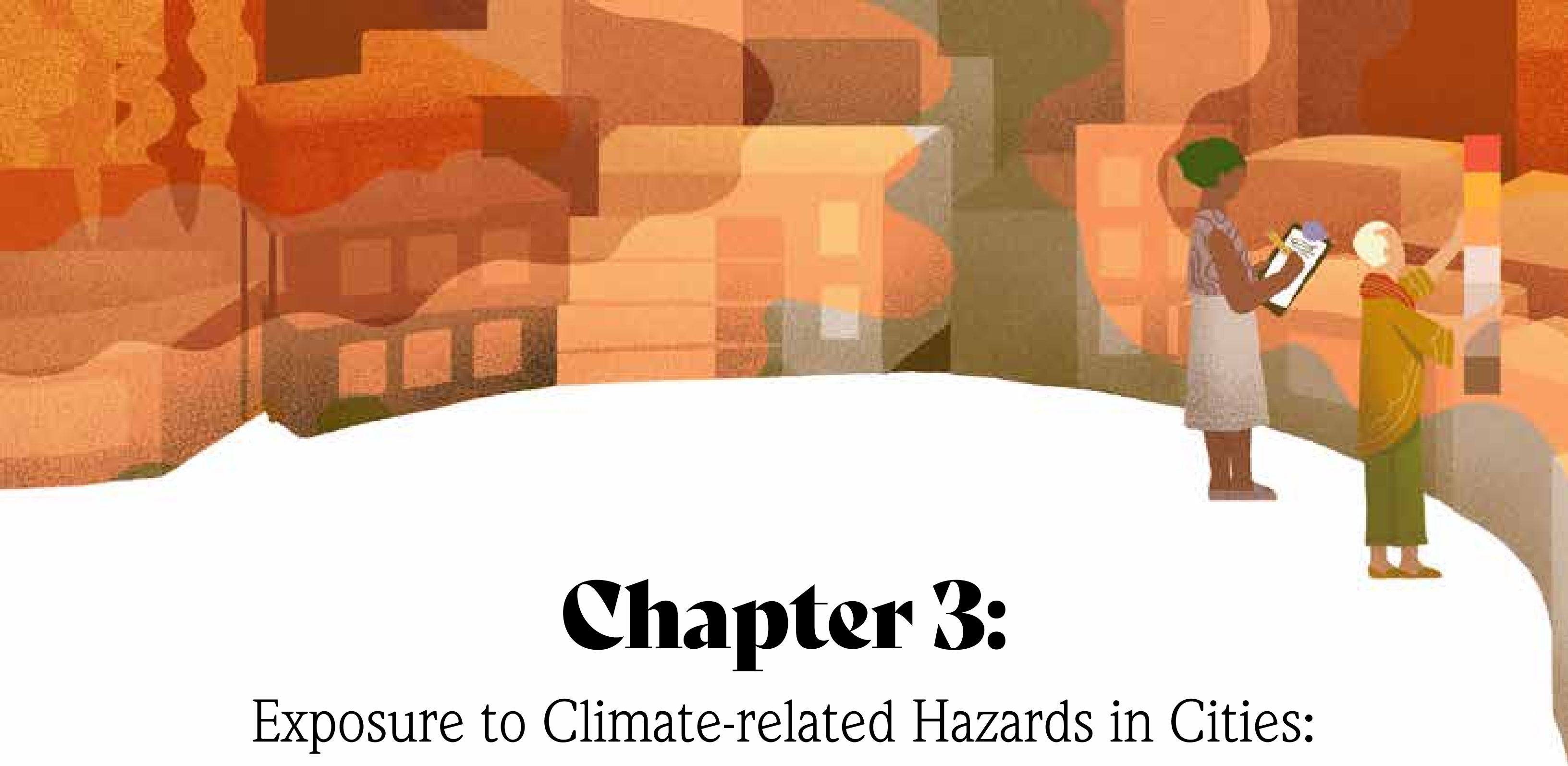


Chapter 3:

