focuses on the proportion of R&D researchers (professionals "engaged in conceiving or creating new knowledge, products, processes, methods or systems"), showing gross inequalities across countries once again (see Figure 8.4).

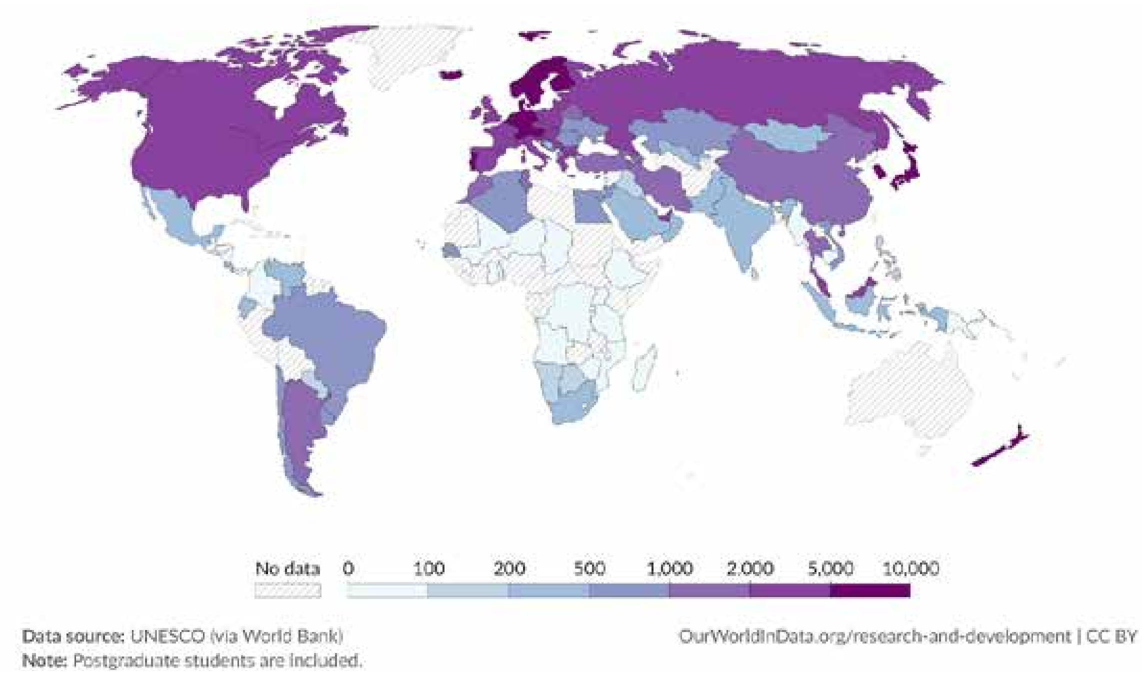
However, at the urban level, rather than the overall number of R&D researchers, what counts is the interactions between a class that could be thought of "creatives" (those who produce original ideas) and "makers" (those who transform those ideas into useful outputs).

For example, in US cities, empirical evidence suggests that the combination of creative and STEM activities fosters innovation.[46] Promoting innovation thus depends on accommodating different industries and groups of workers, prioritizing diversity over the development of specific skills. In advancing climate-resilient development, the diversification of innovation actors must be extended to incorporate those actors with specific experiential or historical knowledge, particularly seeking to reveal those types of knowledge that may remain invisible.[47] For example, many cities can benefit from the creative storytelling and oral transmission methods through which Indigenous Peoples share knowledge relevant to understanding and responding to climate change.[48]



Many cities can benefit from the creative storytelling and oral transmission methods through which Indigenous Peoples share knowledge relevant to understanding and responding to climate change

Figure 8.4: Number of R&D researchers per million people, 2021



Source: Our World in Data, 2024b.

This analysis suggests the following policy recommendations:

- While specialization may give an advantage to some regions, a balanced approach to facilitate innovation (including supporting overlooked regions) may provide further opportunities for innovation in the longterm.
- Within cities, facilitating the interaction between creatives and practically-oriented STEM workers and technicians may generate innovations that bridge originality with social purpose.

8.2.2 Innovation and urban policy in Nationally Determined Contributions (NDCs)

Perhaps the most important policy tool for transitions to climate-resilient development is the NDCs. Since the Paris Agreement, the NDCs have become the main instrument for international negotiations, including establishing the "headline numbers" that indicate progress towards global emission reductions (see also Chapter 2).[49] At the same time, given that at least in principle they signal a country's budgetary commitments and political priorities for years to come, NDCs play an important role in shaping local level action.[50] However, the influence of NDCs on innovation, specifically urban innovation, is not well understood.

The first generation of NDCs, produced in the wake of the Habitat III conference and the New Urban Agenda, contained urban references. Still, only 26 out of 164 NDCs were judged to have "strong" urban content, mostly countries facing the challenges of rapid urbanization in countries in Africa or large-scale urban challenges such as in India and China, with another 87 having "moderate" urban content.[51] In general, urban innovation was not a strong concern of the NDCs. However, an updated report in 2022 found increasing urban content, with a greater emphasis on responses rather than challenges in sectors such as energy, transport and waste.[52]

Current policies of transition in cities depend first of all on the NDCs and how they have translated into national and urban policy. In this regard, it is tentatively encouraging that over two-thirds of the NDCs pay substantial attention to the question of innovation in climate action, either putting innovation at the core of their strategies or proposing specific measures to promote innovation. NDCs from countries such as Azerbaijan, Bolivia, Brazil, Canada, China, Indonesia, Mexico, Panama, Sri Lanka or Türkiye highlight innovation as a key enabler of climate change mitigation, adaptation and sustainable development. The need for collaboration at multiple scales between governmental institutions, civil society, academia, and international organizations to facilitate innovation is central to many national strategies, including Bahamas, Cambodia, Egypt, El Salvador, Lesotho, Oman and Saudi Arabia. For example, Lebanon's policies seek to foster an innovative environment driving public research investment in research and encouraging innovation labs.[53] Liberia's NDC explains the development of an education and communication plan to establish R&D centres and multi-stakeholder platforms within communities.[54] Technology transfer is a common theme in many NDCs.

Over two-thirds of the NDCs pay substantial attention to the question of innovation in climate action, either putting innovation at the core of their strategies or proposing specific measures to promote innovation

The majority of NDCs adopt a sectoral approach to innovation. One of the sectors that receive most attention is agriculture, with proposals to advance digital technologies and smart techniques,[55] irrigation technologies,[56] social innovation to improve the effectiveness of the supply chain,[57] vertical farming,[58] hydroponics[59] or organic cultivation methods.[60] The NDC of South Sudan, for example, pays particular attention to innovative business models that can enable adequate transport and cold-storage solutions to reduce post-harvest losses.[61] Innovations in forestry,[62] aquaculture[63] and coastal restoration[64] are also commonly mentioned in the NDCs. Other sectors that are perceived as innovative are energy, water and waste management, and adaptation. A few countries mention climate technologies for carbon capture, storage and use, and in some cases nature-based solutions (NbS) for mitigation.[65]

There are, however, few NDCs that consider urban innovation explicitly, although different forms of urban innovation intersect with sectoral proposals. Innovations in mobility (smart mobility and clean technologies) are the most common.[66] The built environment is also perceived as providing opportunities for innovation, for example through designs that improve energy efficiency,[67] the incorporation of nature-based design in buildings and infrastructures,[68] or the incorporation of traditional materials and construction techniques.[69] Singapore, for example, has established a Green Buildings Innovation Cluster program to support the development of energy-efficient building technologies.[70] Similarly, Moldova recognizes the role of municipalities in advancing innovative solutions in infrastructure resilience projects.[71] Morocco's eco-district proposal, meanwhile, aims to capitalize on innovative sustainable city systems by establishing a charter for eco-neighbourhood projects to leverage finance and engage residents in sustainable futures.[72]

While the NDCs anticipate a supportive policy landscape for transition innovations, there is a need for a coordinated approach to building partnerships across actors and sectors to deliver net zero and resilient cities

There is a strong theme through the NDCs linking innovation and economic development. The assumption of growth is a constant in every NDC. Some see innovation as a means to attract private investment in sectors where they have less presence, such as Disaster Risk Reduction (DRR),[73] or to foster productivity[74] and facilitate industrial development.[75] Republic of Korea, for example, proposes the establishment of "innovative green industry ecosystems".[76] Innovation is also seen as a means to advance more sustainable economic arrangements, for example by facilitating the establishment of a circular economy,[77] the entry of small companies,[78] inclusive economic growth[79] or the provision of the means for economic diversification, particularly in economies dependent on one sector, such as tourism.[80] The UK's Net Zero Strategy, for example, foregrounds innovation together as a means for job creation with a focus on green, high-skilled jobs, but urban concerns are only highlighted in transport and mobility questions.[81]

Nevertheless, most NDCs take an expansive view of innovation beyond narrowly defined technological innovation. Many propose measures for a range of social innovation: innovation that generates new social practices and institutions. A number of NDCs emphasize the need for financial innovations. Some of the suggestions include mechanisms to facilitate payment for ecosystem services,[82] cooperation mechanisms such as blended finance,[83] risk-sharing insurance products,[84] and adaptive green finance using ICT technologies: for example, innovations that enable the distribution of funds across government[85] or allow disadvantaged groups to access finance.[86] The 27 European Union (EU) countries, in a collective NDC, have now established their Emissions Trading System (ETS), the world's first and biggest carbon market, as a means to finance a €40 billion (approximately US$44 billion) innovation fund from 2020 to 2030, supporting innovations in mobility and net zero buildings among other areas.[87] The combination of carbon restrictions and financial support appears to have a positive impact on patents and innovation· Still, there is generally a consensus that the system has not delivered the technological breakthrough to achieve carbon neutrality.[88]

Some NDCs also explain specific aspects of policy innovation, such as measures to increase equality, planning policies and implementation mechanisms. Some countries, such as Mexico, have targeted areas of social innovation, for example through a National Strategy of Remote

Working.[89] Social innovation is also a means to tackle disadvantages, although the means to tackle these challenges are usually modest.[90]

In summary, the comparative analysis of the NDCs shows the growing importance of innovation, including NbS and social innovation, as a strategy for climate-resilient development. However, a sectoral approach still dominates. In urban environments, innovations are emphasized in the energy sector, the built environment, and transport and mobility. Thus, while the NDCs anticipate a supportive policy landscape for transition innovations, there is a need for a coordinated approach to building partnerships across actors and sectors to deliver net zero and resilient cities.

The following section explores integrative approaches to transition innovation that seek to mobilize and coordinate three domains of innovation: technological, nature-based and social innovations. It highlights four key areas with significant potential for urban transition—energy mix, networks and storage, urban electrification, and demand management—and discusses interrelated strategies for scaling transition innovations in these areas.

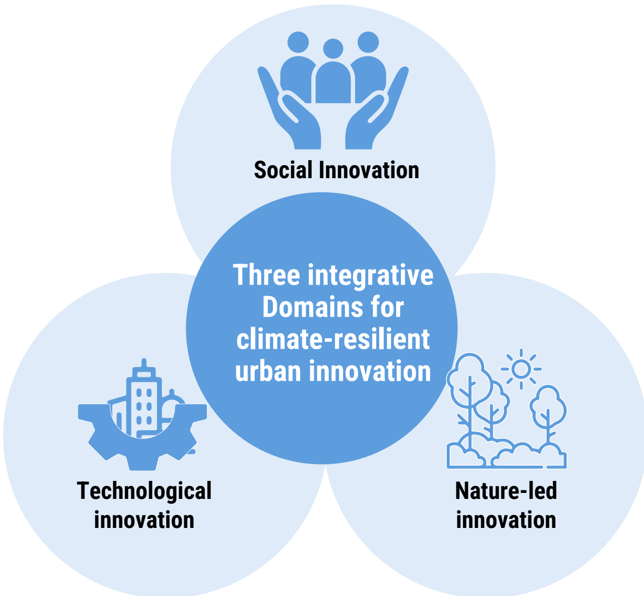
8.3 Domains and Strategies for Integrative Approaches to Transition Innovation

As highlighted by the IPCC, there is a wide range of technological innovation that can be deployed for climate action.[91] Affordable and existing innovations will enable significant emission reductions and adaptation before 2030, but further innovation, as well as integration and coordination across innovations, will be needed to break dependencies from unsustainable economies to realize climate-resilient net zero cities. For example, lifestyle changes to reduce dependence on fossil fuels are interlinked with changes in infrastructure and urban form that privilege the petrol car over more sustainable modes of transport, as well as changes in extractive practices, reaching within and beyond the city.[92]

Therefore, thinking of the transition towards net zero requires looking beyond specific innovations to consider the broader perspective of the shifts needed in existing technologies, infrastructures and the supporting ecosystems towards more sustainable social practices and economic systems. These include appropriate governance and institutional conditions that enable the sharing, diffusion and co-creation of innovation, for example through collaborative spaces to test and pilot urban innovation, as well as the fixity of infrastructures and the ecological dynamics of the city.[93]

Three domains of innovation are possible to foster a transition, but achieving this potential depends on integrating responses across such domains (see Figure 8.5).[94] Transition innovations can emerge in any domain, but impact on all of them.

Figure 8.5: Three domains for climate-resilient urban innovation

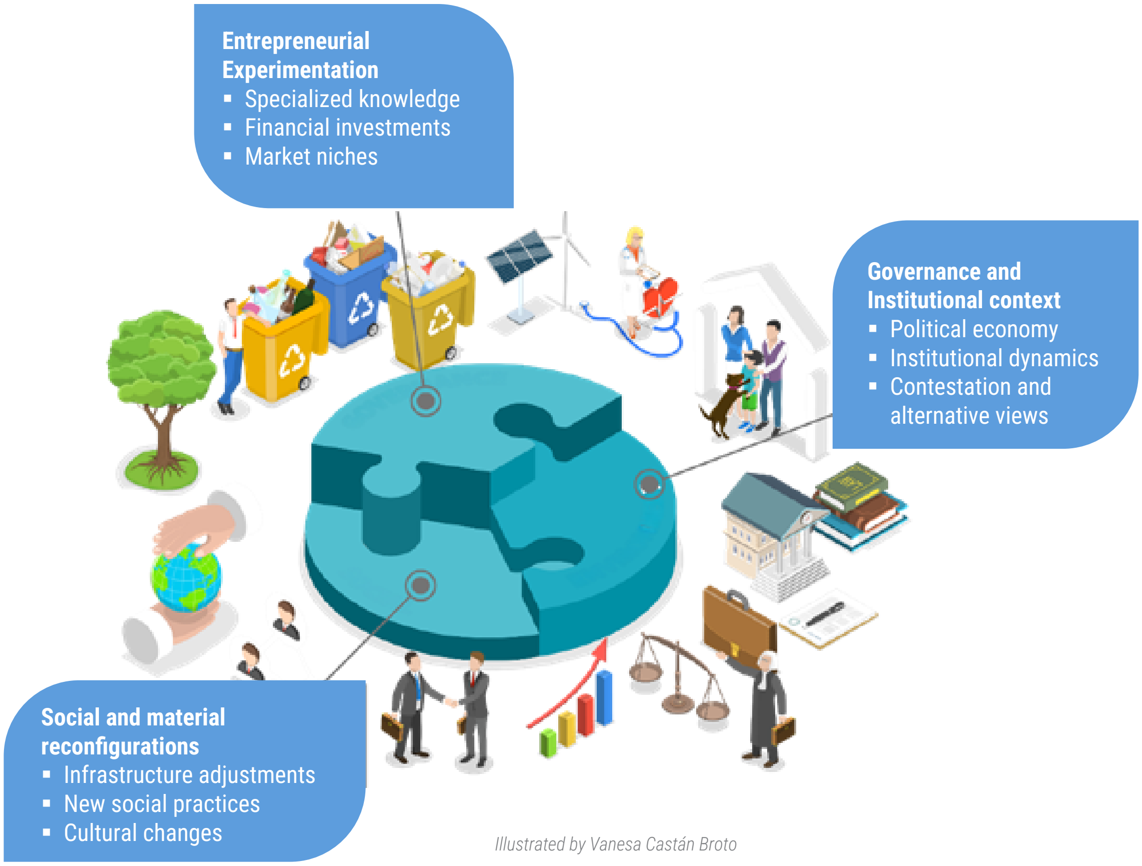


Illustrated by Vanesa Castán Broto based on Dodman et. al., 2022.

Agents of change in urban environments—policymakers, planners, private actors and civil society—face the complex question of how to exploit the possibilities for place-based action offered by cities to catalyze transition innovations while mobilizing global knowledge and facilitating learning across contexts.[95] This means recognizing that transition innovations are generated within a wider context of innovation.

Digital graphics overlay a cityscape © Shutterstock

Figure 8.6: Dimensions of transition innovations in an urban context



Illustrated by Vanesa Castán Broto

As outlined in Figure 8.6, there are three main areas of intervention that may support the generation of contextually situated, integrated transition innovation in an urban context.[96]

1. *Facilitating spaces for entrepreneurial experimentation* with multiple innovations, whether this is within existing businesses and industries or in purposively developed arenas such as urban labs: for instance, local governments, national-level institutions, and donors may choose to *develop policies* that favor entrepreneurial experimentation, such as supporting SMEs or facilitating the development of innovation systems.

2. *Articulating an appropriate governance and institutional context* that enables the sharing, diffusion and contestation of innovation through collaborative spaces to test and pilot urban innovation: for example, local authorities and partners can support an innovation-oriented political culture through *forums of debate and exchange* that enable sharing and contesting innovations.

3. *Promoting innovation within a spatial and socio-cultural reconfiguration* that creates demands for innovation within existing infrastructures, inhabitation practices or ways of thinking: for instance, local actors may *support practical actions* to intervene through place-based innovations in existing infrastructures and cultures, for example, by identifying incremental innovations emerging spontaneously within the current systems of provision and workforce.

The three domains are closely interrelated and broaden the possibilities of action to develop innovation policies at the local level and extend the range of actors in transition innovations. Each one is discussed further below, highlighting key opportunities within each domain.

8.3.1 Technological innovation

Technological solutions for reducing carbon emissions and enhancing adaptation are being deployed across various urban systems, including renewable energy, energy efficiency, food systems, urban planning, data analysis, water supply and waste management. Energy systems are especially important as they underpin urban life and modern economies. Urban areas account for as much as 70-80 per cent of the global carbon footprint,[97] predominantly in electricity and heat generation, transportation and the production of industrial goods. Transition innovations that focus on the structural shift in energy source towards clean energy, as well as improving energy consumption efficiencies such as upgrading fittings in buildings and appliances, can significantly contribute to restraining emissions.[98]

Four areas hold significant promise for developing transition innovation for the net zero city: diversification of the energy mix, transforming networks and storage, urban electrification and demand management

Four areas hold significant promise for developing transition innovation for the net zero city: diversification of the energy mix, transforming networks and storage, urban electrification and demand management.

First, the proliferation of *accessible and versatile renewable technologies* allows the diversification of the energy mix through the use of various alternative energy sources and the decentralization of power systems (for example, small-scale household solar photovoltaic systems). The surge in the adoption of solar systems within urban areas has spurred a growing demand for solar panels that exhibit enhanced flexibility and reduced weight.[99] These qualities are vital for ease of mobility, efficient distribution and adaptability to diverse applications, especially on uneven surfaces, while remaining cost-effective. While renewable energy continues to be a key area of interest, the past decade has seen a significant shift in focus toward exploring and advancing novel energy forms such as hydrogen.[100]

Second, there have been fascinating advancements in delivering *more efficient networks and better storage alternatives*, with increasing attention to the development of the battery industry and how it is shaping regional and urban policy. Increasingly, attention is being given to the potential of infrastructures as energy generators. Roadway energy harvesting[101] uses innovative electromagnetic technologies that have been proposed and developed to efficiently capture and convert energy from diverse sources present on roadways.[102] Solar energy harvesting technology is gaining popularity globally,[103] and in increasingly innovative ways: for instance, installing solar panels atop pavements transforms them into functional driving surfaces.[104] These and other technologies are also enabling the development of community and off-grid energy systems (see Box 8.4).

Box 8.4: The promotion of off-grid community energy systems in informal and peri-urban settlements in Malawi

Community and off-grid energy systems, which have often been seen as a solution for remote rural areas, are increasingly also recognized as a viable alternative in informal settlements and peri-urban areas where residents lack access to electricity even when living under the grid.105 The deployment of these flexible, autonomous modes of energy generation can enable the adoption of more accessible, citizen-controlled electricity networks in urban areas. Moreover, community energy systems may help accelerate shifts to more sustainable urban practices, such as the electrification of cookstoves (still a significant source of household air pollution in developing cities in particular).

In Malawi, a suite of regulatory mechanisms has enabled the development of community energy innovations, supporting the diversification of the country's energy network. Since 2006, various micro-and mini-grids powered by renewables – solar PV, wind power, hydropower and hybrid systems – have been implemented, supported by institutional innovations like cooperatives and community associations and a conducive regulatory context. The 2004 Malawi Electricity Act and 2017 Renewable Energy Strategy were pivotal, enabling community energy systems and collaborations with NGOs.

Initiatives in the energy sector have been complemented with regulations in other sectors. For example, the 2017 National Charcoal Strategy, aiming to reduce deforestation, promotes using alternative fuels through community development. Despite challenges such as equipment access and natural disasters, these projects have advanced low-carbon energy and community resilience, as well as social co-benefits to the community.

Source: Hara et al., 2024.

Third, *urban electrification* is increasingly seen as an important strategy to facilitate fast decarbonization. Urban electrification entails the adoption of electric power as the primary source of energy in city-wide urban infrastructures, the built environment and transportation. In addition to efficiency gains, urban electrification supports a positive feedback cycle with the development of renewable sources close to the city, enabling greater autonomy for local governments in their energy planning. For example, innovations in developing alternative propulsion systems (such as new battery and cell technologies) have been a key strategy for sustainable mobility. Electric vehicles, for instance, are an important form of technological innovation that bring both environmental (reduced air pollution and carbon emissions) and social benefits (improved health and productivity).[106] Data from the International Energy Agency (IEA) shows that the proportion of electric cars in overall sales has surged, more than quadrupling in just three years—from approximately 4 per cent in 2020 to a remarkable 18 per cent in 2023.[107] The environmental and social benefits of the electrification of road transport depend on having renewable energy sources available, as well as appropriate charging points and road infrastructure planning. It is also important that different mobility needs are adequately recognized.[108] Cities are increasingly mobilizing transition innovations to integrate built environments and infrastructures into the grid.[109]

Fourth, *demand management* solutions also hold significant transformative potential. These are aimed at optimizing how and when energy is used to reduce overall consumption and shift usage patterns to align with sustainable practices.[110] How to deliver such transformation remains contentious, however. One approach is through delivering designs and infrastructure that facilitate sustainable choices, such as energy smart meters, automated building systems to manage electricity consumption or low-emission Bus Rapid Transit (BRT) lines. Another approach is through financial incentives or regulations, such as charging higher rates for electricity during peak hours or passing legislation mandating the transition to green energy systems within set timelines. Yet another approach advocates for the transformation of broader cultures of sustainability: in China, for example, there has been a concerted effort to build an "ecological civilization" to benefit society and the economy (see Box 8.5).

Box 8.5: Delivering an ecological civilization in China and its impact on cities

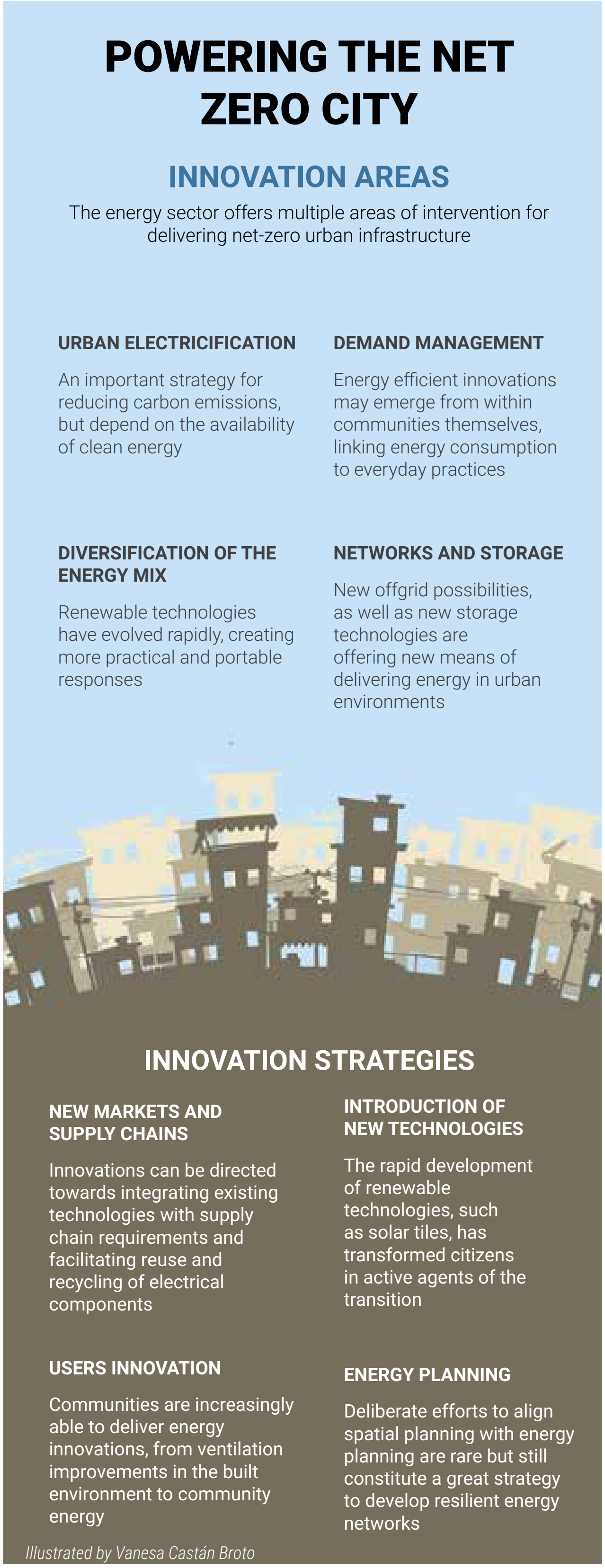
In 2018, China enshrined "ecological civilization" in its Constitution, signifying a national commitment to integrating ecological sustainability in its development strategy. The era of ecological civilization sets the stage for a wide range of environmental and climate initiatives, particularly in urban areas where the majority of China's population reside and climate action is most urgently needed. This commitment builds on previous efforts to promote a more sustainable mindset among city residents. Since 2006, for instance, local governments in China have piloted different forms of social organization, from group walks to outdoor sports events, that promote positive behaviours and interactions with nature and the environment.

A notable example is the revitalization of the traditional tea steaming practice in Enshi, a small city in central China, and transforming it through industrial innovation to bolster a more environmental – friendly and sustainable green tea industry. This has promoted a green transition of the local economy and brought about societal benefits such as poverty alleviation by raising the income of local tea farmers. Enshi's climate action illustrates the power of synergizing traditional practices with contemporary ecological goals to drive sustainable development and enhance social well-being.

Source: Based on analysis, Global Tea Hut, 2020,p.5 and Tea Spring, n.d.

Figure 8.7 provides an overview of the four transition innovation areas proposed in this section, together with four strategies that can activate the urban innovation ecosystem: supporting *new markets and supply chains* that respond to concrete urban needs, *introducing new technologies* through local programs of support, *engaging with community-led innovation* in saving and generating energy and *integrating innovation into local planning processes*. These should not be seen as four separate approaches to transition innovation, but rather closely interlinked strategic components that depend on the integration between urban planning, development and an understanding of local needs. For example, the EU introduced the Strategic Energy Technology Plan, aiming to establish 100 Positive Energy Districts by 2025 as part of its commitment to climate neutrality through enhanced energy efficiency and a net zero energy balance.[111] Concurrently, the continuous advancement of intelligent monitoring tools underscores a noticeable surge in the popularity of energy-saving technologies, seamlessly incorporated into the infrastructure of smart homes.[112] In terms of climate adaptation, increasing attention is paid to the relationship between energy and associated resource systems, particularly water and land resources.[113] The integration and coordination of these strategies suggest that local governments remain key actors who can advance transition innovations in urban environments.

Figure 8.7: Key areas and strategies with strong potential for transition innovation



8.3.2 Innovating with nature

There is a growing interest in NbS for adaptation and mitigation strategies. NbS involves using ecosystems and biodiversity to address climate-related challenges, such as coastal protection through mangroves, urban green infrastructure, and reforestation projects.[114] This requires reimagining nature as an integral part of the city, an area previously explored in detail in the *World Cities Report 2022*.[115]

The NDCs provide multiple examples of nature-related innovations. In some cases, these innovations address the negative impacts of urbanization on land transformations (see Box 8.6). These are particularly important not only because of urban expansion, but also because growing urban energy demands are met with large-scale renewable energy infrastructures that have direct impacts on ecosystems and can disrupt wildlife habitats.[116]

Box 8.6: Pine Island Project, Bahamas: An innovative approach to managing the increasing impact of urbanization on local ecosystems

Almost a third of the land in the Bahamas is covered by forest.[117] The pine forests are an important source of biodiversity and protection for both its soil and water. However, this invaluable natural asset is endangered by unsustainable land use planning and large-scale urban development, including the illegal dumping of waste and the displacement of traditional land uses. These threats are exacerbated by climate change impacts such as rising sea levels and coastal inundation.

In 2015 the Bahamas government, with support from the Global Environmental Facility, launched the Pine Island Project in an effort to balance the preservation of its natural ecosystems with the demands of managing urban expansion. A central focus of the initiative was its innovative approach to community co-management and enhanced land use planning methods that integrate biodiversity values, ecosystem services and concepts of sustainable forestry and land use. Recognizing the specific pressures posed by urbanization, the project expanded its team in 2019 to include an urban planning consultant, ensuring that urban growth does not undermine the project's implementation.

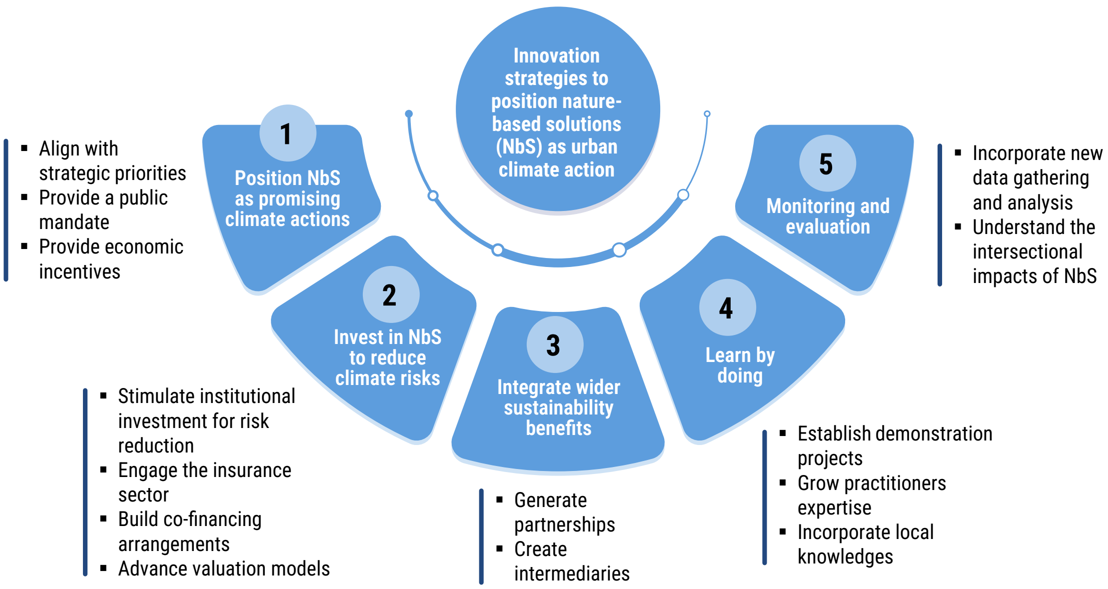
Source: UNFCCC, n.d., Bahamas NDC and UNEP, 2021b.

Sometimes NbS are also designed to create social solutions. The NDC in St Vincent and the Grenadines reports an innovative project that repurposes abandoned land into sustainable farming systems, with a parallel program to teach young people in schools the principles of organic agriculture, environmental art and innovative land uses that work with nature.[118] Many nature-based innovations enable engagement with the experiences of Indigenous Peoples (see also Chapter 6). In the case of Dominica, for instance, the government takes inspiration from innovations in waste and natural resource management by the Kalinago people, whose lives are directly threatened by climate change.[119]

A review of the role of NbS in climate change adaptation and mitigation identified a range of innovation strategies that can be advanced within urban environments.[120] Some of those strategies are directed toward changing narratives about the promise of NbS as climate action and integrating them into broader sustainability benefits. Other strategies are directed toward creating an appealing investment environment. Figure 8.8 illustrates various strategies to advance NbS in urban climate action. Two key strategies hold potential in scaling NbS within the urban context: on the one hand, learning-by-doing, and on the other monitoring and evaluation processes that facilitate such learning. Despite the growing enthusiasm for NbS and the range of benefits they bring, they are still a relatively novel area of action whose full potential has yet to be realized.

Volunteer picking up a plastic bottle in the woods. Green and clean nature/ Shutterstock

Figure 8.8: Strategies for positioning NbS in urban climate action



Credit: Illustrated by Vanesa Castán Broto
I

8.3.3 Social innovation

Unlike supply-side solutions that predominantly focus on technology, demand-side strategies emphasize harnessing social innovation.[121] Social innovation aims to cultivate new relationships through new practices and institutional networks that promote collaboration and learning beyond the traditional boundaries of citizen, government, private sector and civil society.[122] Social innovation is not in itself opposed to technological innovation (and often emerges associated with it):[123] for instance, social innovation can help reshape the consumption of goods and services by influencing decisions regarding technology adoption, consumption habits, behaviour and lifestyles.[124] However, because social innovation emphasizes the importance of building collective resilience, it is grounded on principles of cooperation rather than competitiveness.

Innovations for demand-side mitigation options operate through three strategies, known collectively as Avoid-Shift-Improve:[125] *Avoid* involves mitigating strategies that trim surplus consumption by redesigning service-provisioning systems; *Shift* entails transitioning to existing competitive low-carbon technologies and service-provisioning systems; and *Improve* concentrates on boosting efficiency in current technologies, emphasizing adoption by end users. Adopting a nuanced strategy for contextualizing climate solutions within urban settings necessitates the formulation of context-sensitive, place-based approaches intricately tailored to each city's unique dynamics.[126]

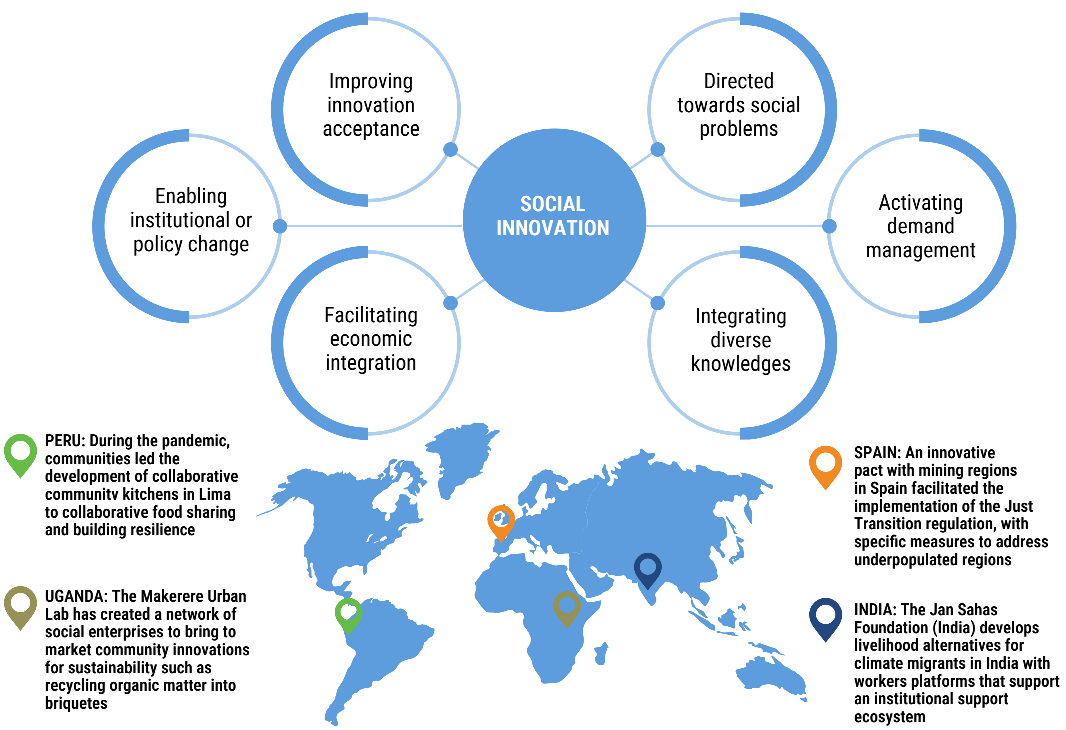
Indigenous knowledge, deeply rooted in the urban fabric, proves especially adept and often underpins important social innovations that are not even recognized.[127] For instance, in a city grappling with urban heat island effects, leveraging Indigenous wisdom may involve the integration of traditional architectural techniques that enhance natural cooling and promote sustainable urban design. Where flooding poses a recurrent threat, Indigenous insights could inform the development of resilient green spaces and community-driven flood preparedness plans. Despite their importance, however, Indigenous voices are most often absent from urban development planning.[128]

Indigenous knowledge, deeply rooted in the urban fabric, proves especially adept and often underpins important social innovations that are not even recognized

By fostering locally adapted and embedded solutions, social innovation broadens the spectrum of innovation agents, extending participation to ordinary individuals within local communities. By engaging a diverse array of actors, from grassroots community members to local institutions, the innovation landscape becomes more inclusive and reflective of the varied needs and insights present at the local level (Figure 8.9). This diversification enhances the effectiveness of climate initiatives by fostering a sense of collective ownership, empowering individuals to contribute actively to sustainable practices and resilience-building efforts.[129]

Social innovation is also linked to social infrastructure, which includes the spaces and institutions that allow people to connect and interact in mutually supportive ways. This can range from physical locations like meeting halls to organized networks of community support. Social infrastructure plays an enabling role in building cohesive communities and enhancing collective well-being, from fostering social connections for delivering effective disaster response.[130] Many social innovations help build social infrastructures, which in turn support social innovations that attend directly to community needs. For instance, a project by an NGO in a flood-hit area of Bangladesh operated boats as mobile emergency service providers, becoming a vital "beacon of hope" and cohesive public space for disaster-affected communities.[131]

Figure 8.9: Characteristics of social innovation and some examples from around the world

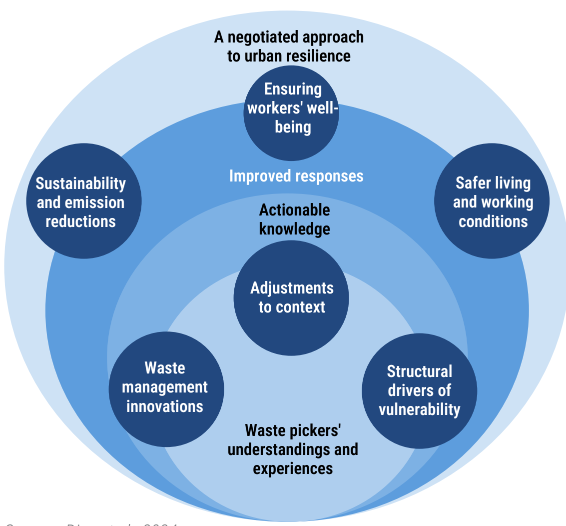


Ilustrated by Vanesa Castán Broto based on different sources.

Social innovations may help integrate the environmental and social benefits of climate action. New models of circular cities and circular economies have led to innovations to favor the mining of resources from existing waste in an emerging discourse that could help reappraise the work of waste pickers in cities and make visible their contributions to urban sustainability.[132] In Belo Horizonte, Brazil, the collaboration with the Estate of Minas Gerais, led by waste pickers cooperatives and NGOs such as WIEGO, has supported the development of policy innovations such as the *bolsa de reciclagem*, a form of payment that recognizes the workers' role in recycling by paying for the materials recovered.[133] Further work is needed to integrate waste pickers in a negotiated approach to urban resilience that begins by recognizing the workers' capacities, particularly their ability to deliver waste management innovations. This should be accompanied by innovations to improve their well-being and achieve safer living conditions: for example, through new models of waste collection and processing adapted to changing weather patterns and recurrent experiences of flooding and heat (Figure 8.10).

Municipal civil servants play a crucial role in implementing urban climate commitments, and their engagement and personal convictions can significantly drive climate action

Figure 8.10: A negotiated approach to urban resilience: Integrating waste pickers into city-wide systems in Belo Horizonte, Brazil



Source : Dias et al., 2024.

The waste-to-energy initiative in Freetown, Sierra Leone offers yet another compelling example of how social, technological and financial innovation can be combined for urban climate action (see Box 8.7).

Box 8.7: The use of digital technologies in circular waste-to-energy systems in Freetown, Sierra Leone

Freetown Waste Transformers (FWT) exemplifies an innovative approach to waste management in Sierra Leone, integrating the principles of the circular economy, digital technology and citizen collaboration. Established in 2019, FWT addresses the pressing issue of waste management by using anaerobic biodigesters to convert organic waste (which comprises 84 per cent of waste produced in the city) into biogas and fertilizer. This not only mitigates landfill overflow but also contributes to reducing reliance on an unstable power grid. A pilot biodigester was installed at the Aberdeen Women's centre in 2022 to help transition the health centre from its over-reliance on costly diesel-powered generators.

A pivotal element of FWT's success is the use of the DortiBox App, which digitizes waste collection, allowing residents to schedule pickups easily and securing a reliable supply of organic waste for FWT. This innovation enhances operational efficiency and improves communication between citizens and waste collection enterprises, fostering a sense of community involvement in sustainable practices. FWT has leveraged blended finance to include own funding, in-kind support grants and private sources, providing a good example of strategic integration of diverse finance sources for enabling locally-led climate action (an area explored in Chapter 9).

Collaboration with the Freetown City Council (FCC) is also crucial in creating an enabling environment. Through partnerships with the FCC, FWT supports local initiatives aimed at strengthening community-based waste management practices, pivotal in executing the "hub and spoke" business model. The council's micro-enterprise schemes aid in door-to-door waste collection, ensuring that even hard-to-reach areas are serviced. This multifaceted collaboration not only promotes efficient waste management, but also aligns with broader climate action objectives, making FWT a model for integrative approach to transition innovation in urban settings.

Source: Asare & Bailey-Morley, 2024; Freetown City Council, n.d.; Dortibox, n.d.; The Waste Transformers, n.d.

Institutional innovation, specifically, encompasses transformative shifts in legal frameworks, policies, financial institutions and organizational structures designed to mitigate and adapt to the impacts of climate change effectively.[134] In recent years, new and innovative approaches to climate change governance have surfaced within urban environments. These include practices like urban experimentation[135] and urban laboratories[136] that attempt to adapt the urban governance system better to tackle the risks of climate change. Urban laboratories, for instance, highlight knowledge co-production processes involving business, civil society and other end users as innovative activity sources.[137] Achieving innovation in climate policy involves intricate processes whereby diverse policy entrepreneurs collaborate with bureaucrats and politicians to advocate for and implement their solutions.[138] With greater attention attached to demand-side solutions for climate change, innovative policy interventions are beginning to target human behaviour-related arenas of action.[139] Municipal civil servants play a crucial role in implementing urban climate commitments, and their engagement and personal convictions can significantly drive climate action. The example of how municipal employees in Amsterdam (the Netherlands) helped trigger a "tipping point" that saw the city undertake an ambitious process of institutional innovation to drive climate action is a case in point (see Box 8.8).

Open landfill of household waste.
Plastic waste/Shutterstock

Box 8.8: Working towards "our city for tomorrow": The role of municipal innovation in driving climate action in Amsterdam, the Netherlands

Amsterdam is one of the most vulnerable cities in the world to climate change, threatened by sea-level rise and even the risk of encroachment by the North Sea. However, like other local governments, the municipality of Amsterdam faces a number of dilemmas that hinder its ability to act decisively in response to the climate crisis. Even with the right political will in place, city authorities have to navigate the existing status quo and the continued dominance of fossil fuel-favoring technologies and policies. The situation is further compounded by government structure that are inherently averse to abrupt change and are therefore only able to adapt slowly.

On 31 October 2022, all 17,000 of Amsterdam's municipal employees received an email from seven civil servants. It called attention to the fact that the city was failing its own stated goal of achieving a 60 per cent reduction in CO_2 emissions by 2030, compared to 1990 - a target it also criticized as insufficient. The authors urged the municipal management to close the gap between rhetorical ambition and actual implementation. This letter prompted management to host "climate events", fostering dialogue and inviting civil servants to actively support the necessary actions to bridge this gap.

Subsequently, in 2023, the city issued an administrative order directing the entire municipality to develop a detailed policy roadmap to guide the development of "our city for tomorrow". The city's sustainability efforts were restructured, shifting from a separate top-down focus in the city budget to a horizontally integrated approach that allowed for stronger alignment across administrative functions. Additionally, with all municipal employees encouraged to use their own initiative in identifying priorities and roadblocks, any issues are now directly escalated for decision-making by a dedicated city council team. Over the space of just two years, some 200 "climate dilemmas" have been reported this way. The success of this model of institutional innovation has inspired municipal employees in other cities such as Utrecht and Almere to urge similar systems to be set up there.

Source: Case study submitted by Gemeente Amsterdam–Municipality of Amsterdam

Another emerging area of innovation is climate finance, with multiple ideas suggested in the NDCs, often linked to financing NbS and facilitating new forms of value (for instance, see further discussions on green bonds in Chapter 9). Encouraging innovations in scaling finance at the local level can provide grassroots, non-state local actors with the opportunity to access much needed resources.

8.4 Towards Transition Innovation Ethics

By its nature, transition innovation is not a neutral process and directly impacts people's lives. Its development is commonly associated with complex trade-offs and ethical dilemmas. To date, no attention has been paid to the ethics of transitions, and when ethical questions have been raised, they have almost always been subsumed under more prevalent concerns about justice in transitions.[140]

Transition innovation is not a neutral process and directly impacts people's lives. Its development is commonly associated with complex trade-offs and ethical dilemmas

However, the ethical dimensions of transition innovation are undeniable and analytically distinct from the identification of negative unintended consequences. In this section, the ethics of transition innovation are examined, both in terms of the normative aspects – how we judge the adequacy of certain actions – and the practical implications of envisioning alternative urban futures through an ethical lens. The section begins by discussing the ethical dilemmas associated with knowledge generation, before discussing some examples of how emerging general concerns about knowledge and ethics are managed in local contexts.

8.4.1 Ethical dilemmas in transition innovation

Research agendas are often shaped by societal biases and the normative value attributed to different types of knowledge, leaving many relevant fields of knowledge underexplored or "undone".[141] For instance, in urban contexts, there is abundant evidence that the emphasis on data and modelling in transport research has directed attention away from analyzing actual transport experiences.[142] There are questions whether some innovation efforts are wasteful or produce more harm than benefits—what is referred to as "the dark side of innovation".[143]

For some urban residents, particularly those from disadvantaged groups, the negative impacts of introducing net zero innovations in the built environment may outweigh the positives. If the technologies developed are inappropriate or dominant knowledge generation processes distract attention from more urgent challenges, then climate policies may even reinforce disparities between poor and affluent urban communities. These divides, when they occur, raise fundamental questions about who is really paying the price of the crisis. Whether at the global, national or local level, it all too often appears that those who contribute least to climate change through lower-emitting lifestyles – low-income communities and developing countries – are typically left to bear the brunt of its impacts.

The framework of undone science offers some hypotheses that explain the interconnected mechanisms whereby this happens, providing a range of areas for local governments and social movements to intervene. These have been related to a number of factors that serve to prioritize, overlook or shut down different areas of knowledge and research:[144]

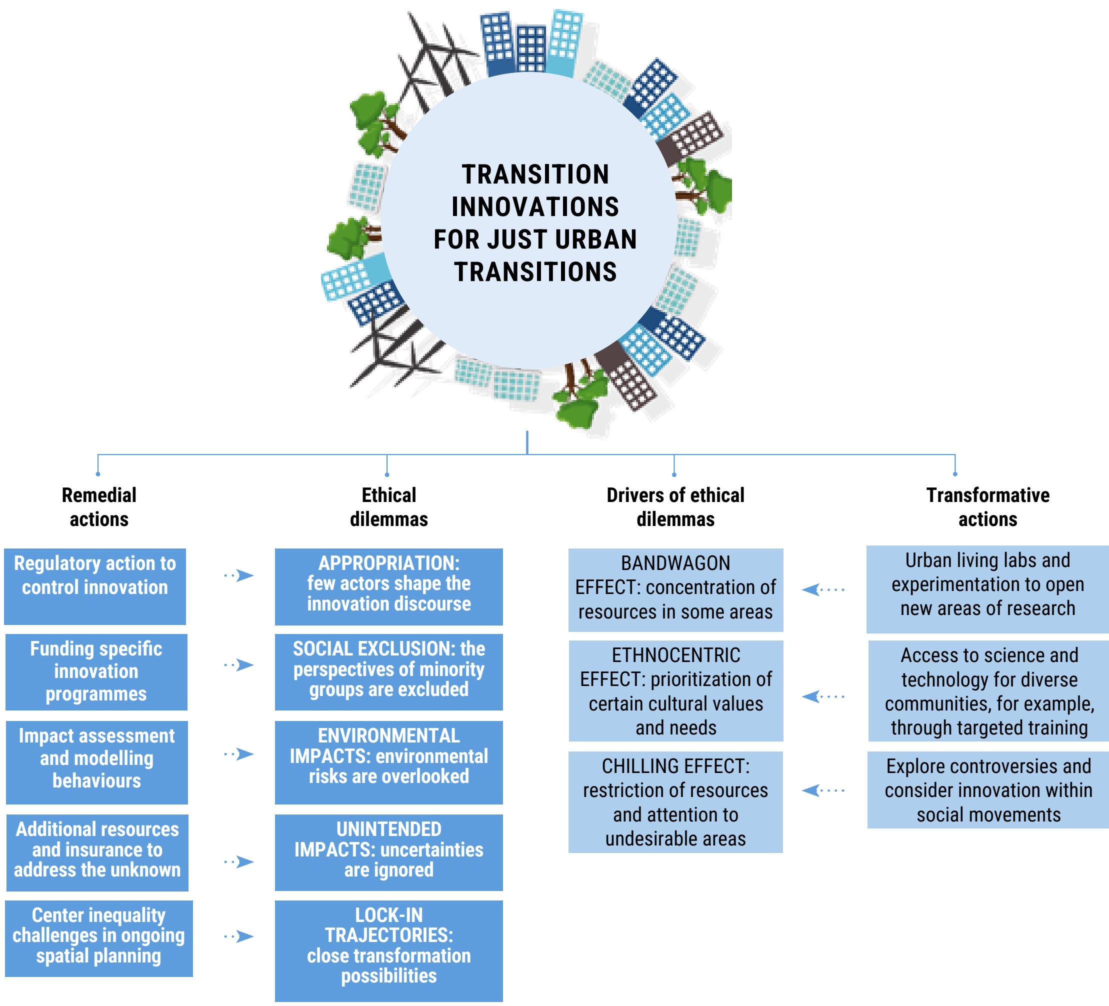
- The *bandwagon effect* occurs when resources, labour and attention are diverted to certain research areas, in the process neglecting other valid concerns. For example, the early successes of BRT transportation networks in some cities led to disproportionate attention being focused on these systems, often at the expense of developing alternatives based on the informal transportation systems that shape many rapidly growing cities.[145]

- The *ethnocentric effect* prioritizes dominant cultural practices, particularly in the postcolonial context, while frequently disregarding Indigenous practices better adaptable to specific urban environments. For instance, this may hinder efforts to restore vacant land in urban areas that rely on native plants in favor of more commercialized alternatives that may be far less suited to local conditions.[146]

For some urban residents, particularly those from disadvantaged groups, the negative impacts of introducing net zero innovations in the built environment may outweigh the positives

- The *chilling effect* refers to the active closing of areas of research because they are not profitable or otherwise valuable to powerful interests. This was evident, for example, in the way many car manufacturers previously turned their attention away from electric vehicles in favor of more efficient petrol and diesel combustion engines.[147]

Figure 8.11: Causes and consequences of undone science and harmful innovation in the urban environment, with proposals for action



Illustrated by Vanesa Castán Broto

Figure 8.11 offers examples of the ethical dilemmas that emerge in the production of transition innovation. On the left-hand side are some examples of specific ethical dilemmas and the remedial actions that are taken to address them. The right-hand side illustrates how the interlocked drivers of ethical dilemmas can be tackled directly through three transformative strategies:

- *Creating arenas of experimentation*, such as urban labs and open research areas, enables diverse actors to try out various strategies to deliver a just urban transition.
- *Expanding knowledge sources* and deliberately finding ways to recognize the views of disadvantaged groups increases diversity and access to R&D forums, in line with the inclusive innovation policies discussed in Section 8.1.2.
- *Encouraging open debates* to acknowledge controversies helps capture society's varied perceptions of innovations.

The field of ethics is vast, but some dilemmas may become clearer by focusing on a particular technology or field of innovation. The following section presents some examples of what an ethical response to key areas of transition innovation may look like.

Initiatives that support the mobilization of local knowledges or recognize Indigenous perspectives constitute valuable social infrastructures that increase urban resilience

8.4.2 Ethical responses in key areas of the transition to net zero cities

As discussed in detail in Section 8.3.1, four areas hold significant promise for developing transition innovation for the net zero city: diversification of the energy mix, transforming networks and storage, urban electrification and demand management. While multiple strategies can be advanced to support innovation in these areas, it is crucial to remember that transition innovations are associated with trade-offs. By definition, these trade-offs can have negative social and environmental implications, particularly for marginalized urban groups, underscoring the need for a responsible and thorough evaluation of the impacts in the context of a just urban transition. Local governments and other urban actors may proactively handle such trade-offs through appropriate responses that recognize the range of effects that transition innovations entail. As Table 8.5 shows, these drivers can be addressed through targeted urban policies that specifically respond to the causes and the consequences of undone science and harmful innovation.

Table 8.5: Examples of trade-offs in transition innovation and suggested responses

Transition innovation area	Positive impact	Potential negative impact	Responses to limit negative impacts
New renewable technologies for the diversification of the energy mix	▪ Cheaper renewable technologies facilitate autonomy and access to electricity and cleaner fuels.	▪ Renewable technologies may need land and water resources that communities depend on and cause forced displacement (e.g., in large-scale installations).	▪ Participatory planning in the design and installation of renewable technologies in consultation with affected communities.
Restructuring networks and storage	▪ Flexibility and modularity may increase the social resilience of the electricity network.	▪ Fragmentation of infrastructure systems may lead to the differentiation of systems with poorer sectors of the population being excluded from reliable services.	▪ Appropriate design may increase the reliability of off-grid designs.
Urban electrification (households, services, industry)	▪ Reduction of indoor air pollution and health improvements. ▪ Less time spent collecting fuel.	▪ Increased costs of energy and appliances may limit access. ▪ Services and industrial products may become more expensive. ▪	▪ Making electricity affordable through supporting renewable energy initiatives. ▪ Local governments, NGOs, and other institutions can facilitate access to appropriate appliances by subsidizing them or enabling local production.
Energy efficiency retrofitting and demand management	▪ Household improvements may reduce the costs of electricity.	▪ New technologies and designs may make housing unaffordable for certain population groups.	▪ Housing programs that incorporate energy efficiency measures can co-design models with future residents.

8.5 Concluding Remarks and Lessons for Policy

A people-centred approach to innovation is central for effective urban climate action. Such an approach prioritizes a just urban transition within the framework of transition innovation. Therefore, transition innovation not only creates "new" ways of responding to climate change challenges, but does so in a way that builds collective resilience and avoids worsening conditions for any particular groups, especially the most vulnerable. This chapter argues that the transition innovation approach, inspired by ideas of just transition, requires three strategies:

- Use innovation to *tackle the structural drivers of climate injustice*.

- Recognize the *multiple forms in which place-based, inclusive innovation occurs* and facilitate their emergence in ways that *link innovations to people's needs*.

- Create the conditions for the *exchange of knowledge through justice-based approaches*.

A people-centred approach to innovation is central for effective urban climate action. Such an approach prioritizes a just urban transition within the framework of transition innovation

This chapter further argues that integration and coordination across the three domains of innovations—technological, nature-based and social—is necessary to unlock co-benefits and optimize synergies for realizing climate-resilient net zero cities. Social innovation is particularly important to facilitate a just urban transition, acting as an important catalyst to mobilize a range of knowledge, address social demands not covered in competitive sectors, and bridge the gap between users and a rapidly changing technological landscape. Initiatives that support the mobilization of local knowledges or recognize Indigenous perspectives constitute valuable social infrastructures that increase urban resilience.

National governments have numerous opportunities to develop policies that support transition innovation for a just urban transition at the local level, such as subsidies and tax breaks, regulation, public sector procurement drives, financial incentives for diffusion and adoption, labelling or certification schemes, and broader changes in the overall architecture of innovation systems. As the NDCs show, national governments can lead innovations that address the injustices associated with transition innovations, as well as adopt national and regional policies to guide just urban transitions.

While national governments can play a key role in creating a policy environment that supports transition innovation for a just urban transition, local governments can lead a range of inclusive policies to support a local innovation ecosystem. Policies in this area can challenge the mainstream narratives of innovation that overlook social and environmental impacts, broadening the range of actors able to access to innovation arenas. This also requires a detailed understanding of the characteristics of innovations and how they impact daily lives.

International agencies, city networks, activist groups, grassroots organizations and other narrative-making actors are key in supporting a people-centered approach to transition innovations. They may organize and collaborate with multiple stakeholders, leading the development of transition innovations (such as grassroots, frugal or mundane innovations) as well as adopt ethical principles to shape innovation processes. Businesses can lead transition innovations with added social value and participate in collaborative innovation processes, such as innovation platforms or cluster innovations. Intermediaries such as universities and think tanks can also support innovation development and create sustained partnerships. In sum, the urgent need for a just urban transition calls for the participation of all actors and the generative potential of knowledge sharing and mutual learning through ethically informed exchange platforms to move towards a better urban future.

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Renewable energy power plants - photovoltaics, wind turbine farm and battery container © Shutterstock

Endnotes

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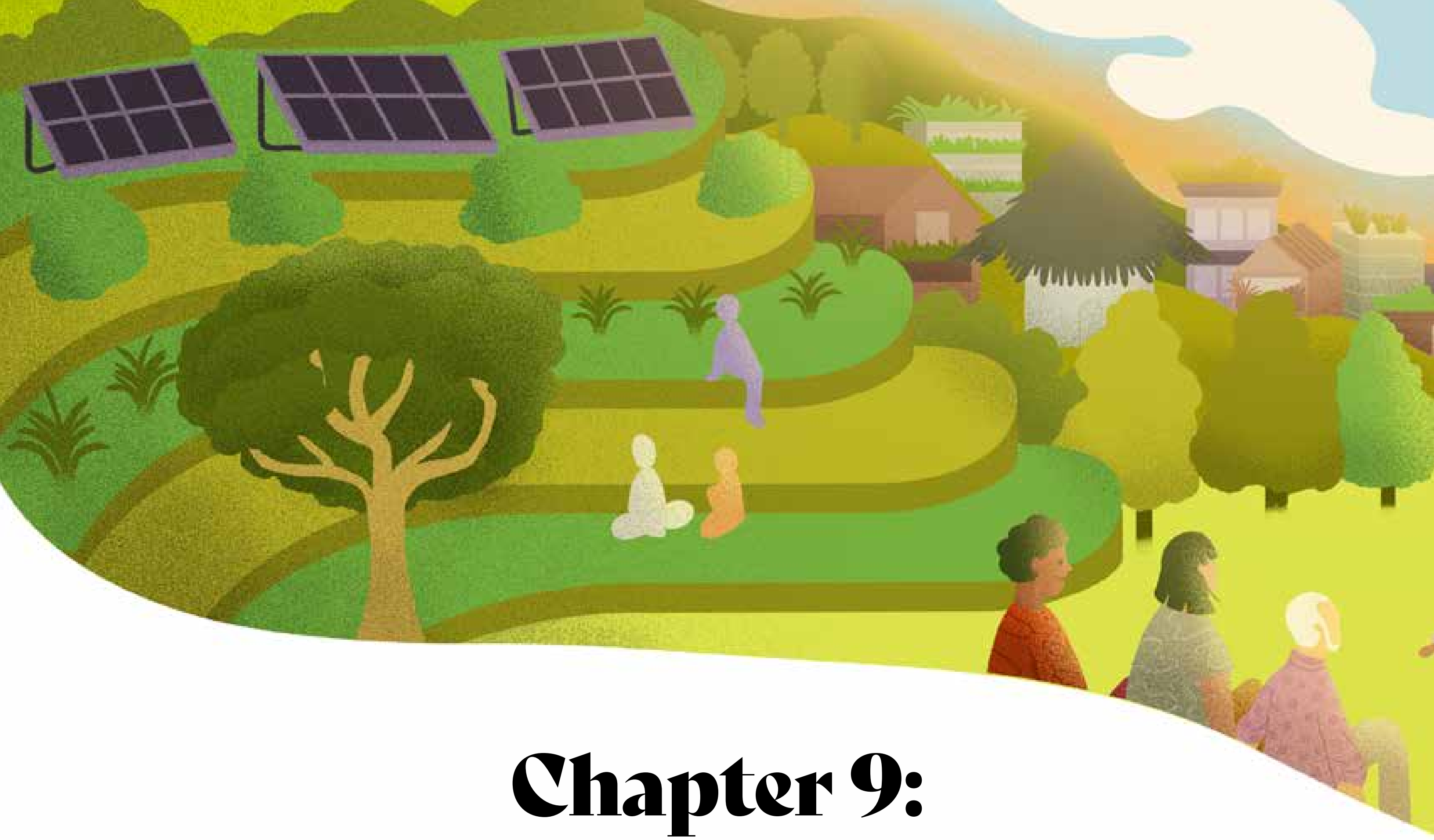
Climate change protest, Melbourne, Australia © Shutterstock



Chapter 9:

Financing Interventions for Climate Change in Cities

Quick facts

1. Cities are receiving less than 20 per cent of the finance required for effective climate action and are struggling to attract financing, particularly for small-scale local projects.

2. Cities' needs for adaptation, mitigation, and sustainable development are deeply intertwined, requiring financing to address these three areas simultaneously for effective response to climate change.

3. Borrowing from private sources is a necessary consideration as public finances, while vital, are insufficient to deliver the required scale and speed of urban climate finance.

4. There is significant potential for local governments to scale up land-based revenue sources to finance urban climate action.

5. National governments play a crucial role in urban climate finance through direct and indirect financing, and through enacting regulations that enable local governments to enhance own revenue, borrow and reduce investment risk.

Policy points

1. To be effective, urban climate finance must be people-centred, addressing not only the climate actions with the highest impact and economic value, but delivering actions that secure a just urban transition.

2. Cities need to collaborate with other levels of government and across sectors to aggregate and synchronize bankable projects to make urban climate actions more attractive for financing.

3. Cities need to leverage a blend of financial sources from both public and private sources to accelerate the scale and speed of urban climate finance.

4. Cities need to enhance their creditworthiness and risk profiles to attract financing at favorable terms, especially from private sources.

As the climate crisis intensifies, cities and urban areas are emerging as critical battlegrounds, driving urgent calls for adequate financial resources to be directed towards them.

Cities face both a challenge and opportunity in financing interventions for climate change in a context where trillions of dollars are needed every year to support the transition to net-zero. On the one hand, cities need

Cities face both a challenge and opportunity in financing interventions for climate change in a context where trillions of dollars are needed every year to support the transition to net-zero

to mobilize US$4.5—5.4 trillion[1] annually up until 2030 to invest in climate-resilient urban infrastructure, while at the same time responding to escalating displacement, livelihood disruptions and damages to critical urban infrastructure at unprecedented scale and speed. Inaction is not an option: the economic costs of climate change-related damages have increased sevenfold since the 1970s[2] and are projected to continue rising for the foreseeable future. By 2030, the annual disaster-related losses on the built environment could reach $415 billion, potentially pushing tens of millions more urban residents into poverty.[3]

By 2030, the annual disaster-related losses on the built environment could reach $415 billion, potentially pushing tens of millions more urban residents into poverty

On the other hand, a substantial opportunity exists—according to one 2018 estimate, as much as US$29.4 trillion cumulatively by 2030[4]—for cities to attract investments in climate—resilient urban infrastructure. The bulk of the new investment is projected for the construction or retrofitting of green buildings as well as enhancing energy efficiency, transitioning to renewable energy, and investing in public transport infrastructure to support anticipated economic and population growth in rapidly urbanizing regions.[5] If successfully implemented, given their long life cycles, these investments could shape the development of cities for decades to come. Cities would also accrue resilience dividends from averted future losses and damages, as well as social and economic co-benefits over the infrastructure's lifetime that enhance sustainable livelihoods and well-being for urban residents.[6] Moreover, when the planning and financing of such investments addresses vulnerabilities and inequalities, the potential benefits can be truly transformative, with the infrastructure contributing to broader and long lasting positive societal changes (see Chapter 6).

Cities' needs for adaptation, mitigation, and sustainable development are therefore deeply intertwined, requiring substantial financial resources of the right mix synchronously directed towards these three needs to effectively respond to the urban impacts of climate change. Despite estimated financial needs in the trillions, cities received only US$831 billion annually on average in climate finance during 2021-22. Of this, less than 3 per cent (US$10 billion) was designated for adaptation.[7] Financing adaptation

Despite estimated financial needs in the trillions, cities received only US$831 billion annually on average in climate finance during 2021-22. Of this, less than 3 per cent (US$10 billion) was designated for adaptation

actions such as early warning systems, disaster response and recovery systems, and adaptive social protection is especially urgent for cities in low-income countries with limited resources and capacities to respond.[8]

The imbalance in how financing is directed for climate action replicates globally, with tracked adaptation finance of US$63 billion accounting for less than 5 per cent of the total tracked annual climate finance of US$1.27 trillion in 2021/22.[9] Striking a balance between financing mitigation and adaptation, in line with Article 7 and 9 of the Paris agreement, is critical for effective climate action as it addresses the different vulnerabilities and capabilities to respond to climate change that exist between developed and developing countries.[10] In some cases, these inequalities stem from historical legacies and systems of exclusion and marginalization that remain deeply embedded in city structures. When these drivers are not addressed, climate action could potentially amplify or even generate new forms of vulnerability and inequality (see Chapter 4).

It follows that the challenge of a fit-for-purpose urban climate finance system goes beyond a narrow tracking of the quantity of finance to consider the quality of finance to cities. To be effective, urban climate finance must be people-centered and advance just urban transitions, addressing the structural drivers of unequal distribution of vulnerabilities across various urban contexts. This approach is essential for realizing inclusive, sustainable and climate-resilient urban futures (see Chapter 4 and 8). With that in mind, this chapter aims to contribute to the discussions on increasing the quantity and quality of finance available to cities. In particular, it identifies key barriers and opportunities for accessing urban climate finance, before going on to explore innovative pathways to financing the desired transition.

A fit-for-purpose urban climate finance system goes beyond a narrow tracking of the quantity of finance to consider the quality of finance to cities

Section 9.1 begins by framing the context of urban climate finance through a review of the current debates on financing climate interventions, from the global to the local, concluding with a clear definition of people-centered urban climate finance. Section 9.2 estimates the financing gap and Section 9.3—9.5 examines the instruments and mechanisms available for financing urban interventions for climate change. Thereafter, Section 9.6 delves into the challenges and barriers of enhancing the quantity and quality of urban climate finance, categorizing them into "traditional" challenges and barriers faced by cities in accessing financing in general and those challenges "unique" to financing urban climate action. Section 9.7 then discusses various strategies and opportunities cities can leverage, including innovative approaches to financing people–centered urban climate actions that enhance inclusion and equity while promoting climate resilience. The final section 9.8 presents recommendations for various actors including local governments, national governments, community level organizations. academics, experts and philanthropists.

9.1 An Overview of the Finance Landscape for Climate Action

Climate finance should enable the efficient allocation of economic resources to respond effectively to the needs arising from climate change. In the context of climate change the predominant needs for cities are twofold:

- *Adaptation: aimed at reducing vulnerabilities* of cities and urban communities to climate change impacts mainly through safeguarding existing infrastructure and systems.
- *Mitigation: aimed at preventing or reducing greenhouse gas emissions* mainly through enabling or accelerating transitions to low-carbon futures such as renewable energy sources (like wind and solar), enhancing green and blue infrastructure to sequester carbon dioxide from the atmosphere (for example, through community gardens, open green spaces, watershed restoration and marshlands), as well as shifting production and consumption models.

Cities, however, existed long before the climate crisis with their development marred by histories of structural exclusion, marginalization and discrimination. These inequalities persist today, creating uneven starting points for enabling climate action at the individual, community and city levels. Urban climate action that ignores these disparities could further entrench existing inequalities and vulnerabilities or even create new ones (see Chapter 4). This is particularly crucial for cities and other urban areas which are home to the majority of the world's population and are on the frontline of the human-induced climate crisis. Context – relevant financing for urban climate action should therefore recognize the reality of unequal vulnerabilities and target specific projects and beneficiaries in developing countries and marginalized areas such as informal settlements to address climate change and social injustice simultaneously.[11] Increasingly, climate finance instruments are seeking to recognize and incorporate these equity, inclusion and justice dimensions in the interventions.

Context – relevant financing for urban climate action should therefore recognize the reality of unequal vulnerabilities and target specific projects and beneficiaries in developing countries and marginalized areas such as informal settlements to address climate change and social injustice simultaneously

9.1.1 The need for systemic global financial reform

Over the past decades, several global agreements have highlighted the interconnected challenges of financing climate action, sustainable development and urban growth, underpinned by a commitment to equity and inclusion. Collectively, the Sustainable Development Goals (SDGs), the Addis Ababa Action Agenda, the Paris Agreement and the New Urban Agenda (NUA) offer a synergistic approach to integrate climate action with urban development, emphasizing the necessity of financial mechanisms to facilitate and accelerate the transition towards more sustainable futures.[12]

However, the international financial framework that should in principle enable this transition has increasingly come under scrutiny for its inefficiencies, misalignment and lack of synergy in addressing the climate crisis and inclusive development at the required scale and speed, prompting calls for reform.[13] It has been argued that the existing framework, originally created over 75 years ago to rebuild the post-war economies of industrialized nations, is obsolete and not fit-or-purpose in responding to today's crises.[14]

In contrast with the past where financial resources were needed to restore established socioeconomic systems at a national level, the present-day polycrisis demands support for local, innovative and often untested solutions. This includes quick response to escalating disasters and intervening holistically across multiple sectors, partnerships and geopolitical scales to be effective. There have been some encouraging examples of initiatives that embrace this perspective, such as the case of the Unlocking Blue Pacific Prosperity programme (see Box 9.1).

In contrast with the past where financial resources were needed to restore established socioeconomic systems at a national level, the present-day polycrisis demands support for local, innovative and often untested solutions

Box 9.1: Unlocking Blue Pacific Prosperity: A holistic approach to financing climate and development

The Unlocking Blue Pacific Prosperity initiative, launched in 2023 at the international climate change conference COP28 in Dubai, brings together 27 members and territories in the Pacific region. The majority are over 60 per cent urbanized, with some countries like Nauru, Guam and Northern Mariana Islands nearly 100 per cent urbanized.

The programme identifies the disproportionate impact of climate change as a fundamental threat to the Pacific region that intertwines and exacerbates challenges in safety, food security, health and productivity, while emphasizing the need for a just transition to climate resilience.

Describing the current climate finance landscape as insufficient, fragmented, slow and unfair for effective ocean-climate action in the region, the initiative adopts a paradigm shift. By leveraging shared resources and collective advocacy, it engages various partnerships and financial mechanisms to simultaneously finance solutions for climate, oceans, food, health and livelihoods. Though at the early stages of implementation, it offers an inspiring pathway for mobilizing resources from diverse sources to promote integrated solutions to climate change across the region, with a target of US$500 million in funding by 2030.

Source: Pacific Community, 2024

UBPP was unanimously endorsed by Pacific Leaders at the 52nd Pacific Island Leaders Forum in Rarotonga, Cook Islands. © UBPP

The debate on reforming the international financial architecture is relevant to cities in two fundamental ways. First, community or local-level projects are best suited to deliver equitable, inclusive climate action tailored to specific contexts, yet the current international financial architecture envisions nation states as the primary implementing partners. Cities, therefore, face significant challenges in navigating the bureaucratic requirements to secure financing for urban climate action from international financial institutions.

Second, the climate crisis is coinciding with a debt crisis that is diverting much needed resources away from expenditure on basic developmental needs, including climate action. This is starkly illustrated by the fact that as many as 3.3 billion people live in countries that are now spending more on paying interest on debt obligations than on public health (Figure 9.1).[15] Moreover, the debt crisis disproportionately affects regions that have historically contributed the least to climate change but are more vulnerable to its effects, with limited capacities to respond effectively.

This debt burden hampers nations occupying more than half of the world's surface area from undertaking climate action at the required scale or speed, in some cases causing significant setbacks during a climate catastrophe. The rising debt burden on national governments has a knock-on effect on fiscal transfers to cities, manifest in insufficient or delayed disbursements. Public funding remains vital for urban climate action, as local governments depend on intergovernmental fiscal transfers for a significant portion of their budget financing. In a survey of about 100 cities worldwide, 55 per cent identified lack of public funding as a major barrier to enabling sustainable urban growth.[16]

The rising debt burden on national governments has a knock-on effect on fiscal transfers to cities, manifest in insufficient or delayed disbursements

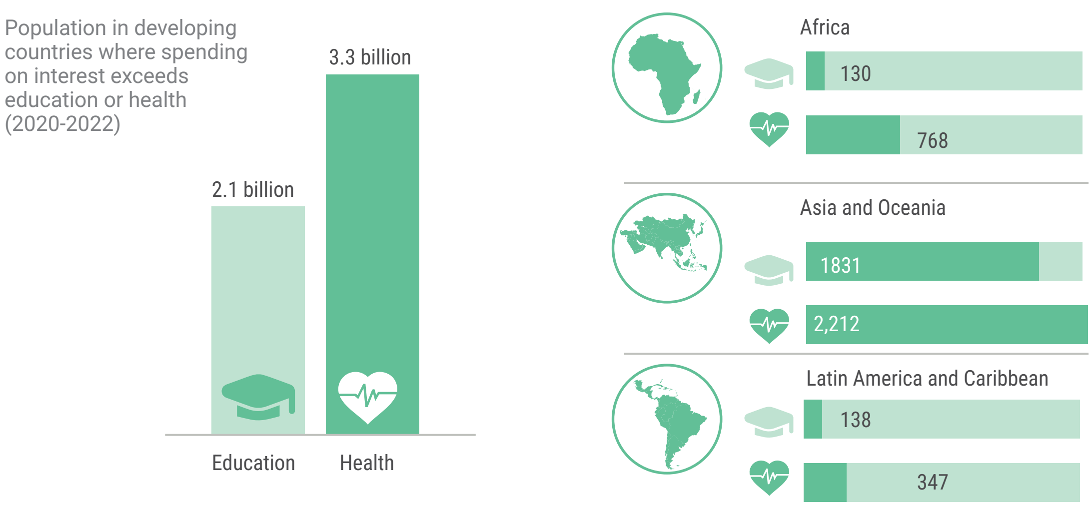
9.1.2 Progressive steps and improvements

Reform efforts aimed at improving access, efficiency, alignment and equity in the international financial architecture are gaining momentum. These shifts could significantly enhance the quantity and quality of finance available for urban climate action. For instance, the Bridgetown Initiative, initiated by Barbados Prime Minister Mia Mottley in 2022, seeks to reframe how debt burdened developing nations progress on the twin goals of SDGs and climate action, arguing they are two sides of the same coin. Among other proposals, the initiative has placed special attention on addressing liquidity and debt sustainability, calling for the inclusion of a natural disaster clause in all lending instruments.[17] This would give a country breathing room to rebuild after a climate disaster without spiraling into debt distress.

The ability to rebuild faster is especially relevant to cities, as delays in repairing damages to critical urban infrastructure such as water and sanitation systems, healthcare facilities and transportation networks could compound to long-term health and economic consequences that make it even harder to recover or achieve resilience. For instance, a study conducted two years after the 2019 Cyclone Idai ravaged the coastal city of Beira, Mozambique, suggested that the city residents were still experiencing "co-occurring" losses in their access to basic resources such as food, cooking fuel, electricity, clean water and medical treatment, potentially contributing to further vulnerabilities and rising inequality in the city.[18]

Another breakthrough that advances the imperatives of equity and justice in climate finance occurred during COP28 with the establishment of a new Loss and Damage Fund for vulnerable countries. In principle, loss and damage seeks to address the disastrous effects of climate change that go beyond the limits of mitigation, adaptation and disaster risk management actions,[19] bringing to focus the lived experience of people whose lives, health and livelihoods are pushed beyond the limits of their

Figure 9.1: Number of people living in countries that spend more on their net interest payments than on education or health



Source: UNCTAD, 2024, p.18, drawing on data from the United Nations Global Crisis Response Group, IMF and World Bank World capacity to prevent or respond to the climate crisis.[20] This third pillar[21] of financing climate actions, in addition to adaptation and mitigation, further advances climate justice and has strong relevance to cities and other urban areas which are home to a growing majority of the world's population. Fundamental challenges remain around defining what constitutes loss and damages, given the complexities surrounding its manifestation, as well as the limited funds committed so far—the initial pledges of US$661 million[22] are less than 0.2 per cent of the total estimated losses that developing countries face as a result of climate change every year.[23] Nevertheless, the fund's setup and operationalization through the World Bank marks a significant milestone in expanding the climate finance landscape.

In principle, loss and damage seeks to address the disastrous effects of climate change that go beyond the limits of mitigation, adaptation and disaster risk management actions

Looking forward to COP29 in Baku in November 2024, it is anticipated that a higher-value New Collective Quantified Goal (NCQG) in line with the Paris Agreement will be signed off to replace the US$100 billion per year target that was set at COP15 in Copenhagen in 2009. The NCQG is relevant to urban climate action, especially for cities in developing countries, in two key ways. First, the initial target of US$100 billion was primarily determined through political negotiations and only partially considered the financing needs of developing countries. Since then, however, there has been greater recognition of the true extent of financial assistance required. The UNFCCC Standing Committee on Finance currently estimates the needs of developing countries at almost 5.9 trillion between 2021 and 2030.[24] Consequently, the negotiations could yield significant amounts of low-cost capital prioritizing adaptation and climate resilience infrastructure needs of developing countries.

Second, during COP16 in Cancún in 2010, the Green Climate Fund (GCF) was established as the primary entity for channeling multilateral funding for climate action under the collective quantified goal. As a dedicated fund the GCF plays an important role in easing access to financing by streamlining funding processes, thus cutting out the inefficiencies arising from the competing criteria set by different players. Additionally with a stated goal of a 50:50 balance between mitigation and adaptation, the GCF is a vital source of low-cost capital for adaptation action in cities, especially in developing countries. For instance, in 2018 the GCF established the Green Cities Facility which plays a catalytic role in derisking investments by providing concessional grants and first loss capital, as well as supporting project readiness and preparatory support. In 2019, the GCF approved financing for the "Building resilience of urban populations with ecosystem-based solutions in Lao PDR" project, a US$11.5 million project to control urban floods in Laos through ecosystem-based adaptation that is expected to benefit around 900,000 people.[25]

The ongoing global discussions are reshaping the understanding of the nature and function of climate finance, with growing awareness that a just and equitable transition is crucial for achieving inclusive, sustainable

There is recognition that in addition to adaptation and mitigation, loss and damage is an integral element for effective climate action

and climate-resilient futures. Additionally, there is recognition that in addition to adaptation and mitigation, loss and damage is an integral element for effective climate action. Consequently, urban climate finance must effectively align to this evolving consciousness within the urban context as outlined in Box 9.2.

Box 9.2: Defining urban climate finance

For this report, urban climate finance is defined as local, national and transnational financial resources drawn from public, private or a blend of sources, directed towards enabling and accelerating urban climate adaptation, mitigation and loss and damage interventions underpinned by the principle of just transitions to achieve inclusive, sustainable, and climate-resilient urban communities.

This definition resonates with UNFCCC's definition of climate finance regarding the source and purpose of the resources (aimed at addressing the drivers and impacts of climate change), with an addition of three key aspects emerging from the evolving discourse and global consensus that are essential to effective urban climate action:

- First, it integrates *loss and damage as the third pillar* of climate action.
- Second, it embraces the idea that *sustainable development and climate actions are inseparable,* with sustainable development complementing and further advancing climate goals.
- Third, it incorporates *just transition as a fundamental guiding principle* in financing ambitious climate targets, a perspective widely acknowledged through inclusive consultations initiated by the COP27 presidency.[26]

9.2. Estimating the Financing Gap for Urban Climate Action

How much do cities and other urban areas need to transition to inclusive, sustainable and climate-resilient futures? This question is a useful starting point for evaluating resource gaps, as well as determining the suitability of various financing sources to enable the desired transition.

9.2.1 Calculating the cost for cities

As mentioned earlier in the chapter, according to one authoritative estimate, cities and other urban areas require US$4.5—5.4 trillion annually to invest in new or retrofitted low-carbon, climate-resilient infrastructure in transport, energy, water, waste and telecommunications projects.[27] Comparing this to the estimated global spending of US$6.5 trillion annually on low-carbon physical assets and enabling infrastructure across various sectors for a net-zero transition from 2021 to 2050,[28] the projections suggest that a significant portion of low-carbon infrastructure investments will be located in cities and urban areas.

It is important to note that these estimates predominantly focus on physical "hard" assets and often exclude the ongoing cost of running high emission assets that may still be in use during the transition period (such as coal plants or fossil fuel cars), estimated at US$2.7 trillion.[29] There is also a real cost of "stranded" assets (infrastructure that is rendered obsolete before its expected useful life) by 2050 as a consequence of the transition, estimated at a total value of US$2.1 trillion.[30] Additionally, the estimates do not include the social "soft" infrastructure necessary to enable people to use climate–resilient physical infrastructure, such as enhancing institutional capacity or reskilling for livelihood transitions (see Chapter 6). Nor do they factor in the cost of financing adaptive social protection to strengthen the resilience of vulnerable urban populations (see Chapter 4). There are also the inevitable costs of resettling communities from some low-lying cities, as already witnessed in the case of the relocation of the Guna Indigenous community from the flood-exposed island of Gardi Sugdub to mainland Panama.[31]

Table 9.1: Estimates of the financial outlay needed for urban climate action

Category	Purpose of investment	Elements of investments (For adaptation, mitigation and loss and damage)	Cost estimates
Physical ("hard") low-carbon, resilient infrastructure	Low-carbon, resilient infrastructure constructed to support the urban population and economies	New construction and retrofitting for green buildings Electric vehicles Renewable energy Solid waste disposal and treatment, wastewater treatment and water supply networks	US$2.5 trillion p.a. (2018-30, IFC)[32] to US$4.5–5.4 trillion p.a. (2015-30, CCFLA).[33]
Social "soft" Infrastructure	Promoting inclusion and just urban transition vital for enhancing well-being, social cohesion and sustainability	Urban planning and zoning Enhancing data and governance systems. Social security systems targeting vulnerable groups such as children, youth, elderly, women, migrants and Indigenous Peoples Disaster risk management and relocations Safeguarding cultural heritage Slum upgrading Healthcare and education systems Reskilling and capacity building.	Not generally accounted for in urban climate actions costings
Green and blue infrastructure	Natural or semi-natural elements in the urban ecosystem that protect and improve regulation of water and air quality, temperature, as well as creating opportunities for community recreation	Open green spaces, parks, rain gardens and urban forests Wetlands, permeable pavements and flood plains Natural water bodies such as rivers, lakes and ponds Canals and stormwater systems	Not generally accounted for in urban climate actions costings
Transition, write-off costs and decommissioning, as well as subsidies	Continued spending on high-emission infrastructure	Coal fired power plants, vehicles still running using fossil fuels, as well as some from industrial productions	Approximately 30 per cent of annual expenditure on energy and land use systems[34]

Source: summarized from CCFLA, 2015, IFC, 2018 and McKinsey Global Institute, 2022.

Table 9.1 summarizes major categories for which financing is needed for urban climate action. These estimates are at best conservative projections of the financial outlay required. It is important to also note that different methodologies and definitions are applied in arriving at such estimates. The values therefore are useful as comparatives as opposed to treating these as absolute set targets. The figures are also illustrative in showing what to date has not been accounted for with any degree of accuracy: in particular, the estimated costs associated with maintaining and improving social and blue-green infrastructure.

Notwithstanding the variability of these estimates, it is abundantly clear that there is a substantial gap between the urban climate finance that is currently available and what is needed for effective urban climate action. Without a significant uptick in financing, this gap could widen in future as required expenditure levels continue to rise over the next few decades (see Figure 9.2).

Notwithstanding the variability of these estimates, it is abundantly clear that there is a substantial gap between the urban climate finance that is currently available and what is needed for effective urban climate action

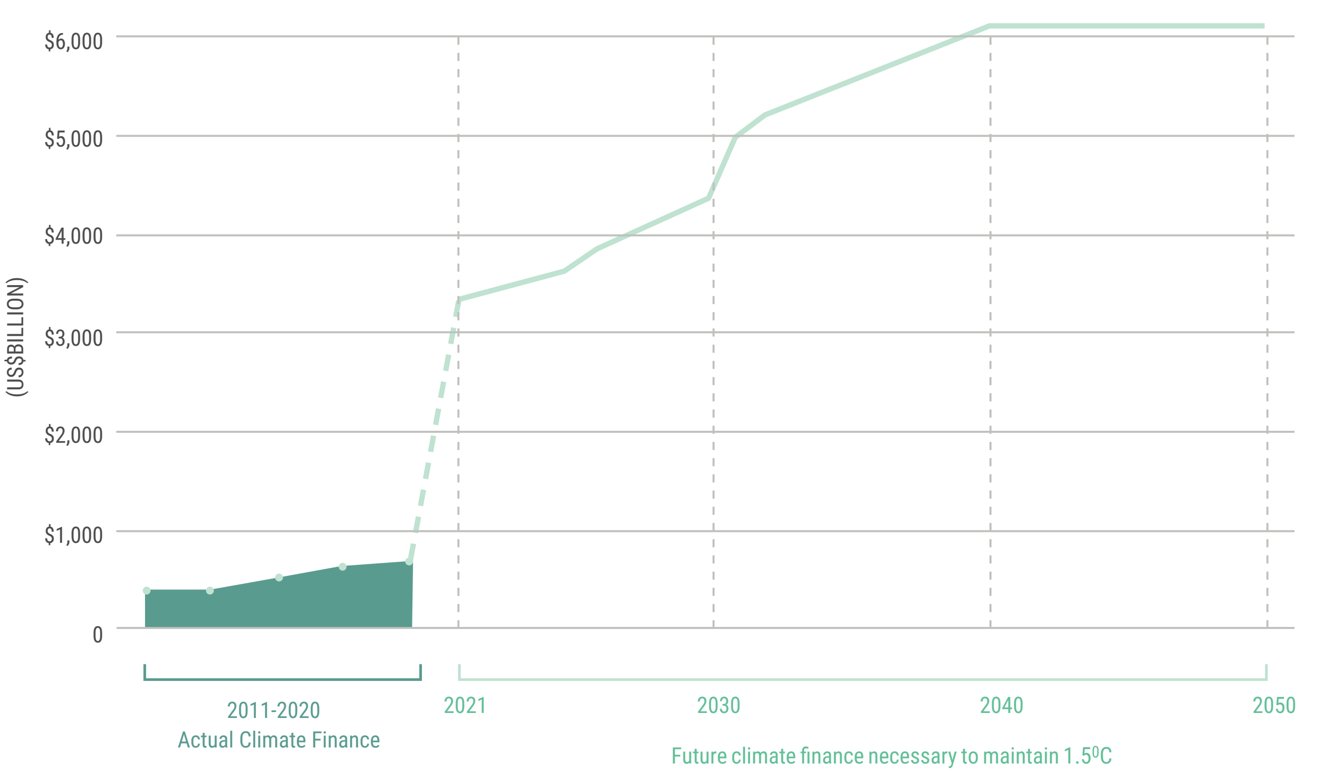
9.2.2 The business case for climate investments in cities

While the required financial outlay for enabling urban climate action is daunting, there is a compelling business case for the multiplied economic and social benefits accruing to cities from such investments, in both the short and longterm. It is estimated that investing in resilient infrastructure in low- and middle-income countries would have a net benefit of US$4.2 trillion, with US$4 in benefit for every US$1 invested

It is estimated that investing in resilient infrastructure in low- and middle-income countries would have a net benefit of US$4.2 trillion, with US$4 in benefit for every US$1 invested in climate resilience

in climate resilience.[35] This is in part because the damage prevented can easily exceed the upfront investment costs. These benefits are evident, too, in developed country contexts such as the United States. The state of Florida, when assessing the impact of its disaster mitigation projects in the aftermath of Hurricane Matthew in 2016, reported a total of US$81.1 million in avoided losses: this far outweighed the combined capital outlay of US$19.2 million, working out to a 422 per cent return on investments.[36]

Figure 9.2: Current and future global climate finance gap until 2050



Source: Climate Policy Initiative, 2021, p.5

Furthermore, by strengthening a city's long-term security from potential disasters, resilient infrastructure can greatly enhance the value of housing and other urban assets. A cost-benefit analysis of the sponge city pilot project in the city Wuhan, China, for instance, found that the initial investment of CNY 15.2 billion (approximately US$2.15 billion) has produced almost CNY 30.9 billion (approximately US$4.4 billion) in added real estate value every year. The project also generates approximately CNY 60 million (approximately US$8.5 million) in annual economic and social benefits, ranging from the prevention of direct losses from waterlogging to the indirect benefits of improved water quality, reduced air pollution, lower maintenance costs, climate regulation and stormwater recycling.[37] Box 9.3 further elaborates Wuhan's cost benefit analysis of the sponge city pilot project.

By strengthening a city's long-term security from potential disasters, resilient infrastructure can greatly enhance the value of housing and other urban assets

Box 9.3: Illustrating the business case for climate action: The sponge city project in Wuhan, China

In 2013, China's national government launched the "Sponge City Programme" in response to its urban water management challenges. The programme encouraged cities to adopt green and blue infrastructure rather than grey infrastructure that is based on concrete and steel. Between 2015 and 2017, the national government dedicated CNY 20.7 billion (US$3 billion) for 16 pilot sponge cities, with ambitious targets that 20 per cent of each pilot city's land should be constructed to sponge city standards by 2020 and 80 per cent by 2030.

In Wuhan, one of the pilot cities, this approach was deployed with considerable success. Authorities implemented 389 separate sponge city projects over a space of 38.5 square kilometers, encompassing gardens, parks and green space that provided vital areas for run-off and drainage during periods of heavy rain and flooding. The economic case for this nature-based solution is also compelling: Wuhan's sponge city programme is estimated to cost almost US$600 million less than the "grey" infrastructure that would have otherwise been developed to strengthen the city's resilience to flooding.

Source : Oates et al., 2020.

Sponge city model. © chapmantaylor.com

It is crucial for cities to recognize that delaying climate investments is costly and counterproductive. It is estimated that the global average loss from the cost of repairing damages to critical infrastructure as a result of natural and climate disasters, the lost economic, social and health outcomes from service disruptions, as well as the erosion of new capital investments, is US$700 billion annually: of this, around 70 per cent is specifically associated with climactic hazards such as storms and flooding, with the remainder attributable to earthquakes, tsunamis and other geological risks.[38] This works out to around US$490 billion lost every year as a result of climatic impacts, of which a significant portion is incurred in cities and other urban areas, Compared to the estimated average climate investments of US$831 billion in cities annually, this arguably illustrates the significant erosion of value as a result of delayed, inadequate, or uncoordinated climate actions.

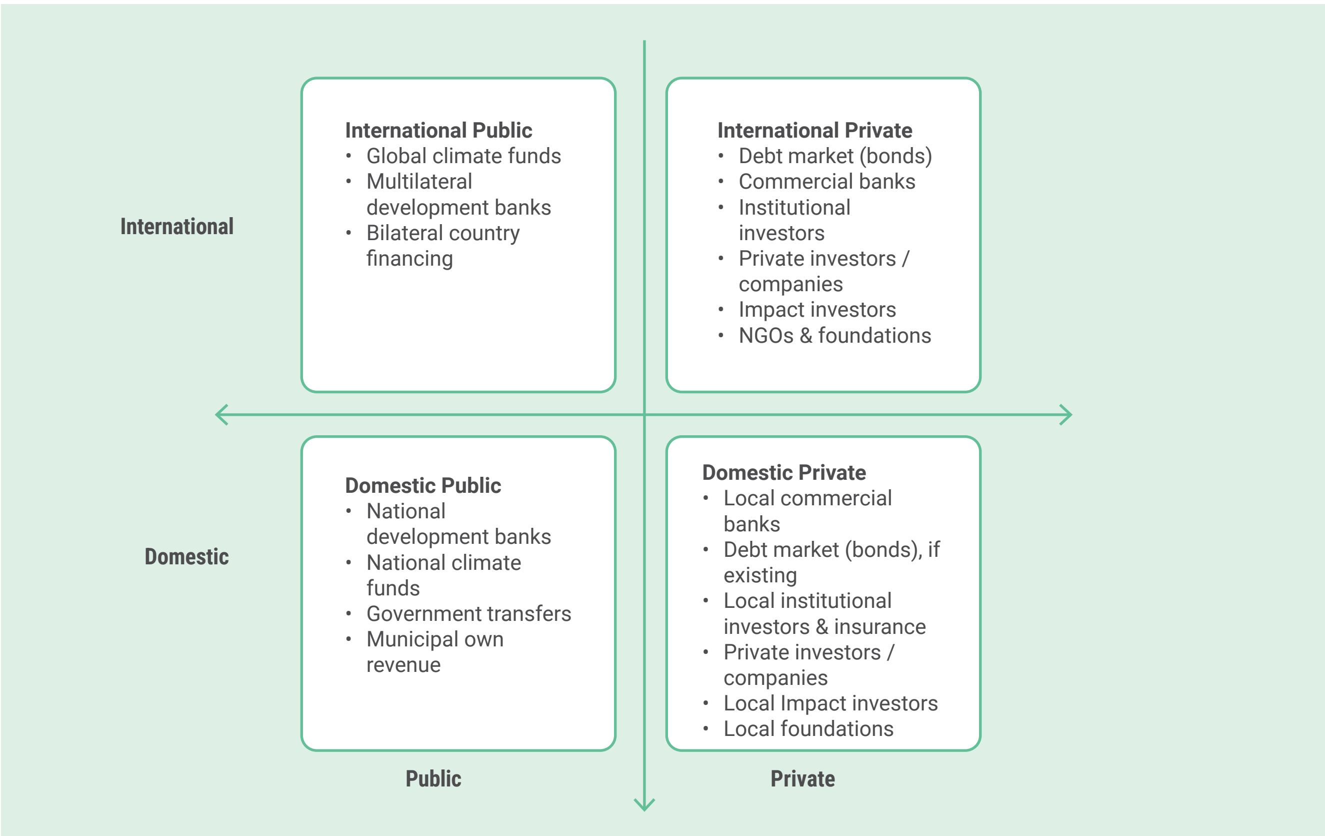
It is crucial for cities to recognize that delaying climate investments is costly and counterproductive

9.2.3 Options for mobilizing financial resources for urban climate action

Cities need to mobilize trillions of dollars to finance the transition to inclusive, sustainable and climate—resilient futures. No single source can deliver the scale and speed of urban climate finance needed. Cities have to strategically engage with multiple players and leverage diverse financing instruments in a way that they complement and enhance each other towards meeting their present and future needs.

The landscape of climate finance is a complex web of diverse actors—local, national, international, bilateral and multilateral—drawing on a range of resources from public, private, for-profit and philanthropic sectors. Each is informed by various rules of engagement, encompassing international agreements, local, national and regional policies, as well as voluntary targets and guidelines. While it is challenging to capture the entire picture, Figure 9.3 summarizes the key sources that local governments can access to finance climate interventions in cities.

Figure 9.3: Overview of different sources of finance available for urban climate interventions



Source: World Bank and United Nations Capital Development Fund, 2024, p.71

To advance the discussion on the strategies for mobilizing urban climate finance, Box 9.4 frames the distinction between funding and financing. This is especially useful in the context of engaging with external parties as it clarifies the expected roles of each party, and the general nature of contractual terms and obligations.

No single source can deliver the scale and speed of urban climate finance needed. Cities have to strategically engage with multiple players and leverage diverse financing instruments

Box 9.4: Distinguishing "financing" and "funding"

Though financing and funding are sometimes used interchangeably, it is important to distinguish between the two terms, especially in a context where local governments are engaging external parties through a variety of financial instruments that set out different terms, conditions and obligations between a borrower and a lender. The distinction is useful in framing the discussion on the different instruments and mechanisms that cities can engage for urban climate action. For the purpose of this report:

Financing refers to mobilizing resources from private or public financial institutions used for up-front investment costs. Most financing has a future obligation of repayment (usually with interest) such as loans, bonds or equity. In this report, financing is classified as "repayable" or "non-repayable", though some financing instruments may not fall neatly into one or other category. With credit enhancement instruments, for instance, future payments are obligated only if certain stated events occur, such as project non-performance or default by the borrower.

Funding refers to the process of paying back the financing, as well as paying for long-term operations and maintenance of the investments made. Funding includes two major types of financial resources that generally do not have any obligation of repayments: local government's own revenue sources raised through taxes, user charges, fees or operational surpluses, as well as intergovernmental fiscal transfers, grants and subsidies directed towards capital investments.

Source: World Bank and United Nations Capital Development Fund, 2024

The following sections explore in greater detail the different sources of urban climate finance, as well as the instruments and strategies that cities can use to mobilize and access the required quantity and quality of finance for effective urban climate action.

9.3. Channeling Local and National Government Revenue

This section outlines some of the opportunities and challenges in raising and disbursing public funds to support urban climate action. These are shaped by a number of factors, including not only the relative wealth or poverty of different countries and cities but also the complex institutional arrangements that determine their respective powers, capacities and autonomy. Though the ratio of national to local revenue varies greatly, most cities are sustained by a mix of income streams, from intergovernmental transfers to land-based revenues, local taxes and service fees (Figure 9.4).

Most cities are sustained by a mix of income streams, from intergovernmental transfers to land-based revenues, local taxes and service fees

Figure 9.4: Local government own revenue sources

Land-based revenues	Non Land-based revenues	User Charges	Intergovernmental transfers
• Property Taxes • Land fees/rates • Land Value Capture: - Infrastructure levy - Developer's obligation - Charges for development rights - Land pooling or readjustment - Strategic land banking - Charges on under- utilized urban land	• Licence fees for business • Pollution and congestion charges • Income taxes • Sale of carbon credits • Sale of data • Advertising rights	• Services: water, sewerage, parking fees • Administrative fees: business permits, registration	• conditional grants • unconditional grants

Source : Adapted from UN-Habitat, 2016a

9.3.1 The relative fiscal power of local governments

The rights and responsibilities of local governments for revenue collection and assignment of expenditures vary widely between countries, according to how national government systems are designed. Consequently, the degree to which various functions such as tax collection are decentralized to the local level is an important determinant of a city's financial autonomy. In a federal system such as India, for example, the role of state governments in policy can overshadow local authorities, in some cases leaving the latter with limited decision-making power over revenues and expenditure, depending on the legislative arrangements in place.[39]

Generally, cities in higher-income countries have a greater level of decentralization,[40] with more autonomy and administrative capacity in decision-making, as well as more financial resources and fiscal powers to source for urban climate finance. In developing countries with weaker governmental systems, cities may have limited capacity for revenue collection, and weaker or fragmented service delivery mandates and procurement processes. In such cases, delivering urban climate finance must begin by strengthening city planning, budgeting and financial management systems, including the broader city finance system beyond climate finance.[41] It should also be noted that decentralization is not in itself a guarantee of a financially resilient local government: in many cases, cities have found themselves charged with ever greater responsibilities in recent years without a concomitant increase in their revenue.

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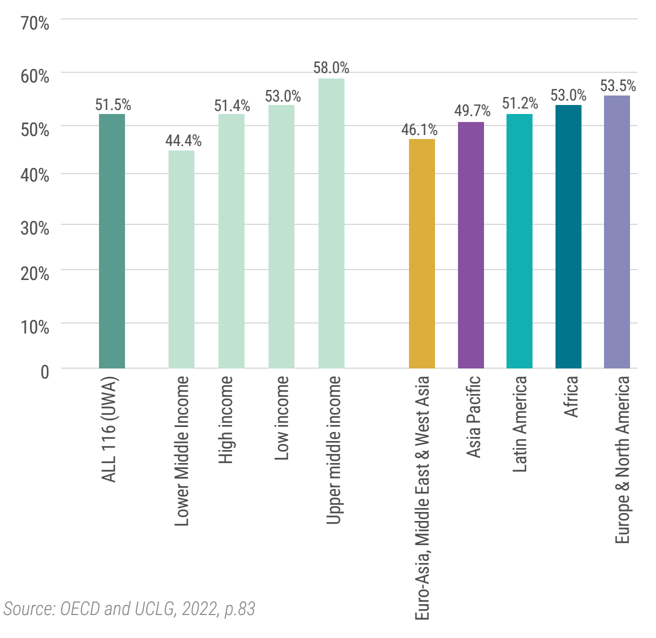
9.3.2 Intergovernmental fiscal transfers

Own revenue source is a key source of financing for local governments, with a diverse array of instruments that can be tailored for climate action including land value capture instruments, user charges and sale of carbon credits (see figure 9.4). Yet, if we consider the global average of own revenue sources against expenditures, cities often spend more than their capacity to raise revenues. One survey of a selection of EU and OECD countries found that local governments accounted for 19 per cent of total public expenditure, but only raised 13 per cent of public revenues.[42] In countries as diverse as Denmark, Ethiopia and Peru, local governments account for a high share of public expenditure but hold a low share in revenues highlighting significant imbalances between local governments revenue-raising capacities and corresponding spending responsibilities.[43] Depending on the powers vested in them, local governments may have a selection of revenue-generating tools at their disposal that can help raise much needed funds for climate-resilient investments (see figure 9.4). At a global aggregate, tax revenue accounts for approximately one-third of local government income, but with wide disparities between countries.[44] To bridge this revenue gap, local governments heavily depend on intergovernmental fiscal transfers from the national governments, with this accounting for over half of their revenue on average globally, though the proportion varies considerably across regions and income groups (see figure 9.5).[45]

Intergovernmental fiscal transfers refer to transfers of financial resources from one level of government (often central or national) to another (regional, state or local), usually in the form of conditional or unconditional grants and subsidies. The proportion of transfers as a percentage of total local government revenue varies widely across countries: from just 1 per cent in Jordan to as much as 90 per cent in Kenya.[46] In many Asian and African nations, the proportion frequently exceeds 80 per cent of total local government revenues. For instance, in Uganda, Malawi and Rwanda transfers from the central governments represent 94, 91 and 89 per cent respectively of the total revenue of the local authorities.[47]

Figure 9.5: Grants and subsidies from central/national governments as a share of local governments revenue by income groups and world regions (2020)



Source: OECD and UCLG, 2022, p.83

Because the costs and benefits of climate action are often unevenly distributed and extend beyond a city's jurisdictional boundary, the traditional structure of intergovernmental fiscal transfers – whether as conditional "earmarked" or non-conditional grants – may not effectively incentivize resilient investments. One approach of reconciling the cost-benefit imbalances of climate actions is through designing territorial-level transfers that invite consortia, including local governments to collaborate and participate.[48] For instance, under the Climate Pollution Reduction Grants program in the United States, nearly US$5 billion will be made available to states, local governments, tribes, territories and coalitions of these entities to implement ambitious community-led climate action projects which seek to reduce greenhouse gas emissions and air pollution within an environmental justice framework.[49]

Another approach to realigning incentives against fiscal transfers is through performance-based grants, generally from government revenues or external grants channeled through the national to local government. These transfers are conditioned on demonstrated performance against predetermined climate goals, incentivizing recipients to enhance their capacities. For instance, an evaluation of a climate resilience programme in Mozambique found its performance-based grants successfully incentivized the participating municipalities to increase their own revenue source collections by 114 per cent.[50]

9.3.3 Innovative approaches to income generation at the local level

Despite the challenges cities face in generating revenue at a local level, some have successfully reconfigured their current tax system in innovative ways to help finance climate action. In the city of Denver in the United States, for instance, residents passed a ballot measure in 2020, introducing a new 0.25 per cent sales tax for non-essential items specifically earmarked for climate protection efforts. This initiative now generates US$40 million for climate change programs, a tenfold increase from the city's previous climate-related expenditure. The generated revenue is allocated towards activities such as clean energy workforce training, neighbourhood-based environmental programs, energy efficiency and renewable energy upgrades, with more than half of the funds intended for communities most affected by climate change impacts, including Indigenous Peoples, minorities and low-income groups.[51]

Cities have also successfully used pollution and congestion charges to raise financial resources for improving air quality and transitioning to low-carbon public transport. For instance, in 2016 the city of London earned an estimated US$182 million, while Stockholm earned US$155 million.[52] To be effective, however, these charges should be implemented alongside incentives for non-motorized transport such as bike-sharing programmes: that way, they do not merely serve as convenient income sources, but also act as catalysts of a wider transformative shift towards more sustainable practices. Over time, this means that income from fees and penalties would decline as residents increasingly adjust their behaviours in compliance.

Land value capture mechanisms have also been effectively used to raise revenue for climate action, allowing local governments to recover and reinvest private land value increases that result from public investment and government actions. These range from simple one-time payments like betterment fees or charges for development rights, to more complex longer-term instruments such as taxes levied over time for future anticipated improvements of a designated area in the city. Land value capture can be leveraged in combination with land use management and mobility planning (both often within the control of city authorities) to incentivize climate-resilient development, as in the case of Quito, Ecuador (see Box 9.5).

Box 9.5: The use of land value capture mechanisms to incentivize sustainable housing and transportation in Quito, Ecuador

Ecuador's capital city, Quito, home to nearly 2 million residents, faces significant challenges from its transportation sector, a major emission source exacerbated by urban sprawl at the city's edges. As urban development has spread increasingly into peripheral areas, including rural communities, the human and environmental cost has been considerable. The situation has resulted not only in rising pollution levels, but also congestion, degradation of local ecosystems and spiraling service provision costs.

To address this, the city designed an innovative land value capture instrument to incentivize low-carbon compact city development. Anchored on a new city metro system, authorities enacted the Eco-Efficiency Ordinance for the Metropolitan District of Quito in 2016. The ordinance allows the sale of additional building rights to developers in transit-accessible areas, promoting compact, energy-efficient construction. In return for increased building heights and other permissions, developments are required to meet climate-positive design standards such as water and energy efficiencies, with additional incentives provided for including affordable housing units.

Since its introduction, over 35 projects have been approved, generating more than US$10 million for further urban improvements. A striking feature of its success is that it has enabled the city to actively encourage positive social and environmental outcomes while at the same time providing it with a valuable income stream that can then subsidize public services and other forms of climate action.

Source: Welch, et.al., 2022

Though land-based revenue sources currently represent an average of just 3.1 per cent of local government revenue,[53] they have significant potential of scaling up as the tools to operationalize them are largely within the control of local governments, including land use regulations, urban design (including parks and green spaces) and urban mobility planning. Additionally, enhancing these revenue sources can improve local governments' creditworthiness, enabling them to access external financial resources at favorable terms.[54]

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Another channel for raising revenue for improved resilience in cities, though complex, is through the sale of carbon credits. Using this approach, local governments can quantify the reduced emissions from undertaking a particular climate action (for example, the development of a renewable energy system or ecological restoration) and convert these into carbon credits that can then be sold in domestic and international carbon markets. Part of the complexity is undergoing the often-lengthy third-party verification process of the project to ensure it meets the approved carbon standards. Nevertheless, once realized, the benefits of a successful programme can be wide-ranging. In the US, for instance, a consortium of cities generated over US$1 million combined in a bundled sale of carbon credits exclusively generated from urban forests. Besides generating revenue, these projects have protected existing nature spaces from redevelopment and helped restore degraded land through regreening.[55]

9.4 Repayable Financing Instruments: Borrowing, Credit and Loans

While national and local governments can direct more of their expenditure to address urban climate change impacts, the high up-front costs of resilient infrastructure will frequently far exceed the resources at their disposal. Well designed, affordable loans and credit can therefore offer a lifeline for cities to invest in climate solutions that over the longterm will pay for themselves many times over in terms of averted damage, enhanced investor security and a range of other social and environmental benefits.

Borrowing is a necessary consideration for cities to bridge the gap of financing urban climate action, especially to cover upfront capital costs where own revenue sources and intergovernmental fiscal transfers are insufficient. In principle, local governments can borrow directly from the national government, as well as from public development financial institutions (DFIs), private financial institutions or the capital markets, with each of these providers having their own merits and drawbacks. Yet in practice, they face considerable obstacles to borrowing and, in many cases, may not have the political standing or credit rating necessary to be recognized as a worthy loan recipient. Section 9.6 delves deeper into the challenges and barriers cities face in securing finance for climate action.

Borrowing is a necessary consideration for cities to bridge the gap of financing urban climate action

Nevertheless, there is growing recognition of the merit of expanding the capacity for local governments to borrow, especially given their responsibility to provide climate-resilient infrastructure for essential services. Borrowing at the local level would improve the alignment of the investment costs with the primary place where the benefit is accrued, ensuring the city-level beneficiaries bear the responsibility to pay. Furthermore, the long-term repayment of borrowing spreads the costs to future generations who will also benefit, unlike the local government revenue or fiscal transfers that are drawn from past and present generations. It also fosters the development of financial markets at the local government level.[56]

There is growing recognition of the merit of expanding the capacity for local governments to borrow, especially given their responsibility to provide climate-resilient infrastructure for essential services

It should be noted that, as with any development loans, clear frameworks should be in place to ensure that any borrowing by cities for climate action programmes is responsibly delivered and in line with what the local government can realistically afford. While the fiscal rules are still evolving and necessarily context specific, the "golden rule" is the most commonly applied fiscal rule that limits local level borrowing only for investment purposes and not for recurrent expenditure or to repay debt to avoid over indebtedness of local governments.[57] This is often combined with other fiscal rules that put a quantitative ceiling on borrowings.

9.4.1 Borrowing from public institutions

One important source of urban climate finance is the complex ecosystem of national, bilateral and multilateral development banks, public financial institutions and dedicated international climate funds. From individual country development agencies to regional and global organizations, they provide access to concessional loans with more favorable interest and longer repayment terms. This assistance also plays a critical catalytic role in de-risking transactions and supporting projects that are less likely to attract private financing.

Generally speaking, local governments are unable to access loans and grants from these financial institutions directly without the backing and technical support of national governments, who either negotiate the facilities themselves or offer a sovereign guarantee to enable cities to apply for the loans. They also help local governments navigate the complex landscape of international climate finance, ensuring urban projects meet the eligibility criteria and are well positioned to secure financing. This involves coordinating with international donors, aligning local projects with global climate goals, and supporting the preparation and submission of funding proposals.

National development banks are particularly well-positioned to support urban infrastructure and can dramatically reduce the transaction costs for cities seeking finance. Engaging with these institutions offers several advantages for cities: they bring a deep understanding of the national context, including challenges and opportunities for investments, and often have a direct role in informing and contributing to the countries' development planning. In most cases, national development banks can borrow from international markets, including international climate finance funds, and have established relationships with private financial institutions and capital markets. They can convert these funds into local currency, providing tailored financing to specific local needs. Moreover, they can bridge the access barriers for municipalities that lack long-term financing options, either by directly lending to them or by pooling different types of funding or small projects together to enhance access to finance.[58]

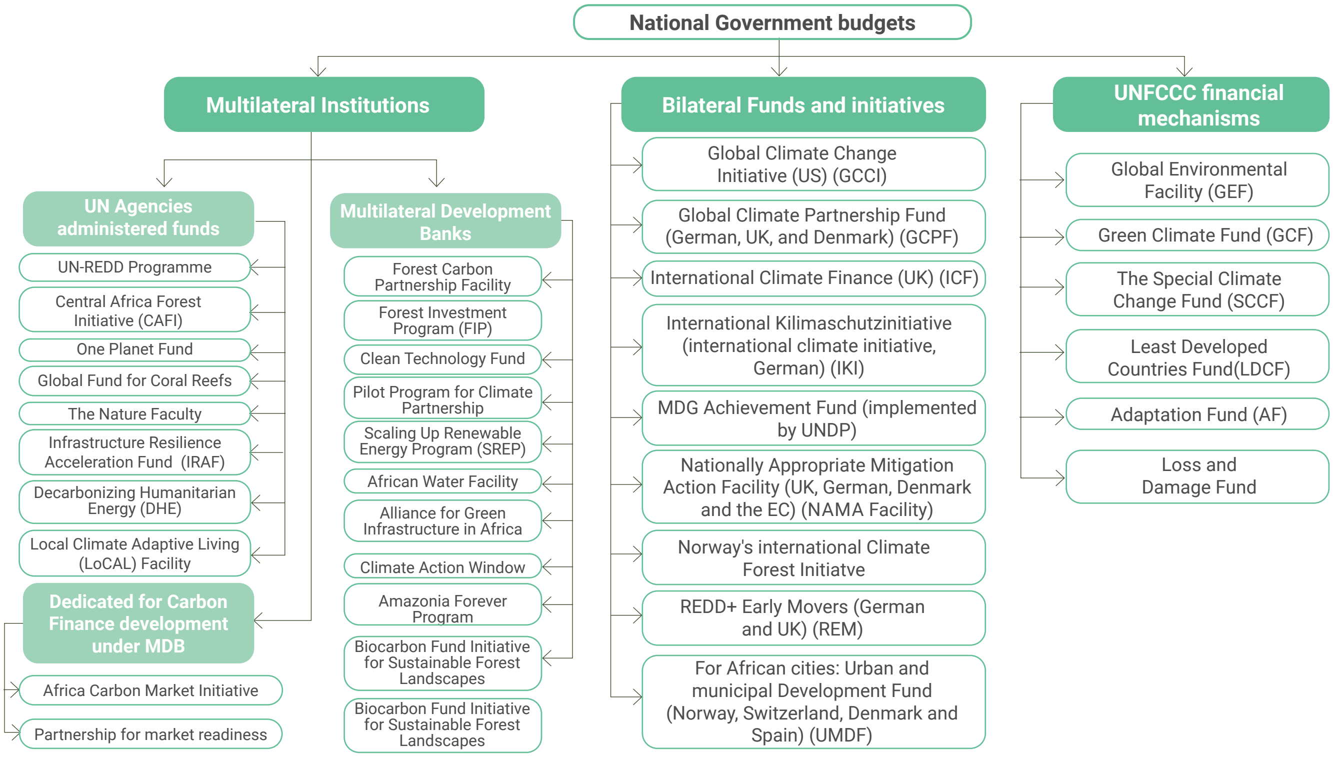
National development banks are particularly well-positioned to support urban infrastructure and can dramatically reduce the transaction costs for cities seeking finance

The urban dimension of bilateral climate finance often fits into a wider agreement or engagement between the involved countries. For example, China has been building climate partnerships for South-South cooperation as part of its Belt and Road initiative. By 2023, China had signed 45 bilateral agreements with 38 countries on climate mitigation and adaptation, mainly in investment in infrastructure projects such as solar farms, donations for e-buses or energy-efficient programs, as well as training programs for low-carbon cities.[59]

As mentioned above, cities often face challenges accessing multilateral development finance due to sovereign guarantee requirements, and therefore national governments act as the main channel for this financing. Multilateral development banks, however, still play a key role by enhancing the capacity of cities to prepare bankable projects and providing early-stage grants for technical studies. By initiating their support during the earlier stages of project preparation, multilateral development banks enable cities to meet the required technical, social and environmental standards for accessing financing. They can further encourage investment flows by providing various credit enhancement mechanisms including guarantees and insurance mechanisms.[60] For example, the European Bank for Reconstruction and Development (EBRD) Green Cities Program effectively integrates financing alongside project preparation support. It has mobilized £5 billion and invested in more than 85 projects to date, supporting cities not only with the financing of sustainable urban infrastructure but also through the development of green action plans and local capacity building to ensure effective implementation and monitoring.[61] Similarly, the African Development Bank's Urban and Municipal Development Fund (UMDF), launched in 2019 to promote "more climate-resilient, liveable and productive urban development in Africa", focuses on assisting cities with the identification, preparation and financial structuring of adaptation projects to bring them to bankability.[62]

Aerial view of the busy city centre of Gondar, Ethiopia © Eric Isselee/Shutterstock

Figure 9.6: The global architecture of public sources of climate finance



Source: adapted from United Nations MPFT Office, 2023, AfDB, 2023b and Watson and Schalatek, 2021

The global architecture of financial institutions providing financing for climate action is evolving, with funds flowing through multiple channels. Though not exhaustive, Figure 9.6 provides an overview of public related mechanisms. Nevertheless, while essential for enabling urban climate action, public financial sources are constrained and cannot alone meet the massive capital outlay required to finance the transition to climate-resilient cities. As of 2023, there were nearly 530 public finance institutions controlling approximately US$23 trillion of assets, financing about 10 per cent of global investments (including non-climate-related investments).[63] Comparing this to the US$90 trillion conservative estimate by the Global Commission on the Economy and Climate Change[64] of the level of global investment needed for low-carbon and climate-resilient infrastructures, public financial resources significantly fall short. This highlights the necessity of private sources of financing and capital markets to achieve the climate goals.

9.4.2 Borrowing from private institutions

Private financial institutions (such as domestic commercial banks) and capital markets can offer market-rate debt instruments to finance resilience projects. Although these instruments often attract higher interest rates than public financing, they provide additional benefits beyond bridging the financing gap in the public sources. Engaging with private sources promotes the development of financial markets and helps to strengthen the financial management systems within local governments, as private financiers often conduct rigorous evaluation of the financial health of the borrower. Additionally, borrowing from commercial entities builds the credit profile of the local governments, reducing perceived risk and making it easier to access future financing.[65]

Globally, private actors contributed 49 per cent (US$404 billion) of the total urban climate finance tracked in 2021-2022.[66] However, private finance flows are heavily skewed across regions. In 2019/2020, private finance accounted for 14 per cent of total climate finance flowing to Africa, compared to 96 per cent in North America, 59 per cent in western Europe and 49 per cent in Latin America and the Caribbean. In Africa, the leverage ratio between private and public finance is 0.16, the lowest in the world: this means that US$1 dollar of public finance attracts just US$0.16 in private finance, compared to US$18.5 in North America.[67]

However, even when private finance is available for climate investments, it is generally skewed more to mitigation than adaptation action due to its greater potential of profitability. This is because mitigation-related investments are easier to measure (for example, based on reduction in emissions by a given percentage), easily scalable and offer a higher return on investment. Adaptation actions, on the other hand, are predominantly localized, usually of smaller scale (lacking economies of scale) and present high uncertainty of their impacts and outcomes.[68]

One approach to encourage private sector resources, particularly in projects that may be less attractive from the perspective of potential investors, is through de-risking projects with instruments such as concessional loans, guarantees and first-loss protection. This is well illustrated by the GCF's Private Sector Facility (PSF). The portfolio of

61 private sector projects supports a range of adaptation and mitigation activities with communities in Africa, Asia, Latin America and the Caribbean, including the development of resilient infrastructure and early warning systems for coastal settlements. Through an array of incentives, the PSF has mobilized US$5.5 billion of GCF funds against a total portfolio value of US$27.1 billion, a more than fourfold leveraging of public finance.[69]

As with public financial sources, accessing private debt financing through commercial finance institutions can be challenging for cities, especially small and intermediary cities with lower fiscal capacity. Cities can face obstacles related to limited revenue streams and creditworthiness, further impeding their ability to take on debt. One approach to resolving these limitations is through the aggregation of urban projects through pooled mechanisms to improve borrowing capacity and credit profiles. Box 9.6 below illustrates the approach undertaken by the Mayor of London to attract private capital by aggregating projects across different boroughs and agencies within the Greater London Authority.

Accessing private debt financing through commercial finance institutions can be challenging for cities, especially small and intermediary cities with lower fiscal capacity

Box 9.6: Mobilizing pooled finance: the London Climate Finance Facility

In response to the growing evidence of the urgency of climate action, London brought forward its net-zero target from 2050 to 2030, a decision that requires an estimated £75 billion (approximately US$96 billion) in investments in renewable energy, retrofitting, energy-efficient construction and sustainable transportation infrastructure by 2030.

Recognizing the constraints of public finance, the city sought to attract private capital to complement public resources and scale up the financing. However, a key barrier identified was the fragmentation of capacities, funding mechanisms, infrastructure and ownership across the Greater London Authority area.

To resolve this, the City Authority established the London Climate Finance Facility as a platform to bring together projects and create coherent business cases across boroughs and agencies, forming a robust pooled project pipeline. Leveraging its credit rating, London then attracts private finance at favorable rates for onward lending to smaller implementing agencies, offering credit and tenor terms tailored to the specific needs of the infrastructure being financed.

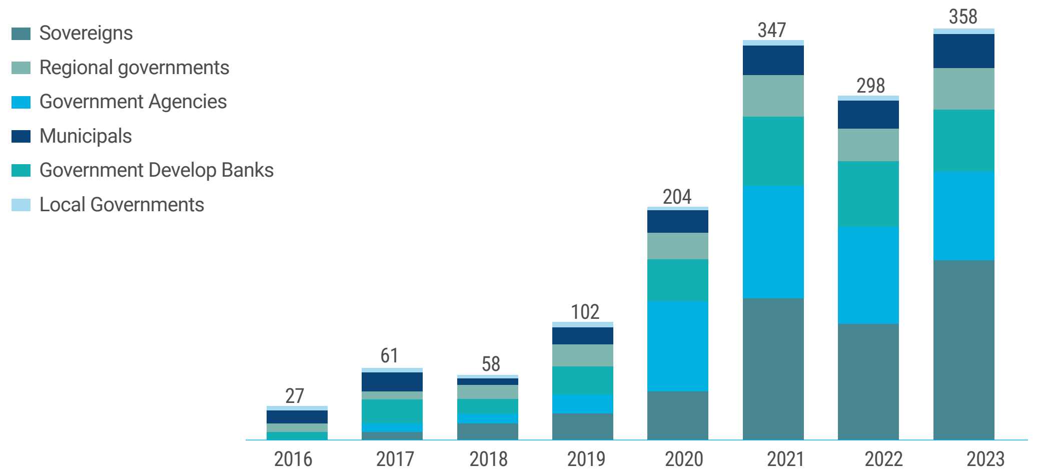
Source: Greater London Authority, 2024

A view across the fields and trees to the City of London. © Laura Stubbs/Shutterstock

9.4.3 Borrowing from capital markets

Another way for cities to mobilize finance for climate action is by issuing bonds in the capital market. This can take multiple forms, including *green bonds* (for projects targeting environmental benefits such as energy efficiency or emissions reduction), *social bonds* (for projects addressing social outcomes such as affordable housing and healthcare), *sustainability bonds* (for projects that combine environmental and social benefits) and *sustainability linked* bonds (not tied to a specific project but linked to the city's overall sustainability performance targets). As of 2023, the cumulative issuance of green, social, sustainability and sustainability-linked (GSSS) bonds since 2016 reached US$4.9 trillion. Public sector issuance, including national governments, regional governments, municipalities, local governments, government agencies and development banks, accounted for 31 per cent (US$1.5 trillion) of this amount, with green bonds making up the majority. However, regional governments, municipalities and local governments issuances cumulatively account for only a quarter of public sector GSSS, amounting to approximately US$375 billion.[70]

Figure 9.7: Cumulative public sector issuance of GSSS bonds as of 2023 in US$billion



Source: World Bank, 2024

To issue bonds cities must demonstrate strong creditworthiness. This is discussed further in section 9.7.3. However, with growing support from national governments and development finance partners, even smaller cities are making progress in accessing bond markets as illustrated by the successful issuance of East Africa's first water green bond by Tanga City, an intermediary city in Tanzania (Box 9.7).

Box 9.7: Tanga Water Green Bond, City of Tanga, Tanzania

Tanga, an intermediary port city in northeastern Tanzania, is home to a population of just over 450,000 residents. In February 2024, Tanga Urban Water Supply and Sanitation Authority (Tanga UWASA), an autonomous water utility, issued the first ever local government water green bond in East Africa. This landmark financing mechanism was valued at TZS53.1 billion (approximately US$23 million), with a 10-year term and an estimated coupon rate of 13.5 per cent and semi-annual coupon repayments. The financing will be directed towards expanding the distribution of safe and affordable water from a capacity of 45,000 cubic meters to 60,000 cubic meters per day, in the process extending the network coverage to around 6,000 households currently without access to piped water. It will also encompass the installation of infrastructure such as kiosks and smart meters, as well as support conservation activities along the Zigi river and surrounding villages.

Importantly, Tanga's local government was able to secure this funding with the support of other stakeholders who provided the necessary financial and technical assistance for the bond to be approved. The national government played a significant role by providing an enabling framework for the development of the domestic municipal bond market as part of the Alternative Project Financing (APF) strategy initiated in 2021, along with offering political support. The UN Capital Development Fund (UNCDF) was also instrumental in providing technical support, building capacity and assisting in the developing and structuring of the project.

Source: UNCDF, 2024.

9.5. Other Sources of Urban Climate Finance

While it is important that national and local governments can access public and private finance to support urban climate action, there are also significant opportunities in mobilizing financial institutions, companies and individuals to actively invest in climate action. By encouraging and facilitating various mechanisms for stakeholders to engage in these efforts, whether in the form of public-private partnerships, equity, household investments or philanthropic activities, cities can mobilize significant untapped potential to drive positive resilience outcomes.

9.5.1 Public private partnerships

Public-private partnerships (PPPs) are long-term contracts between public and private entities to jointly finance and share risk in developing and operating a public infrastructure asset or service. There is no single model for PPPs, as these adjust to the needs of each situation and the capabilities of the private partners. However, in one of the most common types of PPPs for urban climate finance, the private sector provides access to capital, leveraging resources to invest in projects. The public sector's role is to reduce risks for the private partners, by providing guarantees, reducing regulatory uncertainties and contributing to project viability.

This combination of access to capital and de-risking can be observed in a PPP set out in Jakarta, Indonesia, where the public transport authority TransJakarta set an e-bus pilot PPP with bus operators with the aim of achieving its target of 100 per cent bus electrification by 2030. Private operators, having purchased the e-buses themselves, are then paid a set fee per kilometre by the city on a designated route. TransJakarta, in turn, receives payment of the fares from bus users. Given the high upfront investment needed to purchase electric buses, the government increased the concession period for companies from seven to ten years, allowing for better returns on investments. Not wishing to focus exclusively on larger operators, it also worked with small-scale operators in cooperatives who together were able to cover the initial outlay.[71]

9.5.2 Equity investment

Two equity instruments can be leveraged for urban climate action: *private equity* and *project-level equity*. Private equity involves investments in private companies or buyouts of public companies, providing access to liquidity beyond conventional financial mechanisms. Project-level equity, on the other hand, refers to equity provided for project finance, often through the establishment of special purpose vehicles.

Both equity instruments can provide alternative avenues for financing climate-resilient infrastructure projects at the local level and supporting sustainability ventures, especially within public entities closely linked to cities, such as water management or wastewater treatment companies. Accessing equity finance requires a robust bankable project, and investors are likely to focus on the partner's creditworthiness. By having a stronger financial system through collection of taxes and fees cities can improve their creditworthiness and gain access to capital markets. Project preparation facilities can once again be critical partners to support cities in seeking private financing, by incorporating assessments and metrics that specific investors may be looking at to measure bankability.

Accessing private debt financing through commercial finance institutions can be challenging for cities, especially small and intermediary cities with lower fiscal capacity

Private equity funds facilitate investment partnerships, acquiring and managing local companies or urban infrastructure projects. These funds often target larger-scale projects focused on climate resilience and low-carbon solutions, aligning financial returns with environmental objectives. A substantial portion of climate-resilient investment has been facilitated through equity instruments, a trend driven by the significant involvement of the buildings and transport sectors, as well as the interest of private investors in climate transitions.[72]

A case in point is the Smart City Infrastructure Fund (SCIF). Established in 2018 by Whitehelm Capital and Dutch pension fund manager, APG the pool fund focuses on the development of smart city infrastructure in major urban areas in the world. The fund attracted €250 million (approximately US$270 million) in its first closing and targets investments in transportation, energy, resource efficiency and data analytics through common equity in assets, preferred equity and acquisition of assets. Among other projects, SCIF is partnering with a privately owned telecommunications company in the United States to deploy more than US$500 million to support the rollout of high-speed wireless networks and other digital infrastructure in secondary cities across the country.[73]

9.5.3 Household investments

Domestic private finance amounted to US$389 billion in 2021-2022 for urban climate finance.[74] Households and individuals combines the largest number of investors in urban climate finance, reflecting investments directed towards climate-resilient housing and energy efficiency measures, such as house retrofitting and private electric vehicle investments.

Households and individuals combines the largest number of investors in urban climate finance

While the size of each individual investment may appear modest relative to the overall financing needs, they collectively demonstrate the potential for transformative impacts when aggregated. National and local governments can take steps to encourage household-level investment in low-carbon options through targeted incentives, subsidies and tax breaks.

9.5.4 Philanthropic and charitable contributions

Financing from organizations operating at the community level, including philanthropic and charitable entities, has increased significantly over the past few years. Globally, it is estimated that financing from philanthropic foundations towards mitigation actions more than tripled between 2015 and 2021.[75] Such funding is mainly through small grants with no future repayment obligations. This is especially important for the highly vulnerable low-income informal urban communities who face challenges in gaining legal recognition and navigating mainstream financial systems. By making affordable financing accessible to hard-to-reach urban groups

Globally, it is estimated that financing from philanthropic foundations towards mitigation actions more than tripled between 2015 and 2021

who are often invisible to formal financial institutions, such mechanisms further advance the just urban transitions critical for effective urban climate action (Box 9.8).

Box 9.8: The value of decentralized funding for locally-led climate action

Voices for Just Climate Action (VCA), an initiative of six civil society organizations—Akina Mama wa Afrika (AMwA), Fundación Avina, Slum Dwellers International (SDI), SouthSouthNorth (SSN), Hivos and WWF-Netherlands—manages a small grants mechanism totaling €3.5 million (US$3.8 million). This fund provides grants of up to US$10,000 to local climate actors with limited access to formal financing, including marginalized informal groups and small grassroots organizations, particularly targeting women and Indigenous communities.

Biupe Innovators, a youth group in Mukuru slums in Kenya, is one of 106 recipients that received financing support through a local implementing partner, Muungano wa Wanavijiji, to undertake tree planting, community cleanups, waste management, and urban farming. By decentralizing grant management to local partners like Muungano wa Wanavijiji, VCA ensures that access to finance criteria are relevant and accessible to local groups. This approach facilitates prompt responses to climate challenges, enhances local ownership, and builds community capacity in grant management.

Source: Voices for Just Climate Action, 2024

9.6 Challenges and Barriers to Scaling Urban Climate Finance

It is worth noting that in many ways—how urban climate finance is sourced, structured and implemented—is fundamentally no different from any other type of finance.[76] Consequently, the barriers local governments face in accessing finance in general also apply when seeking financing for urban climate action. These include policy and regulatory barriers, project preparation challenges, financing challenges such as low creditworthiness and political constraints, as well as institutional and governance challenges.

It is worth noting that in many ways—how urban climate finance is sourced, structured and implemented—is fundamentally no different from any other type of finance. Consequently, the barriers local governments face in accessing finance in general also apply when seeking financing for urban climate action

Different from typical project financing, climate interventions present three distinct characteristics that create challenges and barriers unique to urban climate finance. First, climate interventions are often long-term, requiring consistency in action across different political regimes. Second, effective implementation spans multiple jurisdictional boundaries, calling for stronger coordination and synergies across geopolitical lines. Third, limitations in historical data make it difficult to accurately evaluate and value the financing requirements.

This section discusses traditional challenges and barriers summarized in Figure 9.8 and further highlights additional emerging challenges to financing urban climate action, including the problems of long-term planning, the complexities surrounding collaboration and synergy-building, as well as the limitations of the data available.

Community Clean up excercice. © Media Lens King/Shutterstock

Figure 9.8: Challenges and barriers to financing urban climate action

Challenges unique to financing urban climate action	• Higher upfront cost • Limited historical and comparable data • Highly interconnected impacts cutting across
Traditional challenges and Barriers	• Policy and regulatory barriers including political challenges and barriers in enhancing own revenue sources • Implementation and financing challenges including lack of or substandard credit rating and ticket size limitations • Limitations in institutional capacity to prepare bankable projects

9.6.1 Traditional barriers and challenges

Though interconnected, the traditional barriers and challenges can be grouped into three main categories. Policy and regulatory barriers are closely linked to the enabling environment in which the city is inserted—often determined by national governments—and have a direct impact on a city's ability to leverage and access financing. Project preparation challenges reflect a city's challenges in translating climate action plans and ideas into bankable projects. These are closely linked to the lack of technical expertise and local political priorities both at the national and local government levels. Implementation and financial barriers include the limited local understanding of financing options that cities have access to, and the challenges they face to access existing sources due to constraints that are often beyond their direct decision-making realm. Other broader challenges exist but are not directly connected to financing projects, and for this reason are not discussed here.

Policy and regulatory barriers

National level legal and regulatory frameworks determine the context within which cities can operate and access financing. Due to regulatory constraints, cities are often unable to directly borrow from public and private international lenders. One analysis of 160 countries found that more than half (89) restrict any kind of borrowing from local governments—including the issuance of municipal bonds—while only 22 allowed local governments to borrow without restrictions.[77]

Cities may also have limited ability to generate revenues from local taxes and fees. Regulations over whether a city may or may not have tax authority are also often outside the control of municipalities, with only an estimated 16 per cent of countries allowing significant taxation powers to cities.[78] Instead, they often rely on intergovernmental transfers from national governments, which are often unpredictable and delayed, hindering local governments' ability to plan and allocate funds effectively. In some cases, the basis for allocation and the legislative guidelines on transfers are unclear, creating room for bias or manipulation.[79]

Political and electoral cycles can also affect the stability and continuity of policies on financing and implementation of climate projects. Climate-resilient infrastructure projects often extend beyond the duration of a political mandate, and the dynamics of political leadership at the city level as well as national level can lead to shifts in budgetary priorities, disruption of financing, or delayed and even revoked approvals. This ultimately undermines the effectiveness of urban climate action. Box 9.9 illustrates a case of the influence of the political landscape on financing city level climate action.

Box 9.9: The influence of the political landscape in the failed municipal bond issuance by the City of Dakar in 2015

Dakar, Senegal's capital and a key seaport on the West African coast, illustrates the critical role of political buy-in for innovative financial reforms. Home to over 3 million people in its metropolitan area, Dakar sought to improve its infrastructure through a US$40 million municipal bond for the development of a 10-hectare marketplace for street vendors. This effort aligned with Senegal's progressive decentralization, particularly the 2013 Acte III de la Décentralisation, which empowered and allocated more responsibilities to local municipalities.

Despite careful planning and meeting all regulatory requirements, including securing a 50 per cent guarantee from USAID, as well as receiving pre-approval from the central government on three separate occasions, the bond was halted by a national government decree just before its launch. The central government's withdrawal of support, influenced by among other factors political concerns, ultimately prevented the bond's issuance.

The city, however, still benefited from the process, substantially increasing its municipal revenue as a result of improved financial management. It also achieved creditworthiness through comprehensive reforms, including enhancing financial operating systems, developing a strategic city plan, and engaging international credit rating agencies.

Source: Delbridge, et.al., 2021

Project preparation challenges

Developing bankable projects is at the crux of unlocking access to financing for climate interventions. The process is often lengthy and complex, involving strategic planning, technical designs, risk and returns assessments, political support, potential pilot testing and investor negotiations. Often, cities lack the internal capacities and resources to execute these complex early phases. Additionally, cities also face challenges in availing the required financial resources to enable such activities, typically ranging between 3 to 5 per cent of the total project costs in developed countries with a stable policy environment, and about 5 – 10 per cent in developing countries.[80] The inability to create projects that meet or can clearly communicate the criteria to receive investment, such as clear feasibility assessments and projected returns on investment, is a key hinderance in a city's ability to attract financing, especially from private sources.[81]

The inability to create projects that meet or can clearly communicate the criteria to receive investment, such as clear feasibility assessments and projected returns on investment, is a key hinderance in a city's ability to attract financing, especially from private sources

Project preparation facilities (PPFs) have emerged as important players in addressing the lack of existing expertise in cities and help create bankable projects.[82] This early-stage project preparation support is critical to bridging capacity gaps. Programs such as the World Bank's City Gap Fund focus on addressing this bottleneck, having to date provided early-stage project preparation grants for over 180 cities in 67 countries to plan and prepare studies to bring projects to a bankability stage.[83] Another notable platform is the UN-Habitat City Investment Advisory Platform within the City Investment Facility, which provides early-stage technical and financial de-risking activities and assesses, verifies and certifies the SDG impact of a project and aligns this with the city plans.[84]

Implementation and financing barriers

Cities encounter a dual challenge when it comes to financing projects. Projects may be too large for cities to finance through their own budgets, but at the same time, considered too small by external donors to finance. The majority of financial institutions set a minimum ticket price—generally between US$10 and 30 million,[85] depending on the investor—which is often higher than what is needed for local government individual projects, especially for cities in low- and middle-income countries.[86] Around 40 per cent of projects reported in the CDP-ICLEI tracker of urban climate projects are small-scale projects, costing less than US$500,000.[87]

Smaller projects can struggle to attract finance due to their limited scale and impact, as well as their disproportionally higher transaction costs for preparation, implementation and monitoring results. Furthermore, while community or local-level projects can be best tailored to address local needs and inclusion directly, their overall impact on climate mitigation or adaptation may seem negligible at the macro level. This fragmentation can make it difficult to demonstrate the intended impact sought by funders, and governments often will prioritize bigger projects that attract more visibility.

Another common barrier is cities' limited creditworthiness. Creditworthiness is a third-party assessment of whether an entity is worthy of receiving credit, based on the confidence in the long-term financial strength and stability of the borrower and its ability to pay back borrowings in a timely manner. It is often a prerequisite for the application of conventional debt financing, including green and municipal bonds and PPPs that involve municipal borrowing. As a result, cities with low credit ratings face more difficulties in securing commercial and private financing or getting access to credit markets.[88] At the municipal level, of the 500 largest cities in the developing world, less than 20 per cent are considered creditworthy.[89] However, cities that take steps to enhance their credit rating can receive substantial benefits as a result. As shown by the World Bank's City Creditworthiness Initiative, just US$1 invested in improving the creditworthiness of a city in a developing country can potentially leverage more than US$100 in financing for low-carbon and climate-resilient infrastructure at the city level.[90]

Small and intermediary cities, which as of 2020 hosted 58 per cent of the urban population in developing countries,[91] face additional challenges in accessing private capital. These cities have often been neglected by national and regional urban development and planning, receiving less investment and fiscal transfers. As a result, there is a growing disparity between metropolitan centres and small and medium-sized cities.[92] Small and intermediary cities are less likely to have sufficient own source revenue and technical capacity to prepare climate projects, and the smaller size of projects in these cities make these less attractive to private finance or finance from large multilateral banks. In most cases, these cities are also in a weaker political and fiscal position to demand a greater share of the resource transfers from national governments dedicated to fund local infrastructure.[93]

Cities globally vary in size, fiscal structure, creditworthiness capacity and financial autonomy. Each city is likely to have its own combination of these barriers and will require its own approach to access finance. Table 9.2 summarizes common barriers and challenges. While not exhaustive, the summary focuses on obstacles directly affecting cities' ability to access finance for urban projects.

Table 9.2: Traditional barriers and challenges faced by cities to access climate finance

Type of barrier	Challenges	Details
Regulatory and policy barriers	Restrictions on borrowing	National regulations that limit the ability of local governments to borrow and contract debt
	Unclear multi-level governance	Lack of a clear governance structure, or one that limits cities' authority over revenue collection and expenditures, reducing a city's ability to autonomously raise revenue to finance urban climate projects
	Irregular intergovernmental transfers	Lack of clarity on the sums or schedule of transfers, making it challenging to plan, structure and finance projects
	Political misalignments	Lack of political alignment between national and city political leaders especially when city leaders belong to opposition political parties. Additionally, electoral cycles from national to city level can create policy breaks and uncertainty in city climate needs and priorities
	Lack of prioritization of urban climate projects	Lack of a clear commitment from national governments on climate action, for example through bold NDCs or local governments engagement in developing climate action plans
	Limited domestic capital market	The absence of regulation that allows the development of a domestic capital market can limit the financial options available to cities, increase the cost of borrowings, create dependency on external finance and hinder the involvement of the private sector
	Limited fiscal decentralization	The lack of fiscal decentralization on the national level constrains cities' financial autonomy, affecting their ability to plan, finance and implement urban climate projects tailored to their needs
Project preparation barriers	Reduced local planning autonomy	National governments may hold the responsibility for planning in specific sectors, limiting a city's ability to plan and finance local low-carbon projects
	Lack of local climate action plans	Without a clear strategy for plans and projects to implement, cities risk continuing implementing business-as-usual, carbon intensive projects
	Limited project development technical expertise	The deficiency of technical expertise to develop climate projects that meet the criteria of bankability of public and private investors
	Lack of knowledge about existing support	Lack of awareness of the support provided by project preparation facilities that can help them structure projects and explore avenues to access climate finance
	Limited project preparation support	There is often limited capacity from project preparation facilities to respond to the demand from cities on project support
Implementation and financing barriers	Need for sovereign guarantees and lack of creditworthiness	Due to a lack of or poor credit ratings, cities have a limited ability to access capital markets and often depend on national governments to provide sovereign guarantees to access finance from public and private financial institutions
	Limited revenues	Climate projects compete with other urban priorities that are also funded by cities own revenue sources
	Lack of resources for operating expenses	A lack of operating expenses may lead to reduced maintenance and long-term efficiency of a project
	Project size dilemma	Cities can have projects that are too large to be financed through their own budgets, and too small to be attractive to other investment sources
	Lack of access to affordable finance	High financing costs, especially in the early stages of project implementation, can render projects economically unviable, especially affecting innovative or untested technologies that involve higher implementation risks
	Limited understanding of available financing options	Cities rely on using their own resources to pay for projects, instead of exploring alternative or innovative financing mechanisms. Given the limitation imposed by cities' own budgets, projects may be deprioritized or cancelled
	Weakness in financial management integrity	Lack of transparency, accountability, and the presence of corruption in institutional processes can deter potential investors

9.6.2 Additional challenges unique to financing climate action

Different from other investment undertakings, climate-related projects have distinct features that present unique financing challenges. Climate impacts cut across multiple sectors and geopolitical boundaries and can persist over a long period. Additionally, climate solutions are often untested and non-standardized, with benefits that are only fully realized long after the initial investments, as is the case with increasing urban tree cover. These differentiating characteristics pose additional barriers and challenges.