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

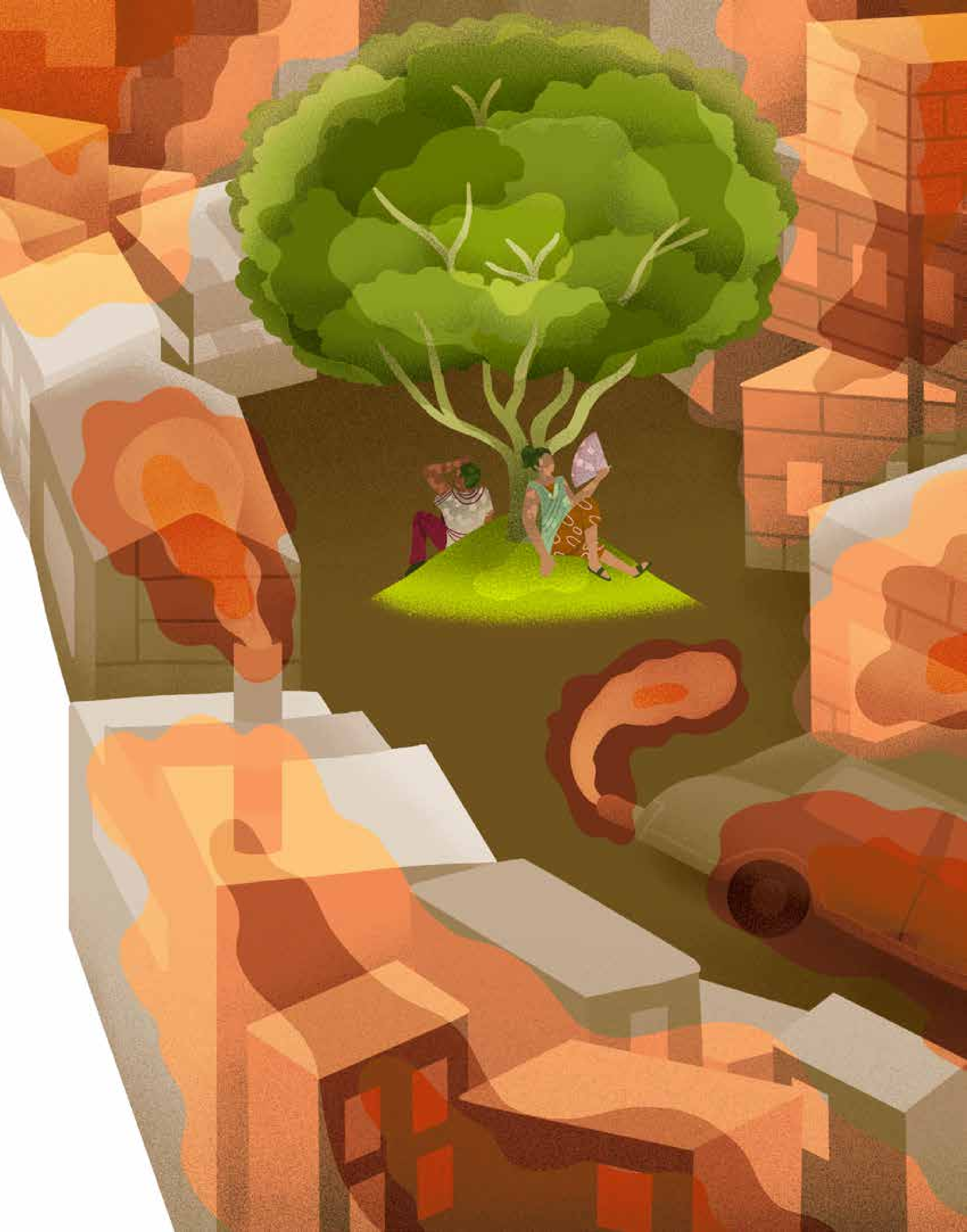
1. The difference in urban exposure associated with the policy measures shows that climate action implemented in cities today can lead to substantially lower levels of urban climate exposure.

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.

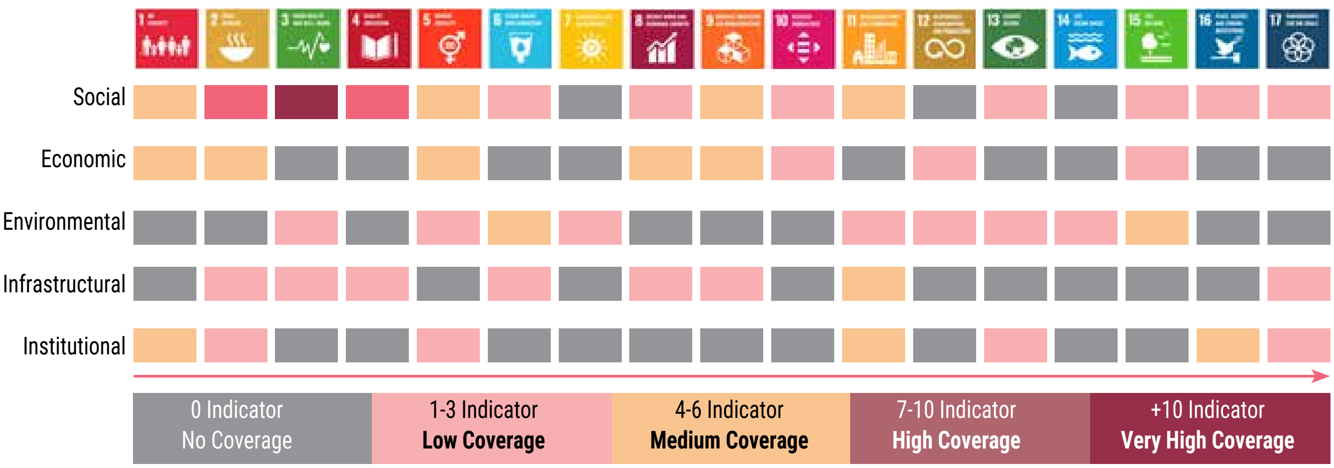
3.1.1 Data integration for climate action

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]