High up-front costs

One important challenge to financing climate interventions is that costs are often heavily front-loaded, especially in the initial stages. These include expenses related to the decommissioning of high-carbon infrastructure, handling job redundancies, and reskilling efforts.[94] With pressing budgetary needs especially in developing countries, such high up-front costs can lead to inertia in adopting low-carbon alternatives, even when the long – term economic viability of the climate-resilient solutions – such as in the case of energy transitions – are clear.[95] Further, with the implementation of such projects often extending beyond political election cycles, the high upfront costs can weaken current elected leaders willingness to commit to these costs due to limited quick wins within their elected term.

Many climate-related solutions are relatively new and untested, with significant data gaps on expected impact, introducing higher degrees of uncertainty. This results in higher due diligence and transaction costs, which in turn can reduce overall returns, making them less attractive to private investors

Limited historical and comparable data

Many climate-related solutions are relatively new and untested, with significant data gaps on expected impact, introducing higher degrees of uncertainty. This results in higher due diligence and transaction costs, which in turn can reduce overall returns, making them less attractive to private investors.[96] One approach to resolving this challenge is availing long-term patient capital[97] such as grants and philanthropic financing and creating an enabling environment for research and development of urban innovation (see chapter 8).

Highly interconnected impacts cutting across sectors and jurisdictional boundaries

Climate change is a necessarily whole-of-economy complex challenge, cutting across sectors and jurisdictional boundaries. Given this scope and scale, a whole-of-society and whole-of-government approach is required for climate action to be effective. Institutions that foster coordination, policy integration and mainstreaming are especially crucial. Effective coordination horizontally (across sectors) and vertically (across different levels of government) can reduce siloed actions, avoid duplication, align incentives and build a shared vision for climate action. Chapter 7 delves deeper into the different governance frameworks, from the global to the national to the local, that promote co-actioning.

Integrating and synchronizing climate actions beyond the city level presents both challenges and opportunities for cities. The challenge lies in securing the financial resources needed for effective coordination, which many local and national governments highlight as lacking.[98] The opportunity lies in scaling impact through a holistic approach that unlocks synergies and co-benefits from the strategic alignment of resources. The resulting financial aggregation enhances the borrowing power of recipients, attracting more capital and favorable financing terms.[99]

9.7 Opportunities for Scaling Urban Climate Finance

Resolving project-level financing barriers for local governments is necessary but not sufficient for the scale and speed needed for effective urban climate action, especially given the unique complexities of climate-related challenges. This section focuses on strategic opportunities to scale up public and private financial resources directed towards investing in inclusive, sustainable, and climate-resilient cities

Resolving project-level financing barriers for local governments is necessary but not sufficient for the scale and speed needed for effective urban climate action, especially given the unique complexities of climate-related challenges

9.7.1 Leveraging integrated long – term urban planning

An integrated approach to planning and implementing climate projects, effectively coordinated both horizontally and vertically, provides a strong foundation for identifying, prioritizing and aggregating city interventions aligned to regional and national plans.[100] This enables robust decision-making and optimizes synergies while minimizing the trade-offs and redundancies between mitigation and adaptation.[101] Chapter 5 explores deeper on how to leverage urban planning for climate action. Relevant to scaling financing, a long-term plan accompanied by a detailed financing strategy signals opportunities and a pipeline of “bankable” projects to finance providers, offering greater certainty on their coherence across government levels, particularly when aligned with Nationally Determined Contributions (NDCs) and National Adaptation Plans (NAPs). Additionally, it can facilitate strategic collaboration with other local governments to aggregate project development, leverage economies of scale and reduce the transaction costs associated with smaller projects, thus making the aggregated projects more attractive for financing.[102]

9.7.2 Leveraging blended finance

When it comes to financing at the local level, context really matters: no “one-size-fits-all” approach exists. It is not only necessary to secure the required levels of financing, but equally important to consider how the different instruments are integrated to support the intended local climate action outcomes.

Blended finance is a structured approach of layering different financing instruments such as repayable debt, concessional grants and equity, often blending capital from public sources with that from private investors, impact investors as well as philanthropists for climate action. Blending is particularly useful for project profiles with relatively low financial returns but high social and environmental benefits, shifting the risk-return profile of a particular climate project (for example, through the provision of some concessional finance) so as to attract private capital sources.[103] It is important to note, however, that blending cannot make up for underdeveloped institutional, regulatory and policy environments or a lack of "bankable" projects.[104]

It is not only necessary to secure the required levels of financing, but equally important to consider how the different instruments are integrated to support the intended local climate action outcomes

Figure 9.9: Example of blending for enhancing adaptation and resilience

Outcome based instruments	Adaptation benefits mechanism	Debt-for-nature-swaps	Nature-based- credits	Sustainability-linked bonds	Development policy lensing/CAT DDO
Catalytic investments	Risk guarantrees	Subordinate capital	Credit tranching/ bundling/ green securitization	Pool investment funds	
Disaster risk	Climate-resilient debt clauses	Parametric insurance	CAT bonds	Regional insurance pools	
Traditional investments	Technical assistance	Project preparation facility	Bonds (e.g. green and climate bonds)		
	Loans	Equity	Concessional debt (e.g., IDA)		

Source: Sivaprasad, et.al., 2024

Blended finance designs vary by project and investor type, but generally fall into three categories: disaster risk instruments like catastrophe bonds and climate resilience debt clauses, providing quick liquidity and debt relief after a climate disaster; catalytic instruments such as risk guarantees that reduce risk or enhance returns for private investors; and outcome-based instruments like debt-for-nature swaps that incentivize specific climate outcomes.[105] Figure 9.9 illustrates an example of how several financial instruments can be blended for adaptation and resilience climate action. The City of London climate facility discussed in Box 9.6 is a good example of a blended finance approach.

9.7.3 Improving creditworthiness and credit enhancement mechanisms

The primary obstacle to private sector investment in local governments, especially in developing countries where financing is needed the most, is the lack of an adequate investment grade credit rating. Cities need to invest in key factors to successfully access the private sector for climate investments, including clear and supportive policy and regulatory frameworks, transparent working practices at the local government as well as take concrete steps to improving their creditworthiness. By having a stronger financial system in their collection of taxes and fees, procurement and financial reporting, cities can improve their creditworthiness and gain access to external financial resources at favorable rates.[106] Additionally, cities can improve their capacities for collecting and analyzing climate risk data to enable them to improve their project risk assessments, providing them with a better evidence base to inform the right mix of instruments to be used for financing.

The primary obstacle to private sector investment in local governments, especially in developing countries where financing is needed the most, is the lack of an adequate investment grade credit rating

Almost three-quarters (73 per cent) of low- and middle-income countries have a sovereign credit rating of grade "B" or below, which is often beyond the risk thresholds for most investors.[107] In the context of Africa, a region highly vulnerable to climate change and facing significant financing constraints, 30 of the 32 countries with sovereign credit ratings were rated with non-investment grade as of 2022, with only Botswana and Mauritius being exceptions.[108] Sovereign credit ratings, which consider among other metrics the country's economic stability, political risks and fiscal policies, weigh in turn on local governments' credit ratings. Consequently, potential investors lack confidence in the ability of local or national governments to meet their debt repayment obligations, resulting either in credit access being declined or only being extended at unfavorable rates to factor in the additional risk to the investor.

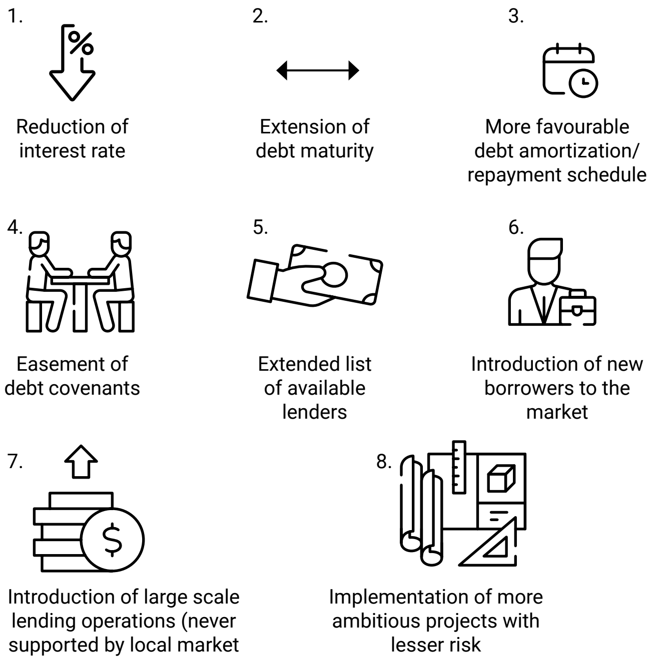
Initiatives and mechanisms for enhancing the creditworthiness and risk profiles of cities are therefore pivotal to increasing the flow of financing, especially from private sources. Among other benefits, as part of the process of achieving investment-grade credit rating process, the city strengthens its financial management to reduce the risk of defaults. This improves its capacity to attract more capital and at more favorable terms in the future.

At a project level, credit enhancement mechanisms can act as a substitute for a local government's creditworthiness. These can take various forms including credit guarantees, revenue guarantees, first-loss provisions, collateral, loan syndication and insurance. The main aim of insurance is to deliver financial and fiscal resilience by addressing the risks associated with shocks, including climate-related ones, while also reducing risk by increasing awareness and supporting economic development. Traditional insurance products often cover disaster response and so, whilst not directly tagged as "climate-change" related, can double up as insurance against climatic hazards.

To complement insurance instruments, more cities are buying catastrophe bonds. These high-yield bonds, financed by municipal governments and issued by reinsurance companies, are paid out in the case of climate catastrophes. As cities are first responders in the aftermath of disasters, these bonds can fill the temporal gap usually left by insurance companies when these are assessing risks for other, more traditional insurance instruments.[109] Figure 9.10 illustrates some of the main benefits of credit enhancement and insurance mechanisms that could potentially accrue to cities.

The damage caused by Hurricane Otis in Acapulco, Mexico. © Jessica Rodriguez Leon/ Shutterstock

Figure 9.10: Main benefits of credit enhancement mechanisms



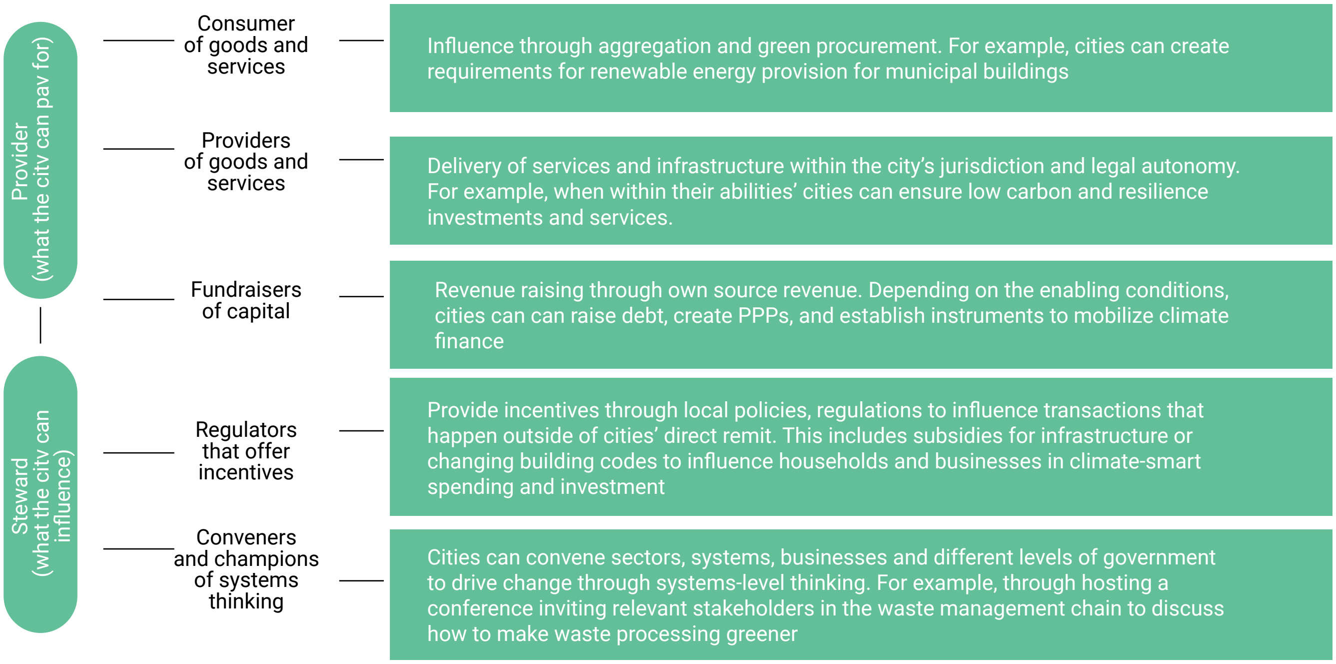
Source: World Bank, 2018c.

9.7.4 Enabling, proactive governance frameworks

A common theme throughout the analysis of this chapter is the roles that national and local governments can both play in supporting climate action beyond providing finance. Though the limitations and constraints that city authorities in particular face have been repeatedly emphasized, there are nevertheless important actions that can be taken to catalyze investment in climate finance. For instance, local governments can have an important bearing on planning and financing decisions through their dual roles as providers and stewards of urban climate finance. As providers, they contribute through consumption, payments and fundraising for climate initiatives. As stewards, they help shape planning regulations and advocate for greener policies, plans and technologies.[110] Figure 9.11 summarizes the various ways cities can influence planning and financing. Cities' role as enablers, regulators and conveners of finance may often be equally or at times more effective in influencing urban climate finance than the impact they may have through their own budgetary actions.[111]

Cities' role as enablers, regulators and conveners of finance may often be equally or at times more effective in influencing urban climate finance than the impact they may have through their own budgetary actions

Figure 9.11: The different roles of cities in influencing planning and financing around urban climate action



Source: adapted from World Bank, 2021b, pp.9-10

As discussed earlier, national governments play a critical role in facilitating access to urban climate finance, directly financing or indirectly channeling resources to local government entities. It is the national government that puts most of regulatory frameworks and policies in place that can encourage investment in climate-resilient infrastructure and sustainable urban development projects. This is directly connected to the enabling conditions in place in a country. By setting clear targets for emissions reductions, renewable energy adoption and energy efficiency, national governments can provide a stable and predictable environment that attracts finance, including private investment. Developing frameworks for assessing enabling conditions is one approach to further identify and resolve challenges in the policy and regulatory environment. One such solution is illustrated in Box 9.10.

Box 9.10: A standardized toolkit to assess enabling framework conditions (EFCs) to accelerate climate finance in Asia and the Pacific

A robust enabling environment – with sound policy, fiscal, regulatory and institutional conditions at both the national and local levels – is crucial for cities to access climate finance. The Urban-Act and Cities Climate Finance Leadership Alliance (CCFLA), in collaboration with the Economic and Social Commission for Asia and the Pacific (ESCAP), developed a standardized toolkit to assess national and local-level enabling framework conditions (EFCs).

The toolkit consists of the National assessment tool that reviews the national level enabling conditions, while a similar local level assessment tool reviews a specific local government jurisdiction within the country. Together, these tools provide a comprehensive evaluation of the EFCs in a country and can be used to identify areas for improvement to enable more climate finance flow to cities. The tools cover four main categories: climate policy, budget and finance, climate data, and vertical and horizontal coordination. Each category includes sub-categories and dimensions to deep dive into each country's context. Guidance in each of the tools includes examples of best practices, case studies and resources.

The National assessment tool was piloted in India and Indonesia, providing key recommendations for enhancing EFCs at the national and local level. The standardized assessment tools facilitated discussion during stakeholder workshops held to discuss the identified gaps and develop recommendations and plans for improvement. The impacts of this standardized toolkit will thus be directly tied to both strengthening multi-level governance for climate action and enhancing financing interventions, by improving national support for urban climate finance.

Source: Case study submitted by the Economic and Social Commission for Asia and the Pacific (ESCAP)

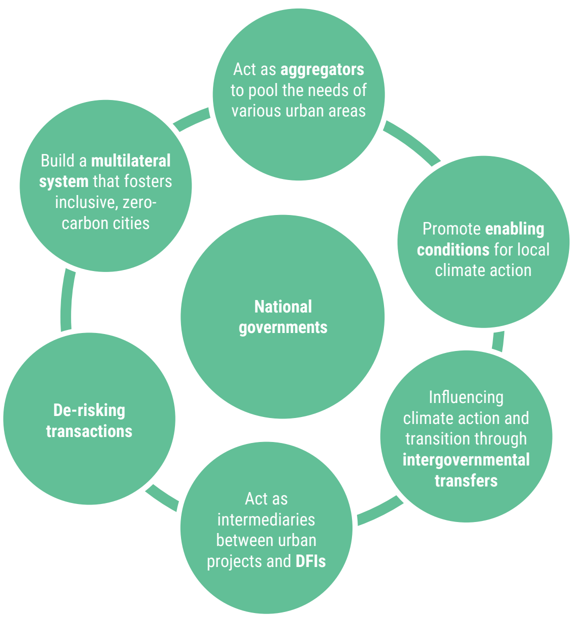
As supply and demand aggregators, national governments can leverage their unique position to scale up urban climate finance, attracting larger investments and achieving economies of scale by pooling the needs of various urban areas and acting as a single large customer. This aggregation can also facilitate the bundling of smaller, less economically attractive projects into larger, more viable investment opportunities for investors.

As supply and demand aggregators, national governments can leverage their unique position to scale up urban climate finance, attracting larger investments and achieving economies of scale by pooling the needs of various urban areas and acting as a single large customer

Furthermore, national governments can implement measures to reduce the financial risks associated with investing in urban climate projects. This can be achieved through mechanisms such as guarantees, insurance products and first-loss protections that mitigate investor risks and enhance the creditworthiness of urban projects. By reducing the perceived and actual risks, governments can attract more private investment, lower the cost of capital for urban climate projects, and accelerate the transition to sustainable urban development.

Finally, as the primary stakeholders in multilateral negotiations, national governments play a crucial role in ensuring that climate negotiations and the reformation of development finance institutions prioritize the promotion of inclusive and zero-carbon cities. Figure 9.12 illustrates the different ways in which national governments can directly or indirectly promote urban climate finance.

Figure 9.12: Different roles of national government in promoting urban climate investments



Source: Adapted from Coalition for Urban Transitions, 2019, p.19 and other sources.

9.7.5 Promising progress in international financing mechanisms

Promisingly, there have recently been concerted efforts at the global level towards increasing and aligning the flow of affordable climate finance, especially to developing countries where it is needed the most. These efforts also aim to reduce the institutional fragmentation in financing the concurrent priorities of sustainable development, climate action and ensuring just transitions. This progress holds great promise for scaling the right mix of financing for urban climate action where, as earlier discussed, sustainable development and climate actions are inseparable and just, equitable transitions are essential for effective action. Chapter 2 discusses in more detail the momentum in international policy towards scaling up climate action. Three developments relevant to finance are worth mentioning:

Progress towards balancing adaptation and mitigation finance

As discussed in this chapter, adaptation finance is especially important for effective urban climate action. Under the Glasgow Climate Pact Article 18, developed country parties were urged to double their provision of adaptation finance to developing country parties by 2025—as a progress towards achieving a balance in financial resources for adaptation and mitigation, and in line with Article 7 and 9 of the Paris agreement.[112] To this end, commitments towards adaptation finance have been growing. Multilateral development banks, which account for more than 50 per cent of available adaptation finance,[113] have stepped up their efforts in balancing the mix of financial instruments by committing to higher adaptation finance targets as a share of their total lending. For instance, the World Bank pledged to allocate 50 per cent of its climate finance to adaptation action in its 2021 – 2025 strategy,[114] while the Africa Development Bank committed to double climate finance to US$25 billion by 2025 with equal shares to adaptation and mitigation.[115] These shifts portend more financial flows for much needed adaptation action at city level.

Progress on operationalizing the loss and damage funds

A significant breakthrough at COP28 was the agreement to establish the Loss and Damage Fund, with US$661 million pledged as of September 2024.[116] Though, arguably, the pledges fall far short of the estimated hundreds of billion required annually for loss and damage, the establishment of the fund marks a significant milestone in addressing the recovery needs of the most vulnerable communities.[117] The fund will provide financing in the form of grants and highly concessional loans,[118] thus potentially increasing the availability of more affordable financing for urban climate action.

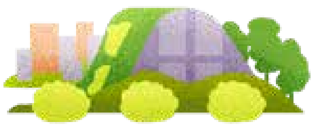
Progress on a New Collective Quantified Goal (NSQG)

Set for agreement at COP29 in 2024, the NCCQ aims to set more ambitious financing targets and frameworks from the current floor of US$100 billion per year, considering the needs of developing countries.[119] The NCQG moment presents an opportunity not only for scaling up the quantity of finance available, but also improving the framework and mechanisms of ensuring equitable access to finance for climate action. This potentially could increase the accessibility and impact of low-cost finance available for urban climate action, especially for fast urbanizing regions in developing countries.

The NCQG moment presents an opportunity not only for scaling up the quantity of finance available, but also improving the framework and mechanisms of ensuring equitable access to finance for climate action

9.8 Concluding Remarks and Lessons for Policy

The urgency of the climate crisis will require not one, but several strategies deployed in parallel to drastically improve the availability and affordability of financial resources for urban climate action. Rather than being conflicting, exploring these different sources, instruments and mechanisms of urban climate finance and how they can be effectively integrated will allow policymakers to understand the complex spectrum in which decisions need to be made, with a focus on the solution most appropriate to each specific context.



The urgency of the climate crisis will require not one, but several strategies deployed in parallel to drastically improve the availability and affordability of financial resources for urban climate action

- *Focus on the quality as well as quality of urban climate finance investments:* While the scale of the climate crisis requires significant investment to address the current gaps in financing, more attention needs to be given to the quality of financing and its transformative potential, especially for those most vulnerable. To be effective, urban climate finance has to be people-centered and focused on addressing not only the targets with the highest impact and economic value, but also delivering climate actions that secure a just urban transition to ensure no one, and no place is left behind. In this regard, the current imbalance in finance, heavily skewed towards mitigation projects, needs to be addressed and more resources allocated towards investments in adaptation that will benefit marginalized and at-risk populations particularly exposed to climate change impacts.

- *Mobilize a wide range of public and private finance sources:* Public finance is and will remain crucial for urban climate finance. Public resources should be aimed not just at directly financing urban climate projects, but rather at unlocking finance from other sources, through de-risking mechanisms, insurance and the provision of guarantees. Cities need to invest in key areas to successfully access the private sector for climate investments, including clear and supportive policy and regulatory frameworks, transparent working practices at the local level, as well as concrete steps to achieve creditworthiness.

- *Strengthen enabling conditions at national and local level:* National governments have a crucial role to play in the access of urban climate finance, both through the provision (direct or indirect) of financial assistance and through regulations to reduce the risks of investment. Countries undergoing public finance management reforms should consider how policies and regulations can be improved to allow cities greater autonomy in allocating resources for urban climate projects. On the other side of the spectrum, cities can use their own fiscal resources to plan and invest in climate projects, as well as strengthen their roles as both stewards and enablers to facilitate finance flows from other sources.

- *Adopt an integrated approach to developing "bankable" projects through fostering stronger vertical and horizontal collaboration:* Enhancing project preparation capacities remains critical for improving the bankability of specific projects and enabling their financing. To scale up the impact of urban climate finance, local governments should integrate climate actions beyond the city level. This can be done by unlocking synergies and co-benefits through the strategic alignment and synchronization of projects and plans at regional and national levels. Collaborating with other local governments and the national governments to aggregate project development, leverage economies of scale and reduce the transaction costs associated with smaller projects can make the aggregated projects more attractive for financing. These arrangements can help optimize shared synergies while minimizing the trade-offs and redundancies between mitigation and adaptation.

- *Embrace blending of existing financial sources and instruments to catalyze* investments for urban climate action: When it comes to financing at the local level, context really matters as no "one-size-fits-all" approach exists. It is not only necessary to secure the required levels of financing, but equally important to consider how the different instruments are integrated to support the intended local climate action outcomes. Blended finance helps make projects "bankable" by combining different instruments to balance risk and attract funding. National governments and financial institutions can further encourage investment flows by providing various credit enhancement mechanisms, including guarantees and insurance mechanisms that can be blended with other financial sources. These reforms to "business-as-usual" finance can open the way for innovative financing mechanisms that catalyze investments tailored to local needs, taking into consideration the impacts on the most vulnerable urban residents.

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Chapter 10:

Building Climate Resilience in Urban Areas

Quick facts

1. The intersecting challenges of climate change and urbanization have been on the global development agenda for decades, yet action on the ground is still failing to keep pace with the worsening impacts.

2. Cities are only as resilient as their most vulnerable inhabitants: urban resilience cannot be achieved without putting fairness and equity at the centre of urban climate action.

3. Most of the solutions cities need to respond decisively to climate change are already available.

4. Resilience interventions achieve the greatest impact when they harness local resources and deliver collective benefits.

Policy points

1. Resilience should be negotiated with communities, rather than imposed on them: a negotiated approach can open up different perspectives and enable the most vulnerable to define what form it should take.

2. City authorities should move beyond top-down hierarchies to embrace their role as coordinators, striving to engage a broad range of stakeholders to share responsibility for climate resilience.

3. Urban resilience is not a fixed end-point that cities reach through a single prescribed pathway, but rather a horizon to travel towards through incremental steps.

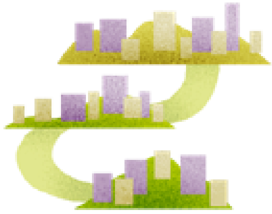
4. Rather than focusing on the specific, immediate symptoms of climate change, cities should embrace a more holistic approach that addresses the root causes of vulnerability.

In the first decade of the 21st century, a period that culminated with the publication of UN-Habitat's *2011 Global Report on Human Settlements on Cities and Climate Change*,[1] interest in the role of cities in responding to climate change grew. The increasing frequency of disaster events globally was motivating cities to focus greater attention on how to alleviate their climate vulnerabilities through policy and planning. Globally, there appeared to be a strong consensus that, in the words of UN-Habitat, "the effects of urbanization and climate change are converging in dangerous ways".[2] However, despite this apparent momentum, urban policy is still not keeping pace with the threat of climate change even in cities most exposed to its impacts,[3] let alone develop into transformative action.[4] Some explanation for this disconnect can be found in the vagaries of short-term planning and policy cycles.[5] The disconnect also results from a constrained view of urban resilience.

The evidence that emerges throughout this report is that current climate change action is insufficient, given the urgency of emission reductions and resilience building. As the IPCC argues, every fractional increase in global average temperatures will reduce the window for achieving a safe and sustainable future. At the same time, cities are at the forefront of climate risks and could play a vital role in bridging the "adaptation gap". It is important to remember that options already exist: each of the chapters here provide a wealth of information about how existing knowledge, technologies and community-based approaches can be streamlined into planning, infrastructure development, governance, innovation and finance.

A recurrent theme throughout this Report is the importance of a people-centred approach to climate action: communities must be at the centre of any meaningful climate action in urban areas. While this offers an overarching principle that is relevant to almost any context, the sheer diversity of local conditions, needs and capacities in different settings makes it almost impossible to develop a single roadmap for cities to achieve resilience. Actions to advance urban adaptation and mitigation must be tailored to specific locations and timescales; at the same time, no action will deliver climate-resilient development once and for all. In practice, delivering climate-resilient development in cities and urban areas depends on open-ended processes in which outcomes to some extent always remain provisional—and dependent, too, on the interpretation of multiple actors with very different points of view.

These are the contradictions and uncertainties that a people-centred approach to climate action must necessarily embrace. Climate-resilient development is not a fixed destination, but rather a horizon that can guide urban development towards inclusive and solidarity-based decision-making. In this context, this chapter asks what urban managers can do to deliver effective, inclusive and just climate action. By urban managers, this chapter refers particularly to officials and policymakers in local governments but also acknowledges that many different actors can act as urban managers on different occasions: national government officials responsible for urban policies, consultants developing master plans, NGOs organizing community groups in neighbourhoods, companies investing in urban social enterprises and many others.



The evidence that emerges throughout this report is that current climate change action is insufficient, given the urgency of emission reductions and resilience building

The chapter provides an action-oriented framework to understand climate-resilient development in cities, beginning with recognition of the complex nature of urban resilience and the need to adopt multi-dimensional, multi-scalar and long-term approaches to deliver it. In addition, focusing on the inclusive aspects of urban resilience, the framework highlights the importance of committing to a negotiated approach to climate action. The framework explores different styles of resilience delivery, aiming to balance expert-led approaches with those pioneered by communities themselves. Finally, building on the findings of what has already been covered in this report, the chapter reflects on the transformative possibilities of different actions, including infrastructure development, multi-level governance, sustainability innovations and sustainable finance, to address the structural drivers of climate vulnerability in cities. The chapter finishes by reflecting on the value of envisioning future scenarios to develop focused and inclusive climate action.

10.1 Putting Urban Resilience into Action

This section explores how cities can put resilience into action, beginning with an exploration of the complex and contested nature of how resilience itself should be defined and delivered. With that in mind, it goes on to make the case for a negotiated approach to resilience – one that recognizes the need to tolerate and indeed welcome disagreement and conflicting perspectives into the process from the very outset, allowing a range of stakeholders (in particular, those most marginalized from traditional decision-making) to define the priorities. Finally, it offers a brief overview of some of the different models, from "shock-proofing" to "resilient community development", that have guided urban climate action.

10.1.1 The complex nature of urban resilience

Urban resilience is shaped by the complex interactions between communities, markets, ecosystems, infrastructures and the wider societal system in which a city is situated.[6] As shown in Figure 10.1, resilience is determined by humans and their engagement with their surroundings: in addition to individual resilience, their resilience is also the product of their relationship with ecosystems, resources and technologies. Consequently, urban resilience transcends conventional silos of analysis because of its emphasis on the interconnectedness that characterizes city systems.[7]

Figure 10.1: Dimensions of urban resilience

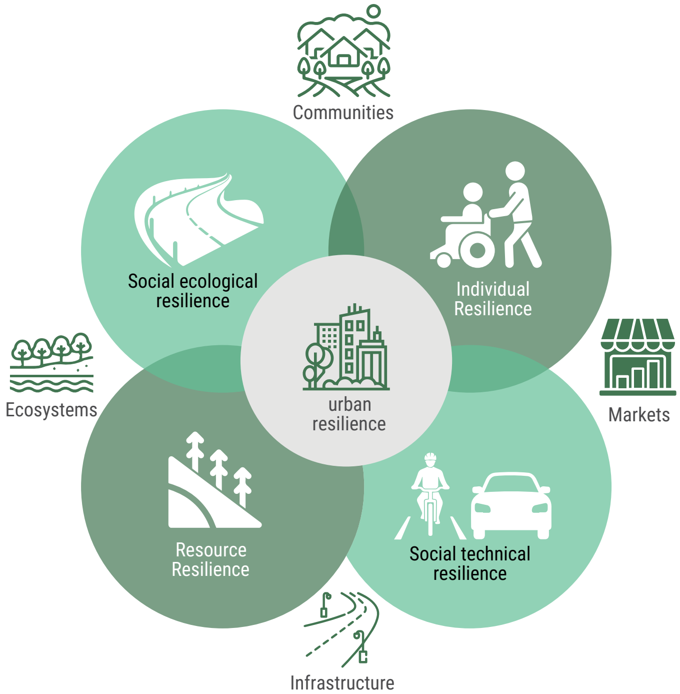


Illustration by Vanesa Castán Broto

Today, resilience is recognized as a multi-sectoral, multi-dimensional and multi-stakeholder effort that requires effective collaboration and cooperation across various scales. This is because the dimensions of climate resilience—and indeed, of climate vulnerability too—are interrelated and mutually reinforcing. Resilience should therefore be viewed from an integrated perspective that cuts across sectoral boundaries and brings together a variety of stakeholders across the city. This was why the 100 Resilient Cities Program, launched in 2013 and funded by the Rockefeller Foundation, appointed a dedicated Chief Resilience Officer to oversee the different activities and ensure their efforts were not obstructed by sectoral boundaries.[8] While the programme results were mixed, and there is still work to do to integrate social justice concerns into the concept of resilience, the position of the Chief Resilience Officer constituted a critical institutional innovation that advanced the practice of urban resilience.[9]

Urban resilience is shaped by the complex interactions between communities, markets, ecosystems, infrastructures and the wider societal system in which a city is situated

In addition, urban resilience is a relational property: it cannot be isolated into a single element of the city. Instead, resilience connects different components that together make the city more than the sum of its individual parts. This means urban resilience emerges from different dependencies, connecting the city with wider global networks. A multitude of threats—from terrorism and pandemics to economic recession and climate-induced hazards—make risk and uncertainty a routine feature of urban decision-making and foster a culture of being in perpetual preparation.[10] This may be overwhelming for urban decision-makers and managers who already face restrictions in overseeing the day-to-day functioning of cities and urban settlements. with no discretionary funding available to invest in potential or future risks. Two considerations may help in engaging productively with the notion of resilience: reflecting on the *timescales* of different risks, and considering the best *spatial scale* to intervene to build urban resilience.

Chapter 3 provides an overview of the risks posed by climate change to urban areas. Urban areas in low-elevated coastal zones face both rapid- and slow-onset impacts, from typhoons and flooding to rising sea levels. Slow-onset events such as heatwaves, while often attracting less attention than large-scale but isolated natural disasters such as tsunamis, will result in increasingly challenging living conditions in urban areas. For urban managers, this means engaging in diverse strategies to manage the relationships between urban systems, ecosystems, infrastructure and resources. Rather than one-off actions to protect the city, resilience calls for building an ongoing culture of managing and addressing disasters, emphasizing social and ecological protection over the longterm. Resilience needs to be built into every aspect of urban management, harnessing the city's available resources and mobilizing every segment of its population. Adaptive social protection programmes, such as community health or livelihood support programs, are the most effective way of managing resilience in slow-onset events.

The second challenge is identifying the appropriate scale for action to build urban resilience. Given that resilience encompasses a wide range of sectors, assets and constituencies, from globalized markets and regional ecosystems to city-wide infrastructure networks and community-led initiatives, urban managers find themselves working to create alignment between government bodies, private sector entities and local residents.[11] At the same time, resilience requires a certain level of autonomy. Communities may find that government policies to deliver resilience at a city level result in repressive practices that reduce rather than increase the resilience of some households or settlements.[12] Resilience should develop organically in the communities themselves: it needs to be negotiated rather than imposed. Ultimately, resilience efforts are at their most successful when they harness local resources and initiatives to deliver collective infrastructure and service provision.[13] When this happens, local capacity and social networks are progressively strengthened, empowering communities to develop autonomous, context-specific solutions to climate change.

Of course, it is also the case that communities may themselves drive exposure to risks. For example, on the Gold Coast in Australia, communities gravitate towards areas closer to the sea, which are perceived as more desirable despite the risks.[14] In these circumstances, local governments may find that demand for land and housing may conflict with attempts to increase resilience. Consequently, an effective resilience agenda needs to enrol all urban actors as responsible collaborators in the process. As Chapter 2 emphasizes, it is vital to move past the perception that lack of government ambition, whether at the national or local level, is the only obstacle to advancing policies to reduce emissions and protect the safety of communities. Instead, the journey towards urban resilience has multiple pilots at its helm, requiring governments, businesses and communities to work together towards a common goal.

In summary, a resilience perspective will promote integrated approaches to urban decision-making, redefining the role of the local government as a coordinator, and distributing responsibilities among different actors. For example, the city of Rotterdam in the Netherlands, one of the participants in the 100 Resilient Cities program, transformed its response to environmental vulnerability by moving from specific actions to address the direct effects of flooding to a broader social and ecological resilience agenda. By increasing sectoral integration across multiple scales of action, as well as recognizing the autonomy of diverse actors beyond the state, Rotterdam successfully expanded its field of intervention to include a wide range of potential threats, from food shortages to cyber-attacks.[15]

Table 10.1: Rotterdam's resilience approach before and after participating in the 100 Resilient Cities program

	Before the 100 Resilient Cities program	After the 100 Resilient Cities program
Scope of resilience agenda	▪ Focus almost exclusively on water management and flooding.	▪ Integrated approach encompassing water safety and flooding, cyber security, infrastructure robustness, socioeconomic protection and inclusion of vulnerable groups, clean air and ecological quality. ▪ Emergency strategies are broadened to consider food security, drinking water supply, energy access and electronic data.
Institutional changes	▪ Led by individual sectors, with few joined-up initiatives concerning flooding and safety.	▪ Resilience is redefined as an integrated, cross-cutting challenge: the local government becomes a coordinator or node between diverse actors, including businesses, NGOs, communities, and the public. ▪ Relations between departments within the city government also increase.
Resilience responsibilities	▪ Resilience is regarded as a task for national or local government.	▪ An inclusive approach to resilience that recasts resilience as a task for public government, NGOs, private companies, as well as individual citizens.

Source: Spaans & Waterhout, 2017.

A negotiated approach to urban resilience

For many cities, "resilience" regularly headlines environmental assessments, spatial strategies and economic plans, even if the exact meaning of the word itself is rarely interrogated. However, given the complexity of the concept, it begs the question: what form of resilience is being promoted? Indeed, historically resilience has entailed a broad and at times contradictory range of ideas, depending on how shocks are approached:[16]

- Approaches that emphasize *endurance and absorption of shocks through robustness and redundancy*, especially in infrastructure systems;
- Approaches that emphasize *prevention of shocks through preparedness* strategies;
- Approaches that emphasize *anticipation of shocks through embedded resilience practices* in everyday life;
- Approaches that emphasize *mediated transformations for a more resilient environment*.

Thus, practical strategies for urban resilience may aim to mobilize resources in response to shocks, attempt to prevent them through careful planning or seek to integrate shock management into daily life. This may generate contradictions. For instance, one of the central aims of building resilience should be that communities are able to maintain continuity in their own lives. At the same time, however, for people living in high-risk areas, displacement may be the only option to ensure their long-term security and a more sustainable future. In this regard, even relatively successful resettlement projects can be challenging. For example, the village of Vunidogoloa on Vanua Levu, Fiji's second largest island, suffered multiple challenges related to seawater inundation, salinization and cyclone exposure. In response, in 2009 authorities began the process of relocating 26 households living on the shoreline of Natewa Bay to a new village one mile inland, with construction starting in 2012. However, while some of the villagers described the relocation as a "blessing", it also disrupted established cultural and social relations in the process. Furthermore, as the community were excluded from the technical aspects of the project, such as the housing design and village layout, the project also undermined their autonomy.[17] While relocating may have increased resilience, the failure to mobilize local perspectives and knowledge represented a missed opportunity.

Figure 10.2 outlines a non-exhaustive list of some common characteristics associated with urban resilience, none of which is easy to define or characterize. It shows that urban resilience is complex to define and even more challenging to measure and evaluate.[18] Quantitative indicators may be helpful in some situations (for example, the number of households safer due to the relocation) but may miss less understood aspects of urban resilience (for instance, the potential disruption of local livelihoods because the current urban layout is inappropriate). For this reason, urban resilience is better thought of as emerging through the interaction between *concrete measures that strengthen or stabilize ecosystems, markets, technological networks and communities*—in this instance, the decision to invest in housing and infrastructure in a safer area away from the shore—and the *governance and decision-making processes that determine how these are planned and implemented*: the latter should help create a social dialogue that reveals multiple perspectives on urban resilience and their inherent contradictions.

Storm surge barrier, Rotterdam, Netherlands © Shutterstock

Figure 10.2: Normative attributes that confer resilience in preparing or responding to shocks

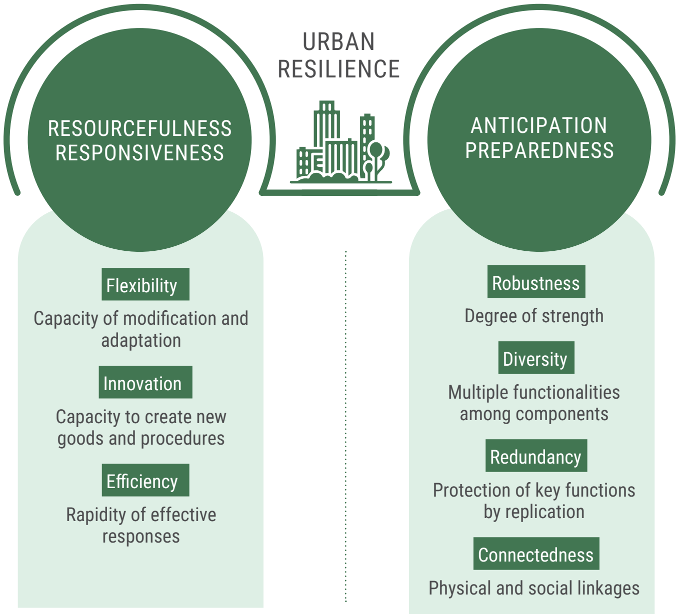


Illustration by Vanesa Castán Broto

A negotiated approach to urban resilience avoids pre-defining its components, instead focusing on actions emerging through the dialogue and negotiation of multiple interests in the city.[19] Negotiated urban resilience requires that such negotiations occur at the point of defining the normative aspirations of resilience. For example, in Seville (Spain), community-led movements have fostered a shift away from grey infrastructure to nature-based solutions (NbS) to climate change impacts.[20] Following the municipality's publication of its climate change adaptation plan in 2017,[21] followed in 2019 by the local water utility company's adoption of a climate emergency plan,[22] most of the budget for these plans was initially allocated to engineered measures such as advanced water treatment systems, retention tanks and rainwater sewer systems.[23] However, the active role of residents has led to the development of NbS such as parks, urban farms and renaturing. These responses have created a new model of resilience that addresses multiple risks (drought, flooding and heat) while also tackling social challenges and inequalities in the city.

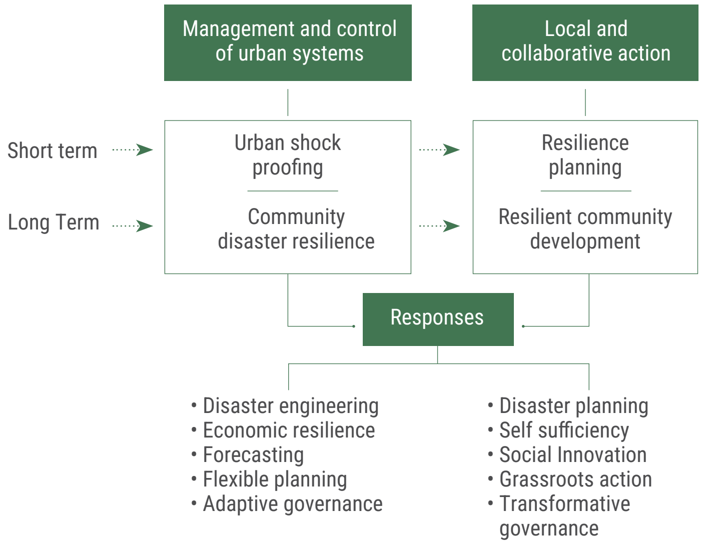
A negotiated approach to urban resilience avoids pre-defining its components, instead focusing on actions emerging through the dialogue and negotiation of multiple interests in the city

Seville, Spain cityscape with Plaza de Espana buildings. © Shutterstock

10.1.3 Styles of resilience delivery: from shock-proofing to resilient community development

Despite the need to reconcile top-down, technocratic planning with the collaborative, bottom-up thinking that is increasingly prevalent today, there is still a marked gap between these two approaches. Both are well represented in the urban resilience activities of different international organizations (including UN-Habitat and various other UN agencies) and the World Bank. In practice, there remain significant tensions in the deployment of different visions of resilience in urban policy and planning, from reactive "shock proofing" to long-term "resilience planning", from top-down "management" to bottom-up "collaboration" (Figure 10.3).[24] In this regard, a particular concern is how an over-emphasis on technocratic responses tends to obliterate the political aspects of resilience. In practice, policy makers "must decide which system is to become resilient, with respect to what threats, at what scale, for what purpose, and for whose benefit": given that these decisions can have profound and wide-ranging implications for cities and their populations, "the question of who uses the concept of resilience and how is, therefore, also a question of power".[25]

Figure 10.3: Styles of resilience delivery



Source: Based on Wardekker, 2021.

Urban shock-proofing refers to sectoral, system-specific actions to address specific shocks such as floods, heatwaves or droughts. Tools such as early warning systems, "city dashboards", forecasting tools and stress tests are central to this approach. Shock-proofing may also be directed towards maintaining the functionality of a particular sector, such as transport, in urban development strategies (Box 10.1). Measures to facilitate urban shock-proofing are ubiquitous and often benefit from significant funding. For example, the Climate Investment Fund Smart Cities Programme focuses on successful urban shock-proofing projects.[26] This programme, together with the World Bank, funded the Mozambique Cities and Climate Project: among the areas targeted was the coastal city of Beira, where the programme combined an emphasis on "hard" infrastructure to upgrade the city's stormwater drainage system with a nature-based approach to flood prevention that included the planting of 7,000 trees and mangrove restoration.[27] In many cases, these projects build on ongoing initiatives by incorporating the risk-proofing element into sectoral interventions. While these investments are unlikely to support transformations, they may foster productive partnerships between the government, civil society and the private sector, potentially increasing resilience if they do not exacerbate existing inequalities.

Box 10.1: The challenge of shock-proofing urban transport in Pune, India

The Pune agglomeration, comprising the cities of Pune, Pimpri and Chinchwad, is a large and expanding metropolitan area with a population of more than 7 million people. Its rapid urbanization has brought a number of challenges, particularly as a result of the growing number of commuters from adjacent areas and a transportation system still heavily dependent on fossil fuels. According to the 2023 Tomtom Traffic Index, Pune was ranked the seventh most congested city in the world.[28] Unsurprisingly, this had had a significant impact on air pollution: data collected by the Indian Institute of Tropical Meteorology in 2018, for instance, showed that Pune Metro's levels of PM2.5 air pollution had increased by 60 per cent in the space of just five years. Research by another organization, Urban Emissions Air Pollution Knowledge Assessment, also estimated that in 2014 Pune's PM2.5 levels were already more than four times over the World Health Organization's recommended limit.[29]

The city's daily flow of commuters is made up of a heterogenous mix of vehicles, with private vehicles accounting for almost half (47 per cent) of the modal share, with the remainder distributed between public transport (12 per cent), intermediate public transport (7 per cent) and non-motorized transport (33 per cent).[30] While Pune's public transport is operated with clean fuel (CNG and electric), with 1,570 vehicles on the road the current fleet is not sufficient to meet existing demand.[31] Auto-rickshaws, meanwhile, which offer last-mile connectivity, have increased to almost 136,000 in 2023 (amounting to 1,850 auto rickshaws per 100,000 population) and operate alongside 100,000 app-supported taxi services. This has created many challenges within Pune's transportation system. The reluctance of many residents to use public transport has contributed to the proliferation of private vehicles, while many informal rickshaw operators—though playing a vital role in connecting areas that lack formal transit infrastructure—are unregulated.

An integrated and accessible public transportation system is key to strengthening the resilience of the metropolitan area as it continues to grow. Promoting accessible, low-carbon public transportation will not only reduce pollution levels and enhance quality of life for residents, but also help the city in reaching its emission reduction targets. Pune was in fact an early pioneer of public transport, with the introduction of its Bus Rapid Transit System (BRTS) in 2006 (Pimpri and Chinchwad both followed suit in 2008).[32] However, the BRTS faced challenges due to poor project planning, poor receptivity from commuters and the public, who preferred private vehicles over the BRTS, and a lack of commitment from transport authorities. Subsequently, Pune has shifted its efforts towards the development of a Mass Rapid Transit System (MRTS) that will ultimately cover more than 165 kilometres (km), [33] with around 30 km operational as of September 2024. The proposed metro lines were prioritized over the BRTS and designed to follow the same routes, despite the significant financial drawbacks (MRTS's estimated costs are almost six times higher than the BRTS). The MRTS is also less flexible than the BRTS and poorly integrated with last-mile connectivity vehicles. Large infrastructure projects such as the MRTS also reduce the city's green cover, reducing protection against air pollution.

Shock-proofing transport requires measures to maintain mobility through a multitude of transport routes, infrastructures and nodal links, at the same time fostering diversity in transport modes, planning for population growth and addressing the risk of large-scale travel disruptions.[34] In this regard, the flexible fleet of autorickshaws plays a crucial role in maintaining mobility. However, transport resilience in the longterm requires also addressing air pollution and the increasing inequalities in addressing transport. The process of implementing the BRTS failed to include Pune's public and hindered the project's success. There are doubts about whether the MRTS offers a sustainable alternative and will be successfully integrated into the current heterogeneous fleet. These outcomes demonstrate how shock-proofing an isolated sector is unlikely to make a tangible difference in the city's resilience unless a more holistic approach is deployed. Resilience thinking calls for a comprehensive assessment of needs and inequalities in the transport system, beyond the certainties offered in mathematical models that do not reflect urban development's realities.

Resilience planning takes the lessons of urban shock-proofing, developing an integrated notion that articulates the more complex aspects of urban systems with a long-term perspective. This enables the rich toolbox of adaptive planning and governance to be deployed at the urban scale, from city labs and design competitions to scenario visioning tools and tailored insurance instruments. Many of these approaches build on the legacy of the 100 Resilient Cities mentioned above (Box 10.2). For example, resilience planning may be an essential tool for maintaining ecosystem resilience and developing NbS to rising sea levels, rather than relying on engineered coastal defences that may create additional risks for the inhabitants of coastal cities like Singapore.[35] Long-term thinking tends to show interdependencies between different sectors that short-term approaches overlook. For example, an extended scoping exercise to future-proof water infrastructure in the city of Avignon, France, identified an area of vulnerability that had not been addressed in the existing short-term plans: the city depended on a valve-based flood protection system powered by the grid, meaning it would lack protection in the event of a power failure.[36] Building long-term resilience tends to facilitate the integration of concerns across different urban sectors. However, despite its integrated approach, resilience planning may overlook complex social dynamics and power relations (see Box 10.2).[37]

Box 10.2: Resilient planning in Asian cities

The Temasek Foundation Urban Resilience Program (TFURP), launched in 2021, is a capacity-building program targeting city leaders. It is funded and managed as a collaboration between the Singapore-based Temasek Foundation, the Centre for Liveable Cities in Singapore and the Resilient Cities Network, the legacy of the 100 Resilient Cities programme.

Surat, in India, is one of the first cities to receive support through TFURP. In 2017, Surat published a City Resilience Strategy.[38] The strategy was organized around seven pillars, following the 100 Resilient Cities framework: connectivity and mobility; affordable housing; water availability and quality; economic dependence from dominant sectors; ecosystem and environmental regulation; social cohesion; and public health. One goal was to control pollution and conserve water from the Tapi, the main river supplying water to the city.

In 2022, the city presented its proposal for enhancing the River Tapi at the World Cities Summit. The proposal included three main actions: the design and construction of an additional barrage to provide water security, a feasibility study for the construction of a tertiary sewage treatment plant, and an integrated plan for riverfront development and social inclusion.[39] A stakeholder workshop, including experts, informed the strategy. Still, explicit efforts have not been made to incorporate other voices, such as those living in informal settlements that are likely to be affected by the proposals: the proposal remains an expert-led outlook on the city's needs.[40]

Community disaster resilience emerges from bottom-up experiences managing shocks and disasters at the neighbourhood scale. Various tools can be used to integrate risk knowledge with community perspectives and proposals for action, including indicator studies and maps, communication and education programs, and different modalities of participatory workshops to map risks or facilitate decision-making. Community disaster resilience is particularly relevant in areas where communities already live with frequent disasters, such as Indonesia and the Philippines.[41] In the United States, the National Institute of Standards and Technology has published a guide for communities to advance resilience in buildings and infrastructure systems.[42] The guide recognizes that communities have limited resources for resilience-building actions and aims to identify affordable steps towards resilience and align resources with priorities.

Community disaster resilience may start by bringing together multiple stakeholders for a collaborative planning process, and a key aspect is the identification of existing points of vulnerability in housing and infrastructures and their performance during a hazard. For example, the designated committee could examine existing conditions of critical facilities (emergency operation centres, emergency services, police and fire stations, hospitals, non-ambulatory facilities such as prisons or nursing homes, critical industries), emergency housing and shelters, and housing and neighbourhood facilities for community recovery. A detailed discussion of community living conditions may help identify hazard protection measures effectively. Nevertheless, community disaster resilience may overlook broader interconnections and city-wide shocks. It has also been criticized for shifting the responsibility to communities, thereby minimizing the responsibility of city governments to protect their citizens.[43]

Resilient community development expands this approach by emphasizing the social embeddedness of risks and envisaging a transformative approach to delivering urban resilience. The combination of tools from the other approaches, such as participatory and collaborative planning, long-term visioning, citizen science, co-design laboratories and intersectional analyses, may all lead to the development of systematic methodologies for resilient community development. For example, the collective production of multiple resilience narratives (political, institutional, experiential) may help map alternatives for transformative change that put the concerns of communities at their core. There are few examples of resilient community development, but there is great potential to build on previous experiences of delivering resilience and move towards more transformative approaches. The following sections emphasize what a transformative approach to resilient community development could look like, building on a people-centred approach to resilient urban futures.

10.2 Navigating Climate-Resilient Development Pathways

What are the possible pathways to deliver climate-resilient urban development? Climate-resilient development pathways (CDRPs) are shared courses of action across society that put at their core the improvement of the well-being and prosperity of all people, especially those who are most vulnerable, while reducing carbon emissions and risks from climate change.[44] CDRPs emphasize development and challenge vulnerabilities, enriching a people-centred approach to urban resilience. As Chapter 1 explains, the integration of adaptation and mitigation objectives results in new opportunities for sustainable development.[45] The IPCC uses pathways to represent specific sequences of actions and consequences, emphasizing the complex decision-making processes at different societal levels. The cumulative impact of various choices leads to different levels of resilience, but every choice that reduces climate resilience also reduces the options for further action (Figure 10.4). This is an iterative, cumulative process, but every choice that reduces resilience creates path-dependence mechanisms that make it harder to shift the direction of travel. While there is no single, linear path to a climate-safe future, every urban management decision advances or hinders resilience in some way.

Figure 10.4: Decision points to choose climate-resilient development

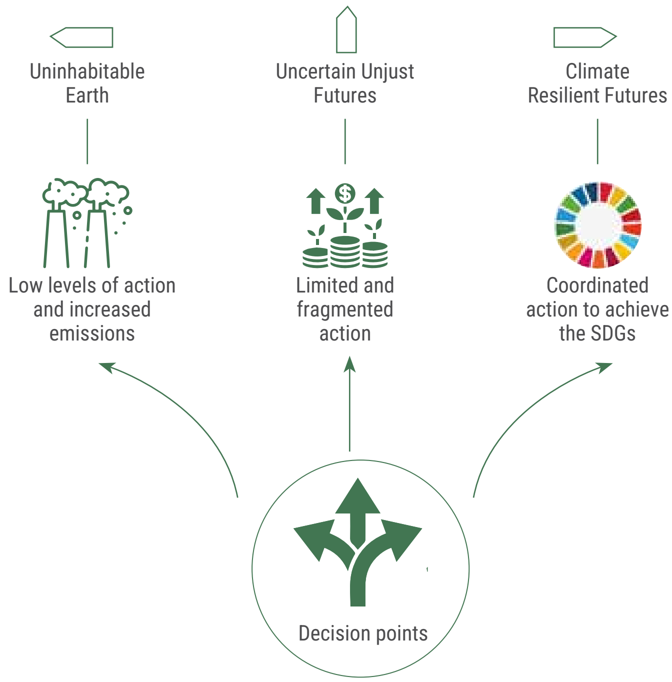


Illustration by Vanesa Castán Broto

The normative perspectives on resilience discussed in Section 10.2 provide a framework for evaluating decisions. Assessing the resource and knowledge base also supports resilience. Chapter 2 explains that despite their importance in climate-resilient development, cities still have inadequate resources for mitigation and resilience building, especially climate funds. These gaps are particularly prominent in rapidly growing cities facing significant infrastructure gaps and sprawling informal settlements. The exacting demands of some resilience-building approaches may be overwhelming for cities already facing profound challenges in maintaining city living. However, as previous chapters show, there is a menu of feasible options that every city can adopt.

Resilience is a way of thinking that puts risk, vulnerability, sustainability and inclusion at the heart of climate action

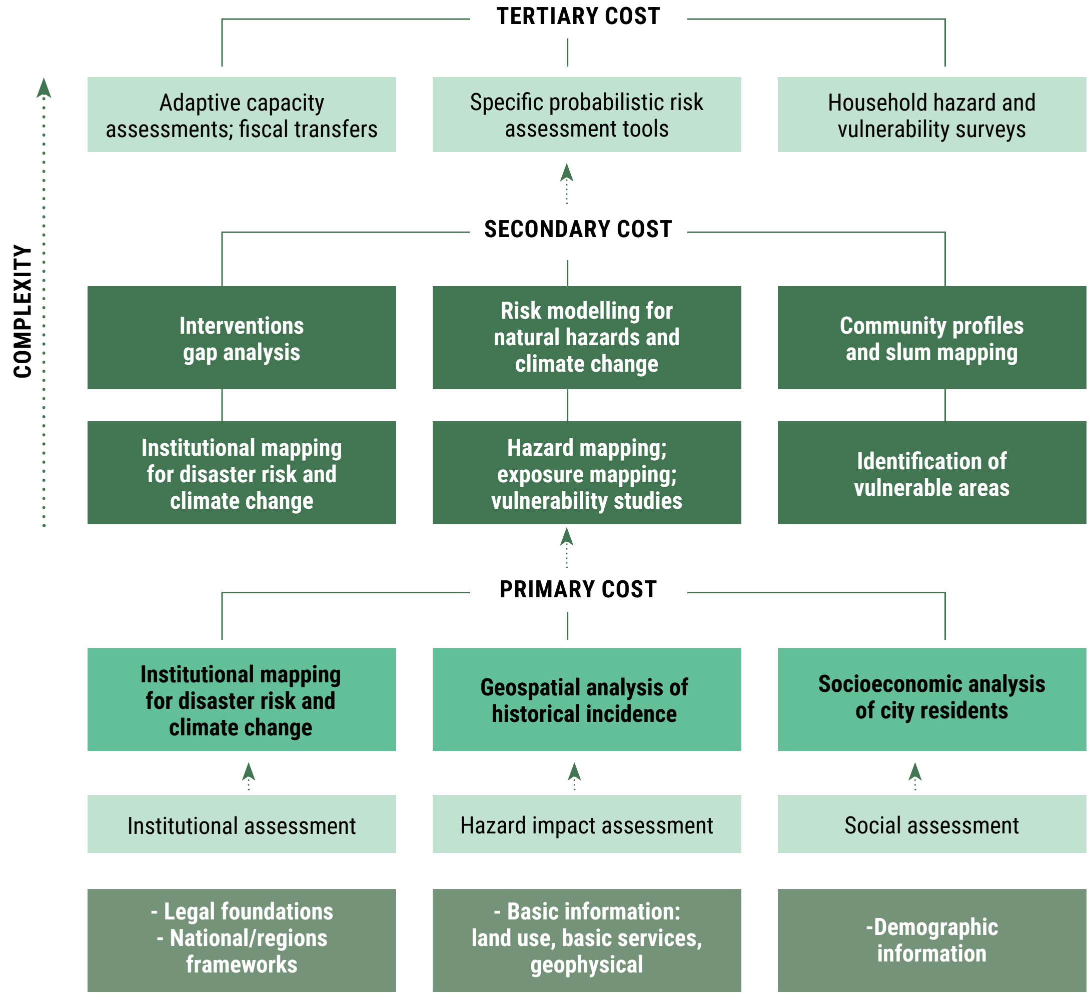
Resilience is a way of thinking that puts risk, vulnerability, sustainability and inclusion at the heart of climate action. By adopting such a way of thinking, those seeking to activate change may be able to deliver more sustainable urban futures starting with feasible, workable action that can lead to future transformative change.

Building resilience requires an understanding of exposure and sensitivity to different climate change-related hazards

10.2.1 Assess interconnected urban risks

Building resilience requires an understanding of exposure and sensitivity to different climate change-related hazards. For urban managers, the question is how to balance the assessment with the potential resources and capacity to act. Risk assessment is an essential tool that, beyond informing sectoral plans or masterplans, should be regularly consulted in municipal strategy and operations. Guidance from the World Bank on Urban Risk Assessment (URA) proposes assessing hazards alongside socioeconomic and institutional assessments (Figure. 10.5). This approach requires a geospatial analysis of the historical incidence of risks and forecasting tools.

Figure 10.5: Risk assessment levers and pillars



Source: World Bank, 2022.

Chapter 3 provides an overview of the risks threatening cities. The chapter also shows the availability of information and data to understand those risks in the form of the Global Human Settlement Layer produced by the Joint Research Centre of the European Commission and the Copernicus Emergency Management Service. This resource supports all phases of disaster risk management. However, a full risk assessment may not always be possible. The World Bank's URA proposes three assessment tiers (primary, secondary and tertiary) as shown in Figure 10.5:

- The *primary level* involves an assessment using limited resources to assist cities in identifying hazard-prone areas and basic climate change impacts, as well as plan for disaster preparedness. This may involve simple risk maps through the overlay of a base map, a socioeconomic profile, a hazard profile based on historical hazards, and any projected growth and development maps.

- The *secondary level* mobilizes additional resources to support early-warning systems, estimation of losses, policy coordination, risk reduction measures and community-based programmes for risk reduction. For example, built-up area maps (which integrate a map of the building's footprint and estimated height) define built environment typologies and inform loss scenarios. The assessment relies on more advanced techniques, requiring more financial and technical resources to develop disaster-response capacities and to plan and implement non-structural measures to reduce risk

- The *tertiary level* focuses on developing probabilistic tools for risk assessment, and advanced risk management policies from early-warning systems to large-scale adaptation programmes. Box 10.3 describes the application of different approaches to urban risk assessment in different cities. As fuller understandings of urban risks are gained, their interconnections can also be assessed. Institutional analysis and vulnerability analysis are also important parts of risk assessment. However, as understanding of vulnerability increases, the need for more detailed assessments grows.

Box 10.3: Different approaches to urban risk assessment: Case studies from Senegal, Philippines and Yemen

With the development of new digital technologies and the expansion of available data sources, urban risk assessment is a rapidly evolving field that is of particular relevance to climate resilience planning. There are a range of methodologies that can be deployed in this context, with varying degrees of detail and sophistication. Some examples (classified in line with the primary, secondary and tertiary levels in the URA) are presented below:

- *Multi-hazard mapping (primary level):* given the improved availability of geographical and hazard data, cities have greater opportunities to deliver hazard assessments even in contexts where capacity and resources are relatively constrained. These can, for instance, develop a picture of risk from observation and analysis of existing climate impacts. The capital of Senegal, Dakar, for instance, faces natural hazards such as flooding, coastal erosion, drought and the threat of rising sea levels due to climate change. In June 2009, an urban risk assessment was conducted for a pilot study, with the intention of creating feasible methodologies for risk assessment in cities with strained resources. The assessment mapped hazards using available information such as population maps, land-price data and land cover information derived from Landsat satellite images. Spatial analysis showed that the city had undergone massive spatial transformations over the previous 20 years, and it helped to identify risk hotspots in peri-urban areas and derive an approximate loss scenario.

- *Detailed scenario mapping (secondary level):* This approach involves more detailed inputs and analysis, such as future projections or the synthesis of different data typologies. The case of Legazpi, in the Philippines, illustrates a more advanced approach, integrating GIS and remote sensing data to develop a detailed picture of built-up area, land use and land cover, buildings and height assessments and population data to assess densities. The assessment considered different building typologies and their vulnerability (reinforced concrete, traditional brick construction with or without concrete reinforcements, assembled materials, timber). After consulting the Emergency Events Database to assess the main risks in the city, two damage scenarios were developed for tsunamis and earthquakes.

- *Probabilistic hazard modelling (tertiary level):* This involves the use of sophisticated modelling. An example of this approach is the assessment of storm-water drainage in Sana'a, the capital of Yemen. The city is in an inter-mountainous plain which contains many wadis and faces frequent flooding during the annual rainy season, resulting in property damage and traffic congestion. A probabilistic risk assessment was developed to build a storm-water system, the Saylah Project. The risk assessment in Sana'a started with a historical hazard review and analysis, as well as probabilistic hazard modelling, which included hydraulic analysis of the Sana'a basin. This information made it possible to calculate precisely the probability of the hazard's occurrence and calculate building losses for different return periods.

Experiences of urban risk assessment demonstrate that even a relatively straightforward hazard assessment, drawing on existing and readily available data, can be very useful in planning for urban resilience. At the same time, the advancement of assessment methods and the availability of geographical information increasingly support more sophisticated methods of assessment.

Source: World Bank, 2012b.

Tackling the drivers of differential vulnerabilities

Focusing on vulnerability, or susceptibility to harm, enables the social components of urban resilience to be articulated.[46] The objective is to find practical ways for policymakers to address the social and economic inequalities associated with gender, poverty, race/ethnicity, disability, religion, age or location that compound vulnerability to climate change. Chapter 4 explains that vulnerability results from a web of interconnected drivers, including socioeconomic disparities, inadequate infrastructure, urbanization patterns, governance structures and local environmental conditions. Climate vulnerability has complex political dimensions[47] and is often strongly linked to colonial legacies, such as land tenure and legal structures. In this vein, decolonization agendas have the potential to address the underlying vulnerabilities of marginalized groups, including to climate change. However, all too often the protracted and contested process of tackling the historical, cultural and political drivers of vulnerability in this way is beyond the scope of urban managers and other resilience-building agents.

Chapter 4 makes a strong case for recognizing how vulnerabilities are differentiated.[48] Differential vulnerabilities result from the combination of uneven socioeconomic development (poverty, climate-sensitive livelihoods), unsustainable patterns of land use, and historical and ongoing patterns of inequity embedded in processes such as colonialism and exclusionary governance.[49] Vulnerability is thus differentiated across different axes of vulnerability (Figure 10. 6), which enable the identification of specific vulnerability drivers. Those can be tackled directly through specific strategies contributing to urban resilience. Differential vulnerabilities require a multi-pronged approach to challenge vulnerability, including investments in resilient infrastructure, social protection and health provision, alongside cultural measures to foster solidarity and social cohesion, forms of governance that transform entrenched power relations, and an assessment of existing experiences, knowledge and capacities.

As Figure 10.6 shows, strategies that tackle those axes of differentiation tend to reduce vulnerability among marginalized groups and contribute to the city's overall resilience. For example, analysis of the drivers of spatial differentiation may lead to identifying challenges related to access to infrastructure, which can be directly addressed through planning for resilience (Chapter 5), investment in resilient infrastructure (Chapter 6), and inclusive governance (Chapter 7), all in line with the six pathways already proposed in Chapter 4. However, questions remain about how to challenge the cultural and historical drivers of vulnerability and the role of approaches that explicitly try to do so (Chapter 2). Local governments and urban managers are likely to face contestation over measures to tackle climate change if these measures do not tackle existing vulnerabilities.

Identifying the spatial drivers of differential vulnerability can help determine the exposure ranges of informal or deprived settlements.[50] For example, Chapter 4 explains how informal settlements face higher levels of vulnerability and proposes advancing a multi-pronged approach. Furthermore, Chapter 6 identifies informal infrastructure (such as informal water vendors or waste pickers) as a mode of service provision, which is often not acknowledged in risk and vulnerability assessments. Strategies to address the spatial drivers of differential vulnerability may include providing protective infrastructure, enforcing land use regulations, including vulnerable groups in the planning process, and facilitating engagement and partnerships with the private sector. However, vulnerable groups often find that many interventions increase rather than reduce their vulnerability, whether by acts of omission or commission. For example, local budgets that prioritize economic development and the protection of financial assets ignore vulnerable groups' needs and may divert investment from poor communities.

Figure 10.6: Axes of differentiation of vulnerability and response strategies

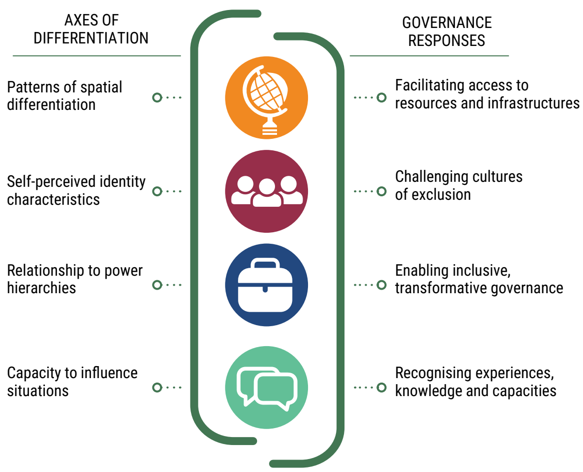


Illustration by Vanesa Castán Broto

Beira's drainage system contributes to the reduction of cyclical floods in the area, Beira, Mozambique © UN-Habitat/Veridiana Mathieu

The development of green infrastructure and regeneration projects can potentially reinforce existing socio-spatial inequalities, creating a process of "green gentrification" that displaces or dispossesses the urban poor (Chapter 4). Similarly, post-disaster relief programmes can have discriminatory or exclusionary impacts on certain groups, depending on ethnicity, gender or other characteristics. For instance, government support programmes during and after disasters are often shaped by assumptions tied to biologically deterministic stereotypes, such as those embedded in programmes for motherhood support.[51] Often, bottom-up networks are more effective than governmental institutions in delivering emergency support.[52] Responses to disasters often reproduce gendered hierarchies of work and responsibility, including the perception that women have "extra time" to participate in active networks to support the community.[53]

A first step towards tackling the spatial drivers of vulnerability is identifying how they work so that planning and urban management processes do not compound them. Community-led evaluations of vulnerabilities, often done hand in hand with risk assessments, may constitute efficient ways to identify the drivers of spatial differentiation (see Box 10.4). For instance, land prices and tenure security are both central factors in driving vulnerability because they determine housing structures, community relations and the maintenance of urban environments. From individual property ownership to customary rights, there are an array of tenure types with different social and economic vulnerabilities. Unfortunately, the dynamic relationship between tenure and resilience has received little attention in the literature.

Post-disaster relief programmes can have discriminatory or exclusionary impacts on certain groups, depending on ethnicity, gender or other characteristics

Box 10.4: Differential vulnerability in the Philippines

Spatial indexes of urban vulnerability are increasingly popular to identify spatial drivers of vulnerability. For example, in the Philippines, a tailored metric known as the Social Vulnerability Index (SVI) uses 18 indicators from the 2020 Census of Population and Housing as proxies for vulnerability in the Philippines. It provides a composite of individual, household and housing characteristics and natural hazards, showing relative differences between barangays. However, there are limitations to exclusively spatial assessments because these do not reflect the multi-dimensional nature of vulnerability differences. Spatial assessments tend to privilege experts' views on risk, deemphasizing participatory or community-led approaches to understanding vulnerability. To address this, the application of the SVI in the Philippines has been coupled with robust social vulnerability assessments and participatory assessments of adaptive capacity to ensure these dimensions are not overlooked.

In 2014, the organization Environmental Science for Social Change (ESSC) in the Philippines piloted a participatory assessment of vulnerability and flood risk in Barangay Carmen, Cagayan de Oro City, and developed guidelines for the implementation of the Philippine National Disaster Risk Reduction and Management Plan (2011-2028). The assessment characterized risks in detail by co-producing knowledge that revealed key vulnerability factors such as work patterns, employment sources, access to evacuation centres and detailed building characterization. However, uptake by local governments of these methodologies has been slow.

Building on these experiences, the Homeless People's Federation of the Philippines (HPFPI) has partnered with a network of organizations led by the Technical Assistance Movement for People and Environment Inc. (TAMPEI) to create partnerships with local governments and other institutions and enable a community-led approach to urban resilience and adaptation in informal settlements across the country. Working in nine different communities across all regions, the project aims to tackle the drivers of differentiated vulnerabilities. These efforts are invaluable in challenging the widespread tendency in the Philippines to channel climate resilience efforts through established power hierarchies, often resulting in neoliberal urban transformations and the violent expulsion of people living in informal settlements. Communities may feel excluded and powerless in the face of such processes. To counter this, HPFPI promotes the formation of local savings groups to secure and access land. Iloilo City's Participatory Housing and Development project, for instance, a proximity relocation project, was made possible when the city government provided a 16.2-hectare plot in a lower-risk area.

Source: ESSC, 2014, 2016 & 2023; CLARE Programme, 2023; Ramalho, 2019a; WRI, 2022.

The road towards sustainability

The new generation of NDCs has paid close attention to the importance of urban climate action. More than ever, there is an urgent need to advance the potential of place-based action to reduce emissions. UN-Habitat's *World Cities Report 2022* emphasized several actions in policy and planning that could support the transformation of cities towards greater resilience. First, there is the importance of small-scale measures towards sustainability. While often associated with major projects such as eco-cities or smart cities, low-carbon urban development usually occurs unspectacularly: either incorporated into the routine operations of urban management and service provision or reflected in local livelihoods and the urban economy. For example, in China, a solid waste generation project in Yichun (Heilongjiang) or a low-carbon industrial park in Anqiu (Shandong) may not be especially attention-grabbing, but they nevertheless contribute to a long-term sustainability trajectory. Rather than considering emission reductions as an add-on, many cities mainstream emission reduction concerns by aligning their activities with the NDCs in their country and thus, more broadly, with the international commitments of the Paris Agreement.

One way to ensure this synchronization is through the development of targeted policy and planning evaluations that can be applied to different investments made by local governments or other institutions. This approach has become much more widespread in recent years. For example, in 2018, the multilateral development banks launched a joint declaration to harmonizej financial flows with the objectives of the Paris Agreement, including mitigation targets and commitments to deliver adaptation and climate-resilient operations.[54] There are now various methodological principles in place to assess those goals in direct investment lending operations.[55]

Climate-resilient development calls for a fundamental reimagining of urban economies and lifestyles. The challenge for local governments is that achieving such a shift depends on broader societal and behavioural changes that need to be underpinned by a collective process of dialogue, exchange and interaction. This is beyond the scope of any institution to undertake alone: again, climate-resilient development reconfigures the question of responsibility and how it is distributed across the city. What is needed is a simultaneous transformation in cultural and social values among the urban population (for instance, through the adoption of sustainable practices by individuals and households) alongside institutional, social and technological innovations to support these changes (Chapter 8).

One of the dilemmas of ensuring a just climate transition is how to navigate a socioeconomic transformation compatible with the climate, something articulated succinctly by the concept of "doughnut economics": this theory hypothesizes that there is a safe operating space for humanity between a "social foundation" of minimum living requirements and well-being that should leave no one behind and an "ecological ceiling" of planetary limits that no one should surpass.[56] The question is how to translate this thinking into practical proposals for urban living. Many cities have been inspired by the idea to attempt different models of urban development that are less carbon-intensive and more resilient. Figure 10.7 provides an overview of 40 subnational authorities worldwide that have embraced this paradigm in their policy and governance. The model provides a model of action for initiating the journey, implementing action and committing to the longterm that resonates with the priorities of many local governments and other subnational authorities.[57]

Figure 10.7: Cities that have declared a commitment to the "doughnut economics" model

Source: Doughnut Economics Action Lab, n.d.

Amsterdam (the Netherlands) was the first city to adopt the doughnut model into its urban strategy in 2020 with the launch of its "city portrait". This emphasized not only the health and well-being of its own residents, but also those of people and ecosystems worldwide.[58] Moreover, the implementation of this vision is overseen by the Amsterdam Doughnut Coalition, which brings together over 20 organizations, including design agencies, neighbourhood initiatives, universities, think-and-do tanks, social enterprises and the municipal government. The results so far have been encouraging, with Amsterdam emerging as a leader in this exciting new model of urban development (see Table 10.2). One notable feature of its policy framework is the emphasis on equity and accessibility in land and housing.

Climate-resilient development calls for a fundamental reimagining of urban economies and lifestyles

Bloemgracht canal in Amsterdam, the Netherlands. © Shutterstock

Table 10.2: How "doughnut economics" supports sustainable outcomes in Amsterdam, the Netherlands

Outcomes	Measures
Control of urban growth and city size	▪ Control urban growth by converting light industry districts into mixed-use areas and facilitating smart densification (as shown in the city district of Buiksloterham) ▪ Actively lead land development by acquiring land, which is then serviced and provided as ground lease to developers and housing associations, with an emphasis on building affordable housing and urban commons initiatives (see below)
Sustainable urban land rent and land use patterns	▪ Cooperation with various commons initiatives and networks as part of its "democratization" agenda ▪ Pilot projects to facilitate access to affordable housing
Resource reductions through industrial location, agglomeration and clustering	▪ Plan for the circular transition of the Port of Amsterdam ▪ Ethical companies and civic organizations that aim to improve workers' conditions in global supply chains ▪ Sharing and second-hand platforms, along with repair and restoration services
Sustainable housing	▪ Increasing the number of housing cooperatives ▪ Requirement to use more circular materials and that more buildings have a material passport ▪ Ban on letting new-build homes so those owning homes have to live in them ▪ Squatting policies to reduce vacancies
Sustainable transport and mobility needs	▪ Creation of more infrastructure for walking and cycling ▪ Incentives and privileges for e-vehicles

Source: Based on Khmara and Kronenburg, 2023.

By systematically embracing the recycling, reuse and recovery of resources, circular cities offer the promise of a "revolution in urban sustainability

Cities engaged in this model aim to move away from urban development models that emphasize growth at the expense of other well-being factors. The challenge is to develop the local economy without creating additional resource dependencies. Diverse economies are grounded in place-based experiences of people and knowledge worldwide; thus, it proposes engaging with diverse livelihoods and solidarity economies to develop alternative ways of inhabiting the world.[59] Such diverse livelihoods take advantage of the resource possibilities of a given context, reversing extractivist practices and questioning the supply chains that sustain a product or a service. However, this may not be feasible for a city working alone without the support of national-level institutions. China's Sustainable Development Plan of National Resource-based Cities, 2013–2020 focuses on delivering industrial transformation for resource-intensive cities. For example, Jiaozuo City in Henan Province and Xiaoyi City in Shanxi have diversified their economies through tourism and ecological agriculture, shifting their economies away from coal.[60] The plan has had a more significant impact in the central and western regions than in coastal ones, but it constitutes an example of a national-level effort to reduce cities' resource dependence.

In every case, the challenge is finding ways to rethink the current socioeconomic systems, linked as they are, to high levels of resource consumption and growing injustices. Urban living offers many opportunities to activate solidarity economies that help redefine broader investment patterns and work within larger political economy structures, away from fossil fuels and towards greater societal robustness, connectivity and flexibility. One approach, mentioned in Chapter 5, is the promotion of "circularity" in urban settings. By systematically embracing the recycling, reuse and recovery of resources, circular cities offer the promise of a "revolution in urban sustainability".[61] In many cases, the application of these ideas is most evident in high-income cities such as London, Paris and Stockholm,[62] where there have been successful efforts to integrate adaptive and blue-and-green infrastructure into the urban fabric while engaging communities. However, the circular economy can also be developed in the context of informality, where communities themselves are already leading initiatives to deliver sustainability (see Box 10.5).

Justice-based approaches to climate action can dismantle the oppressive systems that perpetuate inequalities based on gender, race or perceptions of ability and legitimacy

Box 10.5: Developing the circular economy initiatives in Kampala, Uganda

Kampala Capital City Authority (KCCA) is working with stakeholders to improve waste management in the Ugandan capital with the support of multilateral agencies and universities. Municipal waste collection remains inadequate and non-existent due to problems with accessibility and the limited availability of facilities. This perennial deficit in waste collection leads many people to develop their own waste management methods, including the harmful practice of burning or burying waste in inappropriate places, where it can pose significant hazards to both human and environmental health.

During the last two decades, an array of local workers and entrepreneurs have come together to address Kampala's waste challenges. The Lubaga Charcoal Briquettes Cooperative Society Limited (LUCHACOS) has worked with ACTogether (an NGO affiliated to the international network Shack/Slum Dwellers International (SDI)) to reimagine the flows of waste through the city in a circular way. They aim to establish micro-, small- and medium-sized enterprises that can process organic waste to produce briquettes, which then can be commercialized through local markets. In addition to reducing the waste reaching landfills and facilitating waste management, this initiative adds value to the organic fraction of waste, while also attending to the energy needs of the communities.

The initiative also has a number of challenges: for instance, producing briquettes requires controlled burning, which has additional impacts on the workers. Technological development is needed to facilitate their production with minimal pollution. To achieve this, the Urban Action Lab at Makerere University[63] has actively supported the establishment of circular economy initiatives, especially with waste, working directly with LUCHACOS, ACTogether and the communities they represent to understand the supply chain of briquettes and facilitate circularity in resource streams across the city. The Lab has developed a range of innovative capacity-building methods, including peer-to-peer learning exchanges. Some of the areas of learning include:

- *Waste and product management*: collection, sorting, mixing, proportions of ingredients, storage and post-production handling.
- *Management and organizational skills*: costing, pricing, record keeping, advertising and branding.
- *Fabrication technologies:* from simple briquette-making technology to environmentally sensitive carbonizing char drums.

Source: Kisembo et al, 2024.

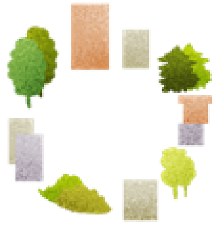
Making urban climate action plans inclusive

Risk and vulnerability assessments constitute the core of urban climate action plans: there is mounting evidence demonstrating the potential effectiveness of urban design responses to address many of those vulnerabilities. As outlined in Chapter 6, these can range from urban form and density interventions, the use of sustainable building designs and materials to reduce risks and emissions, the creation of public and green spaces to promote health and well-being, the provision of adequate sanitation and clean water, integrated waste management and the development of measures that enable circular economy approaches.

Chapter 4 proposes mainstreaming intersectional climate justice while also harnessing and strengthening local resources, institutions and locally-led climate action initiatives. Intersectional climate mitigation and adaptation plans prioritize the protection of the most vulnerable groups of residents, following participatory or community-based methods such as those outlined above. If unaddressed, structural dynamics such as racism, misogyny and other forms of exclusion may be replicated in urban resilience efforts. However, justice-based approaches to climate action can dismantle the oppressive systems that perpetuate inequalities based on gender, race or perceptions of ability and legitimacy.[64] To be realized, capacity building among planners and urban managers is needed to ensure intersectional thinking is integrated meaningfully into planning and urban design.

This transformation may begin with reflection at the individual level among urban practitioners on any existing unconscious biases, beliefs, judgements and practices—whether held by individuals or at the organizational level—that may be influencing planning practices.[65] For example, sanitation in many cities is designed for male users, and women often struggle to access toilets when they are most urgently needed. Moreover, the work that women perform may be overlooked entirely.[66] For instance, like many cities in Sub-Saharan Africa, Mwanza (Tanzania) lacks adequate sewerage: this infrastructural gap ends up being filled by women, who take on the (unpaid) responsibility of maintaining shared household toilets, cleaning them and emptying the pit latrines at significant risk to their own health.[67] These realities, which are not always reflected in planning initiatives, directly impact urban resilience.

Historically, urban planning and design have developed on the assumption that the able-bodied, working male is the "neutral" user of the city.[68] With this in mind, gender-inclusive planning and design offers valuable lessons for resilient planning. This approach does not aim to deliver actions for specific vulnerable groups, but instead aims to deliver action to everyone, even to those who are routinely excluded from the benefits of planning because of their position in society. The World Bank's *Handbook for Gender-inclusive Urban Planning and Design* lists six basic characteristics (replicated in full in Table 10.3) that actively address gender-based discrimination in the urban environment. Gender-inclusive planning emerges from a history of struggles around gender, but recognizes that different drivers of discrimination intersect. Thus, the challenge for gender practitioners is how to transcend this history to address multiple and situated forms of vulnerability and deliver intersectional, transformative forms of planning. While new methods are emerging, the principles of gender-inclusive planning and design offer a solid base to deliver urban resilience for everyone.



One of the first actions for transformative infrastructure is the integration of informal settlements into city-wide strategies

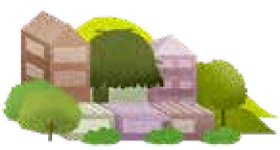
Table 10.3: Characteristics of gender-inclusive planning and design

Gender-inclusive planning and design is….	Gender-inclusive planning and design is not….
▪ *Participatory*: actively including the voices of women, girls, and sexual and gender minorities	▪ *Prescriptive:* designing and planning for women, girls, and sexual and gender minorities instead of with them
▪ *Integrated*: adopting a holistic, cross-cutting approach that centers gender throughout and promotes citizen-city relationship building	▪ *An add-on:* considering women separately from other beneficiaries and project goals; failing to connect the dots or the actors involved
▪ *Universal*: meeting the needs of women, girls, and sexual and gender minorities of all ages and abilities	▪ *Exclusive:* being concerned with the needs of able-bodied women or female persons alone
▪ *Knowledge-building:* seeking out and sharing robust, meaningful new data on gender equity	▪ *Uninformative:* operating in a vacuum without engaging with and contributing to broader knowledge on gender
▪ *Power-building*: growing the capacity and influence of under-represented groups in key decisions	▪ *Disempowering:* repeating or reinforcing historical imbalances in representation and agency
▪ *Invested-in:* committing the necessary finances and expertise to follow through on intentional gender equity goals	▪ *Uninvested-in:* assuming gender goals are achieved if women are among beneficiaries without investing the required time and resources to follow through

Source: World Bank, 2021.

For example, one common component of gender-inclusive planning and design is "universal design", signifying a built environment which can be "accessed, understood and used to the greatest extent possible by all people regardless of their age, size, ability or disability". The exclusion of any member of society leads to less resilient systems. People with disabilities have long advocated for their inclusion as active stakeholders in the design and implementation of disaster risk reduction policy, a point that was explicitly recognized in the Sendai Framework for Disaster Risk Reduction 2015-2030. Urban managers thus can make a difference by creating positive spaces for the meaningful participation of people with disabilities, who have been routinely excluded from climate resilience planning.[69]

In summary, there is no excuse for local governments, businesses, civil society and communities not to integrate resilient thinking in their activities at any scale. Adopting resilience as a way of thinking enables multiple steps that can be taken today. Many chapters in this report have argued for climate action that is transformative. The following section examines ambitious strategies that may help towards a future-oriented perspective on urban resilient development.



Delivering climate-resilient development requires government action and decisive public policy

10.3 Creating the Conditions for Resilient Transformations

In many contexts, climate-resilient development can be linked to wider trajectories of change: for that reason, it is often linked with the possibility of fostering a fundamental societal transformation whereby human well-being and the health of ecosystems worldwide are both prioritized. Throughout the report, four pathways to achieve this have been emphasized: delivering transformative infrastructures, facilitating action through multi-level governance, mobilizing innovation and ensuring sustainable finance. Together, these approaches can help facilitate a broader transformative shift towards climate resilience.

10.3.1 Delivering transformative infrastructure

Transformative infrastructure tackles the drivers of both vulnerabilities and emissions. One of the first actions for transformative infrastructure is the integration of informal settlements into city-wide strategies: this is especially important given that the official "invisibility" of many marginalized communities is all too often a precursor to their displacement by modernist or "world class" infrastructure projects. One largely unacknowledged aspect of upgrading is the transformative impact it can have not only on the settlements in question, but also on the city as a whole: incremental strategies to facilitate access to basic services in informal settlements, for instance, may change the dynamics of land exchanges and pricing, enhance the capacity of communities to access new markets and improve the overall safety and well-being of residents. In Chamanculo, a neighbourhood of Maputo (Mozambique), an ongoing pilot project for a neighbourhood energy transition led by the Universidade Eduardo Mondlane and developed in partnership with the municipality aims to facilitate access to collectively owned solar infrastructure such as solar lamps and charging kiosks, thus reimagining the possibilities for delivering energy services outside the formal network. Its transformative impacts relate to the demonstration of how off-grid energy can deliver alternative urban energy services in a country in which off-grid renewable energy has until now only been considered in remote areas far outside the reach of the conventional network.

NbS and measures to integrate green-and-blue infrastructures may also play a transformative role in cities. For example, the small city of Genk, with only 65,000 inhabitants, has transformed its post-industrial urban legacy into what is now considered one of the greenest cities of Flanders in Belgium. Among other initiatives, the city hosts the Heempark, a site to demonstrate local agricultural practices that houses some 350 educational groups and attracts about 10,000 visitors a year.[70] The Bee Plan, developed in 2014, aims to improve bee conditions on communal and private land and support local apiarists. A network of organic allotments also brings together volunteers and supports the participation of marginalized groups. These activities connect citizens and nature in inclusive ways. Citizens' involvement in renaturing the city changes the relationship of residents with the local environment and generates investment opportunities. Infrastructure transformations, however, depend on connecting those infrastructures with basic services, housing and access to land, as Chapter 6 makes clear.

10.3.2 Facilitating action through multi-level governance

Transformation also requires an enabling governance framework. Delivering climate-resilient development requires government action and decisive public policy, with all levels of government having key roles to play. Governments, however, are not alone: a multi-level governance approach to urban resilience depends on diversifying the range of actors intervening in the urban environment, including the private sector, civil society organizations and individual residents who recognize the importance of their engagement across all aspects of life (Chapter 7). An alternative strategy for facilitating multi-level governance, instead of focusing on the distribution of responsibilities, is to bring every actor to the table according to their capacities. Table 10.4 provides an overview of low-stakes climate-resilient development strategies that can generate new operating methods for the diverse actors. Adequate capacities may not always be available, but the table provides initial suggestions that enable every actor to work towards resilient development.

Table 10.4: Examples of strategies for the delivery of climate-resilient development at different levels of governance

EXAMPLES OF STRATEGIES FOR CLimate-resilient DEVELOPMENT	National governments and subnational governments when relevant	Local governments and departments	Business and industry	Civil society and intermediaries	International Organizations and City Networks	Individuals and communities
Integrating mitigation, adaptation and development strategies	Analyze and understand the alignment between NDCs and efforts to deliver the SDGs	Develop advanced methods for integrated planning	Consider integration, mitigation and development within current business models	Provide examples of good practices on the integration of mitigation, adaptation and development	Facilitate learning across contexts	Considering how adaptation and mitigation relate to everyday challenges
Policy and regulation	Link resilience strategies with National Urban Policies and other urban policy instruments	Updating building codes, urban planning regulations, and land use policies to consider future climate scenarios	Abide by existing policies and regulations and help design appropriate ones, adapted to industrial conditions	Abide by existing policies and regulations and examine its shortcomings	Provide insights about the operation of policies and regulations across different levels	Abide by existing policies and regulations and help identifying embedded injustices in them
Institutional strengthening	Mainstreaming resilience across contexts	Consider resilience within sectoral policies	Integrate resilience thinking across the business model	Support the development of multi-stakeholder resilience networks	Adapt institutions to the demands of delivering resilience	Organize and protest against institutional abuse

EXAMPLES OF STRATEGIES FOR CLimate-resilient DEVELOPMENT	National governments and subnational governments when relevant	Local governments and departments	Business and industry	Civil society and intermediaries	International Organizations and City Networks	Individuals and communities
Investing in research and technology	Support resilient-specific R&D agendas	Facilitate the constitution of urban laboratories for experimentation	Invest in R&D for resilience	Actively facilitate the production of knowledge for resilience, and integrate different types of knowledge	Fund international R&D programmes on resilience	Mobilize and share local knowledges and experience for resilience
Community engagement and public awareness	Create the institutional conditions to broaden participation in decision-making	Actively create invited spaces for people to participate in policy making and planning	Create partnership and collaborations with a wide range of stakeholders	Deliver social innovation that facilitate spaces of participation and coproduction	Facilitate sharing practices across different contexts	Actively create political momentum collectively, to mobilise local voices
Put ecosystems at the centre of resilient efforts	Develop appropriate frameworks and policy for the integration of nature in all aspects of policy making	Consider the management of urban environments and resources	Adopt green production policies and implement best practices in business and industry	Develop alternatives and mobilize society to identify and respond to environmental challenges	Promote healthy environments for all in line with the SDGs	Develop positive relations with surrounding ecosystems
Financial Mechanisms	Facilitate the transfer of funds according to subsidiarity principles	Mobilize and allocate budgets, and access innovative finance mechanisms	Invest in green business opportunities and develop insurance and other mechanisms to manage future risks	Mobilize budgets in those resilience areas overlooked in mainstream efforts by public and private sectors	Direct international finance to resilient activities and prevent funding maladaptation	Provide the conditions for the implementation of sustainable measures when finance becomes available at the local level
Building Capacity and Sharing Knowledge	Integrate resilience in educational programmes	Deliver resilience training at appropriate levels	Implement resilience training programmes for employees and managers	Innovate in training and education for resilience	Share learning and training practices across international contexts	Actively learn about resilience in the community and beyond

Mobilizing innovation as a transformation lever

As discussed in Chapter 8, innovation can drive urban transformations: new technologies are being developed to facilitate decarbonization and adaptation; new practices and institutions will help transform societies to make them more sustainable and resilient; new forms of organization may help to deal with the growing risks of climate change. While this is generally understood, what is less well known is that inclusive innovation—that is, innovation focused on meeting the needs of marginalized people—may be central to facilitating transformation. Such a perspective must challenge existing drivers of exclusion regarding access to services and resources, as well as recognition of multiple forms of understanding and knowledge in collective responses to climate change. In this regard, local governments are crucial in fostering inclusive and sustainable innovations. From developing inclusive innovation policies that facilitate the participation of a diverse range of actors, to the prioritization of innovation sectors that favour inclusion and capacity building, cities have a variety of actions which can foster transformations at the urban level.

10.3.3 Ensuring sustainable finance

Finance is a major aspect of supporting a transformative approach to climate-resilient development. Chapter 9 show that finance remains one of the main barriers to delivering climate-resilient development, which is already acknowledged in the IPCC's *Sixth Assessment Report*. Local governments face insurmountable obstacles in accessing climate finance, and private investment is not flowing into climate-resilient development projects as it should. As Chapter 9 clearly shows, city governments cannot overcome those barriers alone. National governments and international financing organizations play a key role in facilitating intergovernmental transfers and the development of financial mechanisms to facilitate action at the local level. Chapter 9 further notes that cities have alternative means to leverage finance, and they can work with multiple actors within the city to deliver climate-resilient development. Exercises in visioning or institutional methodologies to evaluate whether current actions are compatible with climate-compatible development may not need additional finance, but the smart integration of existing resources while working across communities and institutions.

10.3.4 A global partnership for urban climate resilience

Within the context of the urgency to address the climate crisis, climate resilience across multiple dimensions is attainable, but requires collective efforts at multiple levels—global, regional, national, subnational and local—including a wide range of stakeholders in different contexts. Chapter 7 has emphasized the challenges of governance and the need to reinvigorate a global partnership in the context of climate-resilient development. The conditions for a new form of multilateralism that addresses local and place-based conditions have arrived, driven by communities themselves, which in turn could facilitate a greater sense of social responsibility across the world.

SDG 17 calls for the creation of a partnership for the goals, reimagining the role of ODA in promoting human well-being and strengthening human connections. The last SDG report, however, warns that debt distress continues to hinder development and that despite increases in ODA, this is largely related to the provision of support to refugees in a context of geopolitical instability.[71] Partnerships that take seriously the potential of collaboration within cities, towns and urban areas are still missing. This continued shortfall in city-level activities may have been a factor in the creation of the Sustainable Urban Resilience for the Next Generation (SURGe) initiative: it aims to accelerate local and urban climate action through multi-level governance, engagement and delivery through five integrated tracks, contributing to the achievement of the Paris climate goals and SDGs (Box 10.6).

New technologies are being developed to facilitate decarbonization and adaptation

Box 10.6: Increasing connectivity: The SURGe initiative

Launched in 2022 by the Conference of Parties (COP) Presidency at COP 27, in collaboration with UN-Habitat and ICLEI, the SURGe initiative has been endorsed by more than 180 Parties to the conference. SURGe focuses on the integration of urban concerns into Multilateral Environmental Agreements to recognize the growing importance of subnational forms of governance in the delivery of climate-resilient development. It seeks to do this by connecting local, national and global action through strategies that demonstrate and enact those linkages. For example, some strategies include:

1. *Increasing the visibility of local actions in international political arenas*, for example, by demonstrating the effectiveness of local leadership at the annual COP meetings.
2. *Supporting national governments in developing strategies to engage with local-level action* through nationwide policies for urban management.
3. *Linking global goals to local implementation of climate action*, for example, by including climate-resilient development criteria in local pipelines of infrastructure development.
4. *Building upon existing experiences of city networks* in knowledge exchange and innovation across contexts.

However, SURGe faces fundamental challenges in including subnational governments in the multilateral space. Despite some positive examples, city efforts must be stepped up. Only 25 per cent of the 327 plans investigated in an empirical study in the EU demonstrated a commitment to fully attaining net zero. The challenge is not only for cities and their advocates, but also for national governments and international organizations to build multi-level partnerships capable of significantly improving their current capacities to deliver climate-resilient development. SURGe's success depends on redirecting new resources to cities as much as it depends on recognizing how specific actions catalyse wider transformations.

Source: UN Habitat, 2023a; Heijden, 2023; Salvia et al., 2021.

The IPCC specifically called for partnerships that, alongside political commitments, can enhance the effectiveness of climate-resilient development policy.[72] Partnerships are also important to facilitate the circulation of knowledge and transfer of technologies, as it has been the case through international city networks that have facilitated the spread of mitigation and adaptation practices and enabled learning from context to context.[73] However, those partnerships have to be practically minded, connecting with challenges on the ground. Climate-resilient development is greatly aided by partnerships between governments, civil society, and private sector organizations, across scales to address the vulnerability of communities or ecosytems.[74] Such partnerships are most effective when they include traditionally marginalized groups, including women, youth, Indigenous Peoples, local communities and ethnic minorities.

10.3.5 Envisioning climate-resilient futures

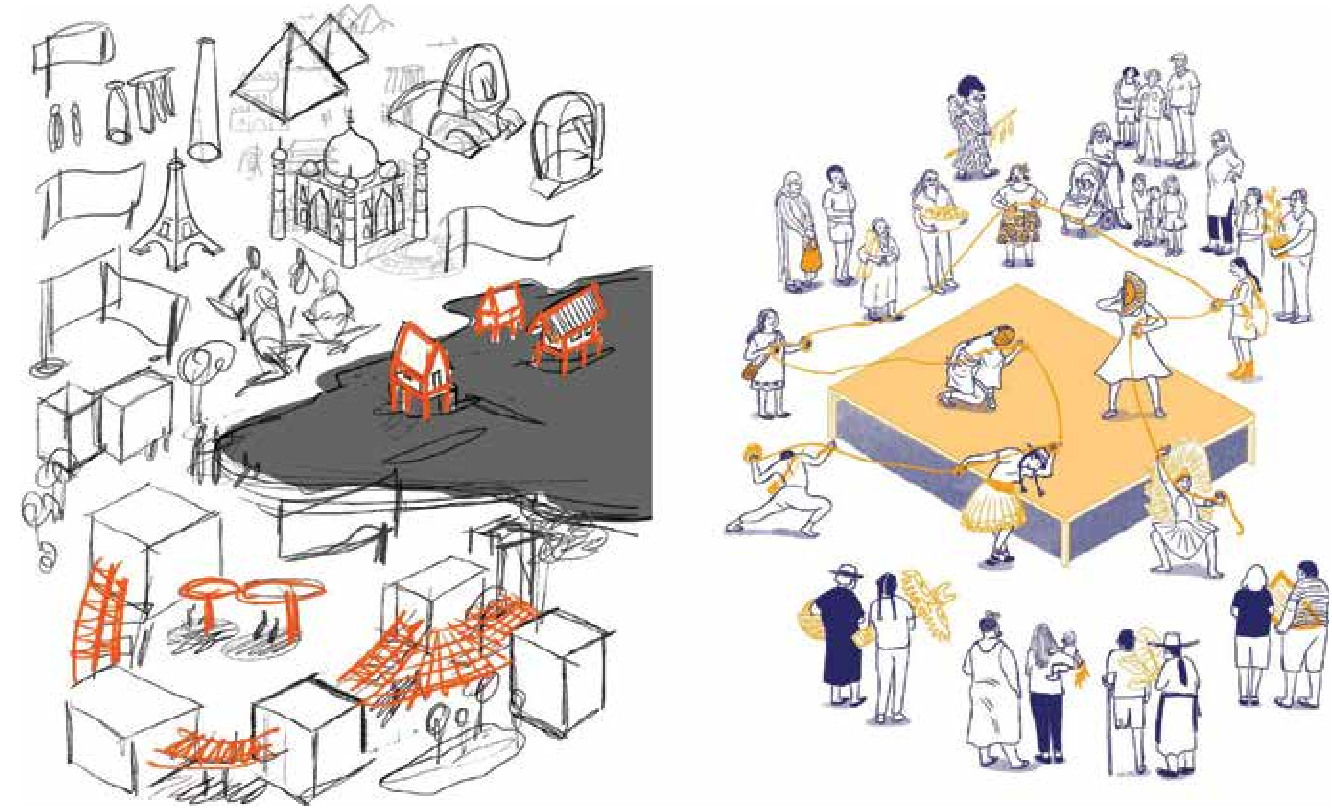
A significant challenge is the failure of current policy imaginations to visualize alternatives for climate-resilient futures.[75] The *2022 World Cities Report* explored how reflecting on possible urban futures was critical in generating demands for action and planning. Expert-based visioning methods—whether this is with a focus on predictive futures (forecasting), drawing back pathways from putative desired futures (backcasting) or facilitating the exploration of plausible futures through hypothetical alternatives (scenario building)—play an important role in linking aspirational targets with concrete actions.[76] Visioning requires a balanced representation of multiple voices (especially those frequently ignored or marginalized) and the articulation of plausible futures, with action plans that are both ambitious and feasible.

When there are divergent opinions, those marginalized voices are set aside, sometimes despite efforts to deliver inclusive visioning exercises. For example, a visioning exercise in the mid-hill region of Nuwakot, in central Nepal, found that climate-resilient development proposals from local development agencies (focusing predominantly on the promotion of entrepreneurship programmes and agricultural innovation) did not match closely with the demands of local communities who emphasized daily concerns such as irrigation, water supply, education and health. In particular, the views of individuals from the most excluded group in Nepal's caste hierarchy (Dalits) were routinely overlooked: Dalits were commonly excluded from development projects, while those from more privileged castes were recognized as legitimate stakeholders who could input more easily into those programmes.[77] Even inclusive planning processes may not challenge established power hierarchies without a clear perspective about the pathway to climate-resilient development.

Crucially, as shown above, climate-resilient development will require the integration of multiple perspectives, including those of experts and planners, but also communities and marginalized groups who should be provided with opportunities to participate and indeed lead decision-making processes. Figure 10.8 presents an example of one such attempt in which international experts on urban adaptation worked with a designer who integrated their perspectives into illustrations that could bring to the fore alternative future visions of the city—in this case, the contribution of heritage to adaptation. The first part represents an initial visual brainstorm, while the second part of the illustration represents a consolidated view in which participants move from a physical heritage perspective to an intangible one, showing how shared identities create invisible links that support collective mobilization efforts for adaptation. Prompting artistic creation to express individual and collective relationships with climate change is an effective way to generate climate-resilient visions of the city, and one that can help create partnerships across differences. Local governments and other local actors should harness the cultural potential of cities not just to develop solutions, but also to generate alternative imaginations about how a sustainable, resilient urban future might look like.

Transjakarta electric buses operating in the Sudirman and Thamrin areas of Jakarta, Indonesia. © Shutterstock

Figure 10.8: Using artistic illustration to understand the role of heritage in adaptation



Source: Olazabal et. at., 2024.

10.4 Concluding Remarks

In summary, resilience and inclusion must be delivered in tandem: a people-centred approach should put inclusion at the heart of the resilient city. Though it is sometimes difficult for local governments to connect the specific challenges they face with the broader objectives of the SDGs and other global agendas, their alignment has become more visible over time as international agencies and financial institutions work more closely with cities to achieve these goals. A concern for the well-being of people and the health of ecosystems within the city resonates with a broader concern for the well-being of people and the health of ecosystems elsewhere. Now, more than ever, cities are becoming global actors, navigating a path towards climate-resilient development in different locations and conditions.

Among other lessons, the chapter has highlighted the following:

- *A negotiated approach to urban resilience helps build a more inclusive understanding of resilience and sustained collective action in the long-term.* Urban managers can promote a negotiated approach to urban resilience that attempts to consider different perspectives, identify trade-offs and prioritize the interests of those who are most vulnerable.

- *Urban resilience depends on multiple, interconnected actions across sectors that is best achieved as a collective dialogue about priorities and preferences.* Vulnerable and excluded groups, such as people with disabilities, must be actively engaged in decisions concerning their well-being.

- *While more finance and resources are urgently needed, urban resilience does not only depend on the mobilization of big budgets and large-scale programmes.* Leveraging the resources and capacities within the city, including those of the most disadvantaged actors, is an important but often neglected pathway to achieving incremental improvements that together over time can prove transformative.

- *Climate resilience development requires putting fairness and equity at the core of urban management and planning.* Marginalization and discrimination create vulnerability, which ultimately affects all urban residents: by contrast, the more equitable and inclusive a city is, the greater its resilience to climate shocks.

- *Notwithstanding the different challenges and limitations many urban areas face, a range of viable alternatives already exist for governments to pursue*. In this context, the widespread inaction that continues to characterize national and local responses to climate change is difficult to excuse. This is especially true when many steps towards climate resilience can be built into existing work within cities.

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Statistical Annex

General Disclaimer: The designations employed and presentation of the data in the Statistical Annex do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, city or area of its authorities, or concerning the delimitation of its frontiers or boundaries.

Table A.1: Basic Urbanizaton and Climate Change Indicators for Selected Available Years by Country and Region, 2000-2030

Country / Territory Name	Annual Urban Population at Mid-Year by Region, Subregion, Country and Area (Thousands)				Percentage of Population at Mid-Year Residing in Urban Areas				Total Greenhouse Gas Emissions (kt of CO_2 Equivalent) [a]			Total Greenhouse Gas Emissions per Capita (kt of CO_2 Equivalent) [a]			CO_2 Emissions (kt) [b]			CO_2 Emissions per Capita (Metric Tons) [b]		
	2000	2010	2020	2030	2000	2010	2020	2030	2000	2010	2020	2000	2010	2020	2000	2010	2020	2000	2010	2020
WORLD	**2,868,308**	**3,594,868**	**4,378,994**	**5,167,258**	**46.7**	**51.7**	**56.2**	**60.4**	**34,208,319**	**43,442,887**	**46,120,921**	**5.57**	**6.23**	**5.90**	**24,280,272**	**32,095,873**	**33,566,428**	**3.95**	**4.60**	**4.29**
More developed regions	883,880	954,091	1,003,640	1,049,699	74.2	77.2	79.1	81.4	...	...	...	...	...	...	...	...	...	...	...	...
Less developed regions	1,984,428	2,640,777	3,375,354	4,117,558	40.1	46.1	51.7	56.7	...	...	...	...	...	...	...	...	...	...	...	...
Least developed countries	166,315	250,013	372,038	538,529	25.0	29.5	34.6	40.4	938,938	1,289,739	1,618,512	1.42	1.53	1.51	110,415	210,098	351,230	0.17	0.25	0.33
Less developed regions, excluding least developed countries	1,818,113	2,390,764	3,003,315	3,579,029	42.4	49.0	55.1	60.4	...	...	...	...	...	...	...	...	...	...	...	...
Less developed regions, excluding China	1,501,700	1,946,607	2,473,276	3,071,076	41.2	44.9	48.8	53.1	...	...	...	...	...	...	...	...	...	...	...	...
High-income countries	821,849	919,423	988,586	1,048,879	76.8	80.0	81.9	83.9	15,731,562	15,682,130	13,880,328	12.52	11.78	9.96	12,857,971	12,887,173	10,864,997	10.23	9.68	7.79
Middle-income countries	1,935,345	2,511,183	3,144,887	3,756,587	41.6	47.9	53.7	59.0	16,131,544	24,926,545	29,750,102	3.60	4.89	5.19	9,982,802	17,394,872	21,203,591	2.23	3.41	3.70
Upper-middle-income countries	1,159,791	1,487,718	1,821,036	2,068,825	50.3	59.8	68.2	74.8	11,346,445	18,419,380	21,786,984	4.80	7.16	7.81	7,522,849	13,650,212	16,383,996	3.18	5.30	5.88
Lower-middle-income countries	775,555	1,023,464	1,323,851	1,687,762	33.1	37.1	41.6	47.0	4,785,099	6,507,165	7,963,118	2.26	2.58	2.70	2,459,953	3,744,660	4,819,596	1.16	1.48	1.64
Low-income countries	109,161	161,884	242,877	358,848	25.7	28.9	33.2	38.3	702,577	887,450	976,442	1.84	1.74	1.46	156,945	196,254	179,665	0.41	0.38	0.27
Sub-Saharan Africa	202,641	305,508	458,670	666,165	31.4	36.1	41.4	47.0	1,529,884	1,978,043	2,258,596	2.28	2.25	1.96	498,621	692,188	760,868	0.74	0.79	0.66
AFRICA	**285,998**	**408,587**	**587,738**	**824,014**	**35.0**	**38.9**	**43.5**	**48.4**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Eastern Africa	**54,951**	**84,504**	**132,520**	**202,579**	**21.0**	**24.4**	**29.0**	**34.5**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Burundi	528	933	1,637	2,780	8.2	10.6	13.7	17.6	1,660	2,561	4,103	0.26	0.28	0.34	263	323	713	0.04	0.04	0.06
Comoros	152	193	255	345	28.1	28.0	29.4	32.5	304	418	620	0.57	0.64	0.77	105	168	328	0.20	0.26	0.41
Djibouti	549	655	781	906	76.5	77.0	78.1	80.0	1,222	1,415	1,395	1.65	1.54	1.28	373	519	428	0.50	0.56	0.39
Eritrea	902	1,544	2,246	3,210	26.6	35.2	41.3	47.8	5,541	5,413	6,242	2.32	1.72	1.76	633	503	706	0.26	0.16	0.20
Ethiopia	9,807	15,189	24,463	37,496	14.7	17.3	21.7	26.9	72,193	116,923	167,300	1.08	1.31	1.43	3,557	6,473	18,098	0.05	0.07	0.15
Kenya	6,256	9,747	14,975	22,383	19.9	23.6	28.0	33.4	35,347	59,567	80,188	1.15	1.43	1.54	8,630	13,424	19,447	0.28	0.32	0.37
Madagascar	4,276	6,755	10,670	16,102	27.1	31.9	38.5	45.2	25,877	27,668	30,566	1.60	1.27	1.08	1,654	1,870	2,745	0.10	0.09	0.10
Malawi	1,662	2,358	3,535	5,551	14.6	15.5	17.4	20.9	3,964	6,370	11,982	0.35	0.43	0.62	875	984	1,640	0.08	0.07	0.08
Mauritius	506	519	519	539	42.7	41.6	40.8	41.9	4,312	5,787	6,436	3.63	4.63	5.08	2,432	3,662	3,720	2.05	2.93	2.94
Mayotte	72	102	125	157	47.7	49.0	45.8	45.7	...	...	...	...	...	...	...	...	...	...	...	...
Mozambique	5,257	7,710	11,978	18,195	29.1	31.8	37.1	42.9	20,049	27,104	33,749	1.13	1.17	1.08	1,427	2,681	6,946	0.08	0.12	0.22
Réunion	672	818	893	956	91.2	98.5	99.7	99.9	...	...	...	...	...	...	...	...	...	...	...	...
Rwanda	1,198	1,735	2,281	3,144	14.9	16.9	17.4	19.6	3,199	4,891	6,330	0.39	0.47	0.48	661	704	1,382	0.08	0.07	0.11
Seychelles	41	49	55	61	50.4	53.3	57.5	61.7	384	556	770	4.73	6.19	7.82	294	444	599	3.62	4.94	6.08
Somalia	2,996	4,738	7,431	11,229	33.2	39.3	46.1	52.1	25,198	24,992	26,272	2.89	2.08	1.59	487	631	660	0.06	0.05	0.04
South Sudan	1,106	1,798	2,749	4,164	16.5	17.9	20.2	24.1	52,686	68,562	56,051	8.62	7.06	5.28	460	1,313	1,743	0.08	0.14	0.16
Uganda	3,554	6,574	11,775	19,914	14.8	19.4	25.0	31.2	17,089	30,982	39,280	0.71	0.96	0.88	1,298	3,332	5,675	0.05	0.10	0.13
United Republic of Tanzania	7,625	12,960	22,113	35,529	22.3	28.1	35.2	42.4	45,589	65,993	89,255	1.32	1.46	1.45	2,946	6,910	14,436	0.09	0.15	0.23
Zambia	3,665	5,451	8,336	12,549	34.8	39.4	44.6	50.5	22,880	29,281	36,108	2.31	2.12	1.91	1,807	2,657	7,607	0.18	0.19	0.40
Zimbabwe	4,126	4,676	5,700	7,370	33.8	33.2	32.2	34.2	31,040	28,229	25,988	2.62	2.20	1.66	13,579	9,518	8,313	1.15	0.74	0.53
Middle Africa	**38,184**	**59,348**	**90,619**	**133,728**	**39.7**	**45.2**	**50.6**	**56.2**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Angola	8,235	13,971	21,937	32,437	50.1	59.8	66.8	72.5	57,983	78,894	70,781	3.54	3.38	2.12	16,204	22,802	19,815	0.99	0.98	0.59
Cameroon	6,956	10,297	14,942	20,857	45.5	51.6	57.6	63.2	86,000	84,904	93,349	5.70	4.27	3.52	5,209	7,014	9,928	0.35	0.35	0.37
Central African Republic	1,413	1,731	2,077	2,918	37.6	38.9	42.2	47.6	24,761	21,491	21,016	6.59	4.61	3.93	243	175	237	0.06	0.04	0.04
Chad	1,805	2,613	3,830	5,819	21.6	22.0	23.5	27.1	34,515	54,743	89,558	4.18	4.60	5.38	507	1,190	1,568	0.06	0.10	0.09
Congo	1,893	2,775	3,857	5,290	58.7	63.3	67.8	72.3	13,092	17,325	19,422	4.18	3.90	3.41	4,347	5,423	7,154	1.39	1.22	1.25
Democratic Republic of the Congo	16,534	25,818	40,848	62,343	35.1	40.0	45.6	51.8	34,138	49,865	56,120	0.70	0.75	0.60	1,635	2,654	3,026	0.03	0.04	0.03
Equatorial Guinea	302	627	1,028	1,445	49.1	65.9	73.1	77.2	6,705	12,842	9,543	9.79	11.73	5.98	1,982	6,048	4,350	2.89	5.53	2.73
Gabon	971	1,403	1,938	2,403	78.9	85.5	90.1	92.7	16,494	15,517	14,849	12.96	9.07	6.48	6,080	5,762	5,349	4.78	3.37	2.33
Sao Tome and Principe	74	114	162	215	53.4	65.0	74.4	80.0	72	128	180	0.50	0.70	0.82	54	103	141	0.37	0.56	0.65
Northern Africa	**83,357**	**103,079**	**129,068**	**157,849**	**48.3**	**50.5**	**52.5**	**55.3**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Algeria	18,685	24,394	31,951	38,232	59.9	67.5	73.7	78.3	161,799	210,956	266,703	5.26	5.88	6.14	80,047	114,179	161,563	2.60	3.18	3.72
Egypt	29,917	36,183	44,041	53,613	42.8	43.0	42.8	44.8	187,899	289,376	299,779	2.63	3.32	2.79	114,614	200,313	210,752	1.61	2.30	1.96
Libya	4,091	4,815	5,376	6,140	76.4	78.1	80.7	83.6	102,689	126,229	75,370	19.92	19.44	11.33	44,725	59,560	44,467	8.68	9.17	6.68
Morocco	15,387	18,803	23,552	28,069	53.3	58.0	63.5	68.7	49,443	70,743	88,028	1.73	2.18	2.40	32,877	51,750	66,720	1.15	1.59	1.82
Sudan	8,855	11,378	15,349	21,775	32.5	33.1	35.3	39.7	77,778	93,567	107,114	2.96	2.77	2.41	5,691	16,427	20,796	0.22	0.49	0.47
Tunisia	6,152	7,092	8,281	9,372	63.4	66.7	69.6	73.0	30,634	39,562	40,883	3.10	3.63	3.36	21,069	28,322	29,293	2.13	2.60	2.41
Western Sahara	269	414	519	647	85.8	86.3	86.8	87.8	...	...	...	...	...	...	...	...	...	...	...	...
Southern Africa	**28,156**	**35,033**	**43,688**	**51,909**	**53.8**	**59.4**	**64.6**	**69.4**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Botswana	920	1,258	1,712	2,151	53.2	62.4	70.9	76.8	13,641	20,890	12,375	7.90	9.99	4.86	4,034	3,372	5,764	2.34	1.61	2.26
Lesotho	365	506	674	887	19.5	24.8	29.0	34.0	3,640	3,922	4,014	1.82	1.94	1.78	1,748	2,159	2,312	0.87	1.07	1.03
Namibia	615	904	1,403	1,972	32.4	41.6	52.0	60.8	10,654	12,644	13,560	5.86	6.02	5.45	1,942	3,104	3,953	1.07	1.48	1.59
South Africa	26,015	32,095	39,551	46,457	56.9	62.2	67.4	72.1	368,778	528,518	501,521	7.88	10.21	8.53	284,463	425,548	393,242	6.08	8.22	6.69
Eswatini	241	270	348	442	22.7	22.5	24.2	26.5	2,737	2,596	3,001	2.66	2.36	2.54	1,091	849	1,148	1.06	0.77	0.97
Western Africa	**81,350**	**126,623**	**191,842**	**277,949**	**34.5**	**41.1**	**47.7**	**53.6**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Benin	2,632	3,964	5,869	8,461	38.3	43.1	48.4	54.1	7,029	10,476	16,191	1.00	1.11	1.28	1,425	4,825	7,980	0.20	0.51	0.63
Burkina Faso	2,071	3,844	6,398	10,163	17.8	24.6	30.6	37.1	15,985	23,652	32,263	1.35	1.47	1.50	1,049	2,094	5,457	0.09	0.13	0.25
Cabo Verde	232	311	378	450	53.4	61.8	66.7	70.9	462	700	792	1.01	1.34	1.36	306	541	621	0.67	1.04	1.07
Côte d'Ivoire	7,201	9,656	13,532	18,912	43.2	47.3	51.7	56.7	25,737	19,242	26,412	1.53	0.91	0.99	6,489	6,351	10,895	0.39	0.30	0.41
Gambia	590	942	1,435	2,055	47.9	55.7	62.6	68.5	2,289	2,208	2,453	1.59	1.14	0.95	245	434	611	0.17	0.22	0.24

Table A.1: Continued

Country / Territory Name	Annual Urban Population at Mid-Year by Region, Subregion, Country and Area (Thousands)				Percentage of Population at Mid-Year Residing in Urban Areas				Total Greenhouse Gas Emissions (kt of CO_2 Equivalent) [a]			Total Greenhouse Gas Emissions per Capita (kt of CO_2 Equivalent) [a]			CO_2 Emissions (kt) [b]			CO_2 Emissions per Capita (Metric Tons) [b]		
	2000	2010	2020	2030	2000	2010	2020	2030	2000	2010	2020	2000	2010	2020	2000	2010	2020	2000	2010	2020
Ghana	8,320	12,431	17,626	23,641	43.9	50.7	57.3	63.4	16,828	23,142	39,070	0.86	0.90	1.21	4,950	10,383	19,401	0.25	0.41	0.60
Guinea	2,719	3,635	5,071	7,300	30.9	33.7	36.9	41.4	11,373	19,134	29,746	1.36	1.86	2.25	1,495	2,503	4,538	0.18	0.24	0.34
Guinea-Bissau	451	624	884	1,209	36.2	40.1	44.2	48.5	1,536	2,110	2,547	1.25	1.35	1.26	147	241	329	0.12	0.15	0.16
Liberia	1,279	1,888	2,659	3,722	44.3	47.8	52.1	57.3	828	1,385	2,155	0.29	0.34	0.42	426	730	1,180	0.15	0.18	0.23
Mali	3,110	5,427	8,907	13,850	28.4	36.0	43.9	51.2	20,910	29,096	43,492	1.86	1.87	2.05	1,094	2,154	4,151	0.10	0.14	0.20
Mauritania	1,032	1,682	2,647	3,808	38.1	46.6	55.3	62.7	8,953	10,904	14,056	3.32	3.19	3.12	1,119	2,074	3,847	0.42	0.61	0.86
Niger	1,838	2,664	4,003	6,542	16.2	16.2	16.6	18.7	19,006	28,101	44,796	1.64	1.69	1.84	660	1,361	2,198	0.06	0.08	0.09
Nigeria	42,627	68,950	107,113	156,300	34.8	43.5	52.0	59.2	256,055	271,563	322,337	2.08	1.69	1.55	97,215	90,055	111,978	0.79	0.56	0.54
Saint Helena	2	2	2	2	40.4	39.5	40.1	42.7	...	...	...	...	...	...	...	...	...	...	...	...
Senegal	3,985	5,654	8,277	11,778	40.3	43.8	48.1	53.2	17,764	22,096	30,293	1.83	1.76	1.84	4,064	7,026	10,680	0.42	0.56	0.65
Sierra Leone	1,626	2,510	3,454	4,651	35.6	38.9	42.9	47.8	2,442	4,535	5,952	0.53	0.70	0.72	333	560	1,048	0.07	0.09	0.13
Togo	1,636	2,441	3,588	5,106	32.9	37.5	42.8	48.6	4,388	6,562	8,395	0.88	1.00	0.99	1,269	2,630	2,415	0.25	0.40	0.29
ASIA	**1,399,722**	**1,877,015**	**2,361,464**	**2,802,262**	**37.5**	**44.8**	**51.1**	**56.7**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Eastern Asia	**635,753**	**868,193**	**1,078,435**	**1,222,479**	**42.0**	**54.4**	**64.8**	**72.8**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
China	460,377	669,354	875,076	1,017,847	35.9	49.2	61.4	70.6	4,567,274	10,211,637	12,942,868	3.62	7.63	9.17	3,346,526	8,474,923	10,944,686	2.65	6.34	7.76
China, Hong Kong SAR	6,664	7,025	7,548	7,987	100.0	100.0	100.0	100.0	...	...	...	...	...	...	...	...	...	...	...	...
China, Macao SAR	428	537	652	746	100.0	100.0	100.0	100.0	...	...	...	...	...	...	...	...	...	...	...	...
China, Taiwan Province of China	15,259	17,254	18,802	19,902	69.9	74.7	78.9	82.4	...	...	...	...	...	...	...	...	...	...	...	...
Dem. People's Republic of Korea	13,623	14,848	16,120	17,531	59.4	60.4	62.4	65.6	87,411	73,581	76,080	3.74	2.98	2.94	71,823	51,690	52,437	3.07	2.09	2.03
Japan	100,304	116,741	116,100	112,710	78.6	90.8	91.8	92.7	1,278,174	1,234,821	1,094,556	10.08	9.64	8.67	1,184,425	1,157,242	1,014,065	9.34	9.04	8.03
Mongolia	1,370	1,833	2,203	2,514	57.1	67.6	68.7	70.6	30,535	32,730	53,921	12.46	12.11	16.37	8,997	14,311	21,185	3.67	5.30	6.43
Republic of Korea	37,729	40,602	41,934	43,241	79.6	81.9	81.4	82.0	...	...	...	...	...	...	...	...	...	...	...	...
South-Central Asia	**447,089**	**585,187**	**745,069**	**931,437**	**29.6**	**33.1**	**37.1**	**42.0**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Central Asia	25,366	30,304	35,681	41,414	45.7	48.0	48.3	50.5	...	...	...	...	...	...	...	...	...	...	...	...
Kazakhstan	8,447	9,319	10,829	12,186	56.1	56.8	57.7	60.0	162,134	307,086	294,806	10.89	18.81	15.72	120,152	229,702	211,897	8.07	14.07	11.30
Kyrgyzstan	1,737	1,914	2,323	2,862	35.3	35.3	36.9	40.9	9,464	12,096	16,094	1.93	2.22	2.45	4,643	6,394	9,080	0.95	1.17	1.38
Tajikistan	1,647	2,027	2,606	3,444	26.5	26.5	27.5	30.8	6,617	8,792	17,692	1.05	1.15	1.85	2,201	2,447	9,329	0.35	0.32	0.98
Turkmenistan	2,074	2,467	3,167	3,917	45.9	48.5	52.5	57.9	117,808	151,459	194,092	25.78	28.75	31.05	38,508	59,175	63,655	8.43	11.23	10.18
Uzbekistan	11,462	14,577	16,756	19,005	46.1	51.0	50.4	51.8	178,538	189,868	187,520	7.24	6.65	5.48	123,805	126,241	115,578	5.02	4.42	3.38
Southern Asia	421,723	554,883	709,388	890,024	29.0	32.5	36.6	41.7	...	...	...	...	...	...	...	...	...	...	...	...
Afghanistan	4,436	6,837	9,904	13,818	22.1	23.7	26.0	29.6	14,205	28,586	31,119	0.73	1.01	0.80	1,078	8,576	8,709	0.06	0.30	0.22
Bangladesh	31,041	46,347	64,815	84,689	23.6	30.5	38.2	45.6	111,593	158,532	206,570	0.86	1.07	1.23	20,687	50,488	85,493	0.16	0.34	0.51
Bhutan	146	253	353	444	25.4	34.8	42.3	48.6	1,058	1,163	1,631	1.80	1.65	2.11	389	493	1,035	0.66	0.70	1.34
India	291,350	380,745	483,099	607,342	27.7	30.9	34.9	40.1	1,719,665	2,569,052	3,200,821	1.62	2.07	2.29	937,858	1,659,983	2,200,836	0.89	1.34	1.58
Iran (Islamic Republic of)	42,352	52,664	63,421	71,205	64.0	70.6	75.9	80.1	515,092	756,069	844,649	7.86	10.03	9.68	340,456	541,171	616,561	5.19	7.18	7.06
Maldives	78	133	187	231	27.7	36.4	40.7	45.0	553	1,127	1,995	1.96	3.12	3.88	462	963	1,454	1.64	2.66	2.83
Nepal	3,181	4,531	6,226	8,408	13.4	16.8	20.6	25.4	26,541	31,722	45,869	1.08	1.17	1.56	3,221	4,641	14,949	0.13	0.17	0.51
Pakistan	45,687	59,692	77,438	99,360	33.0	35.0	37.2	40.7	233,585	323,172	436,609	1.51	1.66	1.92	98,374	140,379	184,111	0.64	0.72	0.81
Sri Lanka	3,452	3,681	3,945	4,528	18.4	18.2	18.7	21.1	20,641	24,597	35,117	1.10	1.19	1.60	10,929	13,072	21,846	0.58	0.63	1.00
South-Eastern Asia	**198,781**	**264,804**	**334,419**	**404,497**	**37.9**	**44.3**	**50.0**	**55.6**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Brunei Darussalam	237	291	348	397	71.2	75.0	78.3	81.1	6,700	9,331	11,914	20.06	23.56	26.97	4,718	7,171	9,588	14.13	18.11	21.71
Cambodia	2,259	2,904	4,050	5,458	18.6	20.3	24.2	29.0	19,380	27,846	42,363	1.60	1.94	2.58	1,963	5,141	18,653	0.16	0.36	1.14
Indonesia	88,851	121,053	154,189	185,755	42.0	49.9	56.6	62.8	666,121	788,132	976,488	3.11	3.23	3.59	280,636	415,537	563,197	1.31	1.70	2.07
Lao People's Democratic Republic	1,171	1,878	2,600	3,452	22.0	30.1	36.3	42.9	7,964	12,378	30,491	1.47	1.96	4.17	903	2,877	19,179	0.17	0.45	2.62
Malaysia	14,370	19,935	25,362	30,109	62.0	70.9	77.2	81.8	158,088	248,443	302,089	6.89	8.65	9.10	124,356	199,867	245,139	5.42	6.96	7.38
Myanmar	12,458	14,487	17,068	20,615	27.0	28.9	31.1	35.0	72,065	89,150	128,949	1.58	1.80	2.41	9,441	8,131	33,875	0.21	0.16	0.63
Philippines	35,981	42,488	52,009	63,844	46.1	45.3	47.4	50.9	138,557	158,250	224,972	1.78	1.67	2.01	71,943	81,918	133,471	0.92	0.87	1.19
Singapore	3,914	5,074	5,935	6,342	100.0	100.0	100.0	100.0	54,857	55,950	64,267	13.62	11.02	11.30	42,118	42,414	43,705	10.46	8.35	7.69
Thailand	19,760	29,475	35,698	40,676	31.4	43.9	51.4	58.4	257,421	361,218	433,773	4.08	5.29	6.07	168,941	240,768	265,479	2.68	3.53	3.71
Timor-Leste	211	308	433	600	24.3	27.7	31.3	35.2	657	7,041	5,537	...	6.47	4.26	0	244	446	0.00	0.22	0.34
Viet Nam	19,569	26,911	36,727	47,248	24.4	30.4	37.3	44.5	135,696	257,248	470,578	1.72	2.94	4.87	51,208	151,414	355,323	0.65	1.73	3.68
Western Asia	**118,099**	**158,831**	**203,541**	**243,848**	**63.8**	**68.2**	**72.3**	**75.4**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Armenia	1,985	1,825	1,861	1,906	64.7	63.4	63.3	65.5	5,991	7,562	10,422	1.89	2.57	3.71	3,561	4,337	6,747	1.12	1.47	2.40
Azerbaijan	4,174	4,824	5,696	6,491	51.4	53.4	56.4	60.8	38,179	44,321	55,352	4.74	4.89	5.48	27,687	24,312	34,305	3.44	2.69	3.40
Bahrain	587	1,100	1,520	1,828	88.4	88.6	89.5	90.8	25,624	40,906	54,151	36.02	33.71	36.65	15,877	25,966	32,470	22.32	21.39	21.98
Cyprus	648	752	807	873	68.6	67.6	66.8	68.1	8,155	9,209	8,109	8.60	8.15	6.55	7,128	7,898	6,772	7.52	6.99	5.47
Georgia	2,486	2,350	2,318	2,394	52.6	55.5	59.5	63.9	14,245	13,087	17,669	3.49	3.46	4.75	4,773	5,322	10,255	1.17	1.41	2.75
Iraq	16,141	21,258	29,423	39,208	68.5	69.1	70.9	73.6	139,559	167,515	261,290	5.67	5.36	6.14	87,631	108,550	163,512	3.56	3.47	3.84
Israel	5,485	6,819	8,068	9,337	91.2	91.8	92.6	93.5	73,844	89,229	83,664	11.74	11.70	9.08	56,997	70,520	58,472	9.06	9.25	6.35
Jordan	3,994	6,183	9,333	10,364	78.3	86.1	91.4	93.2	20,836	27,362	33,146	4.12	3.95	3.03	16,268	20,197	20,974	3.22	2.91	1.92
Kuwait	2,030	2,998	4,303	4,874	99.0	100.0	100.0	100.0	70,129	107,628	135,897	36.24	36.57	31.17	49,838	80,726	92,309	25.76	27.43	21.17
Lebanon	2,782	3,788	5,353	4,864	86.0	87.3	88.9	90.6	18,914	25,240	28,947	4.38	5.05	5.11	15,673	20,864	21,475	3.63	4.18	3.79
Oman	1,623	2,286	4,443	5,407	71.6	75.2	86.3	91.7	39,435	64,024	95,082	16.82	22.22	20.93	25,115	47,076	71,042	10.71	16.34	15.64
Qatar	570	1,753	2,770	3,217	96.3	98.5	99.2	99.5	40,411	86,698	119,605	62.56	50.60	43.33	28,666	60,912	87,578	44.38	35.55	31.73
Saudi Arabia	16,580	22,512	29,256	34,143	79.8	82.1	84.3	86.5	344,718	564,853	712,585	16.00	19.20	19.80	249,655	446,132	513,556	11.59	15.17	14.27
State of Palestine	2,320	3,016	4,083	5,371	72.0	74.1	76.7	79.7	...	...	...	...	...	...	...	...	...	...	...	...
Syrian Arab Republic	8,525	11,686	10,498	16,423	51.9	55.6	55.5	61.7	100,230	104,401	47,112	6.15	4.67	2.27	44,401	61,091	25,235	2.72	2.73	1.21
Türkiye	40,942	51,226	63,803	70,951	64.7	70.8	76.1	80.2	283,076	371,145	504,956	4.42	5.07	6.06	216,397	297,814	407,406	3.38	4.07	4.89
United Arab Emirates	2,531	6,955	8,542	9,865	80.2	84.1	87.0	89.2	114,701	207,639	249,928	35.02	24.48	26.91	84,729	162,789	188,089	25.87	19.19	20.25
Yemen	4,695	7,501	11,465	16,330	26.3	31.8	37.9	44.4	34,697	48,104	24,391	1.86	1.94	0.76	15,031	25,432	9,960	0.81	1.03	0.31
EUROPE	**516,725**	**537,673**	**556,684**	**572,890**	**71.1**	**72.9**	**74.9**	**77.5**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Eastern Europe	**207,280**	**202,920**	**203,296**	**203,271**	**68.2**	**68.9**	**69.9**	**72.2**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Belarus	6,951	7,074	7,484	7,631	70.0	74.7	79.5	83.3	82,357	94,200	87,868	8.25	9.93	9.37	52,968	61,444	54,802	5.31	6.48	5.84
Bulgaria	5,510	5,354	5,253	5,082	68.9	72.3	75.7	79.0	57,838	57,044	46,493	7.08	7.71	6.71	43,421	44,741	34,138	5.31	6.05	4.92
Czechia	7,613	7,718	7,875	8,009	74.0	73.3	74.1	76.1	145,672	134,692	108,308	14.20	12.86	10.12	124,717	114,168	88,835	12.16	10.90	8.30
Hungary	6,600	6,841	6,922	6,940	64.6	68.9	71.9	75.1	71,353	62,678	59,597	6.99	6.27	6.11	54,633	47,881	44,769	5.35	4.79	4.59
Poland	23,792	23,336	22,782	22,533	61.7	60.9	60.0	61.5	356,692	377,248	338,384	9.32	9.92	8.93	295,774	313,739	279,224	7.73	8.25	7.37
Republic of Moldova	1,873	1,741	1,722	1,749	44.6	42.6	42.8	45.5	11,426	12,677	12,986	3.91	4.43	4.93	6,710	8,295	8,611	2.29	2.90	3.27
Romania	11,729	11,003	10,507	10,456	53.0	53.8	54.2	56.6	120,735	106,102	95,744	5.38	5.24	4.97	89,003	77,602	68,664	3.97	3.83	3.56

Table A.1: Continued

Country / Territory Name	Annual Urban Population at Mid-Year by Region, Subregion, Country and Area (Thousands)				Percentage of Population at Mid-Year Residing in Urban Areas				Total Greenhouse Gas Emissions (kt of CO_2 Equivalent) [a]			Total Greenhouse Gas Emissions per Capita (kt of CO_2 Equivalent) [a]			CO_2 Emissions (kt) [b]			CO_2 Emissions per Capita (Metric Tons) [b]		
	2000	2010	2020	2030	2000	2010	2020	2030	2000	2010	2020	2000	2010	2020	2000	2010	2020	2000	2010	2020
Russian Federation	107,382	105,486	107,486	108,337	73.4	73.7	74.8	77.1	2,137,886	2,249,521	2,331,479	14.58	15.75	16.05	1,563,846	1,617,828	1,618,271	10.67	11.33	11.14
Slovakia	3,036	2,955	2,931	2,998	56.2	54.7	53.8	55.6	45,992	43,072	35,984	8.53	7.99	6.59	38,072	35,432	29,036	7.07	6.57	5.32
Ukraine	32,794	31,412	30,335	29,537	67.1	68.6	69.6	71.7	367,478	329,151	227,342	7.47	7.18	5.14	297,377	268,925	165,664	6.05	5.86	3.75
Northern Europe	**73,633**	**80,326**	**87,488**	**94,053**	**77.9**	**80.1**	**82.6**	**85.0**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Channel Islands	45	50	52	56	30.5	31.1	31.0	32.2	...	...	...	...	...	...	...	...	...	...	...	...
Denmark	4,545	4,821	5,108	5,389	85.1	86.8	88.1	89.4	70,523	63,737	41,136	13.21	11.49	7.05	52,602	48,125	27,357	9.85	8.67	4.69
Estonia	971	907	900	895	69.4	68.1	69.2	71.4	18,061	21,672	10,199	12.93	16.28	7.67	14,933	18,500	7,098	10.69	13.89	5.34
Faroe Islands	17	20	21	23	36.3	40.9	42.4	44.8	...	...	...	...	...	...	...	...	...	...	...	...
Finland	4,264	4,495	4,772	4,970	82.2	83.8	85.5	86.6	69,644	75,320	47,740	13.45	14.04	8.63	55,098	62,526	36,330	10.64	11.66	6.57
Iceland	259	300	322	345	92.4	93.6	93.9	94.4	3,379	3,237	2,653	12.02	10.18	7.24	2,225	1,959	1,447	7.91	6.16	3.95
Ireland	2,277	2,848	3,111	3,484	59.2	61.5	63.7	66.8	71,316	64,973	59,498	18.74	14.25	11.93	42,534	40,348	33,742	11.18	8.85	6.77
Isle of Man	38	42	45	50	51.8	52.0	52.9	55.4	...	...	...	...	...	...	...	...	...	...	...	...
Latvia	1,623	1,437	1,293	1,222	68.1	67.8	68.3	69.9	10,909	12,854	11,437	4.61	6.13	6.02	6,930	8,518	6,928	2.93	4.06	3.65
Lithuania	2,346	2,085	1,941	1,920	67.0	66.8	68.0	70.6	20,401	21,317	19,785	5.83	6.88	7.08	10,516	12,603	11,694	3.00	4.07	4.18
Norway	3,420	3,865	4,522	5,130	76.0	79.1	83.0	86.1	47,471	50,072	46,117	10.57	10.24	8.57	34,283	40,116	36,177	7.63	8.21	6.73
Sweden	7,463	7,987	8,905	9,669	84.0	85.1	88.0	90.3	68,330	61,014	45,459	7.70	6.51	4.39	53,278	47,986	33,576	6.01	5.12	3.24
United Kingdom of Great Britain and Northern Ireland	46,365	51,470	56,495	60,899	78.7	81.3	83.9	86.3	690,358	594,575	398,324	11.72	9.47	5.94	530,888	482,646	308,650	9.01	7.69	4.60
Southern Europe	**96,759**	**106,470**	**109,342**	**112,280**	**66.4**	**69.2**	**72.1**	**75.4**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Albania	1,303	1,534	1,827	2,038	41.7	52.2	62.1	69.5	8,164	9,243	8,304	2.64	3.17	2.93	3,187	4,785	4,383	1.03	1.64	1.54
Andorra	60	75	68	69	92.4	88.8	87.9	87.8	588	627	578	8.90	8.77	7.43	524	517	449	7.93	7.22	5.78
Bosnia and Herzegovina	1,596	1,696	1,715	1,824	42.4	45.6	49.0	53.6	18,657	26,071	26,053	4.46	6.84	7.85	13,955	20,843	20,947	3.34	5.47	6.31
Croatia	2,366	2,387	2,369	2,394	53.4	55.2	57.6	61.5	25,206	26,152	21,379	5.64	6.09	5.28	18,034	19,457	15,627	4.04	4.53	3.86
Gibraltar	31	33	35	36	100.0	100.0	100.0	100.0	...	...	...	...	...	...	...	...	...	...	...	...
Greece	8,102	8,732	8,850	8,926	72.7	76.3	79.7	82.8	117,890	108,552	69,283	10.91	9.76	6.48	94,461	87,579	51,002	8.74	7.87	4.77
Holy See	1	1	1	1	100.0	100.0	100.0	100.0	...	...	...	...	...	...	...	...	...	...	...	...
Italy	38,514	40,811	42,007	43,161	67.2	68.3	71.0	74.3	517,178	482,672	352,129	9.08	8.14	5.92	436,297	405,272	281,287	7.66	6.84	4.73
Malta	366	391	412	420	92.4	94.1	94.7	95.4	2,413	3,006	2,082	6.19	7.25	4.04	2,129	2,587	1,611	5.46	6.24	3.13
Montenegro	359	400	425	443	58.5	64.1	67.5	70.9	4,015	4,138	3,764	6.64	6.68	6.06	1,521	2,584	2,527	2.51	4.17	4.07
Portugal	5,633	6,452	6,776	7,049	54.4	60.6	66.3	71.4	78,714	68,074	55,641	7.65	6.44	5.40	61,661	50,937	38,974	5.99	4.82	3.78
San Marino	26	30	33	34	93.4	95.7	97.5	98.4	...	...	...	...	...	...	...	...	...	...	...	...
Serbia	5,006	4,966	4,913	4,953	52.8	55.0	56.4	59.3	60,568	62,995	62,884	8.06	8.64	9.11	43,985	47,104	46,324	5.85	6.46	6.71
Slovenia	1,009	1,077	1,148	1,211	50.8	52.7	55.1	58.8	17,745	18,806	15,287	8.92	9.18	7.27	14,542	15,777	12,477	7.31	7.70	5.93
Spain	31,194	36,702	37,544	38,420	76.3	78.4	80.8	83.3	369,377	350,175	270,311	9.11	7.52	5.71	293,314	274,141	202,706	7.23	5.89	4.28
North Macedonia	1,191	1,182	1,221	1,303	58.5	57.1	58.5	62.7	11,473	11,251	9,769	5.66	5.78	5.26	8,522	8,330	6,797	4.21	4.28	3.66
Western Europe	**139,053**	**147,957**	**156,558**	**163,286**	**76.0**	**78.5**	**80.2**	**82.2**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Austria	4,859	4,827	5,159	5,531	60.2	57.4	58.7	61.8	78,694	83,551	71,018	9.82	9.99	7.96	63,539	69,965	59,142	7.93	8.37	6.63
Belgium	9,987	10,682	11,397	11,811	97.1	97.7	98.1	98.4	138,266	124,908	100,063	13.49	11.46	8.67	117,275	106,873	85,364	11.44	9.81	7.40
France	45,226	49,393	53,218	56,789	75.9	78.4	81.0	83.6	506,378	472,918	376,006	8.31	7.27	5.56	373,236	347,940	267,155	6.13	5.35	3.95
Germany	61,087	62,262	63,930	64,871	75.0	77.0	77.5	78.9	959,125	881,693	692,751	11.67	10.78	8.33	830,284	773,069	603,351	10.10	9.45	7.26
Liechtenstein	5	5	6	6	15.1	14.5	14.4	15.5	224	204	158	6.80	5.68	4.07	217	191	142	6.57	5.31	3.66
Luxembourg	367	450	552	629	84.2	88.5	91.5	93.2	9,437	12,035	8,814	21.63	23.74	13.98	8,557	11,029	7,853	19.61	21.76	12.46
Monaco	32	37	39	41	100.0	100.0	100.0	100.0	...	...	...	...	...	...	...	...	...	...	...	...
Netherlands (Kingdom of the)	12,230	14,536	15,847	16,671	76.8	87.1	92.2	94.8	206,298	200,804	155,912	12.95	12.09	8.94	162,097	171,111	130,315	10.18	10.30	7.47
Switzerland	5,260	5,765	6,409	6,937	73.4	73.6	73.9	75.4	52,787	54,762	43,988	7.35	7.00	5.09	43,709	45,208	34,916	6.08	5.78	4.04
LATIN AMERICA AND THE CARIBBEAN	**397,062**	**469,583**	**539,427**	**600,480**	**75.5**	**78.6**	**81.2**	**83.6**	**2,608,217**	**3,179,979**	**3,064,546**	**5.00**	**5.40**	**4.71**	**1,244,867**	**1,570,609**	**1,438,080**	**2.39**	**2.67**	**2.21**
Caribbean	**24,099**	**28,280**	**32,251**	**35,729**	**62.8**	**67.8**	**72.2**	**76.2**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Anguilla	11	14	15	16	100.0	100.0	100.0	100.0	...	...	...	...	...	...	...	...	...	...	...	...
Antigua and Barbuda	27	25	26	28	32.1	26.2	24.4	24.8	585	1,005	1,204	7.79	11.73	12.99	313	466	475	4.16	5.44	5.12
Aruba	42	44	47	50	46.7	43.1	43.7	46.2	...	...	...	...	...	...	...	...	...	...	...	...
Bahamas	244	297	339	373	82.0	82.4	83.2	84.7	2,319	2,255	2,801	7.14	6.04	6.89	2,115	1,979	2,456	6.51	5.30	6.04
Barbados	91	89	90	95	33.8	31.9	31.2	32.8	3,533	3,874	3,656	13.35	14.10	13.03	1,188	1,482	1,096	4.49	5.39	3.90
British Virgin Islands	9	12	16	19	41.8	44.8	48.5	52.8	...	...	...	...	...	...	...	...	...	...	...	...
Caribbean Netherlands	11	16	20	21	74.9	74.7	75.0	76.5	...	...	...	...	...	...	...	...	...	...	...	...
Cayman Islands	42	56	64	71	100.0	100.0	100.0	100.0	...	...	...	...	...	...	...	...	...	...	...	...
Cuba	8,399	8,681	8,874	9,048	75.3	76.6	77.2	78.7	43,544	43,298	38,559	3.92	3.83	3.41	28,353	28,110	24,328	2.55	2.49	2.15
Curaçao	120	133	146	154	90.8	89.9	89.1	89.3	...	...	...	...	...	...	...	...	...	...	...	...
Dominica	45	49	53	58	65.3	68.1	71.1	74.2	193	237	231	2.82	3.44	3.20	125	173	163	1.83	2.51	2.26
Dominican Republic	5,288	7,300	9,169	10,618	61.8	73.8	82.5	87.8	27,148	32,785	37,053	3.18	3.35	3.37	18,671	20,681	22,881	2.19	2.12	2.08
Grenada	36	38	40	44	35.7	35.9	36.5	38.9	2,059	2,242	2,397	19.17	19.66	19.39	199	274	325	1.85	2.40	2.62
Guadeloupe	418	444	442	442	98.4	98.4	98.5	98.7	...	...	...	...	...	...	...	...	...	...	...	...
Haiti	3,044	4,751	6,492	8,144	35.6	47.5	57.1	64.9	7,322	8,939	10,267	0.88	0.91	0.91	1,473	2,458	3,209	0.18	0.25	0.28
Jamaica	1,377	1,514	1,640	1,770	51.8	53.7	56.3	60.3	11,776	8,846	7,433	4.51	3.24	2.64	10,071	7,480	5,836	3.86	2.74	2.07
Martinique	347	352	344	344	89.7	89.1	89.1	90.1	...	...	...	...	...	...	...	...	...	...	...	...
Montserrat	0	0	0	1	2.1	9.2	9.1	9.9	...	...	...	...	...	...	...	...	...	...	...	...
Puerto Rico	3,584	3,487	3,416	3,376	94.4	93.8	93.6	94.0	...	...	...	...	...	...	...	...	...	...	...	...
Saint Kitts and Nevis	15	16	18	20	32.8	31.3	30.8	32.4	269	330	334	5.92	6.96	7.02	181	229	231	3.99	4.84	4.85
Saint Lucia	44	32	34	38	27.8	18.5	18.8	20.4	619	800	851	3.88	4.68	4.75	367	508	499	2.30	2.97	2.79
Saint Vincent and the Grenadines	49	54	59	64	45.2	49.0	53.0	57.3	235	317	302	2.06	2.90	2.89	156	234	220	1.37	2.14	2.10
Sint Maarten (Dutch part)	32	33	41	46	100.0	100.0	100.0	100.0	...	...	...	...	...	...	...	...	...	...	...	...
Trinidad and Tobago	709	718	733	753	55.9	54.0	53.2	54.8	15,788	32,406	26,481	11.85	22.98	17.44	10,205	21,443	15,420	7.66	15.20	10.16
Turks and Caicos Islands	16	28	35	40	84.6	90.2	93.6	95.3	...	...	...	...	...	...	...	...	...	...	...	...
United States Virgin Islands	101	100	101	99	92.6	94.6	95.9	96.8	...	...	...	...	...	...	...	...	...	...	...	...
Central America	**94,801**	**115,705**	**138,768**	**160,493**	**68.7**	**72.1**	**75.4**	**78.5**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Belize	112	145	183	230	45.4	45.2	46.0	48.6	703	1,214	1,573	2.92	3.77	3.98	425	531	688	1.77	1.65	1.74
Costa Rica	2,318	3,261	4,074	4,647	59.1	71.7	80.8	85.8	10,415	13,252	14,405	2.62	2.87	2.81	4,947	7,106	6,967	1.24	1.54	1.36
El Salvador	3,457	4,035	4,759	5,371	58.9	65.5	73.4	79.2	10,117	12,188	11,064	1.70	1.99	1.76	5,632	6,539	6,376	0.95	1.07	1.01