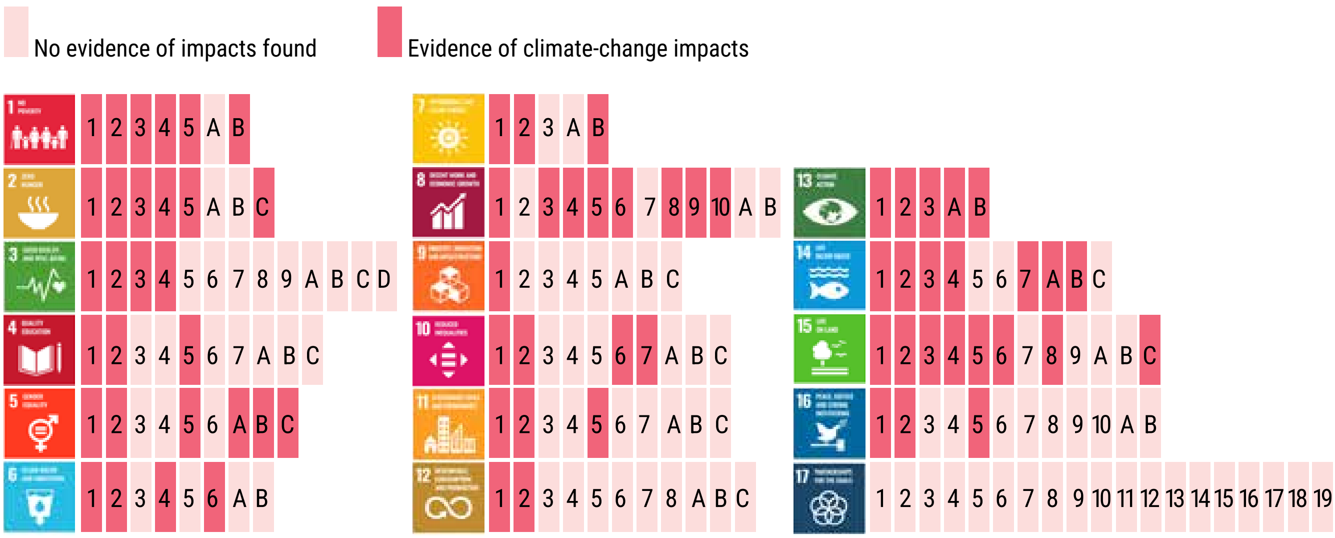
The latest UN DESA and UNFCCC series of reports (Seeking Synergy Solutions[9]) focus on how action to tackle climate change and achieve the SDGs can be accelerated by addressing them synergistically in policy frameworks. A key component of this synergy is the integration of knowledge and data for policymaking, 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.

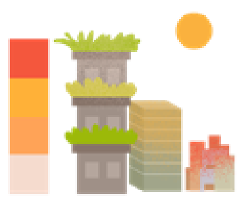
Figure 3.2: Interlinkage between climate change impact and SDG targets



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 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.



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

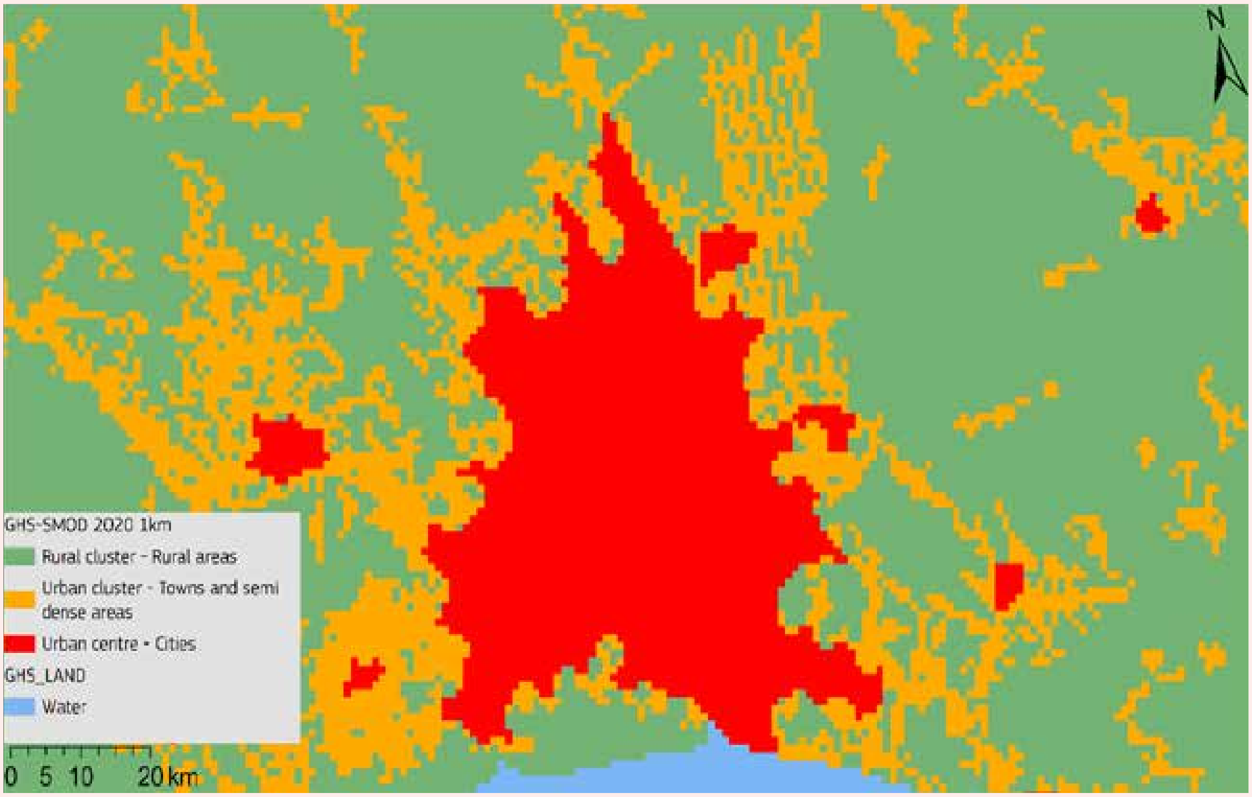
Box 3.1: Degree of Urbanisation: A tool for mapping cities