Table A.1: Continued

Country / Territory Name	Annual Urban Population at Mid-Year by Region, Subregion, Country and Area (Thousands)				Percentage of Population at Mid-Year Residing in Urban Areas				Total Greenhouse Gas Emissions (kt of CO_2 Equivalent) [a]			Total Greenhouse Gas Emissions per Capita (kt of CO_2 Equivalent) [a]			CO_2 Emissions (kt) [b]			CO_2 Emissions per Capita (Metric Tons) [b]		
	2000	2010	2020	2030	2000	2010	2020	2030	2000	2010	2020	2000	2010	2020	2000	2010	2020	2000	2010	2020
Guatemala	5,281	7,082	9,284	11,963	45.3	48.4	51.8	56.4	18,677	24,360	33,166	1.61	1.71	1.97	9,443	11,478	16,865	0.81	0.80	1.00
Honduras	2,966	4,252	5,672	7,169	45.5	51.9	58.4	64.3	12,538	18,084	21,147	1.88	2.14	2.09	4,987	7,927	8,835	0.75	0.94	0.87
Mexico	76,007	91,292	108,074	123,198	74.7	77.8	80.7	83.5	539,609	650,218	592,321	5.51	5.78	4.70	379,176	462,870	383,131	3.87	4.11	3.04
Nicaragua	2,774	3,266	3,787	4,387	55.2	56.9	59.0	62.3	12,238	14,606	18,449	2.39	2.49	2.73	3,768	4,513	4,582	0.74	0.77	0.68
Panama	1,885	2,373	2,935	3,528	62.2	65.1	68.4	72.2	9,923	15,393	17,231	3.31	4.25	4.01	5,283	9,191	9,583	1.76	2.54	2.23
South America	**278,162**	**325,597**	**368,409**	**404,258**	**79.6**	**82.4**	**84.6**	**86.5**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Argentina	33,034	37,452	41,920	45,994	89.1	90.8	92.1	93.2	294,271	342,497	361,433	7.94	8.40	7.97	132,266	167,226	154,536	3.57	4.10	3.41
Bolivia (Plurinational State of)	5,153	6,589	8,095	9,700	61.8	66.4	70.1	73.7	31,098	48,348	55,203	3.62	4.73	4.62	8,108	14,702	18,375	0.94	1.44	1.54
Brazil	142,320	165,969	186,217	201,296	81.2	84.3	87.1	89.3	772,340	999,925	1,064,709	4.39	5.09	4.99	313,671	397,931	414,139	1.78	2.03	1.94
Chile	13,137	14,797	16,206	17,446	86.1	87.1	87.7	88.8	70,030	91,818	106,722	4.56	5.40	5.53	50,425	69,749	84,828	3.28	4.10	4.40
Colombia	29,882	35,799	40,892	44,804	74.0	78.0	81.4	84.3	141,246	162,039	186,999	3.60	3.62	3.67	58,996	64,146	79,058	1.50	1.43	1.55
Ecuador	7,615	9,363	11,124	13,049	60.3	62.7	64.2	66.7	49,012	71,886	68,056	3.88	4.80	3.87	22,052	37,254	34,431	1.75	2.49	1.96
Falkland Islands (Malvinas)	2	2	2	2	67.6	73.7	78.5	82.0	...	...	...	...	...	...	...	...	...	...	...	...
French Guiana	129	194	261	334	79.1	82.9	85.8	87.9	...	...	...	...	...	...	...	...	...	...	...	...
Guyana	216	199	212	236	28.7	26.6	26.8	28.6	3,246	3,575	5,282	4.28	4.78	6.63	1,660	1,759	2,769	2.19	2.35	3.47
Paraguay	2,934	3,680	4,394	5,154	55.3	59.3	62.2	65.7	30,409	39,953	50,784	5.93	6.93	7.67	3,524	5,043	7,576	0.69	0.87	1.14
Peru	18,929	22,450	26,082	29,643	73.0	76.4	78.3	80.5	62,721	84,787	89,865	2.35	2.90	2.70	28,634	44,999	46,579	1.07	1.54	1.40
Suriname	314	349	382	417	66.4	66.3	66.1	67.6	2,668	3,286	4,312	5.57	6.02	7.10	1,480	1,745	2,601	3.09	3.20	4.29
Uruguay	3,056	3,186	3,338	3,461	92.0	94.4	95.5	96.3	32,274	35,997	35,994	9.80	10.74	10.50	5,459	6,284	6,514	1.66	1.87	1.90
Venezuela (Bolivarian Republic of)	21,442	25,569	29,284	32,722	87.6	88.1	88.3	89.0	389,295	409,219	194,260	15.94	14.25	6.82	131,517	164,102	72,509	5.38	5.71	2.55
NORTHERN AMERICA	**247,471**	**277,070**	**304,761**	**334,780**	**79.1**	**80.8**	**82.6**	**84.7**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**
Bermuda	64	64	61	59	100.0	100.0	100.0	100.0	...	...	...	...	...	...	...	...	...	...	...	...
Canada	24,428	27,655	30,670	33,663	79.5	80.9	81.6	82.9	648,194	673,673	677,709	21.12	19.81	17.82	514,215	537,092	516,874	16.76	15.79	13.59
Greenland	46	48	50	51	81.6	84.4	87.3	89.3	...	...	...	...	...	...	...	...	...	...	...	...
Saint Pierre and Miquelon	6	6	6	6	89.1	89.9	90.0	90.5	...	...	...	...	...	...	...	...	...	...	...	...
United States of America	222,928	249,297	273,975	301,001	79.1	80.8	82.7	84.9	6,810,656	6,454,245	5,505,181	24.14	20.87	16.61	5,775,807	5,392,109	4,320,533	20.47	17.43	13.03
OCEANIA	21,329	24,941	28,919	32,831	68.3	68.1	68.2	68.9	...	...	...	...	...	...	...	...	...	...	...	...
Australia/New Zealand	19,380	22,608	26,095	29,319	84.5	85.3	86.3	87.7	...	...	...	...	...	...	...	...	...	...	...	...
Australia	16,060	18,842	21,904	24,740	84.2	85.2	86.2	87.6	606,861	589,473	571,903	31.89	26.76	22.30	339,423	395,993	378,997	17.84	17.97	14.78
New Zealand	3,320	3,765	4,191	4,579	86.0	86.2	86.7	87.8	77,212	80,643	80,158	20.01	18.54	15.75	29,455	31,049	31,360	7.64	7.14	6.16
Melanesia	1,362	1,706	2,138	2,757	18.9	19.0	19.6	21.4	...	...	...	...	...	...	...	...	...	...	...	...
Fiji	389	449	529	601	47.9	52.2	57.2	62.0	1,964	2,263	1,764	2.36	2.50	1.92	837	1,126	1,028	1.00	1.24	1.12
New Caledonia	132	168	205	242	61.9	67.1	71.5	75.3	...	...	...	...	...	...	...	...	...	...	...	...
Papua New Guinea	736	925	1,168	1,592	13.2	13.0	13.3	15.2	11,297	12,945	18,398	2.05	1.71	1.89	2,825	5,042	5,492	0.51	0.66	0.56
Solomon Islands	65	106	160	225	15.8	20.0	24.7	29.1	538	738	835	1.25	1.36	1.21	235	343	223	0.55	0.63	0.32
Vanuatu	40	58	75	97	21.7	24.5	25.5	27.4	569	709	589	2.96	2.89	1.89	89	127	121	0.46	0.52	0.39
Micronesia	326	335	375	421	65.6	66.6	69.2	71.5	...	...	...	...	...	...	...	...	...	...	...	...
Guam	145	150	160	173	93.1	94.1	94.9	95.7	...	...	...	...	...	...	...	...	...	...	...	...
Kiribati	36	49	68	88	43.0	47.4	55.6	62.2	55	79	89	0.62	0.73	0.70	36	54	57	0.40	0.50	0.45
Marshall Islands	36	39	41	45	68.6	73.6	77.8	81.1	135	176	165	2.49	3.30	3.80	103	141	110	1.90	2.64	2.53
Micronesia (Fed. States of)	24	23	25	29	22.3	22.3	22.9	24.9	252	174	194	2.25	1.62	1.73	187	105	108	1.68	0.98	0.96
Nauru	10	10	11	11	100.0	100.0	100.0	100.0	93	48	47	8.92	4.65	3.84	88	43	41	8.48	4.17	3.36
Northern Mariana Islands	62	49	51	53	90.2	90.9	91.8	92.8	...	...	...	...	...	...	...	...	...	...	...	...
Palau	13	15	18	21	70.3	74.8	81.0	85.0	228	236	196	11.58	12.72	10.89	212	215	158	10.72	11.59	8.80
Polynesia	262	292	312	334	42.7	44.3	44.4	45.0	...	...	...	...	...	...	...	...	...	...	...	...
American Samoa	51	49	49	50	88.6	87.6	87.2	87.8	...	...	...	...	...	...	...	...	...	...	...	...
Cook Islands	12	14	13	14	65.2	73.3	75.5	77.8	...	...	...	...	...	...	...	...	...	...	...	...
French Polynesia	133	162	180	195	56.0	60.3	62.0	63.5	...	...	...	...	...	...	...	...	...	...	...	...
Niue	1	1	1	1	33.1	38.7	46.2	52.5	...	...	...	...	...	...	...	...	...	...	...	...
Samoa	38	37	36	37	22.0	20.1	17.9	17.3	435	519	539	2.36	2.67	2.51	149	192	207	0.81	0.99	0.96
Tokelau	0	0	0	0	0.0	0.0	0.0	0.0	...	...	...	...	...	...	...	...	...	...	...	...
Tonga	23	24	26	29	23.0	23.4	23.1	23.8	235	256	268	2.29	2.38	2.55	103	118	118	1.00	1.10	1.12
Tuvalu	4	6	7	9	46.0	54.8	64.0	70.5	20	23	22	2.04	2.13	1.96	8	10	7	0.82	0.91	0.60
Wallis and Futuna Islands	0	0	0	0	0.0	0.0	0.0	0.0	...	...	...	...	...	...	...	...	...	...	...	...

Sources:
For urbanization related data: United Nations, Department of Economic and Social Affairs, Population Division (2018). World Urbanization Prospects: The 2018 Revision.
For climate-related data: The World Bank, World Bank Open Data, Climate Change Data, (Last Access: July 2024).

Notes:
(a) Total greenhouse gas emissions are composed of CO2 totals excluding short-cycle biomass burning (such as agricultural waste burning and savanna burning) but including other biomass burning (such as forest fires, post-burn decay, peat fires and decay of drained peatlands), all anthropogenic CH4 sources, N2O sources and F-gases (HFCs, PFCs and SF6).
(b) Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.
Last Updated: 15/07/2024

Table A.2: Annual Mean Levels of Fine Particulate Matter (Population-Weighted), by Selected Locations at DEGURBA (Degree of Urbanisation)[a] Level (Micrograms per Cubic Metre), 2010-2019

	Total			Urban		
	2010	2015	2019	2010	2015	2019
WORLD	35.3	36.1	31.7	37.2	38.2	33.1
Australia and New Zealand	9.1	6.7	8.9	9.3	6.8	9.1
Central America	22.3	22.1	18.0	23.1	22.8	18.6
Central and Southern Asia	53.0	53.2	48.3	56.4	56.7	51.3
Central Asia	43.8	44.0	37.4	52.1	52.0	44.0
Eastern Africa	19.8	19.9	19.6	21.7	21.9	21.7
Eastern and South-Eastern Asia	38.2	40.4	31.6	41.1	43.8	33.8
Eastern Asia	44.0	48.0	35.7	46.0	50.3	37.4
Eastern Europe	16.5	13.7	12.2	17.9	14.8	13.2
Europe	15.8	13.3	11.5	16.7	14.0	12.1
Europe and Northern America	13.7	11.6	10.0	14.1	12.0	10.3
Latin America and the Caribbean	18.0	17.3	15.0	18.3	17.3	15.0
Micronesia	7.6	7.8	7.9	7.8	8.0	8.2
Northern Africa and Western Asia	35.2	35.8	35.9	38.7	39.3	39.7
Northern America	9.1	8.2	7.1	9.5	8.5	7.3
Northern Europe	11.9	10.0	8.8	12.8	10.8	9.3
Oceania (exc. Australia and New Zealand)	8.3	8.6	8.6	8.7	8.9	9.0
Polynesia	7.5	7.7	7.8	7.8	8.0	8.1
South America	17.0	15.9	14.2	16.9	15.4	13.8
South-Eastern Asia	22.8	21.1	21.3	23.6	21.8	22.0
Southern Africa	18.2	18.5	19.0	20.2	20.7	21.3
Southern Asia	53.3	53.6	48.7	56.5	56.8	51.5
Southern Europe	18.4	15.8	13.3	18.8	16.2	13.5
Sub-Saharan Africa	31.8	33.6	32.7	33.9	36.0	35.4
Western Africa	46.6	50.6	48.5	48.4	52.9	51.2
Western Asia	33.9	34.4	34.1	32.9	33.1	32.6
Western Europe	14.8	12.5	10.6	15.7	13.2	11.2
Least Developed Countries (LDCs)	32.7	33.0	31.4	37.7	38.1	35.9
Landlocked developing countries (LLDCs)	33.6	33.8	31.5	36.3	36.5	34.2
Small Island Developing States (SIDS)	11.4	12.0	11.4	11.9	12.5	11.7
Afghanistan	69.0	67.2	62.5	83.1	81.4	75.2
Albania	21.9	19.0	16.3	22.3	19.3	16.6
Algeria	21.3	22.5	22.7	21.0	22.5	22.9
American Samoa	7.4	7.7	7.8	7.6	7.9	8.0
Andorra	11.4	9.9	8.5	11.9	10.4	8.9
Angola	24.2	25.0	27.2	26.5	28.9	32.3
Anguilla	7.6	8.2	7.7	7.7	8.3	7.8
Antigua and Barbuda	8.2	8.9	8.3	8.3	9.0	8.4
Argentina	13.1	14.2	12.0	12.3	13.2	11.2
Armenia	40.9	40.6	34.1	43.4	43.1	36.2
Aruba	8.7	9.8	8.9	8.8	9.8	9.0
Australia	9.0	6.6	8.9	9.2	6.7	9.1
Austria	15.6	13.6	11.5	17.0	14.8	12.4
Azerbaijan	30.1	29.7	24.6	32.1	31.5	26.2
Bahamas	5.0	5.3	5.2	5.0	5.3	5.2
Bahrain	55.9	56.4	51.8	55.9	56.4	51.8
Bangladesh	49.4	50.6	46.0	50.3	51.6	46.8
Barbados	9.1	10.5	9.8	9.2	10.6	9.8
Belarus	19.9	16.5	15.5	22.3	18.3	17.2
Belgium	16.1	13.3	11.3	16.5	13.6	11.6
Belize	9.9	11.1	10.5	9.9	11.1	10.4
Benin	31.0	33.1	31.5	30.8	33.2	31.8
Bermuda	6.1	5.5	5.0	6.2	5.6	5.1
Bhutan	29.5	29.0	26.1	20.2	19.0	16.9
Bolivia (Plurinational State of)	28.0	26.5	25.2	29.6	28.3	26.9
Bosnia and Herzegovina	34.9	30.7	26.2	39.5	34.7	29.7
Botswana	14.1	12.9	12.8	15.2	14.5	14.4
Brazil	14.6	12.0	10.9	15.0	12.4	11.3
Italy	20.1	17.3	14.2	20.9	17.9	14.7
Jamaica	14.6	15.7	14.8	15.5	16.8	15.8
Japan	14.2	12.8	10.8	14.6	13.1	11.1
Jersey	11.9	10.6	9.8	12.0	10.7	9.9
Jordan	24.5	25.3	25.9	24.4	25.2	25.8
Kazakhstan	30.4	30.8	26.5	41.4	41.7	35.4
Kenya	12.4	12.5	12.5	12.2	12.3	12.3
Kiribati	7.6	7.3	7.6	8.0	7.6	8.0
Kuwait	66.5	66.2	64.1	70.0	69.4	67.2
Kyrgyzstan	44.7	44.6	37.6	47.2	47.1	39.6
Lao People's Democratic Republic	22.9	20.5	21.2	26.0	23.5	24.2
Latvia	16.5	13.4	12.0	19.5	15.9	14.1
Lebanon	24.2	24.5	24.2	24.4	24.7	24.4
Lesotho	18.4	17.7	17.6	19.4	18.6	18.5
Liberia	32.8	37.7	35.8	37.3	42.2	40.5
Libya	31.2	29.1	29.8	29.1	27.3	28.3
Liechtenstein	13.5	11.6	9.9	13.5	11.6	9.9
Lithuania	13.9	11.4	10.4	15.6	12.9	11.7
Luxembourg	12.4	10.4	8.9	12.6	10.7	9.1
Madagascar	16.5	16.4	16.0	18.7	18.8	18.4
Malawi	18.7	18.8	18.6	20.3	20.4	20.2
Malaysia	22.7	21.4	21.5	25.0	23.7	23.7
Maldives	13.4	12.2	13.0	13.2	12.1	12.7
Mali	39.0	40.8	38.5	45.2	47.2	45.1
Malta	17.2	13.9	12.9	17.2	13.9	12.9
Marshall Islands	7.3	7.1	7.2	7.6	7.4	7.5
Martinique	8.6	9.7	9.0	8.8	9.9	9.2
Mauritania	38.9	43.7	42.0	46.9	53.2	51.3
Mauritius	10.6	10.8	10.5	10.6	10.8	10.5
Mayotte	13.2	13.9	13.8	13.3	14.0	13.9
Melanesia	8.4	8.7	8.7	9.0	9.3	9.3
Mexico	22.1	21.8	17.8	22.9	22.6	18.4
Micronesia (Federated States of)	7.6	7.7	7.8	7.8	7.9	8.1
Middle Africa	34.6	36.0	35.2	40.4	41.5	41.1
Monaco	11.9	10.4	9.2	11.9	10.4	9.2
Mongolia	45.2	47.8	41.3	57.4	59.5	50.6
Montenegro	26.1	22.5	19.3	24.0	20.8	17.9
Montserrat	7.8	8.2	7.6	...	...	...
Morocco	13.2	13.5	13.4	13.4	13.8	13.7
Mozambique	16.6	16.7	16.4	17.7	17.7	17.5
Myanmar	29.5	26.5	27.2	30.0	27.2	27.8
Namibia	11.9	11.9	11.8	13.1	13.1	13.1
Nauru	7.5	7.3	7.4	7.5	7.3	7.4
Nepal	39.8	39.8	36.4	40.9	40.7	36.9
Netherlands (Kingdom of the)	15.0	12.6	10.7	15.2	12.8	10.9
New Caledonia	7.6	7.8	8.0	8.2	8.4	8.5
New Zealand	9.3	6.9	8.6	9.5	7.0	8.7
Nicaragua	19.9	20.6	16.0	20.9	21.7	16.7
Niger	49.5	52.9	50.2	54.6	58.3	55.5
Nigeria	52.8	57.3	55.6	52.0	56.3	55.3
Niue	6.4	6.5	6.7	...	...	...
Norfolk Island	6.9	7.0	7.2	...	...	...
North Macedonia	34.5	29.5	25.2	39.5	33.6	28.7
Northern Africa	36.6	37.5	38.1	43.5	44.5	45.6
Northern Mariana Islands	7.5	7.8	7.8	7.5	7.9	7.9
Norway	7.9	6.8	6.3	9.2	7.9	7.2
Oceania	8.9	7.2	8.8	9.2	7.0	9.0

Table A.2: Continued

	Total			Urban		
	2010	2015	2019	2010	2015	2019
British Virgin Islands	7.8	8.3	8.0	7.9	8.4	8.1
Brunei Darussalam	8.3	7.8	6.9	8.2	7.7	6.8
Bulgaria	23.9	20.4	17.3	25.8	22.0	18.6
Burkina Faso	41.3	43.6	40.7	45.4	48.7	46.0
Burundi	27.8	28.4	28.0	28.2	28.7	28.4
Cabo Verde	28.2	33.4	31.1	29.5	34.9	32.6
Cambodia	18.8	17.4	17.8	19.4	18.0	18.3
Cameroon	53.6	59.1	56.4	57.3	63.7	61.6
Canada	7.8	7.2	6.4	8.2	7.5	6.7
Caribbean	10.1	10.7	10.1	10.3	10.9	10.3
Cayman Islands	11.6	12.5	11.8	11.7	12.7	11.9
Central African Republic	27.9	29.1	27.2	32.7	34.2	32.2
Chad	41.6	44.5	41.2	53.1	58.2	54.0
Chile	22.3	24.2	20.5	24.1	26.0	22.2
China	47.2	51.8	38.2	49.5	54.5	40.2
Christmas Island	8.0	8.1	8.4	...	...	...
Cocos (Keeling) Islands	7.3	7.4	7.7	...	...	...
Colombia	17.4	17.3	14.0	18.7	18.6	15.1
Comoros	13.7	14.5	14.4	13.8	14.7	14.5
Congo	30.4	29.0	29.5	36.2	35.0	37.8
Cook Islands	7.5	7.5	7.8	7.5	7.5	7.9
Costa Rica	18.3	18.3	14.7	18.8	18.7	15.1
Côte d'Ivoire	39.4	43.8	40.4	44.2	49.7	46.6
Croatia	21.0	18.6	15.3	21.2	18.9	15.5
Cuba	13.3	14.2	13.3	16.0	17.0	15.9
Cyprus	18.5	15.1	14.5	19.8	16.1	15.5
Czechia	20.2	17.5	14.3	21.1	18.2	14.9
Democratic People's Republic of Korea	50.4	56.4	41.5	53.4	59.8	43.9
Democratic Republic of the Congo	31.8	32.2	31.6	37.6	37.5	37.4
Denmark	12.3	10.7	9.7	12.9	11.2	10.1
Djibouti	20.6	20.4	20.0	20.8	20.6	20.7
Dominica	7.9	8.8	8.2	8.0	9.0	8.4
Dominican Republic	7.5	7.9	7.6	7.7	8.1	7.8
Ecuador	17.5	17.7	16.5	17.8	18.1	16.9
Egypt	60.8	61.6	63.2	61.7	62.5	64.1
El Salvador	26.9	27.2	22.2	27.7	27.9	22.8
Equatorial Guinea	24.2	27.3	25.7	25.3	29.5	27.1
Eritrea	22.4	22.3	22.7	23.7	23.6	24.0
Estonia	8.5	6.7	6.4	8.8	7.0	6.6
Eswatini	15.0	14.8	15.1	15.8	15.7	15.9
Ethiopia	22.3	22.1	21.8	23.3	23.2	22.9
Falkland Islands (Malvinas)	11.2	12.1	10.2	...	...	...
Faroe Islands	8.7	8.3	7.3	...	...	...
Fiji	7.2	7.3	7.4	8.0	8.1	8.1
Finland	7.1	5.8	5.5	8.3	6.8	6.2
France	14.5	12.2	10.5	15.8	13.3	11.3
French Guiana	11.3	13.0	12.1	12.4	14.4	13.5
French Polynesia	7.8	7.8	8.0	8.1	8.1	8.2
Gabon	25.3	26.1	26.3	31.0	32.5	32.9
Gambia	37.5	39.9	39.1	39.5	42.1	41.4
Georgia	22.8	22.6	19.1	25.0	24.7	20.9
Germany	15.1	12.6	10.7	15.7	13.2	11.2
Ghana	44.2	50.0	46.0	47.5	54.8	50.4
Gibraltar	15.7	14.1	12.6	15.7	14.1	12.6
Greece	19.7	16.4	14.6	21.0	17.5	15.6
Greenland	4.3	4.0	4.0	4.5	4.1	4.1
Grenada	9.4	10.8	10.1	9.5	10.9	10.2
Guadeloupe	7.8	8.4	7.9	7.7	8.3	7.8
Guam	7.8	8.1	8.3	7.9	8.2	8.4
Guatemala	26.0	25.4	20.7	27.3	26.7	21.8
Guernsey	12.2	10.9	10.0	12.2	10.9	10.0

	Total			Urban		
	2010	2015	2019	2010	2015	2019
Oman	35.5	35.8	34.9	37.2	37.1	35.8
Pakistan	56.4	55.9	50.1	58.2	57.6	51.6
Palau	7.2	8.0	7.8	7.4	8.1	7.9
Panama	14.1	14.9	11.8	14.2	15.0	11.9
Papua New Guinea	8.7	9.0	8.9	9.3	9.6	9.5
Paraguay	16.4	13.0	12.3	17.4	14.0	13.2
Peru	29.6	30.3	29.1	31.4	32.6	31.7
Philippines	23.8	22.1	22.5	25.9	23.8	24.2
Pitcairn	6.3	6.5	6.6	...	...	...
Poland	26.3	22.6	18.8	28.0	23.9	19.9
Portugal	10.5	8.7	7.3	11.0	9.0	7.6
Puerto Rico	6.5	7.0	6.7	6.6	7.1	6.7
Qatar	64.3	65.9	59.0	65.4	67.0	60.0
Republic of Korea	29.8	27.6	24.0	30.3	28.0	24.4
Republic of Moldova	16.8	13.6	12.4	17.3	14.0	12.7
Réunion	11.8	12.1	12.1	11.9	12.2	12.2
Romania	18.1	15.4	13.3	19.4	16.5	14.1
Russian Federation	11.9	9.5	8.9	13.3	10.5	9.9
Rwanda	34.4	34.7	35.7	34.4	34.8	35.7
Saint Helena	16.9	17.0	17.7	...	...	...
Saint Kitts and Nevis	7.9	8.6	8.1	7.5	8.2	7.6
Saint Lucia	8.4	9.6	9.0	8.4	9.6	8.9
Saint Pierre and Miquelon	5.3	5.0	4.7	5.5	5.2	4.8
Saint Vincent and the Grenadines	8.9	10.1	9.4	8.9	10.2	9.5
Samoa	7.4	7.8	7.8	7.7	8.1	8.1
San Marino	13.0	11.4	9.8	13.0	11.4	9.8
Sao Tome and Principe	31.7	34.0	33.7	34.1	36.5	36.2
Saudi Arabia	56.6	58.5	57.2	61.5	62.7	60.7
Senegal	36.7	39.9	38.2	40.0	43.8	42.2
Serbia	29.4	25.3	21.7	30.3	26.0	22.3
Seychelles	17.9	16.5	17.0	18.4	17.0	17.4
Sierra Leone	36.3	42.5	39.4	40.2	46.0	43.3
Singapore	16.9	16.2	13.3	16.9	16.2	13.3
Slovakia	21.7	19.0	15.9	22.3	19.5	16.3
Slovenia	19.7	17.6	14.1	20.4	18.2	14.6
Solomon Islands	7.4	7.9	7.8	8.2	8.7	8.7
Somalia	14.4	14.2	14.3	14.4	14.5	14.4
South Africa	18.7	19.1	19.7	20.5	21.0	21.7
South Sudan	21.2	22.1	20.2	22.7	23.1	21.4
Spain	12.7	11.1	9.3	13.3	11.6	9.8
Sri Lanka	25.0	23.1	23.9	26.0	24.0	24.8
State of Palestine	29.4	30.5	30.8	30.0	31.1	31.3
Sudan	22.0	22.6	21.4	24.0	24.6	23.5
Suriname	11.4	13.0	12.2	12.2	13.9	13.0
Sweden	7.5	6.4	6.0	8.2	6.9	6.4
Switzerland	12.8	10.8	9.0	13.2	11.2	9.2
Syrian Arab Republic	25.1	24.8	25.1	25.1	24.9	25.3
Tajikistan	63.4	63.3	53.6	67.2	67.0	56.8
Thailand	26.4	24.1	24.6	27.1	24.9	25.5
Timor-Leste	20.8	19.4	20.5	21.9	20.6	21.8
Togo	35.0	38.2	35.7	36.3	40.5	37.9
Tokelau	6.6	6.7	6.7	...	...	...
Tonga	7.1	7.3	7.5	7.4	7.5	7.7
Trinidad and Tobago	9.8	10.9	10.3	9.9	11.1	10.4
Tunisia	26.7	26.1	26.5	27.3	27.0	27.4
Türkiye	23.7	23.0	23.3	24.2	23.2	23.3
Turkmenistan	31.5	31.4	26.4	31.2	31.2	26.4
Turks and Caicos Islands	5.8	6.2	6.1	5.9	6.3	6.2
Tuvalu	6.8	6.9	6.8	...	...	...
Uganda	31.3	31.7	31.3	32.1	32.5	32.3
Ukraine	17.8	14.7	13.5	19.1	15.7	14.5

Table A.2: Continued

	Total			Urban		
	2010	2015	2019	2010	2015	2019
Guinea	36.8	39.2	37.6	40.5	43.5	42.4
Guinea-Bissau	33.9	36.1	34.8	38.5	41.3	40.1
Guyana	10.5	11.7	11.1	11.0	12.3	11.7
Haiti	9.6	10.1	9.7	9.7	10.2	9.8
Holy See	22.0	18.9	15.5	22.0	18.9	15.5
Honduras	22.4	23.1	18.9	23.0	23.6	19.4
Hungary	19.5	17.2	14.2	20.3	17.9	14.8
Iceland	6.9	6.4	5.8	7.4	6.9	6.2
India	55.2	55.5	50.2	58.4	58.6	53.0
Indonesia	20.6	19.3	19.3	21.5	20.0	19.9
Iran (Islamic Republic of)	29.9	29.9	31.6	31.5	32.1	34.1
Iraq	39.3	39.1	39.3	42.4	42.4	43.0
Ireland	9.9	9.2	8.2	10.5	9.7	8.7
Isle of Man	9.0	8.2	7.5	9.3	8.5	7.7
Israel	24.2	21.7	19.5	24.5	21.9	19.6

	Total			Urban		
	2010	2015	2019	2010	2015	2019
United Arab Emirates	43.7	43.9	41.7	40.8	41.2	39.0
United Kingdom of Great Britain and Northern Ireland	13.2	11.1	9.5	13.5	11.3	9.7
United Republic of Tanzania	15.5	15.6	15.4	16.2	16.3	16.1
United States of America	9.3	8.3	7.2	9.7	8.6	7.4
United States Virgin Islands	8.1	8.8	8.4	8.5	9.2	8.7
Uruguay	9.2	9.9	8.5	9.2	9.9	8.5
Uzbekistan	48.5	48.5	41.0	52.9	52.8	44.5
Vanuatu	8.1	8.6	8.4	8.5	9.0	9.1
Venezuela (Bolivarian Republic of)	20.7	20.1	16.2	21.2	20.6	16.5
Viet Nam	22.4	20.5	20.9	23.6	21.6	22.1
Wallis and Futuna Islands	6.8	7.1	6.9	...	...	...
Western Sahara	25.0	27.9	25.1	23.6	28.5	25.1
Yemen	38.8	41.1	41.6	40.1	42.4	43.0
Zambia	17.1	17.4	16.9	18.9	19.3	18.8
Zimbabwe	13.3	13.3	13.1	14.6	14.6	14.5

Source:
United Nations Statistics Division (UNSD), SDG Indicators Global Database.

Notes:
(a) The Degree of Urbanisation offers a standardized definition of urban areas into three categories of human settlements: urban centres or cities; urban clusters or semi-dense areas; and rural areas. For more detailed information: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Applying_the_degree_of_urbanisation_manual

Last Updated: 15/07/2024

Table A.3: Urban population living in slums or informal settlements by Country and Region, 2000-2022

Country or Territory Name	Proportion of urban population living in slums or informal settlements [a]												Urban population living in slums or informal settlements (Thousands) [a]											
	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022
WORLD	31.2	30.9	30.1	29.2	28.2	27.3	26.3	25.4	24.6	24.4	24.2	24.8	894,875	928,034	946,516	961,109	969,070	980,512	983,965	992,179	999,526	1,028,017	1,059,936	1,123,702
Australia and New Zealand	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	26	27	24	22	19	16	13	9	7	7	8	8
Central Asia and Southern Asia	56.0	55.1	54.2	53.5	52.6	51.7	50.9	50.1	49.3	48.5	48.2	42.9	250,317	260,509	271,078	282,167	292,452	302,697	313,017	323,441	333,890	344,495	359,331	334,418
Sub-Saharan Africa	64.1	63.4	61.6	60.2	58.7	57.3	55.7	54.2	52.7	51.3	50.2	53.6	129,979	139,265	146,916	155,638	164,932	174,946	185,179	195,587	206,152	217,647	230,080	265,385
Latin America and the Caribbean	31.9	30.2	28.2	26.2	23.4	21.8	19.2	18.4	17.0	17.9	17.7	16.9	126,505	124,436	119,964	115,414	106,542	102,279	93,048	91,470	87,229	94,201	95,502	93,416
Northern America and Europe	1.4	1.4	1.3	1.2	1.0	0.9	0.9	0.8	0.8	0.8	0.7	0.7	10,725	10,479	9,923	9,161	8,354	7,651	7,010	6,365	7,136	6,658	5,909	5,759
Oceania excluding Australia and New Zealand	17.0	16.0	16.0	15.9	15.7	15.5	15.3	15.0	14.8	15.0	15.3	12.2	331	323	334	345	353	362	369	377	387	408	431	358
Western Asia and Northern Africa	31.6	34.4	32.6	29.8	27.4	25.2	22.8	20.3	18.8	18.7	18.7	17.8	63,633	72,821	72,440	69,907	67,907	65,881	62,830	58,841	57,399	59,482	62,056	61,727
Eastern Asia and South-Eastern Asia	37.5	35.9	34.2	32.4	30.6	28.8	27.1	25.3	23.6	22.4	21.7	24.8	313,358	320,173	325,835	328,456	328,509	326,680	322,500	316,089	307,327	305,119	306,620	362,630
ECA	57.7	58.4	56.8	55.4	54.0	51.9	50.4	48.9	47.4	46.7	46.0	45.7	164,300	178,317	186,229	195,241	204,230	211,165	221,141	230,852	240,845	255,098	269,564	287,381
ECE	3.8	3.6	3.4	3.1	2.9	2.5	2.3	2.1	1.9	1.8	1.8	1.8	32,134	30,806	29,311	27,640	25,736	22,879	21,068	19,336	18,060	17,066	17,402	18,031
ECLAC	31.8	29.7	27.0	25.8	23.7	21.5	19.0	18.2	17.4	17.0	17.1	16.9	126,107	122,245	115,012	113,825	107,710	100,825	91,771	90,563	88,943	89,419	91,976	93,416
ESCAP	41.4	39.9	38.4	37.0	35.4	33.8	32.3	31.8	31.3	30.9	30.5	30.2	556,942	573,331	586,160	597,991	604,832	609,628	611,157	630,780	650,057	669,037	687,951	709,617
ESCWA	34.0	36.6	35.1	33.4	30.6	27.4	24.9	22.5	20.6	20.3	20.5	20.9	51,023	57,980	58,607	59,201	57,692	55,099	53,093	50,644	48,766	50,416	53,534	57,156
Least Developed Countries (LDCs)	65.0	66.6	65.7	65.3	64.6	63.9	63.3	62.7	62.2	61.8	61.2	60.9	107,973	120,197	128,916	138,890	148,694	159,657	171,479	184,129	197,698	212,680	227,482	244,383
Landlocked developing countries (LLDCs)	55.8	54.2	53.1	52.3	50.7	50.4	49.0	47.7	46.4	45.5	45.9	46.6	45,977	47,313	49,056	51,062	52,517	55,425	57,271	59,256	61,334	63,786	68,448	73,828
Small Island Developing States (SIDS)	21.0	20.9	21.0	20.9	20.6	20.1	20.6	20.2	19.7	19.6	19.7	19.9	6,619	6,832	7,151	7,362	7,529	7,569	8,036	8,099	8,136	8,351	8,627	8,923
AFRICA																								
Eastern Africa	76.7	74.8	72.4	69.9	67.4	64.8	62.2	59.5	56.8	54.2	52.8	57.1	42,168	44,662	46,941	49,372	51,844	54,775	57,621	60,381	63,075	65,782	70,033	82,614
Burundi	79.7	79.7	77.0	71.7	66.3	61.0	55.6	50.2	44.9	39.5	36.8	36.8	421	466	506	529	551	569	580	585	585	577	602	672
Comoros	64.5	65.1	65.7	66.3	66.9	67.5	68.0	68.6	68.6	68.6	68.6	48.5	98	104	109	116	123	130	139	148	156	165	175	131
Djibouti	76.7	74.8	72.4	69.9	67.4	64.8	62.2	59.5	56.8	53.4	51.9	48.7	421	427	428	427	427	425	423	420	415	403	405	392
Eritrea	76.7	74.8	72.4	69.9	67.4	64.8	62.2	59.5	56.8	53.4	51.9	48.7	692	766	842	911	970	1,001	1,031	1,062	1,093	1,110	1,167	1,178
Ethiopia	92.2	89.1	86.0	82.9	79.8	76.7	73.6	70.5	67.4	64.3	64.3	64.3	9,040	9,493	9,948	10,391	10,958	11,649	12,356	13,042	13,713	14,360	15,733	17,207
Kenya	63.2	61.6	60.1	58.5	57.0	55.5	53.9	52.4	50.8	50.8	50.8	40.5	3,953	4,216	4,491	4,782	5,088	5,405	5,735	6,078	6,428	6,998	7,609	6,586
Madagascar	91.4	89.0	86.6	84.2	81.8	79.4	77.0	74.6	72.2	69.8	67.4	65.7	3,910	4,129	4,351	4,679	5,019	5,366	5,719	6,079	6,447	6,820	7,194	7,647
Malawi	81.4	77.9	74.4	70.9	67.4	63.8	60.3	56.8	53.3	49.8	49.8	38.0	1,353	1,384	1,411	1,441	1,473	1,505	1,536	1,564	1,592	1,616	1,760	1,464
Mauritius	76.7	74.8	72.4	69.9	67.4	64.8	62.2	59.5	56.8	53.4	51.9	48.7	388	381	371	361	349	336	322	308	294	276	270	254
Mayotte	76.7	74.8	72.4	69.9	67.4	64.8	62.2	59.5	56.8	53.4	51.9	48.7	55	61	63	65	66	66	66	66	65	64	65	63
Mozambique	90.1	86.6	83.1	79.6	76.0	72.5	69.0	65.5	62.0	58.5	55.0	55.0	4,737	4,881	5,031	5,174	5,356	5,592	5,820	6,038	6,241	6,424	6,583	7,171
Réunion	76.7	74.8	72.4	69.9	67.4	64.8	62.2	59.5	56.8	53.4	51.9	48.7	515	533	541	542	538	530	519	506	492	469	464	442
Rwanda	71.4	67.9	64.5	61.0	57.5	54.0	50.5	47.1	43.6	40.1	38.3	38.3	856	973	961	950	945	937	924	906	886	863	875	929
Seychelles	76.7	74.8	72.4	69.9	67.4	64.8	62.2	59.5	56.8	53.4	51.9	48.7	31	32	33	33	32	32	31	31	30	29	29	28
Somalia	76.7	74.8	72.4	69.9	67.4	64.8	62.2	59.5	56.8	53.4	51.9	48.7	2,299	2,430	2,601	2,779	2,760	3,071	3,298	3,433	3,566	3,644	3,860	3,937
South Sudan	...	...	99.8	99.8	99.8	97.0	94.2	94.2	94.2	94.2	94.2	94.2	...	1,211	1,323	1,461	1,623	1,744	1,856	2,023	2,200	2,387	2,590	2,811
Uganda	80.9	78.2	75.5	72.8	70.1	67.5	64.8	62.1	59.4	56.7	54.0	52.7	2,876	3,143	3,437	3,750	4,083	4,434	4,803	5,184	5,575	5,968	6,360	6,924
United Republic of Tanzania	81.3	77.1	72.8	68.6	64.3	60.0	55.8	51.5	47.3	43.0	40.9	70.1	6,201	6,412	6,746	7,097	7,450	7,781	8,075	8,317	8,493	8,584	9,040	17,125
Zambia	63.8	62.2	60.7	59.1	57.6	56.0	54.5	52.9	51.4	49.8	48.3	48.3	2,338	2,455	2,593	2,738	2,890	3,054	3,231	3,421	3,617	3,817	4,023	4,373
Zimbabwe	27.5	26.9	26.3	25.7	25.1	24.5	23.9	23.4	22.8	22.2	21.6	54.9	1,136	1,164	1,154	1,146	1,144	1,148	1,157	1,170	1,187	1,207	1,229	3,278
Middle Africa	52.9	60.1	58.8	59.2	59.9	60.6	61.4	62.4	63.5	64.8	64.6	66.0	20,205	25,021	26,792	29,454	32,535	35,965	39,771	44,025	48,750	54,075	58,512	64,794
Angola	19.7	19.7	19.7	25.8	31.9	38.1	44.2	50.3	56.4	62.6	62.6	62.7	1,622	1,816	2,034	2,967	4,048	5,317	6,794	8,497	10,434	12,617	13,733	14,935
Cameroon	65.4	62.1	58.8	55.6	52.3	49.0	45.7	42.5	39.2	35.9	32.7	32.7	4,547	4,668	4,783	4,887	4,978	5,047	5,089	5,099	5,071	5,000	4,882	5,235
Central African Republic	86.0	83.1	80.3	77.4	74.6	71.8	68.9	68.9	68.9	68.9	68.9	68.9	1,215	1,228	1,236	1,243	1,248	1,242	1,219	1,243	1,286	1,350	1,431	1,525
Chad	91.6	90.5	89.3	88.2	87.1	85.9	84.8	83.7	82.6	82.0	82.0	82.0	1,653	1,767	1,888	2,007	2,123	2,246	2,386	2,541	2,706	2,903	3,141	3,405
Congo	87.8	87.8	84.7	78.5	72.2	66.0	59.8	53.5	47.3	44.2	44.2	75.3	1,662	1,784	1,848	1,852	1,853	1,831	1,777	1,697	1,600	1,597	1,704	3,099
Democratic Republic of the Congo	...	71.9	71.9	72.4	73.3	74.2	75.1	76.1	77.0	77.9	78.4	78.4	...	12,922	14,111	15,539	17,248	19,161	21,292	23,652	26,249	29,095	32,010	34,948
Equatorial Guinea	52.9	60.1	58.8	59.2	59.9	60.6	61.4	62.4	63.5	64.7	64.9	64.7	160	211	239	279	326	380	440	494	552	613	667	717
Gabon	57.4	55.6	53.7	51.8	49.9	48.1	46.2	44.3	44.3	44.3	44.3	38.8	558	578	599	622	647	674	703	729	777	819	859	787
Sao Tome and Principe	...	...	61.4	61.4	60.4	58.5	56.5	54.6	52.6	52.6	52.6	82.4			54	59	63	66	69	72	75	80	85	142
Northern Africa	39.1	45.3	41.6	35.2	31.0	27.9	24.3	20.3	17.2	16.4	15.9	16.8	32,630	39,366	37,735	33,296	30,582	28,730	26,226	22,905	20,397	20,256	20,531	22,591
Algeria	...	...	...	...	30.8	30.8	28.9	25.0	21.1	17.2	13.3	13.2					7,097	7,513	7,478	6,861	6,115	5,239	4,238	4,416
Egypt	42.2	36.7	31.2	25.7	20.2	14.7	9.2	3.7	0.9	0.9	0.9	3.8	12,633	11,431	10,111	8,651	7,036	5,310	3,456	1,438	368	382	396	1,756
Libya	39.1	45.3	41.6	35.2	31.0	27.9	24.3	20.3	17.2	16.4	23.7	16.6	1,601	1,917	1,825	1,598	1,456	1,342	1,183	993	863	849	1,273	920
Morocco	33.2	30.4	27.6	24.8	22.0	19.2	16.4	13.6	10.9	10.9	10.9	10.9	5,101	4,839	4,548	4,266	3,955	3,613	3,238	2,820	2,349	2,453	2,556	2,657
Sudan	...	99.1	99.1	99.1	94.0	88.9	83.8	78.7	73.7	73.7	73.7	73.7	...	9,266	9,784	10,277	10,198	10,117	10,061	10,012	9,948	10,598	11,313	12,101
Tunisia	...	...	...	...	...	10.1	9.6	9.1	8.6	8.1	7.6	7.6						719	706	691	674	655	633	651
Western Sahara	39.1	45.3	41.6	35.2	31.0	27.9	24.3	20.3	17.2	16.4	23.7	16.6	105	141	149	137	125	115	104	90	80	81	123	90
Southern Africa	29.6	29.2	28.8	28.3	27.8	27.3	26.8	26.3	25.7	25.3	25.3	25.3	8,347	8,624	8,877	9,093	9,316	9,556	9,825	10,102	10,357	10,613	11,040	11,507
Botswana	58.7	56.6	54.4	52.3	50.2	48.1	46.0	43.8	41.7	39.6	39.6	39.6	540	549	553	556	581	605	622	631	638	641	678	714
Eswatini	55.4	55.4	55.4	47.9	40.5	33.1	25.7	18.2	10.8	10.8	10.8	17.0	133	134	134	118	103	89	73	55	34	36	38	62
Lesotho	62.7	62.7	58.6	54.5	50.3	46.2	42.1	37.9	33.8	29.7	25.6	25.6	229	246	246	244	240	234	226	216	204	189	172	182
Namibia	42.6	42.4	42.3	42.1	42.0	41.8	41.7	41.5	41.4	41.4	41.4	41.4	262	281	303	326	350	378	412	451	492	536	581	627
South Africa	27.6	27.2	26.8	26.5	26.1	25.7	25.3	24.9	24.6	24.2	24.2	24.2	7,183	7,414	7,642	7,849	8,042	8,250	8,492	8,749	8,990	9,210	9,571	9,922
Western Africa	70.9	68.6	66.3	63.8	61.4	59.0	56.5	53.9	51.4	49.2	47.2	51.4	57,651	60,979	64,330	67,739	71,238	74,650	77,962	81,080	83,970	87,177	90,494	106,470
Benin	71.9	71.5	71.1	70.7	70.3	69.9	69.5	69.1	68.7	68.3	67.9	64.0	1,891	2,035	2,206	2,384	2,572	2,771	2,984	3,211	3,454	3,713	3,987	4,053
Burkina Faso	82.2	76.6	71.1	65.5	59.9	54.4	48.8	43.2	37.7	32.1	26.6	87.9	1,703	1,814	1,923	2,024	2,072	2,090	2,084	2,049	1,977	1,862	1,699	6,192
Cabo Verde	70.9	68.6	66.3	63.8	61.4	59.0	56.5	53.9	51.4	49.2	46.7	46.4	165	171	176	180	182	183	182	181	180	179	177	182
Côte d'Ivoire	67.1	65.5	64.0	62.5	60.9	59.4	57.8	56.3	54.8	53.2	53.2	48.3	4,830	5,006	5,162	5,332	5,522	5,733	5,967	6,217	6,471	6,729	7,201	6,989
Gambia	56.9	55.1	53.3	51.5	49.7	47.9	46.1	44.3	42.5	40.7	38.9	37.1	336	359	382	405	428	451	474	497	519	540	558	575
Ghana	60.4	57.0	53.6	50.3	46.9	43.6	40.2	36.8	33.5	33.5	33.5	33.5	5,022	5,143	5,250	5,336	5,396	5,416	5,388	5,307	5,171	5,531	5,902	6,285
Guinea	40.7	41.5	42.3	43.2	44.0	44.8	45.7	46.5	47.3	48.2	49.0	44.0	1,106	1,191	1,285	1,388	1,504	1,630	1,765	1,913	2,081	2,272	2,485	2,397
Guinea-Bissau	...	...	...	...	...	...	75.2	71.6	68.0	64.4	60.8	59.0							504	516	525	533	538	557
Liberia	...	75.5	75.5	74.6	72.8	71.0	69.2	67.5	65.7	63.9	63.9	60.5	...	1,041	1,096	1,168	1,256	1,341	1,407	1,463	1,523	1,586	1,698	1,721
Mali	83.9	79.7	75.5	71.3	67.1	62.9	58.7	54.5	50.3	46.1	41.9	92.5	2,609	2,764	2,928	3,096	3,264	3,414	3,533	3,624	3,693	3,733	3,734	9,042
Mauritania	84.7	81.3	77.9	74.6	71.2	67.8	64.4	61.1	57.7	56.0	56.0	58.6	874	922	978	1,033	1,086	1,140	1,194	1,246	1,289	1,365	1,482	1,678
Niger	70.0	70.1	70.2	70.2	70.3	70.3	70.4	70.4	70.4	70.4	70.4	70.4	1,287	1,391	1,496	1,611	1,737	1,874	2,023	2,188	2,372	2,582	2,820	3,091

Table A.3: Continued

Country or Territory Name	Proportion of urban population living in slums or informal settlements [a]												Urban population living in slums or informal settlements (Thousands) [a]											
	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022
Nigeria	74.1	71.6	69.1	66.6	64.1	61.5	59.0	56.5	54.0	51.5	49.0	48.5	31,590	33,631	35,741	37,921	40,163	42,435	44,684	46,858	48,901	50,779	52,466	56,285
Senegal	67.2	63.6	60.0	56.5	52.9	49.4	45.8	42.3	38.7	35.2	31.6	46.4	2,676	2,685	2,717	2,750	2,774	2,792	2,801	2,794	2,762	2,704	2,616	4,131
Sierra Leone	73.9	73.9	72.5	69.8	67.1	64.3	61.6	58.9	56.1	53.4	50.6	49.3	1,202	1,323	1,444	1,523	1,575	1,615	1,652	1,685	1,711	1,733	1,749	1,809
Togo	69.3	66.0	62.8	59.5	56.3	53.1	49.8	46.6	43.3	40.1	38.5	38.5	1,133	1,172	1,207	1,239	1,269	1,295	1,317	1,332	1,339	1,336	1,382	1,484
ASIA																								
Eastern Asia	**57.6**	**53.6**	**49.7**	**45.7**	**41.7**	**37.7**	**33.8**	**29.8**	**25.8**	**21.9**	**17.9**	**22.7**	**366,220**	**364,813**	**361,294**	**353,967**	**342,531**	**327,668**	**307,999**	**284,698**	**257,811**	**227,207**	**192,810**	**252,323**
Mongolia	57.6	53.6	49.7	45.7	41.7	37.7	33.8	29.8	25.8	21.9	17.9	17.9	789	777	762	743	719	692	647	594	534	467	394	406
Central Asia	**29.5**	**26.7**	**24.0**	**21.2**	**18.4**	**15.6**	**12.8**	**10.1**	**7.3**	**5.4**	**4.5**	**5.8**	**7,472**	**6,981**	**6,474**	**5,931**	**5,355**	**4,736**	**4,032**	**3,268**	**2,449**	**1,856**	**1,615**	**2,114**
Kazakhstan	24.5	21.7	18.9	16.1	13.3	10.5	7.8	5.0	2.2	0.8	0.8	0.8	2,066	1,841	1,639	1,429	1,208	982	748	496	225	84	86	88
Kyrgyzstan	47.2	42.7	38.2	33.7	29.3	24.8	20.3	15.9	11.4	6.9	2.4	2.4	819	752	679	610	544	475	403	326	244	154	57	59
Tajikistan	60.3	55.7	51.2	46.6	42.1	37.5	33.0	28.4	23.9	19.3	17.1	17.1	993	952	911	865	816	761	700	634	560	478	445	469
Turkmenistan	10.5	10.5	10.5	10.3	10.0	9.8	9.5	9.3	9.0	8.8	8.5	8.4	218	224	231	233	236	241	246	253	259	264	269	278
Uzbekistan	29.5	26.7	24.0	21.2	18.4	15.6	12.8	10.1	7.3	5.4	4.5	7.1	3,376	3,211	3,014	2,793	2,551	2,278	1,936	1,559	1,162	876	759	1,220
Southern Asia	**57.6**	**56.8**	**56.0**	**55.3**	**54.5**	**53.7**	**52.9**	**52.2**	**51.4**	**50.7**	**50.4**	**44.7**	**242,918**	**253,611**	**264,699**	**276,236**	**287,097**	**297,960**	**308,985**	**320,173**	**331,441**	**342,639**	**357,716**	**332,303**
Afghanistan	...	...	...	63.6	63.6	64.8	67.2	69.7	72.1	73.3	73.3	71.6				3,772	4,048	4,431	4,987	5,613	6,254	6,797	7,260	7,580
Bangladesh	58.3	57.7	57.0	56.4	55.7	55.1	54.4	53.8	53.2	52.5	51.9	51.5	18,100	19,501	21,042	22,552	24,025	25,533	27,126	28,760	30,389	32,004	33,619	35,434
Bhutan	57.6	56.8	56.0	55.3	54.5	53.7	52.9	52.2	51.4	50.7	50.4	44.7	84	95	107	118	127	136	145	154	162	169	178	167
India	55.3	54.6	53.9	53.2	52.5	51.8	51.1	50.4	49.7	49.0	49.0	41.4	161,101	168,051	175,430	182,790	190,103	197,240	204,193	211,207	218,417	225,832	236,771	209,847
Iran (Islamic Republic of)	57.6	56.8	56.0	55.3	54.5	53.7	52.9	52.2	51.4	50.7	50.4	44.7	24,395	25,277	26,057	26,866	27,563	28,280	29,045	29,806	30,508	31,121	31,980	29,170
Maldives	...	...	41.5	41.5	41.0	39.9	38.7	37.6	36.5	35.4	34.8	34.8			42	47	50	53	56	59	61	63	65	68
Nepal	66.3	63.4	60.5	57.6	54.7	51.9	49.0	46.1	43.2	40.3	40.3	40.1	2,109	2,218	2,273	2,312	2,334	2,350	2,363	2,372	2,370	2,356	2,508	2,655
Pakistan	71.2	69.7	68.2	66.6	65.1	63.6	62.1	60.5	59.0	57.5	56.0	56.0	32,539	33,653	34,724	35,790	36,862	37,962	39,102	40,241	41,319	42,336	43,345	45,581
Sri Lanka	57.6	56.8	56.0	55.3	54.5	53.7	52.9	52.2	51.4	50.7	50.4	44.7	1,988	1,986	1,986	1,988	1,984	1,977	1,968	1,961	1,959	1,961	1,990	1,803
South-Eastern Asia	**37.4**	**35.8**	**34.1**	**32.4**	**30.6**	**28.8**	**27.0**	**25.3**	**23.5**	**22.4**	**21.7**	**31.5**	**74,365**	**75,643**	**76,541**	**76,832**	**76,684**	**76,188**	**75,305**	**73,978**	**72,125**	**71,882**	**72,660**	**109,898**
Brunei Darussalam	37.4	35.8	34.1	32.4	30.6	28.8	27.0	25.3	47.1	22.4	21.7	21.6	89	89	89	88	86	84	82	80	77	76	76	77
Cambodia	84.8	79.2	73.6	67.9	62.3	56.6	51.0	45.4	39.7	39.7	39.7	42.3	1,915	1,883	1,832	1,765	1,692	1,644	1,585	1,511	1,413	1,508	1,608	1,822
Indonesia	35.1	33.5	31.8	30.2	28.5	26.9	25.2	23.5	21.9	20.2	19.4	19.4	31,210	31,719	32,123	32,401	32,542	32,508	32,160	31,620	30,862	29,872	29,929	31,198
Lao People's Democratic Republic	54.4	51.0	47.5	44.1	40.7	37.3	33.8	30.4	27.0	23.6	21.8	54.8	637	674	706	716	712	700	678	649	616	575	567	1,517
Malaysia	37.4	35.8	34.1	32.4	30.6	28.8	27.0	25.3	23.5	22.4	21.7	21.6	5,376	5,530	5,644	5,709	5,737	5,736	5,701	5,627	5,494	5,466	5,510	5,694
Myanmar	29.4	32.6	35.8	39.0	42.2	45.4	48.7	51.9	55.1	58.3	58.3	58.3	3,662	4,210	4,780	5,363	5,957	6,584	7,260	7,984	8,761	9,598	9,947	10,317
Philippines	50.0	48.6	47.2	45.8	44.3	42.9	41.5	40.1	38.7	37.3	36.6	35.9	17,981	18,161	18,288	18,331	18,295	18,246	18,393	18,517	18,595	18,645	19,043	19,432
Singapore (c)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Thailand	15.6	15.6	15.1	14.1	13.0	12.0	10.9	9.9	8.9	7.8	2.0	2.0	3,084	3,373	3,547	3,577	3,572	3,530	3,373	3,181	2,959	2,706	714	736
Timor-Leste	...	...	56.1	56.1	54.0	50.0	46.0	42.0	37.9	33.9	33.9	33.9			144	155	157	154	151	148	144	137	147	157
Viet Nam	45.3	40.4	35.4	30.5	25.5	20.6	15.7	10.7	5.8	5.8	5.8	32.5	8,868	8,441	7,896	7,235	6,451	5,543	4,496	3,282	1,882	1,998	2,118	12,623
Western Asia	**27.5**	**28.2**	**27.5**	**26.5**	**24.6**	**23.1**	**21.6**	**20.3**	**20.1**	**20.5**	**20.8**	**18.5**	**464,067**	**506,128**	**525,192**	**539,011**	**530,129**	**526,719**	**521,165**	**516,621**	**538,555**	**575,336**	**613,606**	**570,363**
Armenia	12.8	12.3	11.8	11.3	10.8	10.4	9.9	9.4	8.9	8.4	8.4	8.4	254	240	227	214	201	189	180	172	164	156	156	157
Azerbaijan	50.9	44.9	38.9	32.9	26.9	...	...	...	...	...	...	...	2,126	1,926	1,717	1,495	1,259							
Cyprus	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	1	1	1	2	2	2	2	2	2	2	2	2
Georgia	13.6	13.6	13.2	12.4	11.7	10.9	10.1	9.4	8.6	7.8	7.1	7.1	338	330	319	298	278	256	235	214	196	180	164	165
Iraq	33.9	35.4	37.0	38.5	40.1	41.6	43.2	44.7	46.2	47.8	49.3	49.3	5,471	6,063	6,688	7,344	8,041	8,847	9,822	10,917	12,061	13,250	14,517	15,397
Israel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Jordan	40.0	37.7	35.4	33.0	30.7	28.4	26.0	23.7	21.4	19.1	16.7	16.7	1,598	1,560	1,533	1,587	1,667	1,754	1,835	1,880	1,830	1,717	1,561	1,598
Kuwait	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Lebanon	...	92.4	92.4	92.4	67.3	42.2	17.1	4.5	4.5	4.5	4.5	4.5	...	2,807	3,088	3,253	2,408	1,598	736	222	239	243	241	238
Oman	4.3	4.0	3.6	2.9	2.3	1.7	1.0	0.5	0.3	0.2	0.0	0.0	69	67	62	55	47	38	27	16	11	6	...	...
State of Palestine	...	30.0	30.0	29.1	27.2	25.3	23.4	21.4	19.5	19.5	19.5	19.5	...	734	766	780	771	762	748	731	708	750	796	844
Syrian Arab Republic	30.7	32.1	31.3	30.4	28.5	27.0	25.4	24.1	23.9	25.2	25.6	41.1	2,617	2,887	2,978	3,117	3,183	3,155	2,782	2,386	2,329	2,494	2,685	4,778
Türkiye	24.6	23.2	21.8	20.4	19.0	35.2	32.4	29.6	28.3	28.3	28.3	28.3	10,064	9,965	9,817	9,602	9,324	9,021	8,704	8,344	8,327	8,695	9,013	9,250
United Arab Emirates	...	1.0	1.0	1.0	0.8	0.7	0.5	0.4	0.3	0.1	0.0	0.1	...	27	32	41	46	45	38	31	20	8	...	10
Yemen	63.8	61.2	58.6	55.9	53.3	50.7	48.1	45.5	44.2	44.2	44.2	44.2	2,996	3,162	3,328	3,491	3,650	3,803	3,948	4,077	4,315	4,683	5,068	5,469
EUROPE																								
Eastern Europe	**4.5**	**4.3**	**4.0**	**3.7**	**3.4**	**3.0**	**2.7**	**2.4**	**2.8**	**2.5**	**2.5**	**2.5**	**9,328**	**8,743**	**8,206**	**7,470**	**6,833**	**6,165**	**5,563**	**4,923**	**5,711**	**5,155**	**5,135**	**5,152**
Belarus (b)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.3	0.3
Bulgaria	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	3	5	5	5	8	8	8	11	11	11	13	10
Czechia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4	4	4	4	4	4	4	4	4	4	4	2
Hungary	15.4	14.2	12.9	11.6	10.4	9.1	7.9	7.2	7.2	...	...	...	1,016	940	860	780	706	623	543	496	497			
Poland	2.1	1.8	1.6	1.3	0.9	0.6	0.3	0.1	4.5	8.6	3.7	4.2	500	428	366	294	199	128	58	12	1,035	984	843	957
Republic of Moldova	26.5	23.7	20.8	18.0	15.1	12.3	9.4	6.5	6.5	6.5	...	...	496	433	373	319	265	214	163	112	112	112		
Romania	...	3.7	3.7	3.5	3.3	3.0	2.7	2.4	2.1	1.9	1.6	2.5		421	418	396	362	325	289	258	224	196	163	264
Russian Federation	3.7	3.6	3.5	3.4	3.3	3.2	3.2	3.0	2.9	2.9	2.8	2.6	3,919	3,780	3,701	3,529	3,475	3,376	3,334	3,189	3,096	3,054	2,956	2,822
Slovakia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2	2	2	1	1	1	1	1	1	1	1	2
Ukraine	5.0	5.0	4.6	3.9	3.2	2.5	1.8	1.1	1.1	1.1	...	...	1,640	1,614	1,468	1,236	1,010	785	561	341	338	336		
Northern Europe	**0.5**	**0.5**	**0.5**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.5**	**354**	**347**	**346**	**345**	**344**	**343**	**339**	**337**	**334**	**336**	**344**	**416**
Denmark	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Estonia	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.5	0.5	0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	3.1
Finland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Iceland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Ireland	6.2	6.4	6.7	6.9	7.2	7.5	7.7	8.0	8.3	8.5	8.5	8.5	141	152	167	180	198	214	223	234	246	258	264	271
Latvia	2.9	2.8	2.4	2.2	1.9	1.6	1.3	1.1	0.8	0.6	0.6	0.6	46	44	37	33	27	23	18	14	11	8	8	8
Lithuania	4.2	3.7	3.3	2.9	2.4	2.0	1.6	1.1	0.7	0.3	0.3	0.5	97	85	74	63	52	42	31	22	13	5	5	10
Norway	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Sweden	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.3	22	19	19	19	16	12	12	13	9	9	9	31
United Kingdom of Great Britain and Northern Ireland	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	46	47	48	49	50	51	53	54	55	56	56	-
Southern Europe	0.7	0.7	0.6	0.6	0.5	0.4	0.4	0.3	0.3	0.4	0.2	0.2	672	648	619	569	511	454	397	355	307	415	213	232
Albania	28.1	25.5	23.0	20.5	17.9	15.4	12.9	10.3	7.8	5.3	2.8	2.7	366	346	325	299	268	236	205	170	133	94	51	51
Andorra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Bosnia and Herzegovina	5.1	5.1	5.1	4.9	4.7	4.5	4.3	4.0	...	...	...	...	81	83	84	82	79	76	72	67				
Croatia	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.5	9	9	9	8	8	8	7	7	6	6	6	12
Gibraltar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Greece	0.3	0.3	0.3	0.2	0.2	0.1	0.1	...	...	...	...	...	20	21	21	17	13	9	4					
Italy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	...	...	...	...	...	...	...	...	...	...	8

Table A.3: Continued

Country or Territory Name	Proportion of urban population living in slums or informal settlements [a]												Urban population living in slums or informal settlements (Thousands) [a]											
	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018	2020	2022
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	...	...	...	...	...	...	...	...	...	...	...	0
Montenegro	19.1	19.1	18.5	17.3	16.1	14.9	13.6	12.4	11.2	10.0	8.8	8.8	69	71	71	67	63	60	55	51	47	42	37	38
North Macedonia	1.3	1.3	1.3	1.2	1.0	0.8	0.7	0.5	0.3	0.2	0.2	0.3	15	15	15	14	12	9	8	6	4	2	2	-
Portugal	1.3	1.1	1.0	0.8	0.5	0.4	0.3	0.2	0.1	0.0	0.0	0.1	70	64	57	46	35	26	16	10	7	3	3	4
Serbia	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.4	0.4	1.4	33	32	30	30	27	25	25	22	22	20	17	70
Spain	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	...	...	...	...	...	...	...	...	...	...	18	19	...	...	...
Western Europe	**0.2**	**0.2**	**0.1**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**219**	**214**	**214**	**213**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**0.1**
Austria	4.5	4.4	4.4	4.4	...	...	...	...	...	...	...	...	219	214	214	213								
Luxembourg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	...	...	...	...	...	...	...	...	...	...	0.1
Belgium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-
France	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Germany	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Monaco	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Netherlands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Switzerland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-
LATIN AMERICA AND THE CARIBBEAN																								
Caribbean	21.3	21.2	21.0	21.0	20.9	20.7	20.4	20.1	19.6	20.4	20.9	17.1	5,127	5,285	5,419	5,593	5,742	5,861	5,945	6,003	6,036	6,438	6,749	5,630
Anguilla	4.3	3.9	3.4	3.0	2.6	2.1	1.7	1.5	1.5	...	...	...	0.5	0.5	0.4	0.4	0.3	0.3	0.2	0.2	0.2			
Cayman Islands	...	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	...	...	...	...	2	2	2	2	2	2	2	3			
Cuba	2.2	2.2	2.2	3.2	4.3	5.3	6.3	7.4	8.4	9.5	10.5	11.0	181	183	185	276	367	460	555	650	746	840	935	983
Dominican Republic	30.2	27.8	25.4	23.1	20.7	18.3	16.0	13.6	11.2	11.2	11.2	11.2	1,595	1,556	1,528	1,485	1,422	1,339	1,230	1,100	952	993	1,031	1,068
Haiti	61.3	60.0	58.7	57.4	56.1	54.8	53.4	52.1	50.8	49.5	48.9	51.1	1,865	2,063	2,230	2,354	2,478	2,601	2,721	2,836	2,945	3,043	3,174	3,491
Saint Lucia	4.9	4.9	4.5	3.9	3.4	2.8	2.2	1.6	1.1	0.5	0.5	0.4	2.1	2.0	1.8	1.4	1.1	0.9	0.7	0.5	0.3	0.2	0.2	0.2
Trinidad and Tobago	...	...	...	...	...	8.7	7.9	7.5	7.5	...	...	...						63	57	54	55			
Central America	**33.7**	**33.8**	**32.2**	**30.4**	**28.4**	**26.6**	**23.4**	**21.5**	**19.7**	**19.1**	**18.6**	**17.5**	**31,910**	**33,333**	**32,904**	**32,302**	**31,574**	**30,729**	**28,221**	**26,894**	**25,569**	**25,576**	**25,772**	**25,072**
Belize	15.8	15.8	15.8	15.8	15.7	15.7	15.7	15.7	15.7	15.7	15.7	15.7	18	19	20	21	22	23	24	25	26	28	29	30
Costa Rica	12.7	11.8	10.9	10.0	9.0	8.1	7.2	6.3	5.4	4.5	3.5	3.5	294	296	293	287	278	265	248	227	203	175	144	149
El Salvador	...	...	...	46.5	40.5	34.5	28.5	22.5	16.5	16.5	16.5	16.5				1,751	1,575	1,391	1,191	973	737	762	785	1,612
Guatemala	55.5	53.3	51.0	48.8	46.5	44.3	42.1	39.8	37.6	37.6	37.6	37.6	2,931	2,991	3,044	3,086	3,117	3,138	3,148	3,149	3,138	3,310	3,491	2,245
Honduras	44.4	44.4	43.2	40.9	38.6	36.2	33.9	31.5	...	...	...	...	1,317	1,420	1,493	1,519	1,535	1,540	1,533	1,515				
Mexico	32.2	30.4	28.7	27.0	25.3	23.6	21.9	20.2	18.4	17.6	17.6	17.6	24,446	23,947	23,364	22,789	22,209	21,534	20,721	19,780	18,718	18,447	19,021	686
Nicaragua	71.6	70.3	69.1	67.8	67.2	67.2	...	...	...	...	...	...	1,986	2,018	2,046	2,075	2,125	2,195						
Panama	48.7	44.4	40.1	35.7	31.4	27.1	22.8	18.5	16.3	16.3	...	...	917	877	830	776	713	644	566	479	441	459		
South America	31.9	29.6	27.2	25.1	21.6	19.9	17.4	16.9	15.6	16.1	16.1	16.8	88,769	85,219	81,163	77,170	68,450	64,659	58,160	58,029	55,043	57,904	59,289	63,019
Argentina	20.3	19.6	18.8	18.1	17.4	16.7	15.9	15.2	14.5	14.5	14.5	14.5	6,703	6,636	6,557	6,464	6,357	6,241	6,114	5,970	5,826	5,953	6,078	1,219
Bolivia (Plurinational State of)	57.9	55.7	53.4	51.2	48.9	46.6	46.6	46.6	...	...	...	...	2,986	3,025	3,052	3,069	3,076	3,072	3,214	3,351				
Brazil	34.7	31.4	28.1	24.8	21.5	18.2	14.9	14.9	14.9	...	...	...	49,441	46,366	42,877	39,002	34,766	30,213	25,373	26,008	26,617			
Chile	14.6	11.0	7.3	7.3	7.3	...	...	...	...	...	...	...	1,920	1,484	1,015	1,035	1,058							
Colombia	21.2	19.8	18.5	17.1	15.8	14.5	13.1	11.8	10.4	9.7	9.7	9.7	6,328	6,167	5,973	5,743	5,477	5,175	4,837	4,466	4,062	3,876	3,967	4,052
Ecuador	57.4	57.8	57.8	57.8	...	...	...	...	...	...	...	...	4,372	4,622	4,803	4,998								
Guyana	...	26.1	25.3	23.7	22.0	20.4	18.7	17.1	15.4	13.8	12.1	11.3	56	56	53	49	45	41	37	34	32	29	26	24
Paraguay	42.0	39.0	36.0	33.0	30.0	27.0	24.0	21.0	18.0	15.1	15.1	15.1	1,233	1,217	1,178	1,126	1,065	995	919	834	741	639	663	686
Peru	47.4	45.6	43.7	41.9	40.0	38.2	46.1	47.1	45.9	44.2	43.7	45.1	8,975	8,951	8,900	8,826	8,717	8,569	10,674	11,247	11,299	11,214	11,406	12,077
Suriname	7.4	8.3	9.1	9.9	10.8	11.6	12.5	13.3	14.1	15.0	15.8	15.8	23	27	30	33	37	41	44	48	52	56	60	61
Uruguay	...	...	23.7	19.9	16.2	12.5	8.8	5.0	1.3	1.3	1.3	1.3			733	622	511	398	282	164	43	43	43	44
Venezuela (Bolivarian Republic of)	27.8	26.4	25.7	25.7	...	...	...	...	...	...	...	...	5,965	5,896	5,949	6,159								
NORTHERN AMERICA	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.3**	**0.2**	**0.2**	**0.2**	**507**	**519**	**531**	**556**	**609**	**637**	**664**	**706**	**734**	**644**	**656**	**603**
Bermuda	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	...	...	...	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0
Canada	0.3	0.3	0.3	0.5	0.5	0.5	0.6	0.7	0.7	1.6	0.8	1.1	61	63	64	79	121	138	156	188	207	241	245	343
United States of America	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	446	457	467	477	488	499	508	518	527	403	411	260
Greenland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-
OCEANIA																								
Australia/New Zealand	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	26	27	24	22	19	16	13	9	7	7	8	8
Australia	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	26	27	24	22	19	16	13	9	7	7	8	8
New Zealand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	-	-
Melanesia	18.3	17.2	17.2	17.2	17.0	16.8	16.6	16.4	16.2	16.4	16.7	14.8	249	245	256	267	277	287	295	305	315	335	357	333
Fiji	...	15.0	15.0	14.5	13.5	12.5	11.4	10.4	9.4	9.4	9.4	9.4	...	60	61	60	58	56	53	50	47	48	50	51
Papua New Guinea	19.8	19.8	19.8	20.1	20.5	20.9	21.3	21.7	22.0	22.4	22.8	22.3	145	152	160	170	182	193	205	218	232	248	266	275
Solomon Islands	10.4	10.4	10.4	9.0	7.5	6.1	4.6	3.2	2.0	2.0	2.0	1.9	6.8	7.5	8.3	7.9	7.2	6.4	5.3	4.0	2.7	2.9	3.1	3.3
Vanuatu	4.6	4.6	4.6	4.5	4.4	4.3	4.2	4.0	4.1	4.2	4.2	3.1	1.8	2.0	2.1	2.2	2.4	2.5	2.5	2.6	2.8	3.0	3.1	2.4
Kiribati	18.1	16.8	15.6	14.4	13.1	11.8	10.6	9.4	8.1	6.9	5.6	5.9	6.6	6.4	6.1	6.0	5.9	5.7	5.5	5.2	4.9	4.4	3.8	4.3
Marshall Islands	...	2.2	2.2	2.0	1.7	1.4	1.0	0.8	0.5	0.1	0.0	2.4		0.8	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.0	...	1.0
Nauru	3.6	3.2	2.8	2.3	1.9	1.4	0.9	0.6	0.6	...	...	...	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1			
Palau	2.2	2.0	1.7	1.5	1.3	1.1	0.8	0.7	0.4	0.3	0.3	0.6	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Polynesia	3.5	3.6	3.6	3.1	2.5	2.0	1.4	1.0	0.5	0.4	0.3	6.1	9.2	9.6	9.8	8.7	7.2	5.8	4.3	2.9	1.6	1.1	0.8	19.1
Samoa	4.6	4.6	4.6	3.9	3.2	2.6	1.9	1.2	0.5	0.3	0.3	34.6	1.7	1.8	1.7	1.5	1.2	1.0	0.7	0.4	0.2	0.1	0.1	12.3
Tonga	1.8	1.8	1.8	1.7	1.5	1.3	1.1	1.0	0.8	0.6	0.4	0.3	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.1	0.1
Tuvalu	...	4.3	4.3	3.8	2.6	1.5	0.4	0.0	0.0	0.0	0.0	50.9	...	0.2	0.2	0.2	0.1	0.1	0.0	...	...	...	...	3.9

Source: United Nations Human Settlement Programme (UN-Habitat), , Global Urban Indicators Database 2024

Notes:

(a) The estimates are based on the global methodology on household deprivations where the inhabitants suffer one or more of the following 'household deprivations': Lack of access to improved water services, Lack of access to improved sanitation facilities, Lack of sufficient living area, and Lack of housing durability.
Informal settlements are synonymous of slums with households/neighborhoods characterized by lack, or are cut off from formal basic services and city infrastructure. Data for the slum/informal settlements components of the indicator is computed from censuses and national household surveys such as the Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS)

(b) Source: BELSTAT-National Statistical Committee of the Republic of Belarus

(c) Source: Singapore-Ministry of National Development

Last Updated: 23/10/2024

Table B.1: Population Size per Upper Threshold of Temperature Change for Selected RCP (Representative Concentration Pathways) [a] Scenarios by Regions, 2000 - 2025

Region Name \ World Bank Income Class	RCP 4.5 Population Size in 2025 [b,c] (Thousands) Temperature Increase (°C)				RCP 8.5 Population Size in 2025 [b,c] (Thousands) Temperature Increase (°C)			
	0.0-0.5	0.5-1.0	1.0-1.5	>1.5	0.0-0.5	0.5-1.0	1.0-1.5	>1.5
Total	1,807,152	1,740,971	139,510	2,537	1,114,285	2,212,452	362,448	214
Australia and New Zealand	11,052	7,681	0	0	312	18,421	0	0
Central and Southern Asia	309,822	571,644	23,686	0	221,128	485,002	199,023	0
Eastern and South-Eastern Asia	672,056	426,995	37,345	0	406,225	686,694	39,366	107
Europe	238,706	55,239	0	0	113,127	168,539	15,100	0
Latin America and the Caribbean	273,694	71,993	0	0	83,532	264,768	185	0
Northern Africa and Western Asia	138,816	205,564	472	0	36,050	202,845	105,850	107
Northern America	20,947	79,300	65,277	0	98,382	64,517	0	0
Oceania	1,585	595	0	2,537	1,008	1,172	0	0
Sub-Saharan Africa	140,469	321,957	12,727	0	154,517	320,348	2,922	0
High Income	320,869	204,644	65,277	2,537	228,710	356,490	5,765	0
Upper Middle	683,949	591,428	37,345	0	338,729	822,891	149,809	107
Lower Middle	684,660	792,927	32,341	0	451,395	857,468	200,957	107
Low Income	116,493	146,828	4,546	0	95,120	169,466	5,915	0

Source: European Commission, Joint Research Centre (EC-JRC)

Notes:
(a) Representative Concentration Pathways (RCP) are scenarios for climate change developed by the Intergovernmental Panel on Climate Change (IPCC) that are used to project future greenhouse gas concentrations.
(b) Data analysis conducted by EC-JRC with raw input data from the Copernicus Climate Change Service (C3S) provides the annual mean temperature over long time periods and two Representative Concentration Pathways (emissions scenarios) the "mid-range" RCP 4.5 and RCP 8.5 as "high-emissions" scenario.
Total GHSL population data is calculated at three temperature change thresholds, data reports the population exposed to a temperature change of more than 0.5, 1 and 1.5 degrees. For each threshold the data is available for the two Representative Concentration Pathways.
For more detailed information and queries: https://data.jrc.ec.europa.eu/
(c) Since the population sizes have been rounded to the closest 1,000, the totals may not be equal.
Last Updated: 15/08/2024

Table B.2: Population Size in Low Elevated Coastal Zones (LECZ) for Areas Below 5 Metres Above Sea Level per Degree of Urbanisation (DEGURBA) [a] Level 1 Classification by Income Groups and Regions, 1975-2025

Region Name \ World Bank Income Class	Total LECZ [b] Population Size [c], 1975-2025 (Thousands)											Urban Centres LECZ [b] Population Size [c], 1975-2025 (Thousands)										
	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025
Total	**452,422**	**503,334**	**563,183**	**629,060**	**692,565**	**757,955**	**817,231**	**873,836**	**934,939**	**989,135**	**1,036,759**	**208,893**	**233,328**	**260,258**	**291,655**	**330,607**	**376,379**	**409,825**	**442,075**	**475,104**	**506,258**	**529,647**
Australia and New Zealand	415	430	462	495	511	552	580	620	644	672	687	780	851	928	1,023	1,122	1,199	1,294	1,413	1,540	1,684	1,781
Central and Southern Asia	139,760	160,010	184,808	211,335	236,764	264,098	291,434	316,028	340,679	364,167	387,573	43,853	50,159	57,067	64,121	71,817	79,703	86,183	91,234	96,861	102,390	108,110
Eastern and South-Eastern Asia	194,097	213,848	237,416	264,661	291,297	317,111	335,647	353,670	372,283	387,302	394,147	109,763	121,550	134,890	151,600	175,819	205,648	224,638	242,837	260,908	277,725	287,921
Europe	47,025	48,231	49,200	50,310	50,652	50,548	50,533	50,974	51,655	52,368	52,306	16,810	17,119	17,415	17,803	18,083	18,300	18,600	19,045	19,553	20,154	20,418
Latin America and the Caribbean	18,110	20,302	22,599	24,893	27,217	29,368	31,307	32,990	35,002	37,057	38,861	11,242	12,877	14,449	16,201	17,885	19,630	21,043	22,414	23,748	24,714	25,630
Northern Africa and Western Asia	27,804	32,328	37,645	43,291	48,773	54,726	61,203	67,700	76,931	84,518	93,062	10,677	12,592	14,768	16,993	19,505	22,283	25,409	29,625	33,308	36,202	38,137
Northern America	10,068	10,682	11,166	11,568	12,212	12,742	13,217	13,645	14,192	14,649	14,996	8,850	9,671	10,400	11,254	12,100	12,991	13,491	13,912	14,552	15,225	15,578
Oceania	82	86	91	97	111	127	142	156	169	180	186	137	150	162	174	193	212	228	241	251	265	279
Sub-Saharan Africa	15,061	17,417	19,796	22,410	25,028	28,683	33,168	38,053	43,384	48,222	54,941	6,777	8,355	10,175	12,482	14,079	16,409	18,934	21,349	24,378	27,894	31,789
High Income	48,737	50,715	52,193	53,950	55,534	56,526	57,822	59,176	60,402	61,504	61,882	51,483	54,442	56,956	60,071	62,867	64,868	66,849	69,944	71,843	73,299	73,469
Upper Middle	192,807	211,082	232,184	256,424	279,681	303,586	321,367	338,833	358,894	375,283	383,705	63,350	70,880	80,719	93,480	113,532	140,709	156,840	172,045	187,819	202,732	211,336
Lower Middle	199,565	228,512	264,410	302,645	339,207	377,024	413,838	448,321	484,525	518,129	552,546	89,905	103,105	116,927	131,344	146,970	162,545	176,870	190,205	204,609	218,259	231,467
Low Income	11,308	13,019	14,385	16,022	18,117	20,786	24,154	27,445	31,045	34,126	38,522	4,082	4,821	5,570	6,665	7,135	8,143	9,133	9,726	10,653	11,754	13,138
Total	**129,335**	**142,835**	**159,061**	**175,442**	**189,414**	**202,005**	**214,173**	**225,290**	**236,889**	**246,288**	**253,489**	**39,097**	**41,998**	**46,087**	**50,412**	**52,287**	**53,943**	**56,320**	**58,799**	**61,652**	**65,525**	**68,552**
Australia and New Zealand	409	439	481	531	577	640	695	758	811	868	909	290	299	323	350	365	400	425	456	480	509	532
Central and Southern Asia	28,720	32,129	36,555	40,717	43,440	46,217	49,300	51,380	53,846	56,882	59,206	5,144	5,066	5,056	5,165	5,199	5,252	5,409	5,520	5,688	5,974	6,191
Eastern and South-Eastern Asia	69,285	76,735	85,449	94,500	102,542	109,062	114,514	119,574	124,655	127,985	130,151	17,788	19,670	22,471	25,498	26,355	27,003	27,961	29,021	30,328	32,320	33,575
Europe	12,770	13,118	13,396	13,672	13,975	14,216	14,503	14,877	15,096	15,159	15,070	7,118	7,340	7,551	7,755	7,883	7,958	8,121	8,331	8,473	8,515	8,596
Latin America and the Caribbean	4,676	5,071	5,583	6,099	6,751	7,410	8,120	8,809	9,424	9,955	10,365	3,171	3,441	3,791	4,122	4,384	4,644	4,974	5,263	5,567	6,032	6,326
Northern Africa and Western Asia	6,437	7,498	8,818	10,258	11,521	12,856	14,226	15,928	17,819	18,992	20,131	896	1,055	1,250	1,447	1,571	1,720	1,871	2,090	2,389	2,708	3,002
Northern America	4,308	4,661	5,122	5,521	5,916	6,290	6,791	7,166	7,577	7,913	8,113	2,427	2,574	2,809	2,948	3,108	3,223	3,447	3,586	3,709	3,777	3,870
Oceania	244	273	313	356	395	444	492	540	583	609	646	597	651	715	784	874	974	1,069	1,158	1,243	1,305	1,373
Sub-Saharan Africa	2,483	2,908	3,340	3,785	4,292	4,865	5,527	6,253	7,074	7,920	8,895	1,663	1,899	2,115	2,338	2,543	2,765	3,039	3,370	3,773	4,381	5,084
High Income	24,472	25,465	26,430	27,043	27,907	28,907	29,901	31,146	32,026	32,383	32,430	11,394	11,794	12,284	12,552	12,779	13,084	13,535	14,001	14,373	14,580	14,838
Upper Middle	41,298	45,015	49,273	54,222	58,416	61,712	65,191	68,730	72,270	74,395	75,345	11,353	12,959	15,001	17,179	17,666	17,842	18,457	19,168	19,944	21,106	21,863
Lower Middle	61,737	70,299	81,057	91,638	100,252	108,219	115,583	121,570	128,391	134,939	140,720	15,003	15,720	17,122	18,855	19,864	20,883	21,996	23,055	24,471	26,529	28,086
Low Income	1,725	1,951	2,186	2,409	2,685	2,992	3,306	3,636	3,979	4,328	4,734	1,309	1,485	1,634	1,771	1,920	2,073	2,266	2,508	2,794	3,232	3,679

Source: European Commission, Joint Research Centre (EC-JRC)

Notes:
(a) The Degree of Urbanisation offers a standardized definition of urban areas into three categories of human settlements: urban centres or cities; urban clusters or semi-dense areas; and rural areas. For more detailed information: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Applying_the_degree_of_urbanisation_manual
(b) Data provided by EC-JRC, with the Low Elevation Coastal Zones (LECZ) input dataset derived by a Digital Surface Model and provided by CIESIN (Center for International Earth Science Information Network). For more detailed information: https://data.jrc.ec.europa.eu/
(c) Since the population sizes have been rounded to the closest 1,000, the totals may not be equal.

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Table B.3: Share of Population in Low Elevated Coastal Zones (LECZ) for Areas Below 5 Metres Above Sea Level per Degree of Urbanisation (DEGURBA) [a] Level 1 Classification by Income Groups and Regions, 1975-2025 (%)

Region Name \ World Bank Income Class	Total LECZ [b] Share of the Population, 1975-2025 (%)											Urban Centres LECZ [b] Share of the Population, 1975-2025 (%)										
	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025
Total	**10.2**	**10.4**	**10.6**	**10.8**	**11.1**	**11.5**	**11.6**	**11.6**	**11.6**	**11.7**	**11.6**	**14.6**	**14.7**	**15.0**	**15.2**	**15.6**	**16.1**	**16.2**	**16.3**	**16.4**	**16.6**	**16.6**
Australia and New Zealand	2.5	2.5	2.5	2.5	2.4	2.5	2.5	2.4	2.3	2.2	2.2	0.9	1.0	1.0	1.0	1.1	1.1	1.2	1.2	1.2	1.2	1.2
Central and Southern Asia	19.0	19.4	20.0	20.4	20.6	20.9	21.1	21.3	21.5	21.7	22.0	20.0	20.3	20.7	21.1	21.4	21.8	22.1	22.3	22.5	22.8	23.0
Eastern and South-Eastern Asia	15.9	16.2	16.6	17.1	17.8	18.7	19.0	19.4	19.7	19.9	20.1	17.2	17.5	18.0	18.5	19.6	20.9	21.7	22.4	23.0	23.5	23.8
Europe	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.4	7.5	7.6	7.6	9.4	9.4	9.4	9.4	9.3	9.3	9.3	9.3	9.3	9.4	9.4
Latin America and the Caribbean	5.9	5.9	6.0	6.0	6.0	6.0	6.0	5.9	6.0	6.0	6.1	5.4	5.4	5.4	5.3	5.3	5.2	5.2	5.1	5.1	5.1	5.1
Northern Africa and Western Asia	16.7	16.9	17.1	17.4	17.6	17.9	18.2	18.0	18.6	18.7	19.2	17.2	17.2	17.3	17.6	17.7	18.0	18.2	17.9	18.7	18.8	19.5
Northern America	4.5	4.5	4.5	4.4	4.3	4.2	4.2	4.1	4.1	4.1	4.1	4.7	4.7	4.6	4.5	4.4	4.3	4.3	4.2	4.1	4.1	4.1
Oceania	1.8	1.8	1.7	1.6	1.6	1.6	1.5	1.5	1.4	1.4	1.3	1.5	1.4	1.2	1.1	1.1	1.0	1.0	0.9	0.8	0.8	0.7
Sub-Saharan Africa	4.9	4.9	4.8	4.7	4.6	4.6	4.7	4.7	4.7	4.5	4.6	5.1	5.2	5.2	5.2	4.9	5.0	5.0	5.0	5.0	4.9	5.0
High Income	5.9	5.9	5.8	5.8	5.7	5.6	5.6	5.5	5.4	5.4	5.4	7.4	7.3	7.2	7.1	6.9	6.7	6.6	6.5	6.4	6.3	6.2
Upper Middle	13.7	13.8	14.0	14.2	14.6	15.3	15.6	15.8	16.1	16.3	16.5	15.2	15.1	15.3	15.5	16.3	17.3	17.8	18.2	18.7	19.1	19.3
Lower Middle	17.2	17.5	18.1	18.5	18.8	19.0	19.1	19.1	19.2	19.2	19.3	17.1	17.4	17.9	18.4	18.7	19.2	19.4	19.5	19.7	19.7	19.8
Low Income	5.3	5.4	5.3	5.2	5.1	5.1	5.2	5.2	5.1	4.9	4.9	6.2	6.6	6.5	6.5	6.1	6.1	6.2	6.1	6.1	6.0	5.9
Total	**9.7**	**9.8**	**9.9**	**10.0**	**10.0**	**10.1**	**10.1**	**9.9**	**9.8**	**9.8**	**9.7**	**4.2**	**4.3**	**4.4**	**4.5**	**4.5**	**4.6**	**4.6**	**4.6**	**4.6**	**4.5**	**4.5**
Australia and New Zealand	3.8	3.7	3.7	3.6	3.5	3.6	3.5	3.5	3.4	3.3	3.2	5.5	5.4	5.4	5.3	5.1	5.0	4.8	4.7	4.4	4.3	4.1
Central and Southern Asia	22.6	23.1	23.7	24.2	24.0	24.0	24.1	24.2	24.4	24.7	25.2	9.4	9.4	9.5	9.6	9.7	9.8	10.0	10.1	10.2	10.1	10.3
Eastern and South-Eastern Asia	18.6	18.8	19.0	19.3	19.6	19.8	19.7	19.6	19.4	19.4	19.3	9.1	9.5	10.1	10.6	10.9	11.2	11.3	11.4	11.5	11.7	11.8
Europe	7.0	7.0	7.0	7.1	7.1	7.1	7.1	7.0	7.0	7.1	7.1	5.4	5.4	5.4	5.5	5.5	5.5	5.4	5.4	5.5	5.5	5.5
Latin America and the Caribbean	6.9	6.9	7.0	7.1	7.1	7.2	7.2	7.3	7.4	7.5	7.7	6.1	6.2	6.3	6.4	6.5	6.5	6.6	6.7	6.8	6.8	6.9
Northern Africa and Western Asia	25.5	25.7	25.9	26.2	25.7	25.7	25.9	25.4	25.4	25.6	25.9	6.0	6.2	6.3	6.4	6.6	6.8	7.1	7.1	7.4	7.8	8.1
Northern America	4.7	4.7	4.6	4.5	4.5	4.4	4.3	4.3	4.2	4.2	4.2	4.0	4.1	4.1	4.0	4.0	4.0	3.9	3.9	3.9	3.9	3.9
Oceania	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.5	0.5	0.4	2.4	2.3	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.1
Sub-Saharan Africa	4.6	4.5	4.4	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.9	4.9	4.9	4.7	4.7	4.7	4.8	4.8	4.6	4.4	4.4
High Income	5.2	5.2	5.2	5.2	5.2	5.2	5.1	5.1	5.0	5.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.9	4.0
Upper Middle	16.2	16.3	16.3	16.3	16.3	16.4	16.4	16.4	16.4	16.4	16.3	8.1	8.4	8.8	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.9
Lower Middle	21.6	22.1	22.6	23.1	23.0	23.0	22.9	22.7	22.7	22.9	23.1	9.1	9.0	9.1	9.4	9.5	9.5	9.5	9.5	9.4	9.3	9.4
Low Income	4.7	4.7	4.5	4.3	4.4	4.4	4.4	4.4	4.4	4.3	4.3	5.2	5.2	5.1	5.0	4.9	5.0	5.1	5.1	4.9	4.5	4.5

Source: European Commission, Joint Research Centre (EC-JRC)
Notes:
(a) The Degree of Urbanisation offers a standardized definition of urban areas into three categories of human settlements: urban centres or cities; urban clusters or semi-dense areas; and rural areas.
For more detailed information: https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/ks-02-20-499
(b) Data provided by EC-JRC, with the Low Elevation Coastal Zones (LECZ) input dataset derived by a Digital Surface Model and provided by CIESIN (Center for International Earth Science Information Network).
For more detailed information: https://data.jrc.ec.europa.eu/
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Table B.4: Population Sizes and Share of Population in the Urban Centres in Low Elevation Coastal Zones with Elevation Classes under 5 and 10 Metres by Income Groups and Regions, 1975 - 2030

Region Name \ World Bank Income Class	Urban Centres Population Size in Elevation Classes under 5 Metres [a,b] (Thousands)											
	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030
Total	**51,667**	**58,600**	**66,245**	**74,999**	**86,285**	**99,837**	**111,937**	**124,563**	**137,374**	**148,398**	**156,474**	**163,494**
Australia and New Zealand	161	184	211	245	279	310	340	371	403	442	468	492
Central and Southern Asia	5,522	6,528	7,698	8,871	10,186	11,591	12,828	13,955	15,053	15,984	16,907	17,816
Eastern and South-Eastern Asia	28,034	31,890	36,130	41,233	48,791	58,164	66,139	74,237	82,359	88,909	93,218	96,400
Europe	7,151	7,339	7,549	7,786	8,049	8,262	8,476	8,738	9,011	9,293	9,436	9,555
Latin America and the Caribbean	2,857	3,306	3,722	4,149	4,630	5,121	5,509	5,861	6,226	6,550	6,823	7,083
Northern Africa and Western Asia	3,604	4,356	5,222	6,110	7,117	8,272	9,598	11,419	12,985	14,321	15,114	15,891
Northern America	2,277	2,414	2,515	2,641	2,759	2,876	2,929	2,906	3,041	3,178	3,254	3,355
Oceania	37	42	47	52	58	64	70	74	79	84	90	98
Sub-Saharan Africa	2,020	2,537	3,147	3,907	4,412	5,173	6,044	6,998	8,214	9,632	11,160	12,801
High Income	18,377	19,309	20,089	21,100	22,105	22,771	23,432	24,550	25,203	25,690	25,747	25,812
Upper Middle	14,056	16,518	19,503	23,108	29,169	37,447	44,205	50,939	57,957	63,731	67,350	69,818
Lower Middle	18,434	21,818	25,521	29,382	33,534	37,876	42,294	46,897	51,757	56,154	60,153	64,199
Low Income	793	946	1,123	1,397	1,465	1,728	1,990	2,159	2,439	2,802	3,202	3,641
Total	**9.2**	**9.3**	**9.5**	**9.7**	**10.1**	**10.5**	**10.9**	**11.3**	**11.6**	**11.7**	**11.8**	**11.8**
Australia and New Zealand	1.8	2.0	2.1	2.3	2.4	2.6	2.7	2.7	2.7	2.7	2.7	2.7
Central and Southern Asia	7.3	7.5	7.7	7.8	8.0	8.1	8.3	8.5	8.5	8.3	8.2	8.0
Eastern and South-Eastern Asia	11.3	11.6	11.9	12.1	12.6	13.2	13.9	14.5	15.2	15.5	15.8	16.0
Europe	9.4	9.4	9.5	9.6	9.8	10.0	10.1	10.2	10.3	10.3	10.3	10.4
Latin America and the Caribbean	5.1	5.2	5.3	5.3	5.4	5.5	5.6	5.6	5.6	5.7	5.7	5.8
Northern Africa and Western Asia	10.3	10.7	11.0	11.3	11.6	12.1	12.6	13.1	13.4	13.7	13.8	13.9
Northern America	5.4	5.4	5.3	5.1	5.0	4.9	4.9	4.7	4.7	4.8	4.8	4.8
Oceania	6.9	6.8	6.6	6.5	6.5	6.5	6.4	6.4	6.3	6.0	5.9	5.8
Sub-Saharan Africa	9.0	9.1	9.3	9.6	9.3	9.3	9.3	9.2	9.1	8.9	9.0	9.0
High Income	8.4	8.3	8.2	8.1	8.1	8.1	8.1	8.1	8.0	8.0	7.9	7.8
Upper Middle	9.2	9.6	10.0	10.4	11.2	12.0	12.9	13.8	14.6	15.0	15.3	15.5
Lower Middle	10.5	10.7	11.0	11.2	11.3	11.5	11.7	11.9	12.0	12.0	12.0	11.9
Low Income	5.4	5.4	5.5	5.8	5.4	5.7	5.8	5.7	5.6	5.6	5.5	5.5

Region Name \ World Bank Income Class	Urban Centres Population Size in Elevation Classes under 10 Metres [a,b] (Thousands)											
	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030
Total	**157,832**	**175,436**	**194,857**	**217,688**	**245,536**	**277,972**	**299,582**	**319,556**	**340,127**	**360,576**	**376,133**	**390,344**
Australia and New Zealand	621	670	721	784	850	897	963	1,053	1,150	1,257	1,330	1,401
Central and Southern Asia	38,346	43,652	49,396	55,290	61,675	68,160	73,410	77,343	81,882	86,495	91,335	96,899
Eastern and South-Eastern Asia	81,951	89,904	99,040	110,709	127,452	148,026	159,177	169,456	179,562	189,916	195,854	199,209
Europe	9,735	9,864	9,957	10,115	10,136	10,143	10,244	10,448	10,700	11,029	11,153	11,256
Latin America and the Caribbean	8,546	9,749	10,926	12,263	13,479	14,747	15,784	16,809	17,790	18,459	19,117	19,746
Northern Africa and Western Asia	7,183	8,386	9,753	11,169	12,749	14,437	16,318	18,829	21,067	22,767	23,986	25,263
Northern America	6,582	7,267	7,896	8,627	9,356	10,131	10,580	11,024	11,530	12,068	12,346	12,765
Oceania	100	108	116	123	136	149	160	169	175	184	192	202
Sub-Saharan Africa	4,765	5,831	7,048	8,604	9,699	11,277	12,940	14,421	16,266	18,397	20,815	23,598
High Income	33,392	35,480	37,287	39,492	41,377	42,798	44,224	46,344	47,732	48,844	49,021	49,371
Upper Middle	49,642	54,762	61,649	70,844	84,900	103,879	113,372	121,984	130,866	140,078	145,099	147,289
Lower Middle	71,556	81,388	91,536	102,146	113,648	124,919	134,869	143,671	153,292	162,629	171,963	182,349
Low Income	3,174	3,733	4,306	5,120	5,518	6,273	6,997	7,418	8,073	8,828	9,832	11,094
Total	**34.5**	**34.6**	**34.8**	**35.1**	**35.9**	**36.7**	**36.7**	**36.3**	**36.0**	**35.6**	**35.5**	**35.2**
Australia and New Zealand	7.5	7.7	7.8	7.9	8.0	8.2	8.3	8.3	8.3	8.3	8.2	8.3
Central and Southern Asia	74.8	73.9	73.2	72.2	71.5	70.8	70.0	69.0	67.6	65.5	64.6	64.1
Eastern and South-Eastern Asia	44.4	43.6	43.3	43.3	44.4	45.4	45.1	44.7	44.5	44.6	44.6	44.5
Europe	13.9	13.7	13.6	13.6	13.5	13.4	13.3	13.2	13.2	13.3	13.3	13.3
Latin America and the Caribbean	17.3	17.3	17.5	17.7	17.8	17.9	17.9	18.0	18.0	18.0	18.0	18.0
Northern Africa and Western Asia	23.3	23.3	23.3	23.5	23.7	24.2	24.5	24.9	25.2	25.1	25.3	25.5
Northern America	15.4	16.2	16.6	17.0	17.3	17.6	17.8	17.9	18.1	18.2	18.3	18.3
Oceania	22.4	20.9	19.4	18.2	18.0	17.7	17.3	16.8	16.2	15.0	14.4	13.7
Sub-Saharan Africa	24.7	24.6	24.6	25.0	24.0	23.8	23.3	21.9	20.5	19.3	19.0	18.6
High Income	17.0	17.0	16.9	16.9	16.9	16.9	16.9	17.0	16.9	16.8	16.7	16.6
Upper Middle	41.8	40.8	40.7	41.1	42.6	44.3	44.1	43.7	43.6	43.9	43.8	43.4
Lower Middle	56.4	55.2	54.4	53.6	52.7	51.8	50.7	49.0	47.5	46.0	45.2	44.6
Low Income	23.4	23.5	23.5	24.1	23.1	23.4	23.0	21.9	20.8	19.6	19.1	18.7

Source: European Commission, Joint Research Centre (EC-JRC)

Notes:
(a) Data provided by EC-JRC, with the Low Elevation Coastal Zones (LECZ) input dataset derived by a Digital Surface Model and provided by CIESIN (Center for International Earth Science Information Network). For more detailed information: https://data.jrc.ec.europa.eu/
(b) Since the population sizes have been rounded to the closest 1,000, the totals may not be equal.

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Table B.5: Population Size and Share of Population in the Degree of Urbanisation (DEGURBA) [a] Typologies Level 1 Classification in Areas Exposed to 100 y Floods by Income Groups and Regions, 1975 - 2025

Region Name \ World Bank Income Class	Total Population Size, Exposed to 100 y Floods, 1975-2025 [b,c] (Thousands)										
	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025
Total	452,426	503,340	563,188	629,064	692,569	757,959	817,235	873,840	934,943	989,138	1,036,765
Australia and New Zealand	415	430	462	495	511	552	580	620	644	672	687
Central and Southern Asia	139,760	160,010	184,808	211,335	236,764	264,098	291,434	316,028	340,679	364,167	387,573
Eastern and South-Eastern Asia	194,097	213,848	237,416	264,661	291,297	317,111	335,647	353,670	372,283	387,302	394,147
Europe	47,025	48,231	49,200	50,310	50,652	50,548	50,533	50,974	51,655	52,368	52,306
Latin America and the Caribbean	18,110	20,302	22,599	24,893	27,217	29,368	31,307	32,990	35,002	37,057	38,861
Northern Africa and Western Asia	27,804	32,328	37,645	43,291	48,773	54,726	61,203	67,700	76,931	84,518	93,062
Northern America	10,068	10,682	11,166	11,568	12,212	12,742	13,217	13,645	14,192	14,649	14,996
Oceania	82	86	91	97	111	127	142	156	169	180	186
Sub-Saharan Africa	15,061	17,417	19,796	22,410	25,028	28,683	33,168	38,053	43,384	48,222	54,941
High Income	48,737	50,715	52,193	53,950	55,534	56,526	57,822	59,176	60,402	61,504	61,882
Upper Middle	192,807	211,082	232,184	256,424	279,681	303,586	321,367	338,833	358,894	375,283	383,705
Lower Middle	199,565	228,512	264,410	302,645	339,207	377,024	413,838	448,321	484,525	518,129	552,546
Low Income	11,308	13,019	14,385	16,022	18,117	20,786	24,154	27,445	31,045	34,126	38,522

Region Name \ World Bank Income Class	Urban Centres Population Size, Exposed to 100 y Floods, 1975-2025 [b,c] (Thousands)										
	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025
Total	194,605	217,812	243,775	273,959	313,718	359,855	394,441	426,865	462,326	492,122	517,158
Australia and New Zealand	85	95	106	118	131	139	153	172	189	206	218
Central and Southern Asia	60,654	68,980	78,727	89,284	103,426	118,392	131,234	142,652	153,330	161,179	169,370
Eastern and South-Eastern Asia	78,045	86,941	97,408	110,510	130,065	154,413	168,988	182,578	197,290	210,683	218,190
Europe	22,910	23,747	24,211	24,741	24,697	24,565	24,624	24,897	25,404	26,180	26,273
Latin America and the Caribbean	8,336	9,660	10,789	12,013	13,203	14,307	15,105	15,808	16,741	17,336	18,032
Northern Africa and Western Asia	15,006	17,522	20,473	23,776	27,426	31,294	35,434	39,673	45,592	50,390	55,884
Northern America	4,224	4,469	4,679	4,932	5,191	5,453	5,637	5,781	6,084	6,387	6,569
Oceania	9	10	10	10	12	13	14	14	14	15	15
Sub-Saharan Africa	5,331	6,384	7,368	8,570	9,563	11,275	13,248	15,286	17,676	19,742	22,604
High Income	27,453	28,685	29,524	30,797	31,583	31,953	32,574	33,235	33,970	34,858	34,998
Upper Middle	77,669	86,502	96,796	109,378	127,803	151,644	165,685	178,713	194,293	208,528	216,995
Lower Middle	85,744	98,042	112,261	127,767	147,624	168,330	186,876	204,407	222,089	235,571	250,181
Low Income	3,738	4,581	5,193	6,015	6,706	7,926	9,305	10,509	11,972	13,165	14,983

Region Name \ World Bank Income Class	Urban Clusters Population Size, Exposed to 100 y Floods, 1975-2025 [b,c] (Thousands)										
	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025
Total	194,238	216,552	243,336	271,390	292,462	309,972	330,613	350,246	370,898	388,894	405,501
Australia and New Zealand	144	148	159	170	175	193	204	218	225	233	236
Central and Southern Asia	65,894	76,816	90,475	104,696	115,152	126,562	139,549	151,226	163,612	177,149	190,235
Eastern and South-Eastern Asia	90,485	98,691	108,068	118,118	124,834	126,939	130,263	133,708	136,548	136,608	135,511
Europe	14,083	14,300	14,583	14,920	15,247	15,355	15,317	15,420	15,547	15,558	15,385
Latin America and the Caribbean	5,164	5,601	6,201	6,748	7,489	8,181	8,901	9,546	10,231	11,072	11,727
Northern Africa and Western Asia	10,556	12,206	14,186	16,188	17,812	19,647	21,709	23,707	26,485	28,573	30,906
Northern America	3,226	3,416	3,549	3,647	3,867	4,045	4,224	4,406	4,588	4,713	4,807
Oceania	8	9	10	11	13	15	17	19	21	20	21
Sub-Saharan Africa	4,675	5,360	6,100	6,888	7,869	9,030	10,425	11,992	13,637	14,963	16,669
High Income	12,982	13,409	13,757	14,066	14,590	15,021	15,441	15,868	16,210	16,368	16,416
Upper Middle	85,160	91,565	98,545	106,185	110,741	111,604	114,736	118,256	121,540	122,181	121,418
Lower Middle	92,818	107,865	126,944	146,567	161,663	176,984	192,906	207,397	223,160	239,420	255,560
Low Income	3,273	3,706	4,079	4,557	5,449	6,337	7,491	8,677	9,931	10,855	12,026

Region Name \ World Bank Income Class	Rural Areas Population Size, Exposed to 100 y Floods, 1975-2025 [b,c] (Thousands)										
	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025
Total	63,581	68,974	76,076	83,715	86,388	88,131	92,180	96,728	101,718	108,121	114,104
Australia and New Zealand	185	186	196	206	204	220	222	229	229	231	231
Central and Southern Asia	13,211	14,213	15,605	17,354	18,184	19,143	20,650	22,149	23,736	25,838	27,968
Eastern and South-Eastern Asia	25,566	28,214	31,940	36,032	36,397	35,758	36,394	37,383	38,443	40,010	40,445
Europe	10,032	10,183	10,405	10,647	10,707	10,627	10,591	10,656	10,703	10,629	10,647
Latin America and the Caribbean	4,609	5,040	5,607	6,131	6,524	6,878	7,300	7,634	8,028	8,648	9,101
Northern Africa and Western Asia	2,241	2,599	2,985	3,327	3,534	3,784	4,059	4,320	4,853	5,553	6,271
Northern America	2,617	2,797	2,937	2,988	3,153	3,242	3,355	3,457	3,519	3,548	3,620
Oceania	63	67	70	74	85	98	110	122	133	143	149
Sub-Saharan Africa	5,054	5,672	6,326	6,951	7,595	8,378	9,494	10,774	12,069	13,516	15,667
High Income	8,302	8,620	8,910	9,086	9,360	9,551	9,806	10,072	10,221	10,278	10,467
Upper Middle	29,977	33,015	36,842	40,861	41,136	40,338	40,945	41,863	43,060	44,574	45,291
Lower Middle	21,002	22,604	25,204	28,310	29,919	31,709	34,055	36,516	39,275	43,137	46,804
Low Income	4,295	4,731	5,112	5,448	5,961	6,522	7,357	8,258	9,141	10,105	11,512

Region Name \ World Bank Income Class	Total Share of Population, Exposed to 100 y Floods, 1975-2025 [b] (%)										
	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025
Total	12.5	12.8	13.1	13.4	13.7	14.1	14.2	14.3	14.4	14.5	14.5
Australia and New Zealand	2.5	2.5	2.5	2.5	2.4	2.5	2.5	2.4	2.3	2.2	2.2
Central and Southern Asia	19.0	19.4	20.0	20.4	20.6	20.9	21.1	21.3	21.5	21.7	22.0
Eastern and South-Eastern Asia	15.9	16.2	16.6	17.1	17.8	18.7	19.0	19.4	19.7	19.9	20.1
Europe	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.4	7.5	7.6	7.6
Latin America and the Caribbean	5.9	5.9	6.0	6.0	6.0	6.0	6.0	5.9	6.0	6.0	6.1
Northern Africa and Western Asia	16.7	16.9	17.1	17.4	17.6	17.9	18.2	18.0	18.6	18.7	19.2
Northern America	4.5	4.5	4.5	4.4	4.3	4.2	4.2	4.1	4.1	4.1	4.1
Oceania	1.8	1.8	1.7	1.6	1.6	1.6	1.5	1.5	1.4	1.4	1.3
Sub-Saharan Africa	4.9	4.9	4.8	4.7	4.6	4.6	4.7	4.7	4.7	4.5	4.6
High Income	5.9	5.9	5.8	5.8	5.7	5.6	5.6	5.5	5.4	5.4	5.4
Upper Middle	13.7	13.8	14.0	14.2	14.6	15.3	15.6	15.8	16.1	16.3	16.5
Lower Middle	17.2	17.5	18.1	18.5	18.8	19.0	19.1	19.1	19.2	19.2	19.3
Low Income	5.3	5.4	5.3	5.2	5.1	5.1	5.2	5.2	5.1	4.9	4.9

Region Name \ World Bank Income Class	Urban Centres Share of Population, Exposed to 100 y Floods, 1975-2025 [b] (%)										
	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025
Total	13.4	13.6	13.9	14.2	14.6	15.2	15.5	15.7	15.9	16.1	16.1
Australia and New Zealand	0.9	1.0	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.2	1.2
Central and Southern Asia	16.6	16.9	17.2	17.4	17.6	17.9	18.1	18.2	18.4	18.6	18.7
Eastern and South-Eastern Asia	14.6	14.9	15.2	15.6	16.4	17.3	17.8	18.3	18.7	19.0	19.2
Europe	8.6	8.6	8.6	8.6	8.5	8.5	8.5	8.5	8.5	8.6	8.6
Latin America and the Caribbean	5.1	5.1	5.1	5.0	5.0	5.0	4.9	4.8	4.8	4.8	4.9
Northern Africa and Western Asia	14.7	14.7	14.8	15.0	15.1	15.3	15.4	15.2	15.7	15.8	16.3
Northern America	4.5	4.5	4.4	4.3	4.2	4.1	4.1	4.0	4.0	4.0	4.0
Oceania	1.5	1.3	1.2	1.1	1.1	1.0	1.0	0.9	0.8	0.8	0.7
Sub-Saharan Africa	4.9	5.0	4.9	4.9	4.7	4.7	4.8	4.8	4.8	4.7	4.7
High Income	7.4	7.3	7.2	7.1	6.9	6.7	6.6	6.5	6.4	6.3	6.2
Upper Middle	15.2	15.1	15.3	15.5	16.3	17.3	17.8	18.2	18.7	19.1	19.3
Lower Middle	17.1	17.4	17.9	18.4	18.7	19.2	19.4	19.5	19.7	19.7	19.8
Low Income	6.2	6.6	6.5	6.5	6.1	6.1	6.2	6.1	6.1	6.0	5.9

Region Name \ World Bank Income Class	Urban Clusters Share of Population, Exposed to 100 y Floods, 1975-2025 [b] (%)										
	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025
Total	15.3	15.6	16.0	16.3	16.4	16.4	16.4	16.3	16.3	16.4	16.5
Australia and New Zealand	3.6	3.6	3.5	3.5	3.4	3.5	3.4	3.4	3.3	3.2	3.1
Central and Southern Asia	18.4	18.8	19.2	19.5	19.3	19.4	19.4	19.5	19.6	19.8	20.1
Eastern and South-Eastern Asia	15.7	15.8	16.0	16.2	16.4	16.5	16.5	16.4	16.3	16.2	16.2
Europe	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
Latin America and the Caribbean	6.5	6.5	6.6	6.6	6.6	6.7	6.7	6.8	6.9	7.0	7.2
Northern Africa and Western Asia	20.3	20.4	20.6	20.8	20.5	20.4	20.6	20.2	20.3	20.4	20.5
Northern America	4.5	4.5	4.4	4.3	4.3	4.2	4.1	4.1	4.1	4.0	4.0
Oceania	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.4
Sub-Saharan Africa	4.4	4.3	4.2	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
High Income	5.2	5.2	5.2	5.2	5.2	5.2	5.1	5.1	5.0	5.0	5.0
Upper Middle	16.2	16.3	16.3	16.3	16.3	16.4	16.4	16.4	16.4	16.4	16.3
Lower Middle	21.6	22.1	22.6	23.1	23.0	23.0	22.9	22.7	22.7	22.9	23.1
Low Income	4.7	4.7	4.5	4.3	4.4	4.4	4.4	4.4	4.4	4.3	4.3

Region Name \ World Bank Income Class	Rural Areas Share of Population, Exposed to 100 y Floods, 1975-2025 [b] (%)										
	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025
Total	7.1	7.2	7.5	7.7	7.7	7.7	7.8	7.8	7.8	7.7	7.7
Australia and New Zealand	5.2	5.1	5.1	5.0	4.8	4.8	4.6	4.4	4.3	4.1	4.0
Central and Southern Asia	8.6	8.6	8.6	8.8	8.8	8.9	9.1	9.2	9.3	9.2	9.3
Eastern and South-Eastern Asia	8.3	8.7	9.1	9.6	9.8	10.1	10.2	10.2	10.3	10.5	10.6
Europe	5.1	5.1	5.1	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
Latin America and the Caribbean	5.7	5.8	5.9	6.0	6.1	6.1	6.2	6.3	6.3	6.4	6.5
Northern Africa and Western Asia	5.6	5.8	6.0	6.1	6.2	6.4	6.6	6.6	6.9	7.2	7.5
Northern America	3.9	3.9	3.9	3.8	3.8	3.8	3.8	3.8	3.7	3.7	3.7
Oceania	2.4	2.3	2.2	2.1	2.2	2.2	2.2	2.2	2.2	2.1	2.1
Sub-Saharan Africa	4.7	4.7	4.6	4.5	4.4	4.5	4.5	4.5	4.4	4.2	4.2
High Income	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.9	4.0
Upper Middle	8.1	8.4	8.8	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.9
Lower Middle	9.1	9.0	9.1	9.4	9.5	9.5	9.5	9.5	9.4	9.3	9.4
Low Income	5.2	5.2	5.1	5.0	4.9	5.0	5.1	5.1	4.9	4.5	4.5

Source: European Commission, Joint Research Centre (EC-JRC)

Notes:

(a) The Degree of Urbanisation offers a standardized definition of urban areas into three categories of human settlements: urban centres or cities; urban clusters or semi-dense areas; and rural areas.
For more detailed information: https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/ks-02-20-499

(b) Data analysis conducted by EC-JRC with raw input data from the global flood hazard maps for different return periods provided by GLOFAS-JRC. The 100 years return period flood hazard map represents the modelled area flooded by a flood event to occur at, or above, a specific intensity within 100 years.
The data shows total population living in these modelled areas during the timeseries 1975-2025 for each GHSL settlement general class, being rural areas, urban clusters or towns and urban centers or cities.
For more detailed information: https://data.jrc.ec.europa.eu/

(c) Since the population sizes have been rounded to the closest 1,000, the totals may not be equal.

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Table C.1: Spatial Urbanization Indicators in Regions and Selected Cities for Selected Years

Country / Territory Name	City Name	Green Area per Capita (UMF 47-3.3.2) [a]								SDG 11.2.1. Public Transport (UMF 10-1.2.2), 2020 [b]	SDG 11.7.1. Open Public Spaces (UMF44-3.2.1), 2020 [b]		SDG 11.3.1. Land Consumption (UMF 51-3.4.2)[b]				
		Green Area Per Capita 1990 (m² per capita)	Green Area Per Capita 2000 (m² per capita)	Green Area Per Capita 2010 (m² per capita)	Green Area Per Capita 2020 (m² per capita)	Proportion of Green Area in City/ Urban Area 1990 (%)	Proportion of Green Area in City/ Urban Area 2000 (%)	Proportion of Green Area in City/ Urban Area 2010 (%)	Proportion of Green Area in City/ Urban Area 2020 (%)	Proportion of population living within convenient walking distance to public transport (%)[c]	Average share of urban area that is open space for public use for all (%)[d]	Average share of urban population with convenient access to open public spaces (%) [e]	Land Consumption Rate to Population Growth Rate (LCRPGR) Year 1 to Year 2 (Ratio)	Land Consumption Rate to Population Growth Rate (LCRPGR) Year 2 to Year 3 (Ratio)	Built Up area Per Capita Year 1 (m² per capita)	Built Up area Per Capita Year 2 (m² per capita)	Built Up area Per Capita Year 3 (m² per capita)
WORLD [f]		**86.6**	**63.7**	**50.1**	**43.8**	**21.9**	**19.2**	**16.7**	**15.3**	**60.9**	**...**	**44.2**	**...**	**...**	**...**	**...**	**...**
Australia and New Zealand [f]		**144.4**	**113.1**	**105.6**	**92.8**	**21.9**	**19.9**	**20.3**	**20.0**	**81.3**	**...**	**71.1**	**...**	**...**	**...**	**...**	**...**
Central and Southern Asia [f]		**37.2**	**24.8**	**17.6**	**13.6**	**15.8**	**13.2**	**10.4**	**9.2**	**52.8**	**...**	**38.2**	**...**	**...**	**...**	**...**	**...**
Sub-Saharan Africa [f]		**81.5**	**48.8**	**30.6**	**19.6**	**19.1**	**15.7**	**13.1**	**9.5**	**33.8**	**...**	**21.2**	**...**	**...**	**...**	**...**	**...**
Latin America and the Caribbean [f]		**96.0**	**59.3**	**41.7**	**33.6**	**29.7**	**23.6**	**19.5**	**17.3**	**60.6**	**...**	**57.6**	**...**	**...**	**...**	**...**	**...**
Northern America and Europe [f]		**139.2**	**120.3**	**105.9**	**100.8**	**22.6**	**22.4**	**22.0**	**23.0**	**82.6**	**...**	**65.8**	**...**	**...**	**...**	**...**	**...**
Oceania excluding Australia and New Zealand [f]		**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**16.2**	**...**	**30.5**	**...**	**...**	**...**	**...**	**...**
Western Asia and Northern Africa [f]		**23.6**	**16.1**	**10.8**	**9.1**	**14.0**	**11.4**	**9.5**	**8.0**	**49.3**	**...**	**41.1**	**...**	**...**	**...**	**...**	**...**
Eastern and South-Eastern Asia [f]		**110.3**	**69.6**	**45.0**	**34.6**	**34.4**	**30.8**	**23.7**	**19.8**	**56.6**	**...**	**36.1**	**...**	**...**	**...**	**...**	**...**
ECA [f]		**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**34.9**	**...**	**23.2**	**...**	**...**	**...**	**...**	**...**
ECE [f]		**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**81.5**	**...**	**63.5**	**...**	**...**	**...**	**...**	**...**
ECLAC [f]		**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**60.6**	**...**	**57.6**	**...**	**...**	**...**	**...**	**...**
ESCAP [f]		**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**59.0**	**...**	**40.2**	**...**	**...**	**...**	**...**	**...**
ESCWA [f]		**...**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	**33.7**	**...**	**32.5**	**...**	**...**	**...**	**...**	**...**
Afghanistan	Herat	25.0	7.8	3.6	1.7	11.0	5.1	3.8	3.2	50.4	17.2	55.6	...	...	...	...	...
Afghanistan	Kabul	7.8	5.3	2.6	1.7	5.5	5.8	3.9	3.5	19.1	19.9	13.0	0.4	0.2	40.8	33.7	26.5
Afghanistan	Mazar-e Sharif	6.9	1.0	1.3	1.5	2.6	0.4	0.7	1.2	57.8	15.3	65.6	2.5	0.5	53.1	79.7	65.5
Algeria	Annaba	23.3	18.9	16.5	17.7	13.3	11.1	9.6	10.9	15.4	14.8	49.6	0.0	1.9	69.6	85.6	89.7
Algeria	Blida	30.4	25.1	16.2	13.5	10.0	11.0	9.1	10.0	41.1	15.4	54.0	0.5	0.6	105.0	91.8	83.4
Angola	Huambo	13.4	11.6	11.8	11.4	8.0	8.1	7.8	7.1	21.5	16.1	14.0	...	...	...	...	...
Angola	Luena	163.7	55.6	16.7	4.5	4.5	5.5	5.3	3.4	5.2	13.2	22.9	...	...	...	...	...
Angola	Malanje	12.0	7.0	4.8	2.1	3.4	3.7	3.8	2.6	10.5	9.9	9.5	0.3	1.1	72.4	55.1	56.8
Argentina	Buenos Aires	64.8	56.8	33.2	25.0	31.9	31.1	20.4	16.0	87.3	16.3	49.5	0.5	1.6	116.8	110.8	113.6
Argentina	Clorinda	204.4	115.0	79.9	51.1	49.5	32.4	24.0	16.5	...	18.5	73.7	1.5	1.4	184.5	189.8	195.0
Argentina	Rosario	54.4	55.4	31.5	28.0	22.6	24.1	14.4	14.5	90.6	22.8	52.8	1.9	0.8	126.9	132.3	128.4
Argentina	San Juan	79.2	44.6	28.7	19.2	23.2	15.1	10.5	7.5	15.7	17.5	59.1	1.6	1.6	150.7	158.0	164.6
Armenia	Yerevan	35.5	27.7	27.3	31.7	16.7	12.0	11.2	12.3	68.9	19.8	47.2	...	...	...	...	...
Australia	Cairns	252.7	146.6	118.5	110.9	23.5	17.6	18.0	19.0	77.2	23.9	97.8	1.7	0.1	272.5	320.2	286.0
Australia	Central Coast	101.6	80.4	85.3	77.8	10.2	11.0	13.7	14.3	94.4	17.9	76.2	0.7	0.4	375.8	359.0	329.5
Australia	Hobart	135.1	128.6	112.8	84.4	22.2	20.5	18.6	14.3	94.3	26.2	73.9	1.8	3.9	375.9	386.5	419.3
Australia	Newcastle-Maitland	106.7	114.2	110.1	101.0	13.3	16.6	17.7	17.5	90.9	20.7	73.4	0.4	0.8	338.6	319.3	315.0
Australia	Sydney	43.6	36.3	40.4	32.7	9.9	8.6	10.7	10.3	69.6	13.5	33.4	0.3	0.2	251.4	234.4	204.6
Australia	Wollongong	106.0	88.5	105.6	96.7	15.9	14.2	17.9	17.8	90.6	19.2	80.6	1.7	1.4	349.8	364.5	377.0
Austria	Wien (Vienna)	75.3	71.4	58.7	60.4	30.3	29.3	26.3	30.7	97.5	27.5	72.4	0.1	0.4	147.4	136.6	127.0
Azerbaijan	Baku	9.8	6.3	3.9	3.7	4.2	2.8	1.9	2.0	80.0	7.6	36.4	2.2	1.9	112.6	127.1	136.3
Bahrain	Al-Manamah (Manama)	35.1	32.7	11.3	10.5	5.9	7.6	4.5	4.8	...	...	...	0.4	0.6	203.3	148.1	139.4
Bangladesh	Dhaka	15.8	9.4	4.9	1.4	20.2	18.0	13.1	5.1	47.6	0.0	23.0	0.6	0.2	25.8	22.5	17.4
Belarus	Minsk	77.3	56.2	47.4	25.3	40.6	30.9	27.9	16.6	99.1	19.5	...	0.0	-224.1	45.2	45.4	82.2
Belgium	Antwerpen	39.7	46.2	58.5	51.6	12.2	14.7	19.5	18.0	95.3	22.1	64.4	0.9	1.6	133.0	132.6	136.2
Benin	Djougou	23.0	15.4	22.5	15.0	3.8	3.6	6.7	5.8	24.5	16.0	40.7	0.6	0.8	185.6	169.0	159.9
Benin	Kandi	36.4	44.3	14.4	8.9	6.6	13.0	6.7	5.5	58.4	13.7	70.4	0.9	2.0	83.3	78.2	103.2
Benin	Parakou	60.4	47.9	30.4	17.5	8.1	8.9	8.5	7.6	46.2	17.3	81.9	...	...	...	...	...
Bolivia (Plurinational State of)	La Paz	3.3	2.5	2.7	1.8	1.4	1.3	1.6	1.2	51.5	20.7	79.5	1.4	2.0	82.9	87.5	99.4
Botswana	Gaborone	11.9	12.6	5.7	6.4	0.9	1.4	0.8	1.2	66.5	16.6	66.5	0.9	0.2	481.0	471.4	390.2
Brazil	Aparecida de Goiânia	85.2	37.4	37.6	28.1	16.8	10.5	13.0	12.4	87.1	22.2	52.8	0.7	0.4	182.1	170.0	146.6
Brazil	Belém	71.1	27.0	17.6	20.9	39.7	21.2	15.5	20.0	31.2	14.9	29.3	...	...	...	...	...
Brazil	Belo Horizonte	36.1	26.3	19.2	24.3	15.5	15.1	12.1	16.6	85.8	19.3	41.6	0.4	0.4	110.6	104.7	98.9
Brazil	Blumenau	280.0	142.8	107.4	102.3	58.2	38.3	33.7	35.9	...	...	...	...	...	...	...	...
Brazil	Brasília	22.9	19.5	11.9	13.4	6.1	8.4	6.3	8.8	76.3	21.5	47.2	1.4	0.3	91.2	98.7	86.3
Brazil	Campinas	161.3	74.4	73.7	61.6	34.1	21.1	24.5	23.3	78.0	14.3	56.8	0.8	1.0	147.3	143.3	143.9
Brazil	Criciúma	237.1	135.6	97.5	93.4	48.9	31.2	25.4	25.0	57.4	11.3	52.2	1.3	4.3	223.6	231.4	251.7
Brazil	Cuiabá	96.1	68.7	61.8	49.2	23.3	21.1	21.5	18.0	80.1	18.9	47.9	...	...	...	...	...
Brazil	Feira De Santana	36.7	33.8	14.2	13.3	13.3	15.5	7.5	8.0	...	...	...	...	...	...	...	...
Brazil	Fortaleza	39.5	28.0	20.2	15.7	21.3	18.5	15.5	13.1	97.5	20.1	61.5	0.8	1.0	79.9	77.3	77.2
Brazil	Jaraguá do Sul	509.7	227.3	137.8	117.4	61.1	40.4	32.4	33.0	...	...	...	...	...	...	...	...
Brazil	Manaus	134.8	56.2	32.2	24.1	53.7	32.4	23.7	22.0	98.5	15.1	31.5	0.4	0.2	93.8	81.3	68.5
Brazil	Petrolina	3.2	2.4	1.6	2.0	0.8	0.8	0.7	1.1	...	...	...	...	...	...	...	...
Brazil	Pôrto Alegre	62.5	55.6	41.8	37.3	26.5	27.4	21.5	19.8	80.1	18.4	63.0	...	...	...	...	...
Brazil	Pôrto Velho	94.6	39.0	29.8	18.7	24.9	12.0	11.6	8.3	...	...	...	...	...	...	...	...
Brazil	Rio de Janeiro	48.4	32.8	33.5	32.6	33.3	25.9	28.3	29.1	89.7	12.6	58.6	0.9	1.1	77.2	76.6	76.9
Brazil	Salvador	47.1	40.2	29.5	26.2	35.9	37.0	30.2	29.6	80.4	13.5	44.8	1.1	0.5	59.4	59.8	56.6
Brazil	São Gonçalo	81.1	62.8	65.2	65.2	37.9	34.2	39.2	41.9	90.8	...	...	0.5	0.5	107.7	102.7	99.5
Brazil	São Paulo	36.3	25.3	24.1	21.3	27.7	21.0	21.9	20.1	88.3	18.8	53.8	...	...	...	...	...
Bulgaria	Burgas	20.3	14.2	14.1	24.3	10.0	6.9	6.6	10.7	89.2	22.5	85.0	-2.2	-0.2	129.2	139.5	151.3
Bulgaria	Dobrič (Dobrich)	39.6	34.8	45.3	58.1	19.0	14.6	16.2	17.0	87.7	18.4	84.1	-0.4	-0.2	128.5	162.0	206.4
Bulgaria	Sofia	13.9	22.4	26.0	33.1	7.0	10.7	13.2	17.9	92.1	20.5	63.8	0.9	0.3	121.5	120.4	115.4
Burkina Faso	Bobo-Dioulasso	20.7	4.3	3.6	1.9	3.8	1.1	1.4	1.2	43.9	...	...	0.8	0.9	123.3	112.7	107.6
Burkina Faso	Ouagadougou	32.4	4.0	3.8	2.5	3.3	0.7	1.1	1.2	31.5	13.0	44.9	0.4	1.0	193.5	139.8	140.4

Table C.1: Continued

Country / Territory Name	City Name	Green Area per Capita (UMF 47-3.3.2) [a]								SDG 11.2.1. Public Transport (UMF 10-1.2.2), 2020 [b]	SDG 11.7.1. Open Public Spaces (UMF44-3.2.1), 2020 [b]		SDG 11.3.1. Land Consumption (UMF 51-3.4.2)[b]				
		Green Area Per Capita 1990 (m² per capita)	Green Area Per Capita 2000 (m² per capita)	Green Area Per Capita 2010 (m² per capita)	Green Area Per Capita 2020 (m² per capita)	Proportion of Green Area in City/ Urban Area 1990 (%)	Proportion of Green Area in City/ Urban Area 2000 (%)	Proportion of Green Area in City/ Urban Area 2010 (%)	Proportion of Green Area in City/ Urban Area 2020 (%)	Proportion of population living within convenient walking distance to public transport (%)[c]	Average share of urban area that is open space for public use for all (%)[d]	Average share of urban population with convenient access to open public spaces (%) [e]	Land Consumption Rate to Population Growth Rate (LCRPGR) Year 1 to Year 2 (Ratio)	Land Consumption Rate to Population Growth Rate (LCRPGR) Year 2 to Year 3 (Ratio)	Built Up area Per Capita Year 1 (m² per capita)	Built Up area Per Capita Year 2 (m² per capita)	Built Up area Per Capita Year 3 (m² per capita)
Cambodia	Phnum Pénh (Phnom Penh)	138.3	67.9	56.7	28.6	27.5	24.8	28.3	18.6	47.4	14.8	13.7	2.0	1.1	59.5	80.2	81.6
Canada	Calgary	39.8	32.3	20.1	14.3	5.0	5.1	4.1	3.8	88.9	27.3	92.5	0.5	0.4	756.7	666.3	576.2
Canada	London	202.0	183.6	144.3	142.6	31.2	32.7	28.0	29.9	77.7	...	...	2.2	0.5	825.0	912.6	874.1
Canada	Montréal	25.9	23.7	18.2	33.0	7.9	7.7	6.4	12.3	91.6	20.0	91.8	1.6	0.9	402.4	414.8	410.8
Canada	Ottawa-Gatineau	113.6	95.7	80.8	73.3	23.7	22.1	21.3	21.7	85.0	...	...	0.2	0.5	811.9	733.2	688.9
Canada	Regina,SASK	42.7	39.1	29.7	23.4	7.6	6.9	5.6	5.4	90.4	30.1	95.5	7.3	0.6	1,095.5	1,135.9	1,092.3
Canada	Toronto	94.0	75.1	64.9	56.8	20.9	19.6	19.7	19.2	93.0	21.2	91.7	1.1	0.3	439.8	445.7	391.2
Canada	Vancouver	193.8	156.1	122.9	100.1	37.2	37.4	34.0	31.5	92.7	...	...	0.8	0.2	504.5	485.0	430.1
Central African Republic	Bangui	136.6	104.7	67.3	37.8	53.0	51.4	41.8	28.2	17.2	10.9	24.7	0.8	1.2	97.6	93.8	97.5
Chad	N'Djaména	11.4	4.9	4.6	3.0	2.1	1.3	1.7	1.6	13.4	13.7	6.6	0.7	1.4	115.7	103.4	119.8
Chile	Concepción	42.3	32.6	24.4	19.8	25.0	20.7	15.4	13.6	91.8	23.1	90.9	1.5	0.0	171.0	176.9	0.0
Chile	Los Ángeles	210.9	145.1	72.1	23.2	50.6	46.5	30.0	11.7	47.5	17.7	93.6	1.9	0.0	151.8	171.6	0.0
Chile	Santiago	26.5	11.0	5.9	6.5	15.0	7.6	4.6	5.5	92.0	21.5	92.9	0.7	0.0	118.0	112.2	0.0
Chile	Temuco	148.6	69.6	23.7	18.8	48.7	31.9	13.9	13.0	90.0	23.7	93.9	2.5	0.0	151.8	167.9	0.0
China	Beijing	53.3	60.6	42.4	41.6	10.5	16.2	16.0	18.1	...	...	...	1.1	1.4	107.4	111.3	117.6
China	Chaozhou	69.3	15.9	6.7	1.6	26.1	12.8	5.9	1.6	...	...	...	...	...	...	...	...
China	Chengdu	229.2	169.8	86.7	69.4	88.7	79.3	50.6	36.6	49.3	0.0	33.6	1.3	0.0	71.8	77.0	101.6
China	Haikou	96.4	55.3	21.6	22.8	35.2	30.7	16.3	17.7	52.2	0.0	20.6	1.0	5.5	71.7	71.7	81.9
China	Hangzhou	531.1	282.5	152.1	113.6	84.1	70.4	46.6	35.8	37.7	0.0	20.5	1.7	2.9	123.7	142.0	150.1
China	Hong Kong, Hong Kong	1.7	2.7	2.4	2.4	5.9	11.0	10.4	11.2	98.5	29.1	95.7	0.9	1.2	11.9	11.8	12.0
China	Ji'nan, Shandong	280.8	186.5	120.6	66.4	73.1	57.8	43.1	26.2	34.3	0.0	26.1	2.6	2.6	92.2	116.6	137.2
China	Qingdao	241.8	122.9	60.7	38.6	69.6	48.7	28.0	19.0	67.1	0.0	28.5	2.9	2.6	78.3	103.7	115.6
China	Tianjin	8.1	8.4	2.5	2.0	2.4	3.6	1.4	1.3	47.8	0.0	34.1	1.4	0.7	79.7	90.0	84.9
China	Yulin, Guangxi	579.1	275.0	210.0	148.4	79.6	72.5	60.0	43.8	64.3	0.0	55.5	2.8	2.0	159.0	184.0	190.1
Colombia	Barranquilla	38.5	25.0	16.0	10.6	38.8	29.8	22.6	17.7	58.6	28.5	71.1	0.2	0.0	65.7	57.3	0.0
Colombia	Bogotá	23.3	13.9	9.5	5.8	25.6	19.4	16.6	12.5	97.1	38.4	97.5	0.2	0.0	38.6	35.9	0.0
Colombia	Boyaca Duitama	40.6	39.6	31.8	35.2	26.0	28.5	22.8	23.3	...	...	...	0.1	0.0	63.6	57.2	0.0
Colombia	Boyaca Sogamoso	13.9	9.3	17.1	24.8	8.4	6.1	11.2	15.9	...	...	...	1.0	0.0	85.0	84.7	0.0
Colombia	Casanare Yopal	95.3	38.9	13.5	16.7	16.6	16.4	10.1	19.7	...	...	...	0.2	0.0	94.7	79.1	0.0
Colombia	Medellín	42.9	34.6	23.7	19.4	48.3	45.2	34.8	29.8	98.9	42.1	88.8	0.3	0.0	30.8	28.8	0.0
Colombia	Neiva	42.1	32.5	36.9	36.5	22.9	21.9	27.9	29.9	11.0	19.1	78.7	0.2	0.0	75.2	64.8	0.0
Costa Rica	Cartago	147.6	112.1	68.8	27.0	50.4	42.8	30.7	12.5	...	16.5	50.6	0.5	3.5	125.4	115.8	127.1
Costa Rica	San José	199.6	131.3	86.6	53.8	51.6	46.8	34.6	24.5	59.3	14.3	59.1	0.7	0.5	109.5	106.3	99.5
Côte d'Ivoire	Bouake	30.6	24.5	18.3	15.3	12.4	12.2	10.2	9.9	18.4	15.8	28.9	3.2	1.8	70.0	89.1	100.3
Côte d'Ivoire	Korhogo	39.3	16.6	16.1	4.3	7.2	4.7	6.1	2.1	52.6	...	...	0.7	2.0	92.4	85.3	110.5
Côte d'Ivoire	Man	232.7	130.6	59.3	25.7	60.2	48.9	28.4	15.3	6.7	10.8	16.4	1.1	1.7	84.2	86.6	102.0
Côte d'Ivoire	Yamoussoukro	45.3	37.0	50.8	38.3	15.0	17.1	28.5	24.5	20.3	14.3	26.8	0.9	2.2	74.6	73.1	89.0
Croatia	Zagreb	63.2	67.7	61.4	84.7	23.8	24.9	22.8	30.7	89.1	19.9	56.6	11.5	-2.3	122.0	132.3	143.2
Cyprus	Lefkosía (Nicosia)	7.0	7.1	6.8	11.9	1.3	1.5	1.7	3.3	84.6	14.7	63.1	0.5	0.4	262.4	246.8	230.3
Czechia	Brno	82.9	98.8	102.0	124.8	26.8	31.1	33.0	40.6	92.4	15.5	76.5	2.3	0.0	152.2	157.9	172.2
Czechia	Ostrava	190.7	188.2	151.2	161.4	44.2	41.6	31.0	31.0	91.7	12.7	61.8	-0.3	-0.3	212.3	234.0	254.5
Czechia	Praha (Prague)	40.7	48.2	52.1	48.3	16.3	18.6	21.8	21.5	93.7	28.5	83.5	0.9	1.4	132.5	130.9	134.2
Democratic People's Republic of Korea	P'yongyang	2.1	2.1	2.2	1.7	4.4	4.5	4.6	3.5	17.7	0.0	17.9	0.0	1.8	23.9	25.3	25.7
Democratic People's Republic of Korea	Songrim	0.6	0.3	0.3	0.7	1.0	0.6	0.7	1.7	26.0	0.0	21.5	1.0	0.9	21.8	21.9	21.8
Democratic Republic of the Congo	Butembo	416.1	230.8	99.5	39.5	74.6	56.6	38.7	19.1	...	...	...	...	...	...	...	...
Democratic Republic of the Congo	Kisangani	133.1	97.2	44.5	17.1	60.3	58.9	35.6	18.2	...	...	...	0.8	0.9	70.8	67.1	64.9
Denmark	Aalborg	239.0	210.9	204.9	171.2	42.3	39.3	39.7	34.4	94.1	20.3	93.3	0.7	1.0	291.6	288.1	288.2
Denmark	Århus	156.6	133.2	108.6	107.8	34.0	31.3	27.2	30.4	93.2	...	...	1.0	0.5	194.7	194.3	182.9
Denmark	Herning	308.8	263.3	260.3	240.8	40.2	36.8	38.2	37.1	93.4	20.6	91.2	...	...	...	...	...
Denmark	Horsens	210.3	203.6	178.9	168.3	35.3	35.2	30.3	28.8	...	...	...	...	...	...	...	...
Denmark	København (Copenhagen)	78.9	82.0	62.3	58.8	23.1	25.0	20.9	22.3	92.7	17.9	83.7	0.2	0.3	202.6	188.3	173.5
Denmark	Kolding	293.1	238.5	208.3	209.9	41.0	35.9	33.0	34.9	...	...	...	...	...	...	...	...
Denmark	Odense	234.7	212.9	213.1	174.3	38.5	36.2	38.2	34.5	91.6	18.6	91.5	0.8	0.4	294.8	291.9	274.2
Denmark	Randers	214.7	206.2	210.0	193.0	35.7	36.1	37.4	35.2	...	...	...	...	...	...	...	...
Denmark	Vejle	326.0	301.1	259.6	239.2	44.6	44.2	40.0	38.6	...	...	...	...	...	...	...	...
Djibouti	Djibouti	3.2	1.6	0.7	1.0	1.9	1.2	0.6	1.2	31.5	20.7	28.0	1.1	1.5	45.9	47.0	53.9
Egypt	Al-Iskandariyah (Alexandria)	9.9	6.9	3.3	2.3	16.6	13.2	7.6	6.6	36.0	15.1	36.4	0.4	0.1	31.3	28.0	22.5
Egypt	Al-Mansurah	27.1	18.5	11.7	6.6	35.9	29.5	22.3	15.5	...	...	...	...	...	...	...	...
Egypt	Al-Qahirah (Cairo)	31.3	22.7	16.1	9.6	19.4	18.3	15.6	11.4	21.2	15.7	11.2	1.7	0.5	49.3	56.7	50.6
Egypt	Asyut	17.7	14.8	10.2	5.6	27.7	28.2	23.1	15.4	22.8	6.7	34.9	0.4	0.3	32.0	28.7	25.0
Egypt	Az-Zaqazig	51.8	39.1	27.8	17.5	55.9	52.1	44.3	34.6	13.1	13.4	39.0	0.1	0.0	44.9	38.1	31.0
Egypt	Bur Sa'id	0.6	0.6	0.4	0.6	0.7	0.9	0.7	1.5	27.8	24.8	95.1	0.3	0.3	34.2	30.2	25.6
Egypt	Damanhūr (Damanhour)	43.8	28.9	18.7	10.8	50.5	43.1	34.6	23.5	...	...	...	...	...	...	...	...
Egypt	Disūq (Desouk)	21.1	12.2	8.6	5.4	39.2	29.1	24.7	18.0	...	...	...	...	...	...	...	...
Egypt	Dumyāṭ (Damietta)	90.8	63.6	39.6	24.7	56.4	51.2	41.8	31.4	...	...	...	...	...	...	...	...
Egypt	Fāqūs (Faqous)	44.1	30.8	19.7	13.6	45.2	41.9	33.3	24.5	...	...	...	...	...	...	...	...
Egypt	Tanta	16.3	11.9	7.8	4.3	28.1	23.3	17.8	11.8	...	...	...	...	...	...	...	...