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

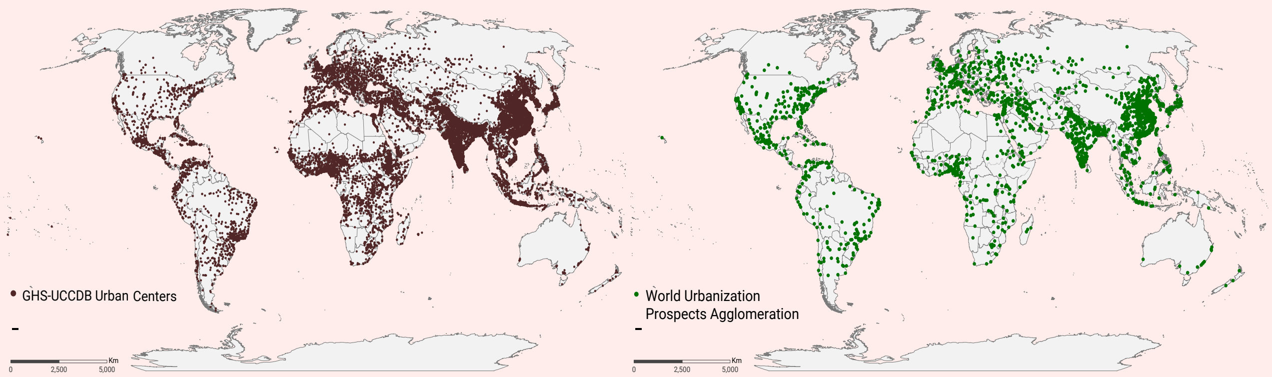
This chapter is supported by geospatial data on world human settlements derived from the Global Human Settlement Layer (GHSL) of the European Commission Joint Research Centre. GHSL produces global information on the distribution of population and built-up surfaces, as well as settlement classifications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



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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.

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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:

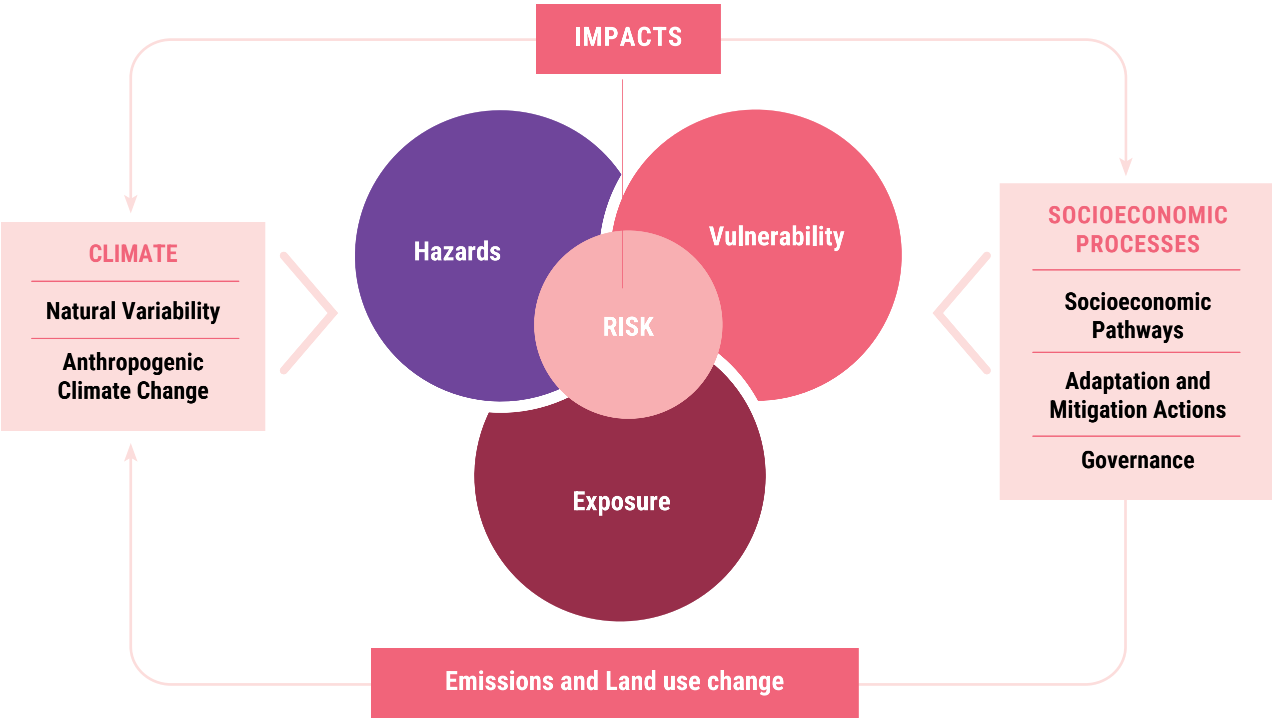
- *Hazard,* which is a potential situation or event that can cause harm, such as temperature increase or sea-level rise.

- *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.