Table C.1: Continued

Country / Territory Name	City Name	Green Area per Capita (UMF 47-3.3.2) ᵃ								SDG 11.2.1. Public Transport (UMF 10-1.2.2), 2020 ᵇ	SDG 11.7.1. Open Public Spaces (UMF44-3.2.1), 2020 ᵇ		SDG 11.3.1. Land Consumption (UMF 51-3.4.2)ᵇ				
		Green Area Per Capita 1990 (m² per capita)	Green Area Per Capita 2000 (m² per capita)	Green Area Per Capita 2010 (m² per capita)	Green Area Per Capita 2020 (m² per capita)	Proportion of Green Area in City/ Urban Area 1990 (%)	Proportion of Green Area in City/ Urban Area 2000 (%)	Proportion of Green Area in City/ Urban Area 2010 (%)	Proportion of Green Area in City/ Urban Area 2020 (%)	Proportion of population living within convenient walking distance to public transport (%)ᶜ	Average share of urban area that is open space for public use for all (%)ᵈ	Average share of urban population with convenient access to open public spaces (%) ᵉ	Land Consumption Rate to Population Growth Rate (LCRPGR) Year 1 to Year 2 (Ratio)	Land Consumption Rate to Population Growth Rate (LCRPGR) Year 2 to Year 3 (Ratio)	Built Up area Per Capita Year 1 (m² per capita)	Built Up area Per Capita Year 2 (m² per capita)	Built Up area Per Capita Year 3 (m² per capita)
Eritrea	Asmara	1.8	6.1	7.5	10.2	1.1	4.0	6.1	5.8	22.5	15.7	34.4	1.0	0.0	73.6	74.2	111.7
Eswatini	Mbabane	138.8	120.1	90.8	99.3	20.0	23.7	19.7	19.5	35.6	11.8	27.4	3.6	0.0	118.9	152.6	235.3
Ethiopia	Dire Dawa	10.0	6.1	4.1	6.5	7.0	6.0	5.1	9.7	24.5	18.2	38.7	1.0	0.2	53.0	53.2	46.6
France	Angers	40.3	60.5	66.8	89.3	9.8	15.6	16.9	21.6	97.5	14.3	81.5	-3.6	-1.2	196.5	216.5	237.0
France	Le Mans	77.1	126.1	120.0	133.1	16.9	27.5	25.5	27.6	95.8	19.1	81.2	...	...	...	...	...
France	Marseille	24.1	31.4	36.5	36.6	11.0	14.9	18.2	18.3	94.4	16.0	46.5	2.3	-11.3	107.6	115.1	117.4
France	Nantes	91.7	82.8	103.6	104.1	20.7	20.0	26.2	28.1	97.3	17.5	67.6	2.4	1.5	178.5	190.6	196.6
France	Strasbourg	17.4	16.9	15.4	25.4	6.0	6.3	5.9	9.9	94.2	16.9	73.2	1.1	1.8	117.0	117.3	119.1
France	Tours	45.7	77.7	81.3	114.1	8.9	15.9	17.0	23.9	95.8	14.9	78.9	3.7	0.0	237.6	254.0	282.6
Germany	Bremen	93.6	74.9	63.0	63.6	29.2	23.0	19.5	21.0	95.7	...	...	...	...	...	...	...
Germany	Halle (Saale)	13.1	26.5	34.7	37.2	5.3	8.4	10.3	11.6	90.8	20.0	76.4	-2.3	0.8	132.6	168.1	166.1
Germany	Hamburg	120.3	108.5	98.6	78.0	36.7	34.5	32.4	26.5	96.4	18.6	78.2	2.2	4.3	145.7	151.2	169.6
Germany	München (Munich)	87.4	70.7	49.9	54.1	36.9	29.9	23.6	29.7	93.6	...	...	0.3	0.5	131.5	121.4	113.2
Germany	Oldenburg (Oldenburg)	157.8	153.7	138.1	129.4	31.8	33.0	30.7	29.3	91.1	15.1	72.8	2.6	10.0	221.6	235.0	274.4
Ghana	Tamale	85.9	30.9	11.7	7.0	12.7	6.0	2.9	3.1	6.6	11.3	8.8	...	...	...	...	...
Greece	Athínai (Athens)	1.8	1.9	2.8	3.2	1.6	1.8	2.6	2.9	97.0	30.5	92.9	-0.9	-0.2	65.1	66.3	69.8
Greece	Thessaloniki	14.9	14.8	13.9	24.7	6.4	6.9	6.5	11.3	98.8	16.2	65.7	...	...	...	...	...
Guatemala	Mazatenango	148.8	104.4	77.9	48.0	60.7	53.8	49.4	37.4	66.7	13.7	58.3	1.9	2.6	43.0	51.4	70.7
Guatemala	Quetzaltenango	18.5	19.0	14.4	13.4	3.7	4.8	4.4	4.8	25.4	15.5	30.1	1.3	1.4	139.1	148.5	158.7
Guatemala	San Juan Sacatepéquez	102.9	91.8	72.2	48.2	57.4	55.3	48.7	34.4	43.8	0.0	43.9	1.5	3.3	54.2	57.3	65.2
Guinea	Conakry	154.4	56.9	42.4	10.3	49.0	25.1	25.3	8.2	23.4	18.1	2.9	0.6	0.7	112.5	98.4	90.7
Guinea	Kankan	36.4	17.7	10.6	9.4	5.5	3.9	3.0	3.2	...	...	...	...	...	...	...	...
Guinea	Nzérékoré	321.6	133.1	69.5	27.0	70.0	47.9	34.0	16.6	...	...	...	...	...	...	...	...
Guinea-Bissau	Bissau	287.4	106.4	52.6	18.8	78.2	42.1	29.9	14.8	38.2	12.4	45.1	1.1	0.9	87.9	91.7	89.5
Honduras	El Progreso	141.0	59.4	45.0	31.0	63.6	34.5	31.1	20.9	33.3	20.2	46.4	1.1	0.0	85.3	87.3	96.9
Honduras	San Pedro Sula	109.4	62.1	40.6	18.8	41.4	32.1	26.5	16.6	17.7	18.6	56.2	0.7	0.6	90.6	84.8	74.9
Hungary	Miskolc	73.5	80.0	89.9	89.8	28.6	29.0	29.5	26.1	93.1	...	...	...	...	...	...	...
Hungary	Sopron	126.7	107.0	95.5	86.0	34.4	32.6	33.0	32.5	...	...	...	...	...	...	...	...
India	Ahmadnagar	9.3	8.1	5.0	5.3	6.9	8.5	5.6	5.6	19.6	16.2	10.8	1.8	0.0	48.0	51.2	58.7
India	Amritsar	30.3	18.7	5.7	5.9	30.5	23.9	8.1	8.7	...	...	...	...	...	...	...	...
India	Bareilly	19.3	17.0	10.0	13.5	19.6	21.2	15.2	21.8	52.4	12.4	22.3	1.1	0.3	24.0	24.5	23.4
India	Bhiwandi	4.3	2.6	2.6	2.3	3.8	3.4	4.5	4.7	16.6	12.2	29.7	0.5	0.8	38.1	33.0	31.8
India	Bhopal	41.5	39.0	29.9	15.3	26.4	33.9	32.3	20.2	62.0	21.7	30.4	1.6	0.4	37.8	43.2	38.1
India	Delhi	13.4	7.7	3.9	3.7	8.1	7.0	4.5	5.3	62.0	24.3	43.6	0.8	0.7	47.1	45.1	42.5
India	Hyderabad	16.5	19.5	8.9	9.5	9.5	13.8	7.5	9.3	72.0	21.5	52.3	1.6	0.9	59.2	65.4	64.4
India	Jalandhar	35.1	23.7	22.3	23.6	26.0	20.5	20.9	22.8	...	...	...	...	...	...	...	...
India	Kochi (Cochin)	130.2	135.3	127.5	104.8	45.3	51.0	50.4	48.1	70.0	0.0	17.0	10.1	0.7	79.1	122.0	116.3
India	Lakhīmpur	6.0	5.4	4.5	6.2	10.2	12.4	13.2	14.3	...	...	...	...	...	...	...	...
India	Ludhiana	33.2	15.1	11.6	9.2	21.1	13.0	11.4	10.1	...	...	...	...	...	...	...	...
India	Moradabad	13.3	5.7	3.1	4.0	22.6	11.8	7.8	10.9	...	...	...	...	...	...	...	...
India	Mumbai (Bombay)	2.7	2.2	1.7	1.5	8.0	8.0	6.6	6.4	80.9	17.6	35.3	0.5	0.6	17.2	16.4	15.8
India	Nashik	20.8	15.4	12.0	8.5	12.9	15.0	14.3	11.8	...	...	...	...	...	...	...	...
India	Patna	74.7	47.5	39.5	20.1	67.4	61.7	63.5	38.2	15.3	20.4	36.8	0.9	1.0	35.8	35.0	34.8
India	Pune (Poona)	75.9	39.9	18.8	19.4	37.8	25.5	15.7	18.2	75.1	16.4	30.8	0.8	0.9	64.3	60.8	60.1
India	Shahjahanpur	8.5	5.8	4.4	3.7	19.1	15.4	13.6	8.9	...	...	...	...	...	...	...	...
India	Sītāpur	3.7	2.9	2.7	5.5	7.8	7.8	8.8	12.4	18.5	0.0	28.6	1.2	0.0	13.8	14.5	25.9
India	Surat	18.1	10.0	3.5	1.6	21.8	18.5	8.6	5.3	56.8	18.7	45.0	0.8	0.1	31.3	29.6	22.8
Indonesia	Bandar Lampung	190.8	127.5	74.1	23.4	54.6	59.5	48.1	18.5	26.3	17.9	13.8	0.5	0.3	109.1	92.6	80.5
Indonesia	Cirebon	86.5	72.3	59.1	27.1	50.8	49.3	42.3	20.8	8.0	10.3	17.9	0.0	6.7	19.1	54.4	80.5
Indonesia	Manado	39.4	36.1	29.8	31.7	28.8	31.3	26.6	29.4	...	...	...	...	...	...	...	...
Indonesia	Medan	136.2	104.2	74.0	53.2	78.7	68.2	53.9	42.0	41.5	16.6	29.6	3.2	0.4	49.6	62.5	59.6
Indonesia	Pekalongan	67.7	57.2	24.2	28.2	54.7	46.8	19.9	22.7	13.9	12.1	41.3	...	...	...	...	...
Indonesia	Semarang	90.4	54.6	34.2	28.8	52.8	36.5	24.8	22.9	33.4	12.7	39.4	3.8	1.5	58.9	73.6	77.2
Iran (Islamic Republic of)	Ardabil	13.4	5.2	2.5	3.8	8.3	3.5	1.8	3.0	54.1	22.9	79.4	0.6	1.2	89.5	86.5	87.7
Iran (Islamic Republic of)	Bandar Abbas	15.6	15.3	3.7	5.9	4.4	5.6	1.8	3.6	36.3	18.6	59.5	0.4	0.3	155.5	130.0	112.1
Iran (Islamic Republic of)	Bojnūrd	21.6	8.2	3.2	2.4	8.5	4.5	2.3	2.1	55.7	16.4	45.2	0.3	0.4	104.2	87.1	78.1
Iran (Islamic Republic of)	Dehdasht	1.7	0.7	0.7	1.1	1.8	0.9	0.7	0.8	62.2	16.9	64.8	...	...	...	...	...
Iran (Islamic Republic of)	Eşfahān (Isfahan)	120.0	92.6	44.6	31.4	34.6	34.1	20.1	16.7	43.2	18.8	50.8	0.4	0.2	159.6	140.2	123.3
Iran (Islamic Republic of)	Karaj	16.4	8.5	5.9	4.7	9.0	5.7	5.1	5.3	14.1	14.0	50.6	1.1	0.1	64.0	64.9	51.2
Iran (Islamic Republic of)	Kāshmar	60.7	42.4	27.9	17.2	14.1	13.5	11.1	7.8	19.5	19.5	73.3	0.9	0.4	152.9	151.2	139.9
Iran (Islamic Republic of)	Mashhad	9.6	4.1	2.2	2.1	6.6	3.4	2.2	2.6	55.2	19.6	54.7	0.4	0.3	64.3	55.8	49.1
Iran (Islamic Republic of)	Nīshābūr (Nishapur/ Neyshabur)	11.7	4.2	1.3	1.2	4.5	2.5	0.8	0.8	32.2	16.8	64.7	...	...	...	...	...
Iran (Islamic Republic of)	Shiraz	7.1	7.3	6.0	6.3	5.0	5.0	3.8	3.4	45.4	13.8	54.7	...	...	...	...	...
Iran (Islamic Republic of)	Shīrvān	16.1	3.4	1.3	0.9	6.0	1.8	0.9	0.7	...	...	...	...	...	...	...	...
Iran (Islamic Republic of)	Tabriz	7.8	3.3	3.1	4.1	5.2	2.5	2.8	4.1	59.0	22.9	56.3	0.7	0.2	73.6	70.7	64.3
Iran (Islamic Republic of)	Tehran	7.6	4.4	3.9	4.2	5.7	3.7	3.6	4.6	71.7	23.4	73.9	0.4	0.1	73.1	68.9	58.6
Iraq	Baghdad	5.0	4.7	3.4	2.1	2.7	3.2	2.6	2.0	8.1	18.4	20.3	0.6	0.5	75.0	71.9	64.5
Iraq	Faloojah	35.2	22.5	3.0	0.9	14.1	13.4	2.2	0.9	...	...	...	...	...	...	...	...
Ireland	Dublin	102.2	81.6	62.5	61.5	32.1	27.1	22.9	25.0	92.7	23.0	84.2	0.4	0.3	173.5	163.3	152.1
Israel	Tel Aviv-Yafo (Tel Aviv-Jaffa)	20.1	8.4	3.2	4.0	6.4	4.0	1.8	2.8	100.0	22.8	65.7	0.2	0.6	107.5	96.1	91.6

Table C.1: Continued

Country / Territory Name	City Name	Green Area per Capita (UMF 47-3.3.2) [a]								SDG 11.2.1. Public Transport (UMF 10-1.2.2), 2020 [b]	SDG 11.7.1. Open Public Spaces (UMF44-3.2.1), 2020 [b]		SDG 11.3.1. Land Consumption (UMF 51-3.4.2)[b]				
		Green Area Per Capita 1990 (m² per capita)	Green Area Per Capita 2000 (m² per capita)	Green Area Per Capita 2010 (m² per capita)	Green Area Per Capita 2020 (m² per capita)	Proportion of Green Area in City/ Urban Area 1990 (%)	Proportion of Green Area in City/ Urban Area 2000 (%)	Proportion of Green Area in City/ Urban Area 2010 (%)	Proportion of Green Area in City/ Urban Area 2020 (%)	Proportion of population living within convenient walking distance to public transport (%)[c]	Average share of urban area that is open space for public use for all (%)[d]	Average share of urban population with convenient access to open public spaces (%) [e]	Land Consumption Rate to Population Growth Rate (LCRPGR) Year 1 to Year 2 (Ratio)	Land Consumption Rate to Population Growth Rate (LCRPGR) Year 2 to Year 3 (Ratio)	Built Up area Per Capita Year 1 (m² per capita)	Built Up area Per Capita Year 2 (m² per capita)	Built Up area Per Capita Year 3 (m² per capita)
Italy	Marsala	4.3	5.9	8.7	12.3	1.9	2.6	4.1	5.2	...	...	...	...	...	...	...	...
Italy	Messina	5.0	9.4	16.5	16.8	4.1	8.3	14.2	13.9	98.1	...	...	...	...	...	...	...
Italy	Milano (Milan)	7.7	15.8	18.2	32.8	3.4	7.0	8.3	15.4	77.7	23.6	76.2	1.1	0.9	108.9	109.2	108.7
Italy	Palermo	44.6	38.6	36.7	40.0	28.3	24.5	22.8	24.2	93.9	16.2	42.2	-1.6	-0.7	87.9	93.6	97.6
Italy	Roma (Rome)	32.8	27.5	27.1	44.0	16.8	13.9	14.0	23.9	96.1	21.8	80.0	1.8	0.1	99.4	101.4	97.1
Italy	Venezia	0.4	1.3	1.5	1.1	0.3	1.0	1.1	0.8	87.4	...	...	...	...	...	...	...
Italy	Verona	91.6	52.5	56.4	26.6	28.4	16.7	18.3	9.0	95.3	...	...	...	...	...	...	...
Japan	Akita	36.9	23.7	24.5	29.6	13.5	9.2	9.0	9.7	83.9	13.7	92.1	-0.2	-0.2	163.8	174.9	203.2
Japan	Chukyo M.M.A. (Nagoya)	35.6	36.9	22.2	23.8	9.7	10.4	6.4	7.2	...	...	...	3.4	-3.5	124.7	128.7	119.8
Japan	Kanazawa	17.0	13.6	17.7	29.5	5.0	4.3	5.5	9.0	76.6	16.7	77.0	-2.4	-2.7	174.1	187.8	200.6
Japan	Okinawa	97.7	75.9	75.7	66.2	23.5	21.9	23.1	22.0	...	...	...	...	...	...	...	...
Japan	Osaka	21.0	18.6	15.8	19.8	14.1	12.0	9.9	11.8	69.4	18.4	72.2	1.0	-2.6	78.6	78.6	72.3
Japan	Tokyo	13.9	13.4	11.2	12.8	8.5	8.6	7.7	9.0	74.0	23.1	74.8	...	...	...	...	...
Japan	Toyama	18.0	9.4	12.1	30.0	3.9	2.8	3.4	7.9	...	...	...	...	...	...	...	...
Jordan	Ammān (Amman)	6.2	4.4	4.4	4.0	2.3	2.2	3.1	4.9	10.0	13.0	19.3		2.021	...	48	54
Kenya	Nairobi	38.3	9.8	3.9	4.0	12.2	5.0	2.8	4.2	58.0	15.4	17.9	0.1	0.0	103.0	76.5	54.3
Kenya	Nakuru	18.8	13.7	20.0	21.2	5.3	5.7	11.5	16.0	12.9	11.7	14.9	1.1	0.7	74.6	78.0	71.9
Kuwait	Al-Kuwayt (Kuwait City)	1.7	1.5	0.6	0.9	0.7	0.7	0.4	0.9	39.0	16.1	49.4	0.3	0.8	97.3	72.6	66.2
Kyrgyzstan	Bishkek	39.7	38.6	16.6	18.5	12.1	14.0	6.9	9.3	55.2	17.2	59.5	4.1	0.8	97.7	149.5	142.5
Kyrgyzstan	Žalal-Abat (Jalal-Abad)	89.2	47.9	44.4	29.0	16.3	10.2	10.8	8.4	21.5	13.1	48.6	1.7	1.0	209.1	229.8	231.7
Latvia	Riga	37.0	26.8	37.7	28.3	31.1	18.4	22.0	15.0	92.7	20.2	64.6	-0.2	-0.1	70.6	85.2	94.9
Lebanon	Saydā (Sidon)	25.8	18.1	15.4	9.0	16.1	14.6	14.3	8.9	24.4	16.4	61.2	1.2	1.8	47.4	49.0	51.6
Lebanon	Sūr (Tyre)	47.2	26.9	25.2	19.0	22.0	22.0	22.6	17.8	10.6	18.7	45.9	0.6	2.3	52.2	50.1	52.9
Lebanon	Tarābulus (Tripoli)	14.4	7.6	7.9	4.8	10.8	7.4	8.1	5.3	30.9	17.4	72.8	6.9	2.8	33.6	46.4	52.1
Liberia	Monrovia	131.6	140.8	76.0	48.0	43.6	40.8	29.2	26.2	5.4	10.2	12.1	0.5	0.7	150.1	130.2	116.1
Libya	Tarabulus (Tripoli)	72.3	52.3	16.2	10.6	10.1	9.2	3.4	2.3	...	...	...	2.8	4.1	155.5	209.1	220.5
Lithuania	Vilnius	101.5	95.3	101.9	76.6	32.6	29.2	29.6	22.9	87.9	14.1	51.4	-1.4	1.5	142.5	161.6	163.6
Luxembourg	Luxembourg (Lëtzebuerg)	113.2	118.2	77.0	57.1	25.8	29.5	22.1	22.3	97.4	18.6	93.3	0.4	0.2	170.0	157.3	122.5
Malawi	Blantyre-Limbe	17.3	8.5	11.9	12.0	5.2	3.4	5.7	6.8	15.4	0.0	22.6	1.2	0.4	123.9	130.2	117.9
Malawi	Mzuzu	78.6	45.3	26.1	13.7	10.8	7.9	6.7	5.2	21.4	11.7	23.3	0.7	0.3	212.9	193.0	149.6
Malaysia	Bukit Mertajam	224.3	107.4	62.6	52.3	48.5	28.3	20.7	18.6	70.5	16.9	53.4	0.7	1.5	147.2	136.8	142.7
Malaysia	George Town (Pinang)	22.0	17.9	9.9	11.0	13.2	12.9	8.8	10.5	91.9	19.2	69.7	0.3	0.3	58.0	50.6	48.1
Malaysia	Ipoh	78.3	52.9	37.5	34.4	23.3	18.3	15.5	17.3	38.1	20.0	51.1	0.7	0.3	150.2	143.0	123.6
Malaysia	Kuala Lumpur	262.4	71.3	32.7	31.0	53.1	26.3	16.3	20.4	66.7	19.8	46.1	0.4	0.2	118.3	100.2	80.9
Malaysia	Kuching	228.1	103.1	62.2	42.4	56.4	36.3	26.2	21.4	...	...	...	...	...	...	...	...
Malaysia	Taiping	66.0	55.9	29.7	32.8	23.3	21.9	13.6	15.1	...	...	...	...	...	...	...	...
Mali	Bamako	48.3	10.6	4.1	2.6	10.4	3.5	2.3	2.2	76.6	16.0	76.7	0.7	0.6	126.7	109.2	95.0
Mali	Kayes	22.6	15.3	3.8	4.0	4.0	4.0	1.7	2.7	57.4	19.7	85.3	0.9	0.7	136.5	127.9	114.5
Mali	Sikasso	63.0	31.2	11.3	3.7	7.6	6.1	3.3	1.7	3.9	11.3	5.1	0.8	0.9	148.7	138.1	134.0
Mauritania	Nouakchott	0.7	1.3	1.4	1.2	0.1	0.4	0.6	0.8	27.3	14.4	22.4	1.4	1.6	82.7	97.3	121.2
Mexico	Campeche Campeche	110.9	74.4	46.1	51.8	37.8	30.2	21.2	25.0	16.1	19.7	81.2	...	...	...	...	...
Mexico	Celaya	71.9	38.1	17.3	13.4	25.5	16.5	9.1	7.5	...	...	...	...	...	...	...	...
Mexico	Ciudad Juárez (Juárez)	17.8	3.4	1.1	1.6	5.8	1.5	0.5	0.7	...	22.4	54.8	...	...	...	...	...
Mexico	Coatzacoalcos	43.3	29.3	18.2	19.6	19.5	15.0	10.6	12.2	...	...	...	...	...	...	...	...
Mexico	Ensenada	24.9	7.9	15.9	6.8	5.1	2.1	5.5	2.6	...	16.0	42.9	0.6	0.4	210.1	190.3	177.8
Mexico	Guanajuato Salamanca	37.8	13.0	10.7	4.8	14.5	5.6	5.5	2.6	...	...	...	...	...	...	...	...
Mexico	Irapuato	45.6	24.0	13.6	7.8	16.1	10.3	7.0	4.5	57.7	18.2	85.0	1.4	0.9	95.7	102.6	101.0
Mexico	León de los Aldamas	13.3	8.3	6.0	5.4	5.2	4.1	3.6	3.4	86.8	14.6	56.2	1.5	7.9	79.4	88.3	103.1
Mexico	Mérida	111.2	95.5	37.2	25.6	26.2	27.2	12.2	8.8	...	...	...	...	...	...	...	...
Mexico	Monterrey	69.2	38.4	28.4	35.9	22.5	15.2	12.7	16.7	10.7	19.0	72.6	2.1	1.9	119.4	137.4	141.9
Mexico	Querétaro	29.7	20.1	23.0	10.2	6.9	6.4	9.1	4.3	15.1	...	...	...	...	...	...	...
Mexico	Saltillo	31.5	12.6	4.4	7.4	8.1	4.0	1.7	3.1	86.6	16.6	52.0	1.3	0.9	142.3	152.0	151.0
Mexico	Tabasco Cárdenas	209.3	131.9	92.8	58.2	56.8	45.7	40.8	33.0	...	...	...	...	...	...	...	...
Mexico	Tabasco Comalcalco	162.5	126.5	80.1	53.2	44.8	43.2	33.6	28.6	...	...	...	...	...	...	...	...
Mexico	Tijuana	2.0	1.7	5.5	1.9	0.5	0.7	2.6	1.0	10.9	18.1	51.9	0.6	0.3	155.7	144.4	139.2
Mexico	Veracruz De Ignacio De La Llave Las Choapas	143.9	103.7	74.1	71.8	37.4	31.4	26.8	31.3	...	...	...	...	...	...	...	...
Mexico	Veracruz De Ignacio De La Llave Minatitlán	56.9	73.6	53.6	56.0	21.0	28.1	22.3	24.2	...	...	...	...	...	...	...	...
Mexico	Villahermosa	169.7	102.7	57.2	40.3	49.4	42.3	29.9	23.1	59.7	15.4	89.6	1.0	0.6	92.7	92.0	88.7
Morocco	Agadir	6.2	3.7	3.0	1.7	3.0	2.7	2.7	2.0	86.6	20.7	53.3	0.9	0.6	60.6	58.8	53.9
Morocco	Dar-el-Beida (Casablanca)	0.4	1.0	0.4	0.5	0.5	1.4	0.6	0.9	66.5	16.7	29.2	1.1	0.6	42.7	43.2	41.2
Morocco	Fès	11.5	6.7	4.9	4.2	9.8	7.3	6.5	6.5	39.1	14.8	32.5	1.7	0.9	37.3	42.2	41.2
Morocco	Fkih Ben Salah	5.7	4.2	1.4	1.1	5.9	4.7	1.7	1.5	52.1	18.6	55.9	...	...	...	...	...
Morocco	Marrakech	18.2	9.9	3.6	3.1	9.4	6.6	3.0	3.1	74.8	16.0	61.3	0.9	0.5	74.0	72.4	66.2
Morocco	Meknès	7.2	4.7	4.3	5.8	5.4	4.1	4.4	6.7	31.6	20.9	29.4	0.7	1.9	50.8	49.0	54.8
Morocco	Rabat	4.7	4.4	3.7	2.9	4.8	5.6	5.1	4.2	...	...	...	0.9	1.3	38.8	38.6	39.4
Morocco	Sidi Slimane	5.8	2.2	1.2	2.4	5.0	2.2	1.4	3.4	37.0	22.4	37.4	0.8	0.4	49.8	48.1	43.2
Mozambique	Maputo	132.6	47.9	36.4	9.8	27.7	14.1	14.1	5.3	52.2	17.2	15.3	1.1	0.5	158.1	162.5	137.6

Table C.1: Continued

Country / Territory Name	City Name	Green Area per Capita (UMF 47-3.3.2) [a]: Green Area Per Capita 1990 (m^2 per capita)	Green Area Per Capita 2000 (m^2 per capita)	Green Area Per Capita 2010 (m^2 per capita)	Green Area Per Capita 2020 (m^2 per capita)	Proportion of Green Area in City/ Urban Area 1990 (%)	Proportion of Green Area in City/ Urban Area 2000 (%)	Proportion of Green Area in City/ Urban Area 2010 (%)	Proportion of Green Area in City/ Urban Area 2020 (%)	SDG 11.2.1. Public Transport (UMF 10-1.2.2), 2020 [b]: Proportion of population living within convenient walking distance to public transport (%)[c]	SDG 11.7.1. Open Public Spaces (UMF44-3.2.1), 2020 [b]: Average share of urban area that is open space for public use for all (%)[d]	Average share of urban population with convenient access to open public spaces (%) [e]	SDG 11.3.1. Land Consumption (UMF 51-3.4.2)[b]: Land Consumption Rate to Population Growth Rate (LCRPGR) Year 1 to Year 2 (Ratio)	Land Consumption Rate to Population Growth Rate (LCRPGR) Year 2 to Year 3 (Ratio)	Built Up area Per Capita Year 1 (m^2 per capita)	Built Up area Per Capita Year 2 (m^2 per capita)	Built Up area Per Capita Year 3 (m^2 per capita)
Mozambique	Mocuba	13.4	7.2	4.8	2.9	7.8	5.6	4.4	2.9	41.1	18.5	10.8	1.1	0.4	67.0	68.1	63.8
Mozambique	Nampula	57.6	33.3	21.1	6.1	14.7	13.2	12.4	5.3	10.4	14.2	9.3	1.6	1.0	67.0	86.1	86.1
Myanmar	Sittwe (Akyab)	41.9	37.0	31.5	29.2	32.1	35.8	29.4	22.1	...	...	...	...	...	...	...	...
Namibia	Windhoek	15.9	10.0	13.1	12.2	2.3	2.3	4.0	4.6	70.6	16.6	25.7	0.7	0.6	191.2	173.0	158.8
Netherlands (Kingdom of the)	Amsterdam	44.4	35.2	29.5	27.3	15.9	13.5	11.9	12.0	92.9	21.9	77.6	1.8	1.3	107.3	111.7	114.7
Netherlands (Kingdom of the)	Gouda	34.0	20.3	21.1	28.5	17.1	10.5	10.9	14.8	90.2	19.5	90.7	...	...	...	...	...
Netherlands (Kingdom of the)	Rotterdam	55.9	43.4	41.6	53.1	19.2	15.2	14.9	19.6	90.0	20.6	84.7	3.2	3.0	127.2	134.2	142.5
New Zealand	Auckland	220.1	123.5	92.8	58.2	34.4	24.4	21.8	17.4	94.4	20.7	88.4	0.4	0.0	298.3	268.0	212.3
New Zealand	Dunedin	204.5	169.3	192.9	199.9	37.9	32.7	38.1	44.3	94.4	19.0	76.8	5.3	0.7	279.9	307.8	296.3
New Zealand	Wellington	129.0	130.2	92.3	73.3	29.6	0.0	26.4	24.6	97.7	21.0	82.5	1.2	0.2	208.8	213.4	189.3
Nicaragua	Estelí	30.2	23.6	25.0	24.6	13.9	13.5	15.9	16.0	...	...	...	...	...	...	...	...
Niger	Niamey	10.4	9.1	4.0	3.9	2.6	3.6	2.2	2.8	12.5	15.4	26.1	1.5	0.3	82.7	98.3	81.3
Nigeria	Aba	189.5	140.6	67.1	43.4	71.0	66.1	39.8	32.3	2.7	11.2	2.9	1.8	0.7	81.8	98.0	90.5
Oman	Masqat (Muscat)	7.9	9.1	6.9	5.3	1.7	3.0	2.6	3.8	30.8	21.7	13.2	...	...	...	...	...
Pakistan	Faisalabad	22.7	16.2	5.0	2.6	20.2	20.2	8.1	5.7	73.8	13.6	34.1	0.7	0.6	37.1	34.4	30.5
Pakistan	Gujranwala	69.3	42.2	25.9	15.6	59.9	49.9	38.9	26.6	54.2	15.1	18.3	1.0	1.4	40.4	40.3	42.4
Pakistan	Hyderabad	7.8	4.7	1.8	0.9	11.4	9.0	4.4	2.9	67.7	14.4	42.2	0.8	0.4	25.1	24.2	20.6
Pakistan	Islamabad	16.5	7.6	4.8	4.9	7.2	5.0	4.2	5.1	52.0	20.3	31.3	1.6	1.1	51.0	60.1	61.3
Pakistan	Karachi	0.9	0.7	0.5	0.6	1.2	1.3	1.2	1.8	...	15.1	45.4	...	...	...	...	...
Pakistan	Khaīrpur	9.8	6.4	4.2	3.5	7.9	7.9	6.7	5.7	66.9	...	...	...	...	...	...	...
Pakistan	Larkana	9.4	5.9	2.8	2.1	9.4	9.1	5.3	4.4	50.3	12.6	23.5	2.0	3.0	21.0	26.4	32.3
Pakistan	Multan	45.7	19.6	9.4	9.4	32.2	18.9	11.3	12.2	50.3	13.5	25.7	1.8	2.2	45.6	54.0	58.8
Pakistan	Peshawar	121.0	82.5	48.2	46.0	51.9	48.2	35.5	36.4	83.5	0.0	11.5	1.0	4.6	60.3	60.4	77.8
Pakistan	Sargodha	20.4	9.5	4.6	4.7	24.4	15.6	9.4	9.4	66.9	13.6	28.5	0.9	0.0	29.9	29.0	35.6
Pakistan	Sukkur	1.2	1.0	1.1	1.2	1.3	1.6	2.0	2.5	67.8	...	...	...	...	...	...	...
Panama	Ciudad de Panamá (Panama City)	146.0	61.1	48.7	24.4	40.7	24.4	24.1	15.1	69.7	13.1	44.3	0.5	0.6	126.9	114.9	105.0
Paraguay	Asunción	341.7	199.9	170.6	154.7	70.2	52.7	52.6	40.9	18.8	13.3	32.6	0.9	0.0	183.5	179.8	236.1
Peru	Tacna	20.8	15.0	12.8	10.2	5.4	5.3	5.6	5.5	46.3	14.8	90.8	1.4	0.8	105.7	116.4	111.9
Philippines	Baguio City	23.7	26.9	25.7	23.8	11.1	17.4	21.2	23.7	61.6	10.7	29.9	0.4	0.3	72.6	63.3	55.1
Philippines	Davao City	105.4	63.9	32.7	15.6	55.9	45.6	29.3	18.0	59.1	14.7	34.3	1.0	0.7	55.1	55.5	51.1
Philippines	Iligan	60.9	46.6	34.3	21.5	49.8	46.6	39.4	28.6	...	...	...	...	...	...	...	...
Philippines	Manila	24.4	23.7	29.7	41.3	15.4	18.7	27.7	44.7	32.5	11.1	28.7	0.6	0.8	57.9	53.7	52.3
Philippines	Ozamis	35.3	32.0	22.9	16.9	21.6	26.3	25.0	23.0	...	...	...	...	...	...	...	...
Poland	Głogów	50.7	40.1	48.2	62.9	17.5	14.2	17.4	22.9	92.4	...	...	...	...	...	...	...
Poland	Kalisz	35.5	57.5	61.1	76.8	10.5	17.7	18.1	21.3	97.3	...	...	...	...	...	...	...
Poland	Legnica	14.4	18.5	16.5	26.4	8.4	10.9	9.1	13.5	94.6	...	...	...	...	...	...	...
Poland	Leszno	44.3	40.2	41.8	33.8	15.4	14.0	14.6	11.6	...	...	...	...	...	...	...	...
Poland	Lubin	23.5	21.3	24.4	29.8	13.4	13.1	14.1	16.2	...	...	...	...	...	...	...	...
Poland	Ostrów Wielkopolski	52.2	62.0	84.1	87.0	13.5	16.0	21.3	21.6	97.4	...	...	...	...	...	...	...
Poland	Warszawa (Warsaw)	71.8	96.9	106.7	92.5	17.8	25.2	28.6	26.4	93.5	30.8	88.0	-0.1	0.0	128.6	127.1	0.0
Poland	Wrocław	71.8	68.4	73.3	76.7	22.3	21.4	22.4	23.7	94.6	19.5	75.0	-3.9	0.0	134.1	144.9	0.0
Portugal	Lisboa (Lisbon)	23.7	38.6	52.1	49.2	10.8	18.4	25.6	25.5	99.5	21.7	87.4	-0.1	-0.1	124.9	137.9	137.1
Portugal	Porto	134.3	140.8	112.2	128.3	35.1	39.0	31.1	36.1	...	...	...	-0.1	0.1	145.6	162.8	162.3
Qatar	Ad-Dawhah (Doha)	14.7	11.1	5.6	8.9	0.8	0.9	1.3	3.3	98.3	21.8	...	0.3	...	143.2	123.9	...
Republic of Korea	Daegu	6.5	6.1	10.3	12.2	7.9	7.7	12.6	14.3	...	...	...	...	...	...	...	...
Russian Federation	Berdsk	97.0	90.0	97.8	61.1	29.1	27.8	29.7	18.8	89.9	13.7	58.7	-6.4	6.8	183.5	207.4	223.1
Russian Federation	Moskva (Moscow)	64.3	46.5	38.9	24.1	41.8	32.8	30.9	21.4	85.9	24.6	83.3	0.7	0.8	57.5	55.5	54.5
Saudi Arabia	Abhā	9.0	10.7	7.8	19.8	3.9	5.0	4.1	8.6	56.5	20.5	18.3	0.7	0.0	84.1	80.9	107.3
Saudi Arabia	Ad-Dammam	29.3	16.1	5.6	4.7	6.8	5.2	2.5	2.7	48.4	23.2	44.9	0.9	0.5	116.9	111.3	97.3
Saudi Arabia	Al-Madinah (Medina)	20.4	13.3	9.4	8.4	3.9	3.8	3.7	4.5	4.4	17.6	17.6	0.3	0.6	132.4	107.1	95.6
Saudi Arabia	Ar-Riyadh (Riyadh)	1.7	1.6	0.6	1.0	0.4	0.6	0.3	0.7	27.1	23.1	67.0	0.3	1.0	108.8	83.3	83.6
Saudi Arabia	Jiddah	0.6	0.6	0.3	0.5	0.2	0.4	0.3	0.5	50.6	17.2	24.1	0.3	0.2	76.7	62.7	48.7
Saudi Arabia	Makkah (Mecca)	0.4	0.4	0.2	0.3	0.2	0.3	0.2	0.4	5.5	13.3	22.4	1.4	1.1	50.0	55.1	56.3
Saudi Arabia	Taif	4.0	6.5	4.9	9.0	1.8	3.4	3.2	5.2	12.9	14.9	23.6	1.2	0.0	61.4	63.7	99.9
Senegal	Dakar	10.3	4.0	3.6	2.9	8.1	4.2	4.9	4.8	77.3	16.1	92.5	0.7	0.8	45.0	41.1	39.1
Senegal	Ziguinchor	41.2	41.8	29.6	12.4	19.2	24.3	21.7	11.8	22.4	12.5	44.4	0.7	0.5	91.0	84.9	73.7
Serbia	Beograd (Belgrade)	29.9	19.8	26.7	33.3	12.9	9.5	13.5	18.3	90.3	11.8	63.8	2.8	0.0	96.3	106.9	98.7
Sierra Leone	Bo	270.4	156.1	82.5	19.5	75.1	51.1	44.6	13.7	10.8	13.0	28.0	1.1	1.2	76.1	80.8	85.1
Sierra Leone	Kenema	231.5	129.9	63.2	20.1	78.0	48.4	35.8	13.6	19.5	9.9	14.0	1.3	2.0	58.1	66.1	79.1
Slovakia	Bratislava	42.7	58.4	82.5	90.7	16.5	21.5	27.9	29.9	94.1	26.1	73.9	1.0	0.3	181.1	181.2	168.5
Slovakia	Košice	14.6	38.3	36.2	38.0	7.6	20.1	18.7	19.2	91.8	...	...	-2.0	-0.2	191.9	194.5	208.2
Slovakia	Nitra	55.3	66.8	125.5	136.5	12.6	14.9	25.8	26.7	92.3	...	...	-2.0	-47.3	221.4	234.9	249.2
Slovakia	Trnava	15.3	21.1	32.7	52.0	6.0	8.1	11.8	18.2	95.1	...	...	-2.9	-0.9	238.0	247.9	267.6
South Africa	Bloemfontein	6.7	6.7	10.2	12.0	1.7	1.8	3.0	4.0	...	...	...	...	...	...	...	...
South Africa	Cape Town	11.3	4.3	3.0	6.2	3.4	1.6	1.4	3.7	51.2	22.2	62.2	0.3	0.4	147.2	125.9	107.6
South Africa	Durban (Ethekwini)	64.4	55.8	58.1	64.1	14.1	18.2	20.9	25.1	...	...	...	...	...	...	...	...
South Africa	Gqeberha	49.8	45.3	35.5	31.5	14.2	14.7	12.6	12.7	...	...	...	...	...	...	...	...
South Africa	Johannesburg	41.6	27.7	22.1	17.4	7.1	7.3	7.6	7.8	20.8	14.8	15.4	0.9	0.1	190.8	185.4	148.2
South Africa	Pietermaritzburg (The Msunduzi)	104.2	65.6	51.4	44.7	17.8	16.1	13.4	12.8	...	...	...	...	...	...	...	...
Spain	Barcelona	2.6	2.0	2.1	3.0	3.7	2.9	3.6	5.9	99.7	...	...	...	...	...	...	...

Table C.1: Continued

Country / Territory Name	City Name	Green Area per Capita (UMF 47-3.3.2) [a]								SDG 11.2.1. Public Transport (UMF 10-1.2.2), 2020 [b]	SDG 11.7.1. Open Public Spaces (UMF44-3.2.1), 2020 [b]		SDG 11.3.1. Land Consumption (UMF 51-3.4.2)[b]				
		Green Area Per Capita 1990 (m² per capita)	Green Area Per Capita 2000 (m² per capita)	Green Area Per Capita 2010 (m² per capita)	Green Area Per Capita 2020 (m² per capita)	Proportion of Green Area in City/ Urban Area 1990 (%)	Proportion of Green Area in City/ Urban Area 2000 (%)	Proportion of Green Area in City/ Urban Area 2010 (%)	Proportion of Green Area in City/ Urban Area 2020 (%)	Proportion of population living within convenient walking distance to public transport (%)[c]	Average share of urban area that is open space for public use for all (%)[d]	Average share of urban population with convenient access to open public spaces (%) [e]	Land Consumption Rate to Population Growth Rate (LCRPGR) Year 1 to Year 2 (Ratio)	Land Consumption Rate to Population Growth Rate (LCRPGR) Year 2 to Year 3 (Ratio)	Built Up area Per Capita Year 1 (m² per capita)	Built Up area Per Capita Year 2 (m² per capita)	Built Up area Per Capita Year 3 (m² per capita)
Spain	Burgos	6.8	8.0	9.8	9.8	5.2	5.8	7.2	7.7	98.2	...	...	...	...	...	...	...
Spain	Madrid	8.5	9.6	9.1	12.9	4.9	6.3	6.9	11.3	98.4	22.6	63.1	2.4	0.4	68.9	84.3	76.6
Spain	Santander	99.4	85.8	64.1	67.8	48.6	42.0	32.5	33.5	98.7	...	...	...	...	...	...	...
Spain	Sevilla	1.7	1.6	2.6	3.7	1.7	1.5	2.6	3.8	98.0	22.6	91.6	7.7	2.0	53.2	56.4	58.2
Spain	Torrelavega	73.1	69.4	62.6	61.8	34.5	33.5	34.1	29.5	...	...	...	...	...	...	...	...
Spain	Vitoria-Gasteiz	12.2	15.3	15.9	16.9	7.3	9.3	10.5	12.6	99.0	...	...	...	...	...	...	...
Sudan	Al-Khartum (Khartoum)	4.4	4.4	5.5	7.0	0.7	1.0	1.6	2.6	18.4	15.3	14.8	0.4	1.0	166.9	141.2	139.7
Sweden	Malmö	57.9	45.8	50.3	40.3	16.9	14.8	18.2	17.3	93.2	21.8	92.8	0.2	0.5	145.4	133.1	122.9
Sweden	Stockholm	116.0	87.7	65.6	51.2	30.6	26.6	22.4	21.4	89.1	21.6	86.0	1.1	0.8	126.1	126.9	123.0
Syrian Arab Republic	Dimashq (Damascus)	29.6	12.9	7.1	3.9	17.5	9.2	6.5	3.6	27.5	12.6	45.4	0.3	3.9	63.2	53.5	57.5
Syrian Arab Republic	Halab (Aleppo)	2.9	2.0	0.6	0.7	2.6	2.5	1.4	1.1	24.3	15.6	65.3	...	...	...	...	...
Syrian Arab Republic	Hims (Homs)	3.9	0.7	0.5	0.9	2.7	0.7	0.8	1.3	13.6	18.6	59.9	0.4	0.0	54.8	43.3	47.2
Tajikistan	Dushanbe	107.3	76.3	27.2	25.3	29.0	22.0	10.3	12.5	40.7	11.6	38.7	0.9	0.4	134.0	130.0	111.2
Tajikistan	Istaravšan (Istarawshan)	180.1	117.8	119.4	63.7	21.6	16.2	19.7	12.1	27.0	0.0	40.4	1.4	0.8	310.9	337.6	326.6
Tajikistan	Khujand (Chuçand)	79.6	61.6	31.8	31.4	18.2	14.6	8.4	9.6	43.9	15.8	56.5	1.3	0.5	222.4	229.1	212.7
Tajikistan	Kŭlob	52.2	34.9	22.7	22.0	13.3	10.9	8.5	10.1	39.1	0.0	42.7	1.0	0.4	161.7	160.6	143.7
Thailand	Krung Thep (Bangkok)	165.5	115.5	51.1	28.0	41.4	37.0	23.6	16.8	26.0	14.9	11.8	0.7	0.5	120.4	107.8	95.0
Timor-Leste	Dili	34.1	28.5	15.7	8.0	13.2	13.0	10.4	8.1	16.1	12.1	30.3	0.1	0.1	142.4	102.7	69.2
Tunisia	Al-Munastīr (Monastir)	18.7	11.8	6.0	3.2	5.9	4.8	3.1	2.0	63.5	21.0	67.2	0.4	0.0	98.8	75.0	0.0
Tunisia	Al-Qayrawān (Kairouan)	6.6	4.7	0.6	0.5	1.7	1.5	0.2	0.2	63.2	26.6	20.9	1.4	0.0	74.8	76.6	0.0
Tunisia	Manzil Bū Ruqaybah (Menzel Bourguiba)	20.8	12.4	11.6	10.1	7.9	5.6	5.8	5.6	...	...	...	...	...	...	...	...
Tunisia	Masākin (M'saken)	8.8	5.6	5.0	3.2	1.9	1.5	1.6	1.2	...	19.7	19.2	2.0	0.0	72.0	77.8	0.0
Tunisia	Qābis (Gabès)	119.7	97.3	67.3	65.8	26.5	24.4	19.2	21.4	79.2	21.3	21.9	-6.4	0.0	126.8	133.5	0.0
Tunisia	Safaqis	1.8	1.3	1.8	6.1	0.4	0.3	0.5	2.1	74.3	18.2	16.6	1.4	0.0	139.7	144.0	0.0
Tunisia	Sūsah (Sousse)	33.0	20.4	16.4	12.9	6.1	5.1	5.2	5.1	76.6	16.0	19.2	0.7	0.7	178.6	165.5	155.1
Tunisia	Tunis	17.6	7.0	8.1	5.6	6.4	3.1	4.1	3.5	77.8	25.4	31.6	1.5	0.0	73.4	76.2	0.0
Türkiye	Adana	22.6	9.4	6.1	4.2	14.7	5.9	3.7	2.1	...	...	...	...	...	...	...	...
Türkiye	Ankara	5.7	6.6	5.0	6.6	3.3	4.7	4.6	7.5	87.9	16.5	76.8	0.2	0.4	75.1	61.1	54.5
Türkiye	Bulancak	56.9	28.7	25.1	23.0	42.6	24.3	22.2	19.2	...	...	...	...	...	...	...	...
Türkiye	Bursa	26.3	12.9	8.5	8.1	9.3	6.8	6.4	8.0	98.5	17.0	70.7	0.8	0.5	86.6	79.6	68.9
Türkiye	Çarşamba	54.8	70.1	64.4	49.2	21.0	34.6	36.4	33.2	63.9	15.6	77.3	0.9	0.3	80.2	79.3	69.9
Türkiye	Ceyhan	6.7	6.0	3.4	1.2	6.4	5.6	2.9	0.9	...	...	...	...	...	...	...	...
Türkiye	Gaziantep	10.2	5.1	3.9	2.7	3.2	2.4	2.9	2.7	60.6	17.7	83.1	0.7	1.6	61.6	52.7	63.5
Türkiye	Giresun	30.7	20.2	15.2	12.2	36.8	27.2	23.0	18.2	...	...	...	...	...	...	...	...
Türkiye	Istanbul	5.7	5.3	4.6	7.5	4.3	5.0	5.3	9.6	98.1	15.4	59.8	0.4	0.9	58.2	51.2	50.9
Türkiye	Mersin	52.5	16.4	8.4	3.7	23.8	9.0	6.0	2.7	...	...	...	...	...	...	...	...
Türkiye	Ordu	79.2	45.0	26.3	13.6	48.5	33.3	24.8	13.3	...	...	...	...	...	...	...	...
Türkiye	Rize	30.9	18.4	12.8	8.5	47.2	33.0	26.1	17.9	...	...	...	...	...	...	...	...
Türkiye	Samsun	14.8	13.5	13.9	8.0	8.3	9.2	12.5	9.4	86.0	21.2	71.2	1.2	0.7	56.8	60.8	56.8
Türkiye	Tarsus	28.7	9.5	5.6	3.5	18.7	7.1	3.9	2.6	65.6	24.8	70.3	...	...	...	...	...
Türkiye	Terme	67.5	38.1	33.3	23.9	60.3	41.0	35.1	27.7	...	...	...	...	...	...	...	...
Türkiye	Trabzon	63.9	36.8	31.7	14.5	47.0	33.8	33.0	17.1	79.8	...	...	...	...	...	...	...
Turkmenistan	Ashgabat	14.0	3.1	4.9	3.8	5.0	1.5	3.0	3.0	60.7	15.8	48.8	1.0	0.7	83.3	83.3	77.0
Turkmenistan	Daşoguz	36.3	7.3	30.4	24.8	5.9	1.5	6.6	6.4	9.1	12.3	20.9	2.1	0.5	197.0	219.4	201.6
Turkmenistan	Mary	47.6	57.8	35.0	29.4	8.3	12.6	8.4	8.0	26.9	12.5	27.8	1.6	0.8	226.6	239.3	231.9
Turkmenistan	Tejen (Tedžen)	5.5	1.9	2.7	3.9	0.6	0.3	0.5	0.8	9.2	17.0	52.2	0.8	1.5	316.0	306.2	322.8
Turkmenistan	Türkmenabat	34.9	39.4	19.3	7.3	9.4	12.2	6.5	2.5	24.5	14.2	38.4	0.3	1.3	178.0	168.0	168.4
Uganda	Gulu	208.5	222.4	209.7	168.5	14.6	34.3	47.6	45.0	14.7	10.2	76.0	0.4	0.6	260.1	203.4	192.2
Ukraine	Kyiv (Kiev)	42.9	32.7	19.3	22.3	26.6	20.2	12.5	15.3	87.8	19.1	71.2	1.6	1.4	84.7	87.6	89.5
Ukraine	Lviv	89.4	94.8	61.0	66.8	42.1	42.2	26.6	28.7	89.6	18.6	77.9	-10.6	0.0	78.8	97.9	126.9
Ukraine	Odesa	29.9	41.3	28.9	36.5	16.3	21.4	14.6	18.5	89.9	14.1	56.6	-2.5	10.7	111.3	121.8	125.1
United Arab Emirates	Abu Zaby (Abu Dhabi)	12.2	9.4	1.6	5.2	1.6	1.9	0.9	2.2	27.3	21.1	37.6	...	...	...	...	...
United Arab Emirates	Al-Ain	69.4	58.2	24.0	44.2	8.6	8.9	11.3	15.3	...	15.0	41.3	...	...	...	...	...
United Arab Emirates	Dubayy (Dubai)	4.0	4.8	3.1	5.8	0.4	0.9	1.1	3.0	41.2	12.9	40.6	0.7	0.4	181.6	148.1	117.3
United Kingdom of Great Britain and Northern Ireland	Coventry-Bedworth	47.6	60.9	54.9	58.0	16.3	21.2	20.0	25.1	97.5	...	...	0.5	0.3	169.2	165.2	145.5
United Kingdom of Great Britain and Northern Ireland	Edinburgh	88.4	80.2	85.8	78.0	30.4	29.5	33.5	33.9	96.7	...	...	0.3	0.2	157.9	151.5	139.5
United Kingdom of Great Britain and Northern Ireland	Glasgow	71.9	74.8	73.6	66.1	25.7	25.3	25.1	23.2	94.8	...	...	2.5	1.0	172.4	174.7	174.7
United Kingdom of Great Britain and Northern Ireland	London	77.3	66.8	43.7	42.0	36.2	33.4	24.4	26.9	94.8	23.9	87.1	0.1	0.1	112.0	101.1	88.8
United Kingdom of Great Britain and Northern Ireland	Manchester	191.4	160.7	158.2	129.3	60.1	51.5	54.4	47.8	95.4	22.2	81.6	3.2	2.0	125.7	147.0	158.2
United Kingdom of Great Britain and Northern Ireland	Stoke-on-Trent (The Potteries)	22.8	33.3	79.9	87.7	7.3	10.5	25.7	29.3	...	...	...	...	...	...	...	...
United Republic of Tanzania	Arusha	310.9	159.3	85.5	74.1	33.8	31.1	24.6	26.5	21.7	12.6	16.7	0.6	1.6	167.0	140.9	161.5
United States of America	Albuquerque	50.0	32.7	25.8	28.7	4.8	3.7	3.6	4.8	62.3	...	...	0.6	0.4	367.5	337.4	298.7
United States of America	Atlanta	652.7	420.0	364.0	294.0	42.8	41.8	42.4	41.0	40.7	13.8	21.2	1.9	0.3	374.0	431.7	382.7
United States of America	Austin	420.3	420.0	290.2	219.7	25.5	40.7	38.2	43.2	...	...	...	0.5	0.4	457.5	390.7	303.5

Table C.1: Continued

Country / Territory Name	City Name	Green Area per Capita (UMF 47-3.3.2) [a]								SDG 11.2.1. Public Transport (UMF 10-1.2.2), 2020 [b]	SDG 11.7.1. Open Public Spaces (UMF44-3.2.1), 2020 [b]		SDG 11.3.1. Land Consumption (UMF 51-3.4.2)[b]				
		Green Area Per Capita 1990 (m² per capita)	Green Area Per Capita 2000 (m² per capita)	Green Area Per Capita 2010 (m² per capita)	Green Area Per Capita 2020 (m² per capita)	Proportion of Green Area in City/ Urban Area 1990 (%)	Proportion of Green Area in City/ Urban Area 2000 (%)	Proportion of Green Area in City/ Urban Area 2010 (%)	Proportion of Green Area in City/ Urban Area 2020 (%)	Proportion of population living within convenient walking distance to public transport (%)[c]	Average share of urban area that is open space for public use for all (%)[d]	Average share of urban population with convenient access to open public spaces (%) [e]	Land Consumption Rate to Population Growth Rate (LCRPGR) Year 1 to Year 2 (Ratio)	Land Consumption Rate to Population Growth Rate (LCRPGR) Year 2 to Year 3 (Ratio)	Built Up area Per Capita Year 1 (m² per capita)	Built Up area Per Capita Year 2 (m² per capita)	Built Up area Per Capita Year 3 (m² per capita)
United States of America	Charleston	164.0	289.1	207.5	286.1	15.6	27.5	23.0	37.6	...	...	...	...	...	...	...	...
United States of America	Charlotte	818.9	566.5	449.7	342.2	41.5	39.4	42.3	39.7	...	...	...	...	...	...	...	...
United States of America	Chicago	237.0	203.2	177.2	179.7	27.2	26.5	23.9	25.0	39.1	17.2	47.8	6.6	9.0	253.6	306.3	393.5
United States of America	Cleveland	257.2	223.3	337.6	335.1	35.8	31.7	45.6	43.2	...	20.0	29.8	-0.6	-0.3	291.8	315.9	336.3
United States of America	Columbia, South Carolina	565.0	459.9	389.6	346.3	38.3	37.4	38.1	40.4	...	...	...	...	...	...	...	...
United States of America	Dallas	337.5	160.5	108.9	132.9	28.9	18.4	15.3	22.7	...	...	...	0.3	0.9	363.3	316.3	310.6
United States of America	El Paso	28.7	19.2	11.6	9.1	2.9	2.3	1.6	1.5	67.1	...	...	2.1	0.9	324.6	390.4	382.8
United States of America	Houston	464.0	344.1	267.9	204.4	36.2	34.5	33.6	32.4	29.9	15.2	27.0	1.0	0.8	427.7	426.6	403.4
United States of America	Las Vegas	41.7	33.4	26.1	19.8	2.8	4.2	4.7	4.8	61.5	...	...	...	...	...	...	...
United States of America	Los Angeles-Long Beach-Santa Ana	39.7	25.7	25.8	20.5	9.2	6.6	7.0	5.9	76.9	...	...	...	...	...	...	...
United States of America	Miami	124.3	102.0	72.9	117.0	14.9	15.1	12.1	21.6	...	...	...	...	...	...	...	...
United States of America	Milwaukee	218.0	198.0	172.5	138.8	24.4	23.2	20.8	17.3	...	...	...	...	...	...	...	...
United States of America	Orlando	586.1	437.7	319.3	258.3	31.0	31.9	29.9	29.9	...	...	...	...	...	...	...	...
United States of America	Philadelphia	259.1	227.5	179.5	199.3	41.0	38.8	31.8	37.1	59.2	22.1	37.3	...	...	...	...	...
United States of America	Phoenix-Mesa	124.4	66.7	35.2	30.6	8.7	6.8	4.5	4.9	...	...	...	...	...	...	...	...
United States of America	Raleigh	1,017.4	586.9	427.8	298.7	45.0	41.0	43.0	42.1	33.4	23.7	25.4	0.2	0.1	603.0	446.5	330.4
United States of America	Sacramento	84.0	77.6	49.5	47.7	8.5	9.7	7.4	8.5	56.5	...	...	3.0	0.6	280.2	402.2	373.6
United States of America	San Antonio	325.2	295.7	229.5	184.8	26.8	28.7	27.8	29.5	57.3	...	...	...	...	...	...	...
United States of America	San Diego	75.2	52.5	70.8	77.9	10.5	8.4	12.5	15.1	...	...	...	1.0	1.4	295.8	297.1	308.8
United States of America	Savannah	575.0	557.2	432.8	406.6	45.8	43.8	39.0	41.9	70.7	17.7	47.1	0.6	0.2	647.4	614.8	553.4
United States of America	Seattle	222.3	178.0	133.5	129.7	26.6	26.4	22.4	24.6	...	...	...	...	...	...	...	...
United States of America	Toledo	381.2	442.3	410.9	489.7	30.1	35.2	32.2	37.9	56.2	18.1	27.5	-3.8	-2.1	549.0	585.1	609.3
United States of America	Wilmington	861.8	613.7	470.1	378.2	48.4	41.1	40.1	34.8	...	...	...	...	...	...	...	...
United States of America	Winston-Salem	394.2	431.0	406.7	410.6	24.2	38.1	41.3	47.0	...	...	...	...	...	...	...	...
Uruguay	Ciudad De La Costa	320.5	230.7	172.3	157.5	37.5	33.6	30.2	32.0	...	...	...	0.2	0.2	397.8	340.9	302.5
Uruguay	Montevideo	43.5	34.3	25.7	28.3	27.9	21.4	15.7	16.7	76.0	15.6	82.7	...	...	...	...	...
Uzbekistan	Andizhan	106.6	42.6	41.9	26.6	26.3	13.7	15.4	11.6	11.6	13.0	27.2	3.9	2.2	86.6	129.3	159.2
Uzbekistan	Bekobod	47.3	55.6	46.0	32.3	10.8	11.0	8.9	7.1	15.1	17.0	62.7	0.0	0.8	246.3	284.0	277.9
Uzbekistan	Buxoro (Bukhara)	45.2	53.9	34.6	26.8	9.5	12.6	8.9	7.6	8.2	12.4	38.9	1.4	2.3	188.6	195.9	222.2
Uzbekistan	Jizzax (Dzhizak)	36.6	21.2	21.3	12.0	10.4	6.8	7.6	4.4	...	...	...	...	...	...	...	...
Uzbekistan	Nukus	4.5	1.8	3.4	3.5	1.2	0.6	1.2	1.1	41.9	16.5	54.1	3.7	0.0	130.1	151.0	198.5
Uzbekistan	Qarshi (Karshi)	72.0	27.4	30.2	25.2	11.8	5.9	7.6	7.2	10.0	13.7	28.8	1.2	1.8	212.9	220.1	244.3
Uzbekistan	Qo'qon (Kokand)	145.7	73.7	62.3	49.4	25.9	16.2	15.4	13.8	18.8	0.0	24.6	1.5	1.1	167.4	177.7	179.6
Uzbekistan	Tashkent	66.0	31.5	24.2	16.5	25.7	13.1	10.6	8.1	23.1	15.4	26.3	1.2	0.3	151.6	153.3	142.5
Viet Nam	Hà Noi	150.5	130.7	72.3	67.7	61.8	65.5	44.9	47.0	69.0	...	...	2.0	1.1	60.9	76.1	76.5
Viet Nam	Nha Trang	87.4	73.4	40.1	24.4	31.0	31.9	19.3	12.1	42.6	13.6	40.1	0.6	4.3	113.0	108.4	118.5
Viet Nam	Thành Pho Ho Chí Minh (Ho Chi Minh City)	115.8	121.6	73.8	27.8	33.5	51.8	45.6	23.4	68.7	14.6	30.4	1.4	0.2	55.1	62.8	49.4
Viet Nam	Vĩnh Long	146.8	125.6	112.4	92.5	47.9	48.9	45.8	38.1	8.3	12.3	6.7	9.6	15.6	66.3	99.0	114.9
Yemen	Adan (Aden)	3.3	1.3	0.4	0.4	1.2	0.7	0.3	0.5	24.5	12.1	51.7	0.9	1.1	63.0	60.3	61.6
Yemen	Sana'a'	7.3	4.4	1.4	1.0	3.0	3.4	1.6	1.6	15.2	15.9	12.4	0.9	0.2	49.7	47.8	36.3
Zambia	Chingola	22.6	10.7	11.0	4.4	5.2	3.2	4.1	2.1	5.3	11.6	1.9	0.7	1.3	144.5	135.5	143.8
Zambia	Kitwe	19.3	12.3	11.0	6.2	6.2	4.2	5.3	3.9	7.0	12.0	13.1	0.3	1.1	123.7	99.7	102.0
Zambia	Lusaka	12.9	14.5	7.1	1.9	2.6	4.1	3.4	1.5	41.5	13.7	8.3	0.4	0.4	156.1	113.9	85.5
Zambia	Ndola	21.4	17.5	12.7	8.1	5.7	5.1	5.1	3.9	9.4	12.2	8.0	0.4	1.0	172.7	144.5	145.0
Zimbabwe	Bulawayo	4.8	5.4	8.5	12.8	1.0	1.3	2.0	2.6	...	12.9	21.8	...	...	...	...	...