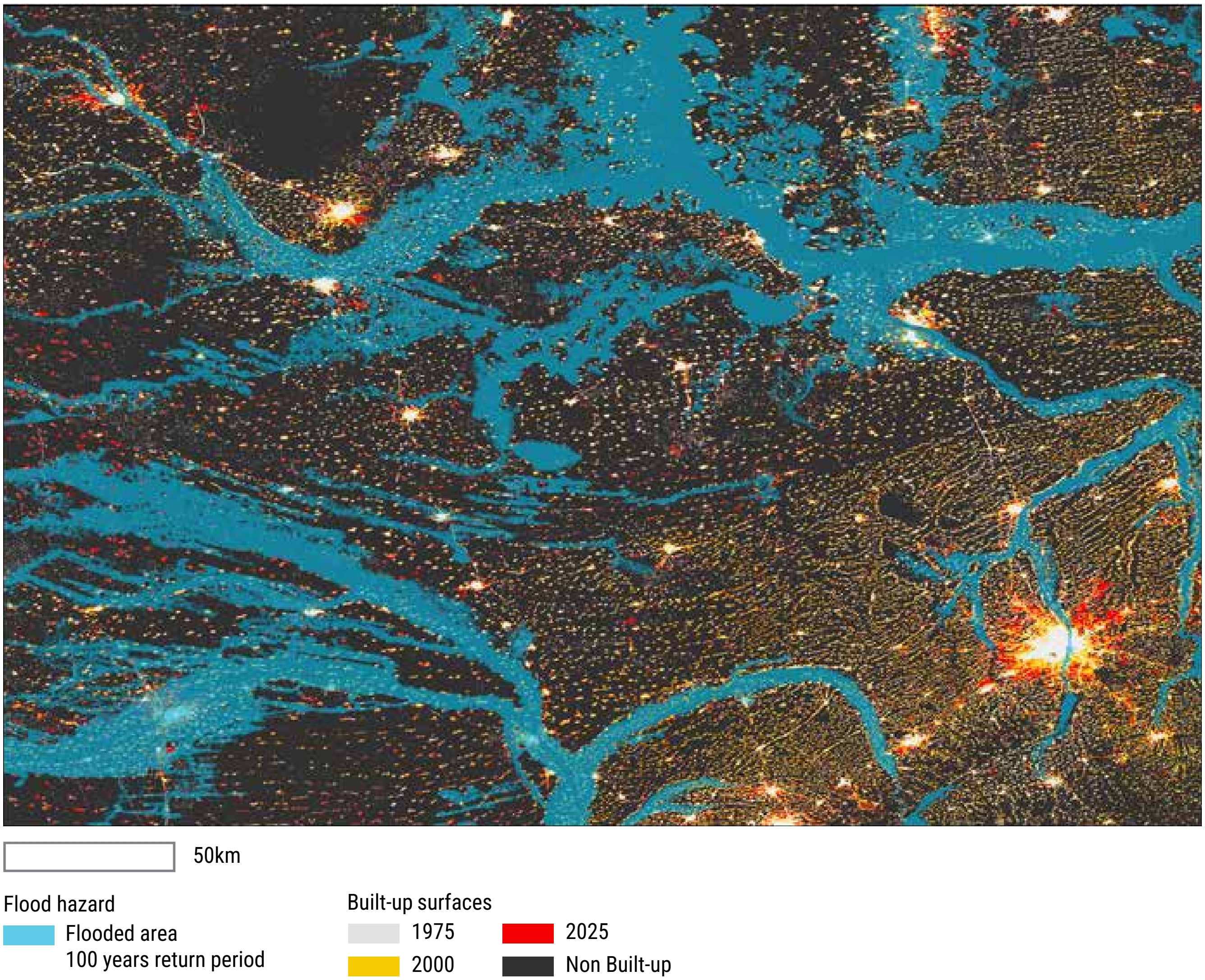
3.1.3 The urban climate impact and exposure data gap

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



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.

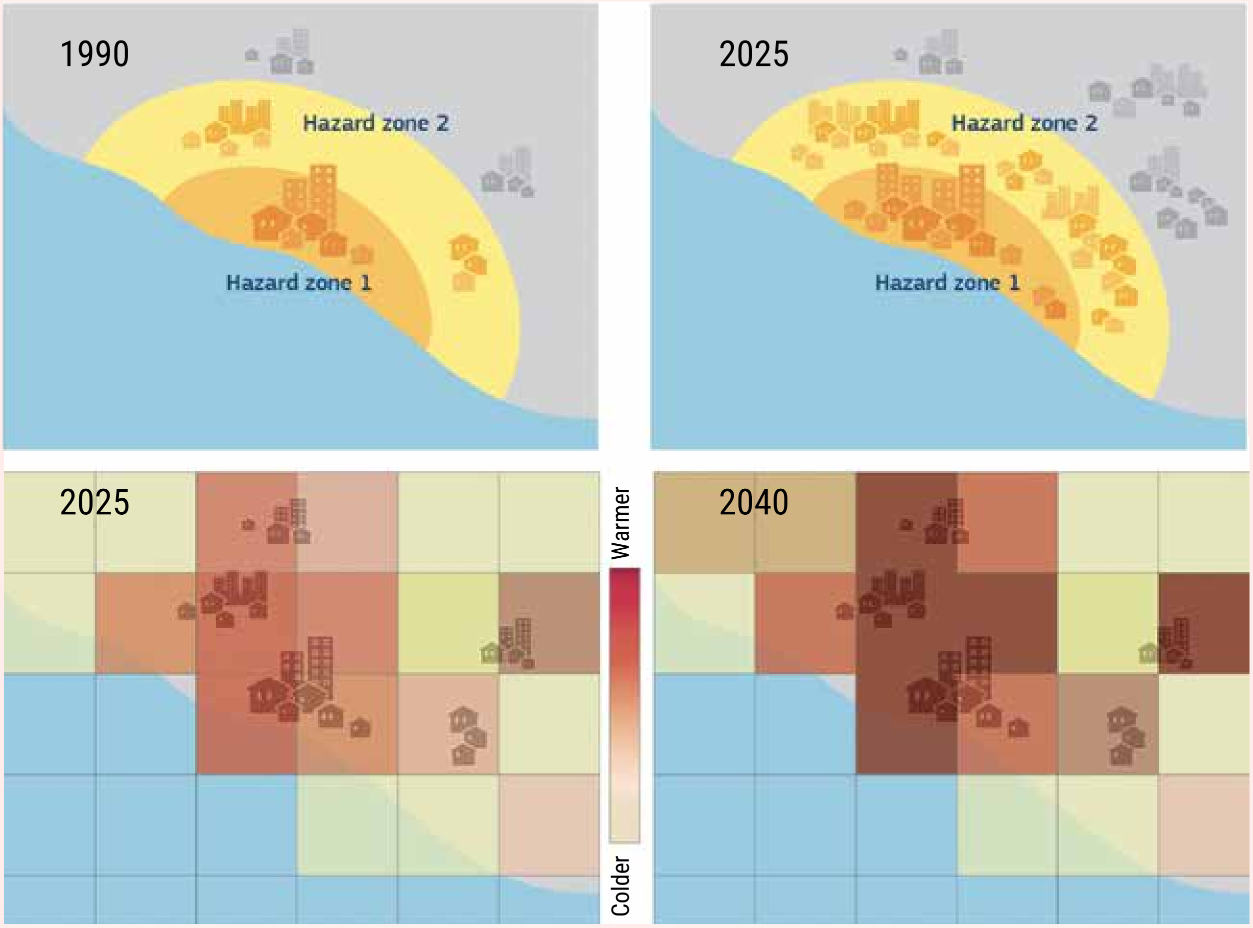
Further improvement to the implementation of the Sendai Framework for Disaster Risk Reduction (especially understanding disaster risk) can be boosted by enhancing the availability of comprehensive and harmonized global geocoded datasets on disaster events and attributes. This would allow a new generation 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.

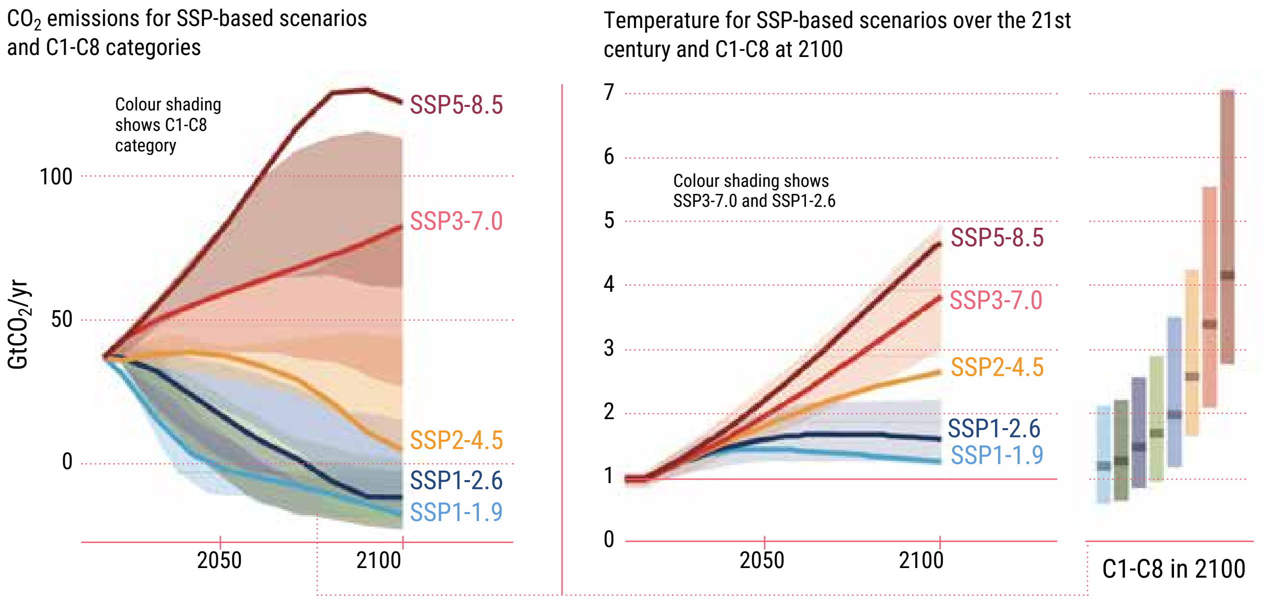
The figures presented in this chapter are based around these different SSPs and RCPs, depending on the way in which different geospatial data in other datasets on climate exposure have been made available. Numbers in this chapter are always presented with their corresponding pathway. For example, maintaining 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