Table C.2: Climate Change Indicators in Selected Cities and Years, 2000-2020 [a]

		Annual Mean Levels of Fine Particulate Matter (PM2.5) (Population-Weighted) (Micrograms per Cubic Metre) [b]			Annual Average Levels of surface Level Nitrogen Dioxide (NO2) Concentrations (Population-Weighted) (Parts per Billion) [c]		The Highest Seasonal (6-Month) Average of 8-Hour Daily Maximum Ozone (O3) Concentrations (Parts per Billion) [d]			Total Carbon Dioxide (CO2) Emissions (Thousand Metric Tons) [e]			Carbon Dioxide (CO2) Emissions per Capita (Metric Tons) [e]		
		2000	2010	2020	2010	2020	2000	2010	2020	2000	2010	2020	2000	2010	2020
Afghanistan	Herat	45.0	48.9	50.7	7.7	8.4	54.2	46.2	50.0	4	29	25	0.0	0.1	0.1
Afghanistan	Kabul	24.8	34.0	31.8	16.2	18.8	59.8	51.6	56.0	136	646	471	0.1	0.2	0.1
Afghanistan	Mazar-e Sharif	48.5	59.4	51.8	4.6	4.6	56.6	46.7	52.7	3	22	13	0.1	0.6	0.4
Algeria	Annaba	17.2	14.8	14.4	10.0	9.9	0.0	0.0	0.0	477	461	436	1.4	1.3	1.1
Algeria	Blida	14.2	14.3	13.8	12.6	13.5	68.4	63.8	55.2	868	1,065	2,885	2.9	2.7	5.4
Angola	Huambo	16.0	24.9	16.7	5.2	5.0	50.5	53.0	52.1	147	371	459	2.1	1.7	2.9
Angola	Malanje	21.5	30.5	20.3	4.0	3.8	53.8	57.4	49.3	68	157	133	1.5	1.0	1.0
Argentina	Buenos Aires	14.8	12.0	13.9	15.9	15.1	32.0	32.6	37.1	-	-	-	1.5	1.6	1.2
Argentina	Clorinda	18.0	16.0	22.1	4.3	4.2	28.3	34.6	41.6	64	81	76	4.8	5.4	3.3
Argentina	Rosario	16.8	14.2	16.1	8.8	8.5	33.4	33.9	36.5	965	1,000	934	1.6	1.6	1.2
Argentina	San Juan	15.8	17.5	18.7	11.1	10.7	34.0	35.6	33.1	559	692	640	2.0	2.3	1.9
Armenia	Yerevan	31.3	38.4	36.4	14.9	14.4	48.1	51.9	54.9	589	926	998	0.5	0.9	1.0
Australia	Cairns	7.5	8.1	7.2	2.9	3.2	28.1	27.5	29.6	169	180	225	3.8	4.0	5.0
Australia	Central Coast	5.6	5.3	8.3	7.1	7.2	31.8	29.4	32.6	109	120	136	2.7	2.9	3.3
Australia	Hobart	3.7	4.0	4.5	6.0	6.3	24.5	28.7	28.2	343	364	416	5.5	5.8	6.6
Australia	Newcastle-Maitland	5.7	5.2	7.7	9.5	9.8	31.1	28.2	29.9	491	514	625	3.0	3.2	3.8
Australia	Sydney	5.5	5.3	8.3	12.8	12.8	29.8	28.8	31.1	7,713	7,731	8,471	2.3	2.3	2.5
Australia	Wollongong	5.3	5.2	8.8	8.3	8.6	0.0	0.0	0.0	8,473	9,536	6,787	95.4	107.1	76.2
Austria	Wien (Vienna)	18.7	19.0	11.4	14.8	14.0	51.5	44.5	48.7	5,394	7,888	5,715	3.8	5.0	3.3
Azerbaijan	Baku	31.1	31.1	26.3	14.0	14.4	41.2	40.3	44.2	3,134	3,441	3,810	2.2	2.1	2.0
Bahrain	Al-Manamah (Manama)	53.4	51.3	44.7	14.7	15.6	61.0	51.2	64.9	7,730	11,370	10,287	14.5	11.2	5.3
Bangladesh	Dhaka	62.8	81.5	89.4	17.1	20.8	55.1	50.2	66.3	2,133	11,467	18,916	0.2	0.8	1.0
Belarus	Minsk	17.1	19.2	12.4	15.9	15.5	42.4	37.6	35.9	7,017	6,926	5,178	4.2	3.8	2.6
Belgium	Antwerpen	16.0	18.2	10.4	15.1	13.4	33.3	35.6	38.4	9,766	10,606	8,923	17.1	16.8	12.8
Benin	Djougou	53.4	36.3	44.0	5.3	5.3	45.2	42.2	54.6	15	52	75	1.6	2.4	3.9
Benin	Parakou	58.1	38.7	46.6	5.2	5.5	46.7	42.8	54.7	23	57	84	0.4	0.5	0.5
Bolivia (Plurinational State of)	La Paz	19.9	30.3	27.2	10.4	11.2	32.3	31.2	42.0	310	657	836	0.4	0.6	0.7
Botswana	Gaborone	13.8	20.1	14.4	6.4	6.4	38.3	38.3	41.7	285	477	593	4.2	5.7	5.3
Brazil	Aparecida de Goiânia	8.5	11.4	10.6	10.2	10.4	34.0	38.6	43.6	937	1,140	1,359	0.7	0.7	0.6
Brazil	Belém	12.1	16.4	16.8	8.8	9.3	27.1	27.0	32.9	676	701	783	0.4	0.4	0.4
Brazil	Belo Horizonte	9.2	11.1	12.3	12.5	12.6	30.5	35.2	39.6	2,867	3,532	3,811	0.8	1.0	0.9
Brazil	Blumenau	12.5	13.7	11.6	7.9	7.6	34.0	35.1	47.9	86	106	115	0.5	0.6	0.5
Brazil	Brasília	9.0	13.6	13.5	11.1	11.6	33.8	38.3	41.9	759	922	959	0.7	0.6	0.5
Brazil	Campinas	15.1	19.0	15.9	13.7	13.2	39.2	39.1	51.8	1,031	1,255	1,415	0.8	0.9	0.8
Brazil	Criciúma	9.6	9.9	10.3	8.6	8.6	34.1	34.8	43.0	162	200	208	1.2	1.3	1.2
Brazil	Cuiabá	15.2	20.6	15.4	8.8	8.9	36.1	40.0	49.7	312	1,051	1,205	0.8	2.2	2.2
Brazil	Feira De Santana	9.2	12.8	12.1	11.1	11.9	31.1	29.7	36.9	201	237	292	0.5	0.5	0.6
Brazil	Manaus	16.2	26.6	23.6	8.3	9.0	22.5	22.2	34.1	331	369	397	0.2	0.2	0.2
Brazil	Petrolina	8.2	11.6	11.1	7.8	8.6	30.3	30.3	33.9	389	443	379	1.4	1.3	0.9
Brazil	Pôrto Alegre	10.6	10.5	10.4	11.3	11.2	33.3	33.6	40.8	420	475	532	0.3	0.3	0.3
Brazil	Rio de Janeiro	12.9	14.7	15.8	14.8	14.3	0.0	0.0	0.0	3,849	4,559	5,022	0.5	0.5	0.5
Brazil	Salvador	7.3	8.8	8.6	12.0	12.7	29.1	28.2	34.1	751	832	898	0.3	0.3	0.3
Brazil	São Gonçalo	14.0	13.8	13.8	12.3	12.1	0.0	0.0	0.0	394	441	497	0.3	0.3	0.3
Brazil	São Paulo	17.3	18.1	15.9	17.7	16.8	38.6	32.2	45.7	8,690	10,999	11,626	0.5	0.6	0.6
Bulgaria	Burgas	27.1	22.7	20.7	7.4	6.7	36.1	40.2	40.4	180	172	204	6.7	5.6	6.5
Bulgaria	Dobrič (Dobrich)	18.7	17.6	14.8	5.8	5.1	34.5	39.2	36.5	151	150	181	15.5	15.1	17.9
Bulgaria	Sofia	33.1	28.6	25.5	10.9	11.1	22.1	48.6	49.5	612	543	601	1.5	1.2	1.1
Burkina Faso	Ouagadougou	44.0	39.0	34.2	7.4	10.1	37.9	36.7	47.9	350	747	1,856	0.4	0.4	0.5
Cambodia	Phnum Pénh (Phnom Penh)	18.4	20.4	24.7	10.7	11.7	31.8	35.9	37.3	544	1,381	1,698	0.5	0.9	0.7
Canada	Calgary	8.5	9.8	7.9	14.0	13.4	39.5	38.6	38.5	4,442	5,546	6,543	5.5	5.4	5.0
Canada	London	11.3	8.2	6.2	10.3	9.4	41.4	47.6	43.4	1,143	1,320	1,475	4.0	4.3	4.4
Canada	Ottawa-Gatineau	7.1	5.7	5.8	10.9	10.9	32.2	38.9	32.7	3,245	3,815	4,334	6.4	6.4	6.1
Canada	Regina,SASK	7.3	7.1	4.9	11.5	10.8	35.9	38.2	27.3	2,003	2,333	2,088	13.4	13.5	10.4
Canada	Toronto	11.0	7.6	6.4	13.5	13.4	38.2	40.9	42.2	26,040	31,260	35,102	6.7	6.9	6.6
Canada	Vancouver	7.3	6.0	5.7	12.9	12.9	26.9	30.1	32.2	7,983	9,198	9,825	5.8	5.6	5.0
Central African Republic	Bangui	40.0	38.2	39.8	8.5	9.8	44.9	44.3	60.4	29	29	26	0.1	0.0	0.0
Chad	N'Djaména	43.1	41.8	41.2	6.2	7.6	39.5	39.5	47.0	42	57	155	0.1	0.1	0.2
Chile	Concepción	12.5	13.6	12.1	8.9	8.9	0.0	0.0	0.0	3,582	2,775	2,478	10.7	7.8	6.4
Chile	Los Ángeles	18.3	21.8	20.1	8.4	7.9	32.9	28.4	30.9	144	184	161	2.2	2.4	1.9
Chile	Santiago	23.4	25.2	24.5	21.0	19.0	42.6	35.7	35.0	5,895	8,079	5,817	1.2	1.5	0.8
Chile	Temuco	29.8	34.0	33.5	9.0	8.3	32.3	27.4	28.9	168	249	220	1.0	1.2	0.8
China	Beijing	66.4	95.3	42.9	24.1	24.5	55.3	54.4	67.3	44,103	64,906	64,415	3.8	3.9	2.7
China	Chaozhou	47.1	59.4	38.6	21.8	20.6	54.5	55.0	49.3	4,399	29,415	34,644	2.2	12.1	11.7
China	Chengdu	53.6	80.6	41.1	20.7	20.5	49.5	55.0	50.5	7,475	12,655	10,492	1.3	1.8	1.2
China	Haikou	18.8	20.4	15.0	11.4	12.8	40.5	41.4	35.3	244	481	497	0.2	0.3	0.3
China	Hangzhou	44.3	54.7	32.9	19.7	19.0	50.5	51.8	58.8	8,028	13,749	13,203	1.5	2.1	1.6
China	Hong Kong, Hong Kong	25.2	25.1	16.1	24.5	23.8	32.1	47.2	38.3	14,047	11,980	7,932	3.3	2.7	1.7
China	Ji'nan, Shandong	49.6	69.5	49.5	24.1	22.6	60.7	61.7	63.4	4,162	8,547	8,331	1.5	2.6	2.2
China	Qingdao	37.1	45.7	35.7	22.4	21.9	49.3	54.2	50.7	13,216	27,999	30,021	4.5	8.3	7.6
China	Tianjin	56.9	70.1	50.6	25.2	25.2	59.7	60.6	52.5	25,409	47,336	47,233	4.5	6.4	4.9
China	Yulin, Guangxi	32.3	43.5	28.1	10.9	10.4	44.4	50.8	35.3	265	584	545	0.6	1.2	1.0

Table C.2: Continued

Green Area per Capita (UMF 47-3.3.2) a | SDG 11.2.1. Public | SDG 11.7.1. Open Public Spaces | SDG 11.3.1. Land Consumption (UMF 51-3.4.2)b

Country / Territory Name	City Name	Annual Mean Levels of Fine Particulate Matter (PM2.5) (Population-Weighted) (Micrograms per Cubic Metre) [b]			Annual Average Levels of surface Level Nitrogen Dioxide (NO2) Concentrations (Population-Weighted) (Parts per Billion) [c]		The Highest Seasonal (6-Month) Average of 8-Hour Daily Maximum Ozone (O3) Concentrations (Parts per Billion) [d]			Total Carbon Dioxide (CO2) Emissions (Thousand Metric Tons) [e]			Carbon Dioxide (CO2) Emissions per Capita (Metric Tons) [e]		
		2000	2010	2020	2010	2020	2000	2010	2020	2000	2010	2020	2000	2010	2020
Colombia	Barranquilla	15.3	16.6	17.0	10.4	11.3	39.2	33.7	34.3	2,217	2,329	1,919	1.8	1.5	0.9
Colombia	Bogotá	15.1	20.8	19.5	13.2	13.9	30.2	24.9	29.6	3,584	3,489	4,314	0.7	0.5	0.4
Colombia	Boyaca Duitama	15.7	21.2	19.2	7.4	7.0	33.9	27.8	31.2	78	84	100	2.0	1.7	1.3
Colombia	Boyaca Sogamoso	15.8	20.7	18.7	7.2	7.1	34.2	28.2	31.3	1,526	1,272	1,708	21.1	15.7	17.0
Colombia	Casanare Yopal	15.6	19.8	19.1	3.1	2.9	33.2	27.7	29.8	92	110	137	6.3	2.5	1.3
Colombia	Medellín	18.3	22.9	21.3	11.8	12.1	28.6	26.2	29.3	816	791	960	0.4	0.3	0.3
Colombia	Neiva	15.0	16.7	16.4	4.7	4.4	28.7	24.5	28.8	154	165	226	1.3	1.0	1.0
Costa Rica	Cartago	17.6	20.8	20.3	8.0	8.7	37.9	29.1	34.5	210	316	355	1.9	2.5	2.3
Costa Rica	San José	17.6	21.2	20.7	9.3	9.7	38.0	28.7	34.8	798	988	955	0.5	0.6	0.5
Côte d'Ivoire	Bouake	28.6	23.8	23.2	4.0	4.3	34.5	31.7	48.6	130	123	221	0.5	0.3	0.5
Côte d'Ivoire	Korhogo	29.0	24.4	24.3	5.3	5.3	40.4	35.7	46.6	21	11	29	0.2	0.1	0.1
Côte d'Ivoire	Man	20.2	20.4	22.0	3.7	4.5	31.1	29.1	46.9	40	43	83	0.7	0.5	0.7
Côte d'Ivoire	Yamoussoukro	21.9	21.4	20.1	2.8	3.2	30.1	28.7	47.0	41	35	82	0.9	0.4	0.7
Croatia	Zagreb	22.7	21.9	16.1	7.4	7.3	48.9	48.6	50.4	190	212	164	0.5	0.6	0.4
Cyprus	Lefkosía (Nicosia)	20.8	21.7	15.9	11.0	11.1	49.9	45.7	53.1	306	343	283	1.6	1.6	1.1
Czechia	Brno	20.4	20.9	13.1	12.3	11.6	39.1	44.6	48.7	6,098	5,716	3,110	26.1	23.2	12.5
Czechia	Ostrava	30.4	35.3	18.5	12.6	10.3	46.9	42.9	46.5	2,009	1,682	1,221	20.4	17.5	13.9
Czechia	Praha (Prague)	18.8	19.7	12.7	13.9	12.7	46.1	44.5	45.8	3,874	3,404	2,465	4.5	3.7	2.5
Democratic People's Republic of Korea	P'yongyang	28.6	30.0	30.9	12.0	12.0	51.3	50.0	60.2	6,960	4,755	3,845	6.2	4.7	4.3
Democratic People's Republic of Korea	Songrim	24.6	25.0	26.5	8.2	8.0	51.9	50.2	62.2	1,643	1,164	1,016	21.3	15.1	13.3
Democratic Republic of the Congo	Butembo	36.9	37.5	35.4	5.1	5.0	31.2	28.5	48.9	2	4	4	0.0	0.0	0.0
Democratic Republic of the Congo	Kisangani	40.2	45.0	36.1	1.5	1.6	20.3	19.8	50.8	2	5	5	0.0	0.0	0.0
Denmark	Aalborg	12.7	10.7	7.6	9.9	8.4	38.0	37.6	36.7	3,041	1,877	2,611	37.9	22.0	28.9
Denmark	Århus	13.9	11.9	8.2	9.4	8.2	39.3	38.4	37.6	670	609	448	3.6	2.9	1.9
Denmark	Herning	13.0	11.7	7.9	7.3	5.9	38.8	39.0	38.2	175	158	120	10.6	9.0	6.7
Denmark	Horsens	14.2	12.3	8.2	9.1	7.5	38.7	38.8	39.2	867	798	263	25.0	23.5	7.6
Denmark	København (Copenhagen)	12.4	11.2	7.8	12.9	12.2	35.3	35.8	35.2	5,556	5,413	2,643	6.2	5.3	2.2
Denmark	Kolding	13.6	12.1	8.1	8.5	7.0	38.3	38.7	38.3	318	308	239	8.6	7.9	5.8
Denmark	Odense	14.1	11.5	7.8	8.9	7.3	37.0	36.3	39.2	2,341	2,531	1,115	20.8	22.4	9.8
Denmark	Randers	13.5	11.3	8.0	8.6	7.2	37.9	37.5	36.9	230	209	160	6.0	5.4	4.2
Denmark	Vejle	13.4	12.2	8.1	9.3	7.8	38.1	38.2	38.5	236	224	173	12.3	10.7	7.8
Djibouti	Djibouti	45.4	40.8	42.2	6.6	6.9	39.1	35.8	45.4	271	274	208	0.9	0.8	0.5
Egypt	Al-Iskandariyah (Alexandria)	32.0	35.5	27.1	17.7	18.9	52.5	53.8	48.9	3,792	4,369	5,276	1.1	1.1	1.1
Egypt	Al-Mansurah	33.8	42.1	32.1	14.5	14.1	55.3	56.1	50.9	2,749	6,036	5,917	3.8	7.2	5.9
Egypt	Al-Qahirah (Cairo)	43.0	49.7	39.5	20.8	21.7	55.2	51.0	46.6	21,274	33,454	34,232	1.5	2.0	1.7
Egypt	Asyut	39.7	46.7	37.5	17.4	17.0	57.2	57.1	52.3	421	765	719	0.7	1.2	0.9
Egypt	Az-Zaqazig	39.7	46.7	37.5	17.4	17.0	57.2	57.1	52.3	421	765	719	0.7	1.2	0.9
Egypt	Bur Sa'id	33.2	32.6	25.1	14.2	15.5	55.0	56.0	50.6	357	549	469	0.8	1.0	0.7
Egypt	Damanhūr (Damanhour)	34.3	39.9	30.4	14.4	13.9	53.6	54.8	49.9	1,474	1,576	973	4.5	4.2	2.2
Egypt	Disūq (Desouk)	31.6	38.9	28.9	10.5	10.8	54.4	55.6	50.6	1,209	3,315	2,293	6.8	15.6	9.0
Egypt	Dumyāt (Damietta)	30.5	31.0	23.7	11.6	12.5	54.2	55.4	50.0	3,890	4,173	3,197	11.6	10.7	6.6
Egypt	Fāqūs (Faqous)	38.3	45.0	33.8	9.9	9.1	56.4	56.5	51.8	160	285	285	0.7	1.2	1.0
Egypt	Tanta	38.4	44.8	34.7	15.7	15.1	55.3	55.2	50.4	881	1,094	960	1.7	1.8	1.3
Eritrea	Asmara	28.4	28.9	25.6	7.6	8.0	41.3	37.2	42.6	31	20	22	0.2	0.1	0.1
Eswatini	Mbabane	17.0	19.1	13.9	8.8	8.3	34.1	34.4	41.3	121	87	116	6.5	4.3	5.4
Ethiopia	Dire Dawa	16.9	23.3	25.5	6.4	6.7	35.2	31.7	45.2	90	206	1,063	0.7	1.2	4.8
France	Angers	12.3	14.5	7.9	12.7	10.9	38.3	45.0	42.7	503	442	312	2.9	2.6	1.9
France	Le Mans	12.2	14.2	7.8	12.8	11.5	37.3	43.6	41.4	835	768	591	5.7	5.4	4.3
France	Marseille	18.4	16.8	10.2	14.3	13.7	49.6	51.4	49.0	1,458	1,454	1,062	1.8	1.7	1.1
France	Nantes	11.8	14.5	8.0	12.9	11.3	38.3	43.8	42.0	733	685	523	1.8	1.6	1.2
France	Strasbourg	16.7	18.3	12.0	13.7	12.5	45.0	46.0	42.4	1,089	1,045	820	2.9	2.7	2.0
France	Tours	12.5	15.8	8.0	13.6	12.3	39.8	43.9	41.9	390	360	267	1.8	1.7	1.2
Germany	Bremen	15.2	14.9	9.4	13.2	11.8	36.7	41.7	37.0	2,109	2,035	1,642	6.3	5.9	4.8
Germany	Halle (Saale)	16.4	17.4	9.3	12.8	11.0	41.4	42.2	41.8	948	793	805	6.0	5.0	5.2
Germany	Hamburg	14.2	14.8	9.5	12.9	11.1	36.4	40.1	36.4	8,207	7,838	10,305	5.8	5.4	7.1
Germany	München (Munich)	12.9	13.6	8.6	13.8	13.7	43.7	44.0	47.0	6,715	7,295	5,963	5.3	5.2	3.7
Germany	Oldenburg (Oldenburg)	13.8	13.6	8.0	11.5	10.3	39.8	41.8	37.7	1,063	977	902	8.4	7.5	7.2
Ghana	Tamale	42.4	30.3	33.2	4.5	4.8	43.3	41.4	54.2	24	41	76	0.1	0.2	0.2
Greece	Athínai (Athens)	19.9	18.4	14.2	16.5	15.8	54.9	53.8	46.4	5,054	4,230	3,361	1.6	1.3	1.1
Greece	Thessaloniki	20.6	18.4	16.1	15.8	15.0	51.5	35.3	54.8	2,638	2,835	2,174	3.4	3.6	2.8
Guatemala	Mazatenango	35.3	33.4	34.4	6.3	7.2	0.0	0.0	0.0	110	138	194	3.1	2.8	2.6
Guatemala	Quetzaltenango	29.2	27.2	29.4	7.5	7.4	0.0	0.0	0.0	68	94	131	0.6	0.7	0.7
Guatemala	San Juan Sacatepéquez	43.9	45.1	45.3	3.2	3.6	0.0	0.0	0.0	103	135	213	4.0	5.3	5.9
Guinea	Conakry	43.1	32.3	32.4	7.7	8.8	36.0	36.8	43.9	171	296	360	0.2	0.2	0.2
Guinea	Kankan	32.3	30.2	26.5	4.3	5.3	37.3	35.9	48.3	7	10	11	0.1	0.1	0.1
Guinea	Nzérékoré	22.2	24.1	23.2	4.5	5.9	32.3	30.3	49.2	6	10	12	0.1	0.1	0.1
Guinea-Bissau	Bissau	39.3	31.7	32.1	4.2	5.8	35.6	37.2	44.4	78	107	100	0.3	0.3	0.2
Honduras	El Progreso	33.5	31.2	45.8	3.8	4.0	39.7	31.5	35.2	76	106	89	1.5	1.8	1.1
Honduras	San Pedro Sula	32.0	28.8	40.9	6.1	6.2	43.1	34.7	39.0	173	274	207	0.4	0.5	0.3

Table C.2: Continued

		Annual Mean Levels of Fine Particulate Matter (PM2.5) (Population-Weighted) (Micrograms per Cubic Metre) [b]			Annual Average Levels of surface Level Nitrogen Dioxide (NO2) Concentrations (Population-Weighted) (Parts per Billion) [c]		The Highest Seasonal (6-Month) Average of 8-Hour Daily Maximum Ozone (O3) Concentrations (Parts per Billion) [d]			Total Carbon Dioxide (CO2) Emissions (Thousand Metric Tons) [e]			Carbon Dioxide (CO2) Emissions per Capita (Metric Tons) [e]		
		2000	2010	2020	2010	2020	2000	2010	2020	2000	2010	2020	2000	2010	2020
Hungary	Miskolc	26.7	20.8	15.0	8.5	7.7	46.4	44.8	46.4	1,060	1,284	1,191	9.3	12.3	11.4
Hungary	Sopron	17.8	18.0	10.9	7.5	6.9	56.4	48.0	52.0	174	181	219	7.4	6.1	5.6
India	Ahmadnagar	27.5	37.8	41.7	7.1	6.4	57.9	54.4	69.7	106	188	235	0.4	0.6	0.9
India	Amritsar	67.2	84.0	77.2	11.8	11.2	63.1	59.7	75.9	604	872	495	0.9	1.1	0.6
India	Bareilly	62.9	90.3	82.5	8.5	8.5	63.4	60.8	69.5	121	204	243	0.1	0.2	0.2
India	Bhiwandi	25.3	36.7	43.7	10.2	10.6	58.2	57.1	68.2	381	836	876	0.3	0.5	0.4
India	Bhopal	29.6	44.3	52.0	7.7	7.8	53.0	50.7	65.4	249	460	515	0.2	0.3	0.3
India	Delhi	90.2	128.9	113.8	18.2	18.2	61.4	62.1	64.3	16,471	25,480	18,849	1.0	1.2	0.7
India	Hyderabad	26.5	39.6	39.4	14.8	14.7	54.5	48.2	69.3	2,221	4,363	4,551	0.4	0.6	0.5
India	Jalandhar	58.6	72.0	73.1	11.6	11.1	62.9	60.9	72.8	182	327	390	0.3	0.4	0.4
India	Kochi (Cochin)	18.9	21.4	22.9	6.0	5.9	43.4	35.3	57.7	3,107	4,653	6,106	1.3	1.8	2.3
India	Lakhīmpur	66.7	88.9	80.8	8.2	7.5	65.8	61.8	71.8	104	198	579	0.9	1.3	2.6
India	Ludhiana	60.0	80.9	79.4	12.4	11.6	64.3	63.3	71.5	648	1,207	1,223	0.5	0.8	0.8
India	Moradabad	48.8	67.8	65.3	9.7	9.7	62.8	61.1	68.4	119	215	239	0.2	0.3	0.2
India	Mumbai (Bombay)	34.0	38.6	40.4	19.3	19.3	53.0	54.8	65.4	16,372	19,728	17,713	1.2	1.3	1.0
India	Nashik	23.6	35.6	37.1	9.2	9.0	58.3	56.3	68.2	5,727	6,067	4,180	5.9	5.1	2.8
India	Patna	68.3	87.5	95.1	11.6	12.3	65.4	63.9	72.7	76	139	184	0.0	0.1	0.1
India	Pune (Poona)	32.0	46.2	50.5	15.7	16.9	58.2	56.1	69.3	1,438	2,858	2,922	0.4	0.6	0.4
India	Shahjahanpur	70.8	104.9	97.2	8.9	8.4	65.2	62.5	70.3	1,164	4,960	6,493	4.7	15.7	15.9
India	Sītāpur	77.5	100.9	92.9	9.2	9.1	64.4	60.4	70.4	78	133	134	0.7	1.1	0.8
India	Surat	34.4	39.0	49.4	15.5	17.7	56.6	55.4	65.0	2,542	4,389	4,289	1.0	1.2	0.8
Indonesia	Bandar Lampung	10.7	14.6	16.5	8.2	9.0	31.1	31.2	50.1	348	448	508	0.7	0.6	0.5
Indonesia	Cirebon	18.1	21.1	19.4	8.1	8.1	28.6	32.6	44.5	572	699	660	0.6	0.6	0.5
Indonesia	Manado	11.5	13.1	12.8	4.1	4.3	21.1	25.8	22.6	214	286	306	0.8	1.1	0.9
Indonesia	Medan	22.9	33.9	33.6	10.3	10.2	26.5	31.5	33.4	823	1,186	1,095	0.3	0.4	0.3
Indonesia	Pekalongan	18.5	20.2	18.9	4.2	4.2	29.9	32.3	51.3	222	170	155	0.3	0.2	0.2
Indonesia	Semarang	19.8	21.0	20.2	8.6	8.7	28.8	32.7	48.9	2,439	3,588	3,354	1.6	2.0	1.6
Iran (Islamic Republic of)	Ardabil	26.4	33.4	26.3	10.4	10.8	45.7	44.4	52.6	673	874	882	4.6	5.4	4.0
Iran (Islamic Republic of)	Bandar Abbas	61.1	60.1	57.2	6.9	7.5	62.1	51.7	53.5	885	1,388	1,554	21.9	20.8	13.5
Iran (Islamic Republic of)	Bojnūrd	34.5	33.4	31.2	8.4	8.7	51.2	43.3	51.2	1,092	3,383	4,096	26.9	80.1	47.6
Iran (Islamic Republic of)	Dehdasht	61.0	62.3	49.5	6.1	6.2	62.5	52.8	63.5	201	205	175	14.6	23.4	18.5
Iran (Islamic Republic of)	Eṣfahān (Isfahan)	41.1	47.6	52.5	12.9	12.8	57.4	49.1	60.8	3,158	4,861	5,622	5.9	6.8	5.3
Iran (Islamic Republic of)	Karaj	36.5	41.7	37.7	14.4	15.2	51.1	39.2	51.2	1,344	2,027	2,407	1.4	1.6	1.3
Iran (Islamic Republic of)	Kāshmar	29.7	35.4	38.2	7.6	8.0	54.7	47.2	54.6	268	378	394	15.6	17.1	12.2
Iran (Islamic Republic of)	Mashhad	33.2	35.0	34.4	11.7	12.5	53.6	46.8	50.7	8,164	12,450	14,631	7.9	9.7	8.1
Iran (Islamic Republic of)	Nīshābūr (Nishapur/ Neyshabur)	29.8	33.1	33.2	10.3	10.6	53.7	46.4	52.3	1,281	2,111	2,836	20.2	35.6	35.7
Iran (Islamic Republic of)	Shiraz	38.3	41.2	40.1	11.7	11.8	59.7	48.7	60.3	1,898	2,392	2,345	5.1	6.8	5.2
Iran (Islamic Republic of)	Shīrvān	34.9	34.3	31.2	8.0	8.6	51.6	43.8	51.1	174	253	265	11.4	16.6	9.9
Iran (Islamic Republic of)	Tabriz	30.1	34.8	32.2	14.1	14.2	51.9	49.6	60.4	4,891	7,436	6,641	13.3	15.4	9.1
Iran (Islamic Republic of)	Tehran	32.4	37.4	33.9	20.9	21.8	48.8	30.6	44.8	20,380	28,590	30,562	3.6	4.6	4.1
Iraq	Baghdad	45.4	58.3	49.7	13.0	13.9	58.7	56.4	55.9	6,241	6,791	7,787	2.2	2.0	1.9
Iraq	Faloojah	45.3	55.8	38.0	6.5	6.6	59.8	57.6	56.6	690	661	1,062	30.1	18.8	34.5
Ireland	Dublin	9.8	10.1	8.2	10.8	9.9	0.0	0.0	0.0	2,981	3,317	2,936	3.1	3.1	2.3
Israel	Tel Aviv-Yafo (Tel Aviv-Jaffa)	20.5	23.4	20.4	14.5	14.1	48.2	50.7	48.8	2,983	2,886	2,475	2.0	1.6	1.2
Italy	Marsala	14.3	14.4	12.7	7.3	7.1	48.4	45.9	45.1	318	304	224	4.0	3.8	2.8
Italy	Messina	14.3	13.3	10.3	11.0	10.5	47.4	41.4	45.4	494	485	372	2.5	2.6	2.1
Italy	Milano (Milan)	31.2	28.4	22.9	18.8	17.5	51.9	51.2	62.0	7,116	7,910	6,169	2.4	2.7	2.0
Italy	Palermo	14.7	14.4	11.5	10.7	10.1	48.1	45.2	46.0	732	705	561	1.0	1.0	0.8
Italy	Roma (Rome)	21.6	18.4	15.3	15.8	15.3	47.5	44.9	51.1	9,923	10,732	8,756	4.5	4.7	3.7
Italy	Venezia	29.7	24.6	22.2	10.5	9.1	45.5	47.7	57.2	355	757	583	5.5	12.2	9.8
Japan	Akita	11.1	8.9	8.3	8.0	7.8	47.9	48.5	39.7	2,354	1,685	757	11.5	8.8	4.2
Japan	Kanazawa	14.5	10.4	8.9	10.3	9.8	51.6	53.7	47.9	1,444	1,210	994	3.2	2.6	2.0
Japan	Okinawa	12.4	13.3	10.3	11.2	11.4	0.0	0.0	0.0	3,505	3,249	2,904	3.8	3.4	2.9
Japan	Osaka	17.5	13.7	12.5	18.7	17.8	44.5	49.5	44.7	75,283	68,267	57,844	5.6	5.0	4.1
Japan	Tokyo	17.2	14.3	13.3	22.3	20.7	45.9	45.1	48.4	120,018	116,476	100,187	4.0	3.6	2.9
Japan	Toyama	15.2	11.4	10.0	11.0	10.9	50.4	53.1	47.6	754	636	456	3.7	3.3	2.1
Jordan	Ammān (Amman)	30.5	40.7	36.5	15.4	16.3	55.1	56.7	53.9	2,148	2,017	2,063	1.1	0.8	0.7
Kenya	Nairobi	17.1	22.4	23.8	12.1	14.3	26.7	29.1	41.0	857	1,170	1,014	0.3	0.3	0.2
Kenya	Nakuru	16.4	24.9	25.1	7.1	8.1	29.0	30.3	42.7	101	151	188	0.4	0.4	0.4
Kuwait	Al-Kuwayt (Kuwait City)	63.9	65.9	55.2	15.8	17.4	64.7	51.8	58.8	18,846	30,935	37,077	17.4	20.3	16.9
Kyrgyzstan	Bishkek	19.0	19.5	23.0	17.3	18.5	48.3	42.0	48.5	2,386	2,063	3,022	2.9	2.3	3.1
Kyrgyzstan	Žalal-Abat (Jalal-Abad)	25.8	23.2	23.5	8.9	8.7	55.5	48.8	58.5	64	94	131	1.0	1.4	1.8
Latvia	Riga	20.2	23.4	16.3	9.9	8.9	35.7	35.1	37.1	1,990	1,113	587	5.9	2.7	1.1
Lebanon	Ṣaydā (Sidon)	28.1	33.7	30.9	16.1	17.4	52.9	54.0	50.0	213	237	255	1.5	1.0	0.7
Lebanon	Ṣūr (Tyre)	23.4	27.4	24.5	9.8	10.7	53.9	55.7	52.9	323	385	423	5.5	3.8	2.3
Liberia	Monrovia	20.7	17.9	19.7	5.6	7.8	27.6	27.2	39.2	143	246	398	0.2	0.2	0.3
Libya	Tarabulus (Tripoli)	19.7	28.0	17.6	10.8	10.5	0.0	0.0	0.0	1,790	2,144	1,352	2.1	2.3	1.3
Lithuania	Vilnius	13.9	18.5	10.7	11.3	10.5	28.6	32.2	31.7	3,248	1,498	580	17.9	9.0	3.4
Luxembourg	Luxembourg (Lëtzebuerg)	14.0	16.1	8.8	13.9	13.4	35.3	43.4	44.2	1,986	2,734	1,936	26.1	29.5	16.6
Malawi	Blantyre-Limbe	16.1	23.2	17.0	7.6	8.3	30.7	32.2	39.1	1,432	2,385	2,701	2.7	3.6	3.2
Malawi	Mzuzu	15.4	23.7	20.0	6.2	7.5	29.7	33.8	38.5	51	62	73	0.7	0.5	0.4

Table C.2: Continued

		Annual Mean Levels of Fine Particulate Matter (PM2.5) (Population-Weighted) (Micrograms per Cubic Metre) [b]			Annual Average Levels of surface Level Nitrogen Dioxide (NO2) Concentrations (Population-Weighted) (Parts per Billion) [c]		The Highest Seasonal (6-Month) Average of 8-Hour Daily Maximum Ozone (O3) Concentrations (Parts per Billion) [d]			Total Carbon Dioxide (CO2) Emissions (Thousand Metric Tons) [e]			Carbon Dioxide (CO2) Emissions per Capita (Metric Tons) [e]		
		2000	2010	2020	2010	2020	2000	2010	2020	2000	2010	2020	2000	2010	2020
Malaysia	Bukit Mertajam	17.8	15.6	16.1	8.7	9.2	30.5	30.1	37.7	1,842	1,993	2,009	5.5	4.9	4.0
Malaysia	George Town (Pinang)	18.4	15.1	14.9	9.4	10.4	30.4	30.3	37.9	5,662	7,314	6,291	11.5	12.0	8.3
Malaysia	Ipoh	18.8	16.7	17.3	7.4	7.9	40.1	38.4	47.5	2,641	3,043	2,898	5.9	5.7	4.3
Malaysia	Kuala Lumpur	17.2	18.6	17.8	12.2	12.3	37.2	36.2	49.5	18,044	21,211	23,607	4.5	4.0	3.3
Malaysia	Kuching	9.8	10.8	9.9	5.1	5.4	22.8	29.1	28.4	1,079	1,387	1,536	4.3	4.7	3.9
Malaysia	Taiping	15.6	13.9	13.8	4.9	5.6	31.7	30.5	40.1	345	418	401	2.6	2.6	2.0
Mali	Bamako	31.1	32.3	26.8	9.6	12.1	35.2	33.6	46.4	118	291	811	0.1	0.1	0.2
Mali	Kayes	45.3	44.3	39.5	6.4	7.9	33.3	32.7	44.8	25	53	126	0.4	0.4	0.6
Mali	Sikasso	29.9	28.1	25.7	4.7	5.5	35.8	34.2	46.5	17	37	90	0.1	0.2	0.3
Mauritania	Nouakchott	68.4	45.4	48.0	8.3	10.2	36.1	32.9	39.3	253	452	772	0.5	0.6	0.6
Mexico	Campeche Campeche	15.5	11.3	15.3	6.3	6.6	49.0	37.6	34.4	209	266	192	1.2	1.3	0.8
Mexico	Celaya	21.2	20.1	19.1	14.0	14.0	51.0	46.8	46.4	338	440	308	1.3	1.3	0.7
Mexico	Ciudad Juárez (Juárez)	10.1	8.5	9.7	14.4	13.9	55.4	47.1	50.1	3,036	3,878	3,878	2.4	3.0	2.9
Mexico	Coatzacoalcos	23.2	14.6	19.2	6.7	7.1	48.3	39.7	31.0	474	596	418	2.1	2.2	1.3
Mexico	Ensenada	13.2	9.2	11.6	9.5	9.8	50.7	43.6	51.7	365	516	373	2.1	2.3	1.3
Mexico	Guanajuato Salamanca	20.4	19.8	18.6	9.7	9.7	48.8	45.3	45.1	245	354	290	2.9	3.4	2.2
Mexico	Irapuato	22.8	23.2	20.6	13.5	13.4	49.3	45.6	45.6	267	348	261	0.9	0.9	0.5
Mexico	León de los Aldamas	22.3	22.8	22.2	14.2	14.6	48.6	45.9	45.8	672	865	644	0.7	0.7	0.4
Mexico	Mérida	16.6	10.9	14.6	8.8	9.1	44.8	39.6	35.2	3,680	3,590	4,009	5.6	4.6	4.1
Mexico	Monterrey	25.2	26.5	28.1	14.2	14.4	43.7	43.1	40.0	10,606	13,469	13,430	3.2	3.7	2.8
Mexico	Querétaro	19.7	17.5	17.6	12.0	12.1	51.6	47.0	45.7	926	1,220	842	1.5	1.5	0.8
Mexico	Saltillo	15.5	14.5	16.0	12.5	13.1	45.2	45.4	43.8	689	930	672	1.3	1.4	0.8
Mexico	Tabasco Cárdenas	24.7	14.1	21.3	7.7	7.9	48.7	38.1	32.3	325	356	364	5.1	4.3	3.4
Mexico	Tabasco Comalcalco	25.1	13.4	19.3	5.5	5.6	48.6	38.7	31.7	76	96	66	2.3	2.3	1.3
Mexico	Tijuana	17.5	13.3	16.6	16.2	16.1	47.8	43.5	51.6	1,348	1,870	1,309	1.2	1.4	0.8
Mexico	Veracruz De Ignacio De La Llave Las Choapas	21.1	14.0	19.3	2.9	3.0	48.9	38.7	31.9	136	158	162	5.0	4.8	4.0
Mexico	Veracruz De Ignacio De La Llave Minatitlán	22.4	15.2	19.0	7.0	7.1	48.1	39.5	31.1	5,222	4,935	3,624	43.8	36.9	24.2
Mexico	Villahermosa	28.0	15.8	23.6	9.2	9.7	49.9	38.3	33.1	907	1,271	1,303	3.2	3.3	2.5
Morocco	Agadir	21.7	23.2	22.4	10.5	11.5	44.4	45.3	47.0	545	1,054	1,086	1.2	1.8	1.5
Morocco	Dar-el-Beida (Casablanca)	22.6	25.0	21.5	17.1	17.8	48.6	48.3	48.5	3,565	4,854	3,247	1.2	1.4	0.8
Morocco	Fès	18.8	24.1	18.8	13.7	14.4	43.0	46.8	56.8	317	516	591	0.4	0.5	0.5
Morocco	Fkih Ben Salah	21.1	27.0	22.1	10.5	10.2	46.0	48.1	55.3	43	68	88	0.5	0.8	0.9
Morocco	Marrakech	23.5	26.4	23.2	14.3	15.6	47.5	47.4	52.6	331	408	430	0.5	0.5	0.4
Morocco	Meknès	15.7	23.5	17.5	12.8	13.1	45.2	48.4	57.0	183	218	235	0.4	0.4	0.4
Morocco	Rabat	21.0	20.5	17.0	14.7	15.0	48.5	49.0	51.2	469	635	751	0.4	0.5	0.6
Morocco	Sidi Slimane	19.8	23.1	16.5	9.7	10.5	45.1	48.0	56.2	20	33	46	0.4	0.5	0.5
Mozambique	Maputo	16.7	15.8	11.9	9.7	10.1	28.6	27.7	36.0	259	960	1,894	0.2	0.5	0.7
Mozambique	Mocuba	18.4	22.9	15.5	2.8	3.0	27.1	27.8	37.0	4	5	8	0.2	0.1	0.1
Mozambique	Nampula	13.3	19.8	15.9	5.7	6.9	26.1	27.2	36.2	12	26	29	0.0	0.1	0.0
Myanmar	Sittwe (Akyab)	56.0	56.0	65.0	3.7	3.6	41.4	38.3	52.0	7	5	25	0.1	0.1	0.5
Namibia	Windhoek	11.7	17.6	12.3	8.1	9.1	38.3	39.7	42.5	92	156	236	0.4	0.5	0.6
Netherlands (Kingdom of the)	Amsterdam	15.0	16.6	9.7	15.8	14.3	36.6	33.0	39.7	7,292	7,470	4,053	8.0	7.7	3.8
Netherlands (Kingdom of the)	Gouda	14.7	16.5	9.3	14.6	12.5	36.9	34.9	40.7	1,130	1,203	875	17.7	18.7	13.6
New Zealand	Auckland	5.3	6.2	5.8	8.3	8.5	27.7	33.7	29.3	2,167	2,093	2,365	2.1	1.8	1.9
New Zealand	Dunedin	8.6	10.3	10.5	7.1	6.8	0.0	0.0	0.0	484	404	461	7.2	5.9	6.6
New Zealand	Wellington	5.8	6.3	6.4	6.2	6.6	23.8	29.5	30.6	932	816	877	8.3	6.6	6.5
Nicaragua	Estelí	23.3	26.6	28.2	3.3	3.2	39.0	32.5	36.8	31	42	61	1.2	1.5	1.4
Niger	Niamey	46.8	49.0	42.3	7.1	8.3	38.0	37.3	46.8	102	181	302	0.2	0.3	0.3
Nigeria	Aba	52.7	44.8	48.9	8.6	10.0	39.4	41.7	57.3	280	355	1,458	0.4	0.4	1.3
Oman	Masqat (Muscat)	46.6	48.8	47.1	10.5	10.7	49.7	40.5	48.4	800	1,616	2,691	4.8	8.9	11.9
Pakistan	Faisalabad	29.7	42.5	38.1	16.5	17.4	61.4	58.3	69.1	1,234	1,534	1,886	0.5	0.5	0.5
Pakistan	Gujranwala	49.6	66.8	61.7	12.5	12.3	62.0	57.2	77.0	197	285	420	0.2	0.2	0.2
Pakistan	Hyderabad	82.4	79.8	83.1	12.1	12.9	48.9	47.0	54.0	381	570	916	0.3	0.4	0.5
Pakistan	Islamabad	52.5	59.7	60.7	11.7	11.9	61.3	55.1	76.8	1,917	2,742	3,046	1.1	1.1	0.9
Pakistan	Karachi	77.9	72.3	72.1	18.2	19.8	46.4	45.4	51.7	9,372	11,681	10,285	1.0	1.0	0.7
Pakistan	Khaīrpur	73.0	77.0	85.2	6.0	5.7	51.8	47.2	54.1	75	104	144	0.9	1.0	1.0
Pakistan	Larkana	69.8	75.5	80.9	7.6	7.3	51.9	46.4	53.3	37	50	65	0.2	0.2	0.2
Pakistan	Multan	45.2	61.0	68.3	13.3	13.5	56.5	54.0	58.6	619	814	1,010	0.4	0.4	0.4
Pakistan	Peshawar	57.8	64.1	71.8	9.8	9.8	61.2	53.7	68.4	631	852	1,036	0.4	0.4	0.4
Pakistan	Sargodha	35.8	47.0	41.1	9.4	8.8	61.1	55.6	72.1	95	131	154	0.3	0.2	0.3
Pakistan	Sukkur	68.8	72.0	79.0	7.8	7.6	52.2	47.5	54.3	181	247	339	0.7	0.7	0.8
Panama	Ciudad de Panamá (Panama City)	14.2	16.5	16.0	9.4	10.1	39.9	31.3	37.7	721	1,239	1,059	0.9	1.3	0.9
Paraguay	Asunción	14.2	13.8	18.3	9.6	9.7	28.7	34.7	41.9	368	448	658	0.3	0.3	0.3
Peru	Tacna	13.1	15.6	15.4	7.8	8.1	30.6	37.0	38.0	49	94	109	0.4	0.5	0.4
Philippines	Baguio City	34.9	39.3	34.7	9.4	10.0	34.6	34.9	29.9	130	132	194	0.4	0.3	0.4
Philippines	Davao City	20.2	20.5	21.0	8.1	9.6	20.2	23.7	19.7	435	517	596	0.5	0.5	0.5
Philippines	Iligan	21.0	20.8	19.7	5.4	5.8	22.0	24.9	19.9	477	678	606	2.5	3.0	2.3
Philippines	Manila	25.0	29.2	28.1	13.8	14.3	32.2	32.8	27.4	8,246	8,956	10,986	0.4	0.4	0.4
Philippines	Ozamis	20.6	20.5	19.8	4.6	5.3	22.3	25.0	20.1	55	51	68	0.7	0.5	0.6
Poland	Głogów	22.5	26.6	14.3	10.1	9.2	46.3	41.5	41.6	259	184	170	8.6	6.1	5.3

Table C.2: Continued

		Annual Mean Levels of Fine Particulate Matter (PM2.5) (Population-Weighted) (Micrograms per Cubic Metre) [b]			Annual Average Levels of surface Level Nitrogen Dioxide (NO2) Concentrations (Population-Weighted) (Parts per Billion) [c]		The Highest Seasonal (6-Month) Average of 8-Hour Daily Maximum Ozone (O3) Concentrations (Parts per Billion) [d]			Total Carbon Dioxide (CO2) Emissions (Thousand Metric Tons) [e]			Carbon Dioxide (CO2) Emissions per Capita (Metric Tons) [e]		
		2000	2010	2020	2010	2020	2000	2010	2020	2000	2010	2020	2000	2010	2020
Poland	Kalisz	27.3	32.8	18.2	11.4	10.1	46.1	42.4	45.5	191	237	209	2.5	3.2	2.9
Poland	Legnica	23.4	27.0	14.4	10.6	9.8	48.0	42.1	44.8	417	432	426	6.0	6.5	6.4
Poland	Leszno	24.3	28.5	15.4	10.2	9.6	45.8	40.5	42.8	130	165	150	2.7	3.3	2.9
Poland	Lubin	23.4	27.5	14.9	10.2	9.4	47.8	42.0	44.7	256	264	249	4.2	4.4	4.3
Poland	Ostrów Wielkopolski	27.8	32.0	17.8	10.9	9.9	45.9	41.9	45.3	119	151	140	2.9	3.6	3.2
Poland	Warszawa (Warsaw)	22.1	26.5	14.6	13.8	12.0	39.3	40.4	40.9	8,125	8,543	6,450	4.8	5.0	3.7
Poland	Wrocław	26.2	31.9	16.4	11.7	10.1	46.0	35.5	44.4	2,059	1,987	1,593	4.6	4.6	3.8
Portugal	Lisboa (Lisbon)	13.4	9.9	8.9	14.3	13.9	39.9	46.3	41.0	2,911	2,769	2,143	1.5	1.4	1.0
Portugal	Porto	13.2	11.2	9.2	14.3	13.4	37.0	40.2	35.0	1,946	1,776	1,384	1.9	1.8	1.4
Qatar	Ad-Dawhah (Doha)	81.5	78.6	81.7	13.4	15.4	65.6	53.2	66.7	4,360	12,785	14,616	15.6	11.5	3.3
Republic of Korea	Daegu	23.5	24.1	20.8	17.3	16.4	54.1	49.1	60.2	5,468	4,615	5,018	2.4	2.1	2.3
Russian Federation	Berdsk	16.0	17.3	14.9	8.2	7.9	47.2	41.7	36.0	270	264	382	4.7	4.6	6.5
Russian Federation	Moskva (Moscow)	20.4	24.7	15.3	18.8	18.4	44.5	44.2	31.1	41,216	48,861	52,865	3.8	4.0	3.8
Saudi Arabia	Abhā	41.1	38.1	35.3	7.0	7.3	53.6	48.9	50.8	1,229	2,175	1,669	304.7	411.5	195.2
Saudi Arabia	Ad-Dammam	81.7	77.1	73.7	12.2	11.6	51.6	48.1	62.0	4,329	8,388	7,063	12.7	17.8	8.4
Saudi Arabia	Al-Madinah (Medina)	44.5	57.2	58.8	6.0	6.1	55.7	50.6	55.4	963	1,795	1,795	9.1	14.5	7.1
Saudi Arabia	Ar-Riyadh (Riyadh)	81.2	91.5	87.7	11.2	10.9	57.2	49.6	59.6	27,470	53,112	50,418	25.3	32.6	17.8
Saudi Arabia	Jiddah	69.3	72.8	68.8	10.7	10.1	0.0	0.0	0.0	10,596	18,260	17,029	11.3	14.8	9.1
Saudi Arabia	Makkah (Mecca)	56.8	66.3	67.1	9.8	9.5	55.2	52.1	52.9	1,151	2,163	1,614	11.5	14.9	6.1
Saudi Arabia	Taif	50.4	51.4	45.6	6.5	6.6	55.8	52.8	54.2	849	1,413	1,302	37.1	43.8	22.4
Senegal	Dakar	41.3	35.2	39.4	12.4	15.1	38.8	36.4	40.3	1,752	2,353	3,419	0.9	0.9	1.0
Senegal	Ziguinchor	42.7	36.7	34.7	1.8	1.8	40.0	40.0	44.9	115	166	252	3.5	3.6	4.7
Serbia	Beograd (Belgrade)	23.2	21.3	23.1	12.9	11.8	43.5	37.8	27.8	787	767	663	0.8	0.8	0.6
Sierra Leone	Bo	24.6	24.0	25.6	6.5	8.2	33.9	33.4	42.5	10	15	19	0.1	0.1	0.1
Sierra Leone	Kenema	22.2	23.3	23.6	5.5	7.0	31.3	31.5	43.3	13	20	24	0.1	0.1	0.1
Slovakia	Bratislava	20.0	20.3	11.9	12.6	11.2	45.6	46.0	48.2	3,777	3,293	2,483	14.5	13.4	10.7
Slovakia	Košice	24.1	22.0	14.3	10.0	9.4	48.7	47.7	44.2	2,053	1,937	1,469	10.6	9.9	7.3
Slovakia	Nitra	21.1	20.9	13.3	11.2	10.3	46.7	45.2	49.2	663	528	409	16.5	15.2	12.1
Slovakia	Trnava	20.7	20.7	12.4	10.6	9.3	46.6	46.3	45.3	285	297	1,328	7.8	8.6	39.3
South Africa	Bloemfontein	20.9	29.3	24.0	10.2	10.6	37.9	37.8	41.2	598	842	730	1.8	2.2	1.7
South Africa	Cape Town	6.4	8.4	7.0	13.3	13.8	24.5	26.6	24.0	5,794	8,392	6,907	2.5	2.8	1.8
South Africa	Durban (Ethekwini)	26.7	27.3	22.7	10.8	10.8	31.2	31.6	36.4	4,961	7,311	6,158	2.0	2.7	2.0
South Africa	Gqeberha	11.9	12.2	9.8	8.1	8.3	0.0	0.0	0.0	2,867	3,354	3,515	5.1	5.2	4.8
South Africa	Johannesburg	52.1	57.2	48.4	14.4	14.9	43.9	40.3	47.0	18,728	26,693	21,491	4.4	4.7	2.8
South Africa	Pietermaritzburg (The Msunduzi)	21.4	28.2	25.1	8.3	8.1	31.9	33.6	39.8	427	619	498	1.2	1.5	1.1
Spain	Burgos	14.2	9.5	7.7	12.2	11.9	43.3	46.0	49.4	487	562	474	5.9	5.9	4.3
Spain	Madrid	12.3	11.5	10.7	18.1	17.6	35.6	45.4	54.0	5,087	6,097	4,779	1.4	1.5	0.9
Spain	Santander	13.7	11.5	10.0	12.7	12.3	38.7	36.6	34.0	639	628	478	4.7	4.2	2.8
Spain	Sevilla	14.8	14.8	12.5	15.1	15.2	41.4	53.6	50.7	1,992	2,101	1,634	3.7	3.5	2.4
Spain	Torrelavega	15.1	11.9	10.5	12.3	12.0	45.0	41.4	37.1	648	535	321	21.8	16.0	8.0
Spain	Vitoria-Gasteiz	10.2	8.2	7.2	11.5	11.1	37.6	44.1	42.3	536	356	272	3.6	2.0	1.2
Sudan	Al-Khartum (Khartoum)	41.5	45.0	37.8	5.9	6.7	40.3	38.7	48.5	1,571	2,845	5,879	1.0	1.3	2.1
Sweden	Malmö	11.7	9.9	7.2	11.7	11.1	36.8	37.9	36.1	223	202	194	1.1	0.8	0.6
Sweden	Stockholm	7.6	6.6	5.0	11.8	11.4	34.8	35.6	31.3	2,372	2,247	1,087	2.6	2.0	0.8
Syrian Arab Republic	Dimashq (Damascus)	30.0	38.4	35.0	18.1	17.7	55.7	55.9	51.9	1,586	2,043	830	0.8	0.8	0.2
Syrian Arab Republic	Halab (Aleppo)	30.1	40.5	34.5	12.7	12.4	52.1	49.5	51.5	1,260	1,850	629	0.9	1.0	0.3
Syrian Arab Republic	Hims (Homs)	25.5	31.5	26.7	11.5	11.2	54.5	53.0	50.7	1,333	1,238	344	3.5	2.4	0.6
Tajikistan	Dushanbe	24.7	31.8	35.2	15.9	16.6	57.5	49.5	53.4	662	505	727	1.0	0.6	0.6
Tajikistan	Istaravšan (Istarawshan)	24.2	28.7	30.5	10.1	10.1	56.6	49.6	54.0	79	99	168	2.0	2.0	2.9
Tajikistan	Khujand (Chuçand)	30.4	35.7	37.2	10.3	10.7	56.3	49.4	52.2	97	116	149	0.7	0.8	0.9
Tajikistan	Kŭlob	21.1	30.5	29.8	7.3	7.1	59.0	51.2	51.1	42	54	75	1.1	0.9	1.0
Thailand	Krung Thep (Bangkok)	20.2	21.7	22.5	12.9	13.7	29.8	33.3	50.6	19,848	25,644	29,910	2.3	2.1	1.7
Timor-Leste	Dili	11.4	13.3	12.4	4.7	6.4	27.7	27.1	35.0	7	74	71	0.1	0.4	0.2
Tunisia	Al-Munastīr (Monastir)	21.9	21.5	19.1	5.6	6.3	65.1	54.1	52.8	120	146	137	3.4	3.3	2.3
Tunisia	Al-Qayrawān (Kairouan)	25.1	21.7	18.1	7.4	7.6	62.1	50.6	53.8	129	167	172	4.0	4.3	3.5
Tunisia	Manzil Bū Ruqaybah (Menzel Bourguiba)	21.1	19.2	18.7	5.1	5.0	50.2	45.1	49.6	121	137	127	2.9	3.1	2.3
Tunisia	Masākin (M'saken)	22.3	19.8	17.0	8.6	8.8	65.2	54.2	52.8	2,183	1,957	2,866	99.2	75.3	89.9
Tunisia	Qābis (Gabès)	25.0	23.2	17.9	6.0	6.0	56.0	47.2	54.1	1,085	871	1,907	11.0	8.1	14.9
Tunisia	Safaqis	26.4	24.0	19.9	9.0	9.1	61.9	51.8	53.4	278	333	305	0.7	0.7	0.6
Tunisia	Sūsah (Sousse)	21.9	20.6	17.9	9.8	10.7	63.6	52.9	51.6	122	161	168	0.5	0.5	0.4
Tunisia	Tunis	23.0	20.8	19.5	13.2	13.1	61.5	50.9	51.9	4,208	5,528	4,764	2.6	3.1	2.2
Türkiye	Adana	25.1	34.1	30.7	9.8	9.7	50.4	48.2	51.2	210	339	389	0.4	0.6	0.6
Türkiye	Ankara	22.5	22.7	25.6	14.0	14.5	42.1	44.3	47.0	2,781	3,940	5,596	1.4	1.8	2.1
Türkiye	Bulancak	21.5	22.4	21.6	5.6	5.6	0.0	0.0	0.0	40	48	47	6.0	5.5	2.5
Türkiye	Bursa	29.2	29.9	28.1	15.1	15.7	42.5	45.4	44.6	2,322	4,422	3,652	2.6	3.7	1.9
Türkiye	Çarşamba	21.9	21.8	18.8	6.6	6.9	44.6	45.2	47.5	94	123	140	4.9	5.3	3.1
Türkiye	Ceyhan	25.5	33.2	30.7	9.0	8.4	52.1	49.9	52.6	141	110	165	41.0	24.0	27.0
Türkiye	Gaziantep	31.5	35.7	38.6	10.0	10.8	52.5	49.8	54.3	260	624	924	0.5	0.9	0.7
Türkiye	Giresun	21.2	23.0	22.4	6.6	7.1	0.0	0.0	0.0	86	135	160	2.5	2.8	1.9
Türkiye	Istanbul	25.0	25.9	20.6	20.5	21.1	41.7	43.2	42.2	9,849	14,433	19,092	0.9	1.2	1.3
Türkiye	Mersin	25.9	31.7	30.3	11.2	10.8	50.5	49.1	51.8	76	142	175	0.2	0.3	0.3

Table C.2: Continued

		Annual Mean Levels of Fine Particulate Matter (PM2.5) (Population-Weighted) (Micrograms per Cubic Metre) [b]			Annual Average Levels of surface Level Nitrogen Dioxide (NO2) Concentrations (Population-Weighted) (Parts per Billion) [c]		The Highest Seasonal (6-Month) Average of 8-Hour Daily Maximum Ozone (O3) Concentrations (Parts per Billion) [d]			Total Carbon Dioxide (CO2) Emissions (Thousand Metric Tons) [e]			Carbon Dioxide (CO2) Emissions per Capita (Metric Tons) [e]		
		2000	2010	2020	2010	2020	2000	2010	2020	2000	2010	2020	2000	2010	2020
Türkiye	Ordu	19.4	21.3	19.6	7.2	7.3	45.2	44.5	47.7	104	172	198	1.7	2.3	1.5
Türkiye	Rize	22.3	24.8	23.6	7.4	7.7	46.4	45.5	48.8	82	125	139	2.9	3.4	2.5
Türkiye	Samsun	23.6	22.3	20.0	10.6	11.1	43.0	44.1	46.4	47	91	125	0.2	0.3	0.3
Türkiye	Tarsus	27.0	32.7	30.6	8.8	8.5	52.4	50.2	52.9	317	329	433	3.7	3.6	3.3
Türkiye	Terme	21.6	22.2	18.7	5.7	5.6	44.3	44.9	47.1	47	61	67	7.0	8.8	5.9
Türkiye	Trabzon	22.0	23.9	22.9	7.9	8.2	45.0	45.1	48.0	511	807	1,133	3.8	5.3	5.1
Turkmenistan	Ashgabat	33.0	32.4	29.7	14.7	15.5	48.1	40.5	47.0	3,290	5,013	5,458	6.1	6.5	4.9
Turkmenistan	Daşoguz	30.7	30.0	32.6	5.8	5.6	46.2	40.1	43.6	657	2,123	1,635	14.6	42.3	20.6
Turkmenistan	Mary	33.2	36.3	34.7	5.8	5.5	51.5	44.8	47.4	357	564	593	6.5	9.4	6.6
Turkmenistan	Tejen (Tedžen)	34.6	34.6	34.2	6.6	6.2	51.8	45.2	46.7	369	610	749	69.6	117.6	86.9
Turkmenistan	Türkmenabat	26.0	35.6	26.1	6.4	5.8	51.6	44.7	46.8	1,687	2,255	2,084	30.5	45.0	24.8
Uganda	Gulu	22.0	25.1	24.7	5.8	6.8	35.4	34.5	41.7	12	19	46	0.1	0.2	0.3
Ukraine	Kyiv (Kiev)	20.9	21.2	16.7	11.5	11.4	41.8	40.7	37.3	5,176	3,663	2,475	2.5	1.7	1.1
Ukraine	Lviv	21.3	22.3	14.7	11.9	11.1	42.3	39.3	38.2	743	542	307	1.3	1.0	0.6
Ukraine	Odesa	15.4	16.5	13.5	12.5	12.0	42.6	41.7	38.9	4,315	2,978	2,507	4.0	2.9	2.4
United Arab Emirates	Abu Zaby (Abu Dhabi)	65.2	60.9	56.4	8.9	8.4	60.8	47.9	53.6	453	859	903	13.2	19.0	14.4
United Arab Emirates	Al-Ain	48.4	50.7	46.9	6.7	6.7	63.7	51.5	54.0	503	1,140	1,202	11.9	16.3	12.3
United Arab Emirates	Dubayy (Dubai)	62.8	64.3	59.0	12.9	13.5	64.6	51.7	52.9	32,373	52,768	57,387	53.8	49.5	26.3
United Kingdom of Great Britain and Northern Ireland	Coventry-Bedworth	12.6	13.1	9.1	15.7	13.4	32.4	32.8	32.9	1,998	1,903	1,590	6.1	5.5	4.4
United Kingdom of Great Britain and Northern Ireland	Edinburgh	10.6	8.7	7.2	12.7	11.3	32.8	35.2	32.1	1,591	1,499	1,273	3.7	3.3	2.6
United Kingdom of Great Britain and Northern Ireland	Glasgow	9.2	9.2	7.5	14.9	12.9	26.9	24.5	30.7	3,648	3,393	2,661	4.0	3.6	2.8
United Kingdom of Great Britain and Northern Ireland	London	13.2	14.3	11.0	18.9	17.1	31.2	32.2	30.2	25,493	24,807	20,178	3.3	2.8	2.0
United Kingdom of Great Britain and Northern Ireland	Stoke-on-Trent (The Potteries)	14.4	13.9	9.6	16.0	13.5	29.6	31.0	34.4	1,047	961	753	3.6	3.2	2.4
United Republic of Tanzania	Arusha	12.2	22.4	21.8	7.6	9.2	25.2	26.9	37.8	39	59	166	0.1	0.1	0.2
United States of America	Albuquerque	6.8	5.7	6.2	13.5	13.5	58.5	52.1	52.4	1,388	1,242	1,262	4.7	3.6	3.0
United States of America	Atlanta	18.9	12.4	8.1	12.7	12.2	56.3	51.4	41.4	1,506	1,467	1,444	3.5	3.1	2.8
United States of America	Austin	10.0	8.8	7.6	9.8	10.2	49.5	42.0	39.1	3,270	3,049	3,145	5.1	3.6	2.8
United States of America	Charlotte	17.0	10.9	7.2	10.8	10.6	56.2	54.4	45.6	2,059	2,231	2,245	3.8	3.1	2.3
United States of America	Chicago	15.5	11.8	8.9	16.4	15.9	38.1	43.2	43.6	50,503	35,550	29,566	9.7	7.0	6.0
United States of America	Cleveland	16.0	11.5	7.6	12.6	11.4	44.6	46.2	39.3	10,472	8,205	6,549	11.3	9.6	8.3
United States of America	Columbia, South Carolina	16.5	10.8	6.8	10.0	9.5	56.2	47.7	38.4	375	395	384	4.9	4.3	3.5
United States of America	Dallas	12.0	9.3	8.2	12.6	12.5	52.9	45.4	42.2	14,415	14,032	14,017	5.5	4.6	3.9
United States of America	El Paso	9.5	7.9	8.7	11.3	11.1	55.1	47.0	49.9	2,862	2,741	2,437	7.1	5.8	4.4
United States of America	Houston	12.2	10.8	8.9	11.9	12.3	46.7	41.0	36.2	17,319	17,416	15,937	7.2	5.9	4.4
United States of America	Las Vegas	7.2	6.0	7.4	11.8	12.4	59.8	57.9	51.8	6,871	7,968	8,971	5.8	4.8	3.8
United States of America	Los Angeles-Long Beach-Santa Ana	17.1	12.9	13.7	19.7	17.5	43.1	50.1	52.2	66,578	58,195	58,918	5.7	4.8	4.6
United States of America	Miami	9.2	7.8	6.9	10.4	10.0	41.3	41.8	31.7	27,483	18,821	22,340	6.4	4.0	4.2
United States of America	Milwaukee	12.4	9.6	7.6	14.3	14.1	42.2	44.1	41.2	2,260	1,739	1,618	3.2	2.5	2.3
United States of America	Orlando	12.0	9.3	8.0	8.9	9.0	49.5	44.1	35.6	2,511	2,683	2,647	3.8	3.2	2.5
United States of America	Philadelphia	14.8	10.2	7.8	15.5	14.7	48.6	51.7	43.0	12,564	10,171	8,807	5.9	4.8	4.1
United States of America	Phoenix-Mesa	11.6	9.4	10.0	11.8	11.6	57.1	54.3	52.3	12,037	13,784	13,917	4.9	4.5	3.6
United States of America	Raleigh	14.7	10.3	6.9	10.6	10.5	53.0	50.4	41.9	1,778	2,013	2,132	5.0	3.9	2.9
United States of America	Sacramento	11.4	7.5	12.7	12.5	12.5	49.2	50.5	47.7	4,792	4,848	5,144	4.4	3.8	3.4
United States of America	San Antonio	10.4	8.8	8.3	10.5	10.7	44.8	40.4	39.0	2,176	2,575	2,822	2.0	1.9	1.7
United States of America	San Diego	14.0	10.5	12.3	14.7	14.0	44.9	45.2	46.8	6,921	8,304	8,610	4.4	4.8	4.5
United States of America	Savannah	14.6	10.0	7.1	9.8	9.3	53.2	45.5	35.0	4,538	2,438	2,076	75.8	35.7	26.7
United States of America	Seattle	10.0	5.7	6.3	13.0	12.5	35.8	30.6	36.4	5,782	5,475	5,198	4.7	3.9	3.3
United States of America	Toledo	15.4	10.3	7.3	12.6	11.4	46.9	47.3	44.7	2,570	2,301	1,838	13.0	12.0	9.9
United States of America	Wilmington	11.4	7.8	5.7	9.7	9.4	52.1	46.8	37.9	4,118	4,254	1,536	428.6	350.7	100.1
United States of America	Winston-Salem	16.9	11.0	7.5	10.3	10.0	55.4	51.4	42.6	1,349	1,325	1,255	8.6	7.3	6.1
Uruguay	Ciudad De La Costa	12.8	13.2	13.4	7.9	8.2	29.7	31.9	31.3	238	265	285	3.7	3.6	3.3
Uruguay	Montevideo	12.2	12.9	13.6	11.5	11.3	29.5	31.5	30.9	1,227	1,333	1,338	1.0	1.1	1.1
Uzbekistan	Andizhan	27.1	30.4	28.8	9.6	9.2	55.9	49.3	57.6	1,269	1,302	1,096	7.1	6.5	4.1
Uzbekistan	Bekobod	28.5	35.0	37.3	8.3	8.3	56.6	49.7	52.4	1,003	1,194	3,291	92.6	122.5	295.0
Uzbekistan	Buxoro (Bukhara)	34.8	41.7	36.7	8.8	8.3	51.8	45.1	46.0	1,054	962	659	19.0	15.8	8.1
Uzbekistan	Jizzax (Dzhizak)	28.5	35.9	40.5	8.1	7.5	55.6	48.7	49.4	729	742	530	10.3	11.6	5.2
Uzbekistan	Nukus	32.1	33.3	34.5	6.4	5.9	46.0	39.9	42.9	515	499	322	9.0	8.0	4.4
Uzbekistan	Qarshi (Karshi)	28.5	38.3	35.5	7.3	7.1	55.4	47.7	51.2	701	725	541	7.6	7.5	3.3
Uzbekistan	Qo'qon (Kokand)	29.9	36.2	35.7	9.4	9.0	55.4	48.7	53.5	525	522	455	5.4	6.0	3.6
Uzbekistan	Tashkent	39.6	45.7	46.5	17.2	16.3	53.6	47.6	49.6	21,490	21,354	14,791	10.7	10.1	6.0
Viet Nam	Hà Noi	30.7	48.8	37.2	14.2	15.7	36.0	44.5	44.8	1,703	3,206	3,200	0.5	0.7	0.6
Viet Nam	Nha Trang	17.4	17.9	18.1	5.0	5.5	29.9	31.0	28.8	126	216	208	0.5	0.7	0.6
Viet Nam	Thành Pho Ho Chí Minh (Ho Chi Minh City)	21.2	28.4	32.0	13.5	16.0	31.7	32.9	36.6	7,154	10,338	11,303	1.2	1.2	0.9
Viet Nam	Vĩnh Long	19.9	21.3	23.3	4.2	4.4	31.1	34.7	38.9	44	72	82	0.2	0.3	0.4
Yemen	Adan (Aden)	47.8	41.9	44.2	8.9	10.2	40.2	37.2	45.4	1,417	2,256	783	8.3	10.3	2.6
Yemen	Sana'a'	37.7	34.1	34.4	15.5	17.3	45.7	40.7	50.5	92	139	59	0.1	0.1	0.0
Zambia	Chingola	20.4	29.3	24.7	4.4	4.6	42.5	44.0	45.3	20	16	51	0.3	0.2	0.5

		Annual Mean Levels of Fine Particulate Matter (PM2.5) (Population-Weighted) (Micrograms per Cubic Metre) [b]			Annual Average Levels of surface Level Nitrogen Dioxide (NO2) Concentrations (Population-Weighted) (Parts per Billion) [c]		The Highest Seasonal (6-Month) Average of 8-Hour Daily Maximum Ozone (O3) Concentrations (Parts per Billion) [d]			Total Carbon Dioxide (CO2) Emissions (Thousand Metric Tons) [e]			Carbon Dioxide (CO2) Emissions per Capita (Metric Tons) [e]		
		2000	2010	2020	2010	2020	2000	2010	2020	2000	2010	2020	2000	2010	2020
Zambia	Kitwe	21.1	29.3	23.8	5.7	6.3	41.7	43.0	44.9	43	34	122	0.2	0.1	0.3
Zambia	Lusaka	13.7	20.6	15.5	8.7	10.8	37.0	38.5	42.8	263	295	809	0.3	0.2	0.3
Zambia	Ndola	19.2	25.5	21.4	4.9	5.2	40.7	41.9	44.5	39	31	129	0.2	0.1	0.4
Zimbabwe	Bulawayo	12.7	16.4	11.0	6.1	6.4	36.2	37.0	42.7	576	217	262	1.3	0.5	0.6

Sources:
The George Washington University, Milken Institute School of Public Health, URL: https://urbanairquality.online/
United Nations Human Settlement Programme (UN-Habitat), Global Urban Indicators Database 2024

Notes:
(a) All published figures take into account city boundaries provided by UN-Habitat and comply with the DEGURBA definition produced by George Washington University.
(b) The concentration levels were provided at a spatial resolution of 0.01˚ x 0.01˚. The dataset combines measurements of aerosol optical depth from several satellites with output from the GEOS-Chem chemical transport model to generate estimated PM2.5.
These estimates are thereafter calibrated to in-situ observations using geographically weighted regression.
(c) The concentration levels were derived from a land use regression model with 50 m x 50 m spatial resolution. Original data are only available since 2005.
(d) The concentration levels were provided at a spatial resolution of 0.01˚ x 0.01˚. M3Fusion method has been used to create a multi-model composite of several global chemistry-climate models.
(e) The Emission Database for Global Atmospheric Research (EDGAR) v8.0 provides sector-specific estimates of fossil fuel CO2 emissions annually at 0.1˚ x 0.1˚ spatial resolution.
The emissions were summed for all available sectors (including power industry, other industrial combustion, buildings, transport, industrial processes, agriculture, and waste). The dataset is publicly available here: https://edgar.jrc.ec.europa.eu/dataset_ghg80.

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World Cities Report 2024

Cities and Climate Action

Cities are both the victims of climate change and among its worst offenders: though disproportionately exposed to its impacts, they are also responsible for generating a significant share of global greenhouse gas emissions. From flooding to heatwaves, powerful storms to drought, urban areas frequently find themselves on the frontline of the climate crisis. Many of the world's largest mega-cities concentrate millions of people and trillions of dollars in assets into areas that are becoming more vulnerable to sudden shocks with every passing year. As they continue to expand, so too does their exposure, paving the way for potentially catastrophic disasters in future.

Climate change is in many ways exacerbating existing inequalities, as the urban poor and other marginalized groups and communities find themselves facing its most extreme impacts with least resources. The complex effects of climate change demand a comprehensive approach, encompassing not only immediate environmental symptoms but also the underlying social drivers of vulnerability. But while the overlapping challenges of environmental stress and rapid urbanization are uniquely daunting, it is precisely this intersection that makes urban climate action so opportune. Climate action can bring an array of additional benefits to cities and residents, from poverty reduction, employment, resilient infrastructure, improved public health and well-being to the restoration of fragile ecosystems.

While projections show that without appropriate measures in place cities will suffer considerable impacts as a result of extreme weather events associated with climate change, these worst-case scenarios are by no means inevitable. The decisions we make now, both in terms of mitigating the causes of climate change through decarbonization and strengthening adaptation by making cities more resilient, will determine to a large extent their severity. If national and local governments are willing to commit to a truly transformative approach, then climate action could serve as a vital tool in delivering a broader agenda of inclusion and social justice.

World Cities Report 2024 provides a wide and far-reaching analysis of the current and expected climate impacts on different regions and cities, as well as the differing vulnerabilities urban populations face as a result of poverty, inequality, ethnicity, gender, disability and other characteristics. Notwithstanding the acute financial and institutional shortfalls many face, this Report shows that cities are leading the way through innovative, community-led approaches that are demonstrating the potential of collaborative, inclusive approaches to climate action. Besides offering a sobering wake-up call on the urgent need to scale up efforts now, various chapters of this Report showcase inspiring practices and success stories that can be replicated or adapted elsewhere.

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