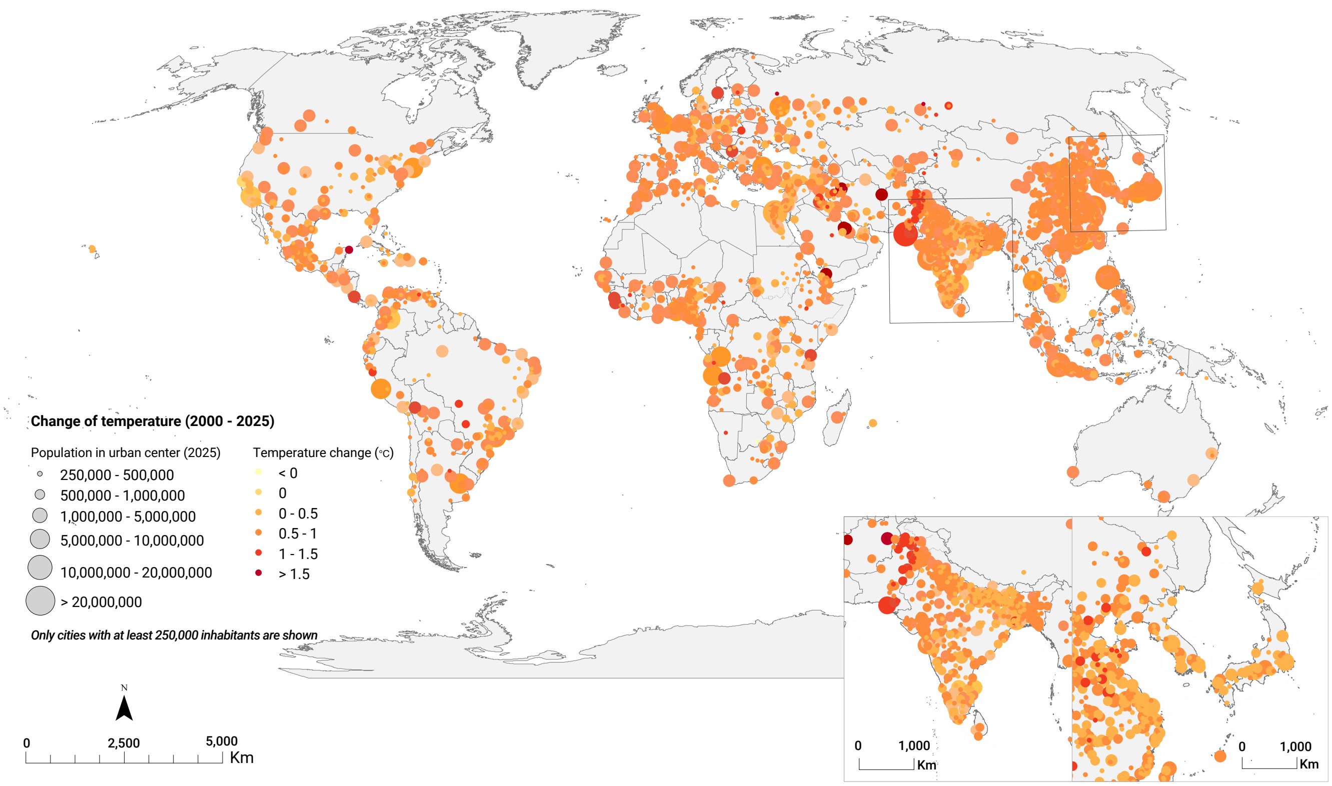


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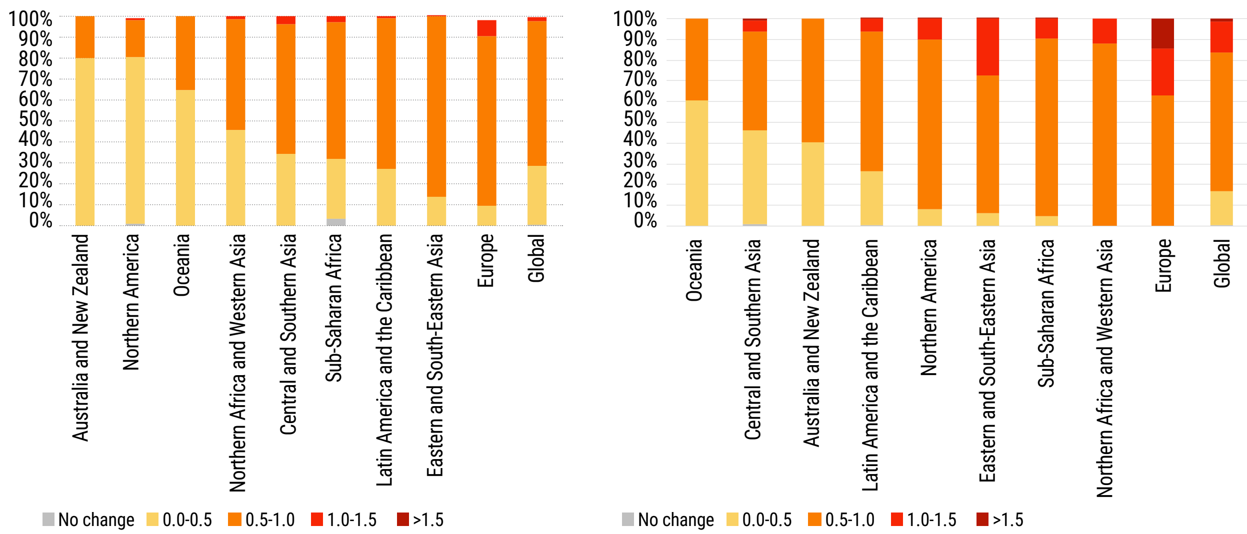
Figure 3.7: Share of population in cities experiencing warmer temperatures between 2000 and 2025, in different regions and under different climate scenarios: RCP 4.5 (left) and RCP 8.5 (right)



3.2.2 Increased exposure of cities

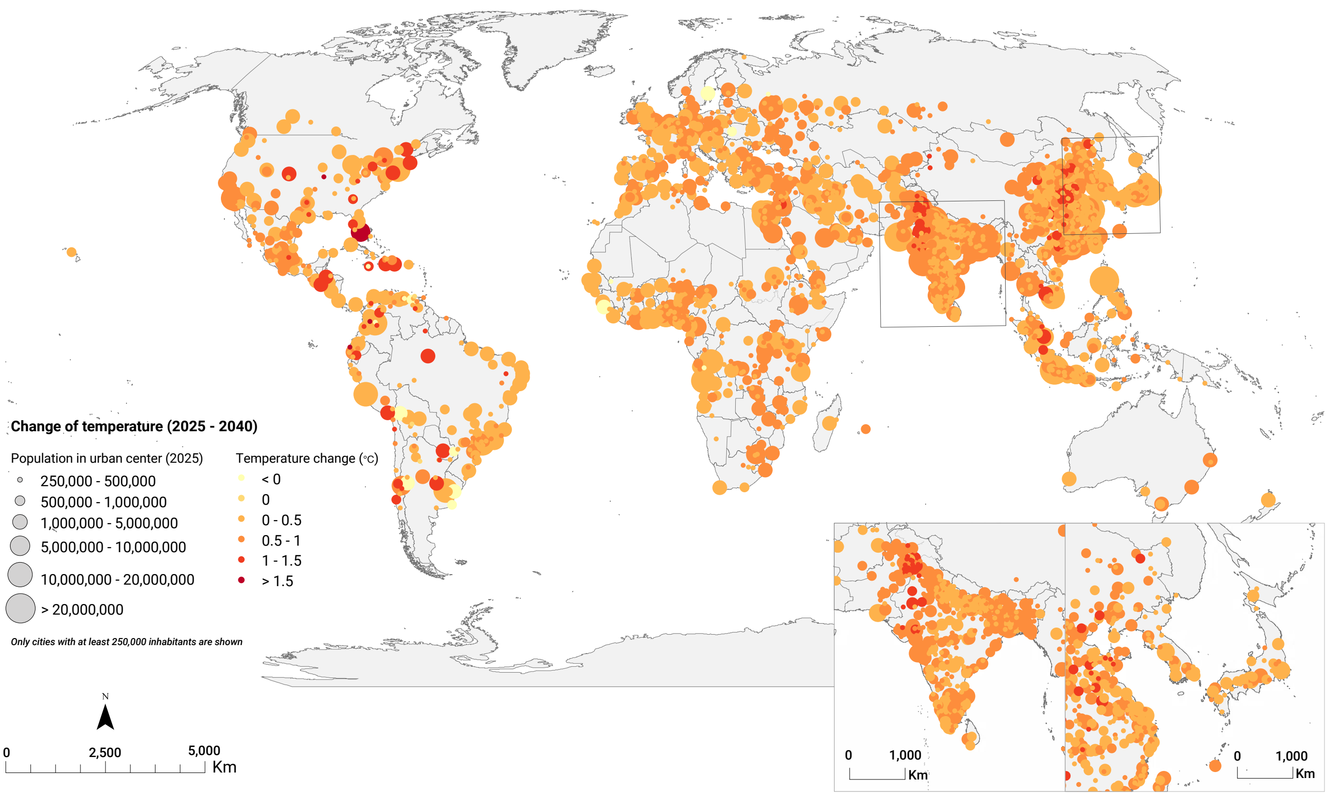
Shifting from historical patterns to future projections, it is expected that half of the world's cities in 2040 will be reaching a mean annual temperature of at least 0.5°C warmer compared to 2025. Of these, about 400 cities will experience a temperature increase between 1 and 1.5°C, while a few cities 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.

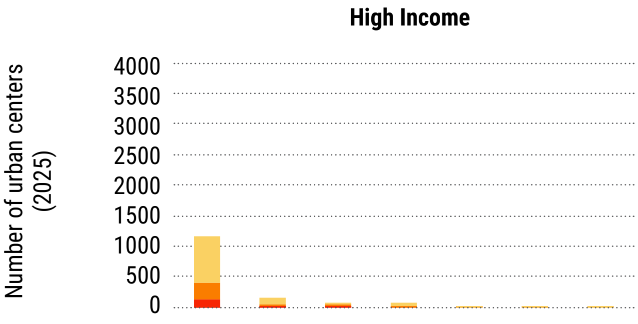
Six megacities (cities exceeding 10 million inhabitants in 2025) in lower-middle income countries (Dhaka, Cairo, Kolkata, Karachi, Lahore and Lagos) and three in high-income countries (Tokyo, Osaka and Los Angeles) could be up to 1°C warmer by 2040. Five cities exceeding 5 million inhabitants today (New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

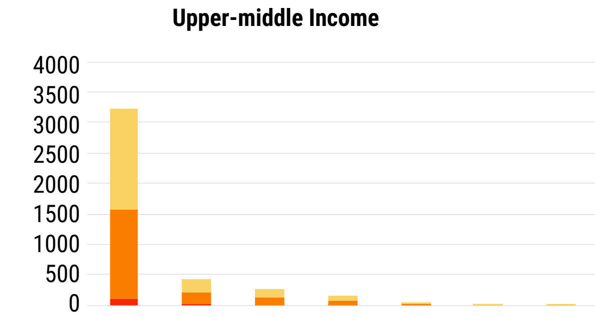


Disclaimer:
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by The United Nations.
Final boundary between the Republic of Sudan the Republic of South Sudan has not yet been determined.
Dotted line represents approximately the Line of 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.

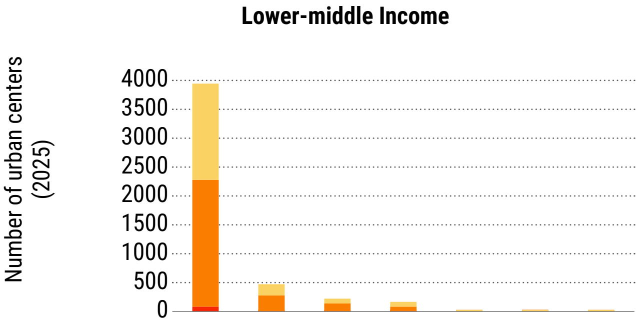
Figure 3.9: Temperature increase in the period 2025-2040 under RCP 4.5 of cities, by size and income group



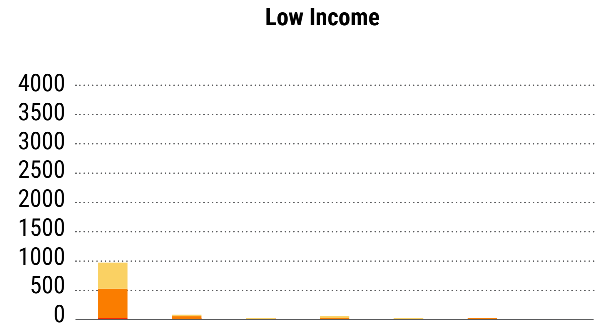
Temperature Increase(⁰C)	50k -250k	250k -500k	500K -1M	1M -5M	5M -10M	10M -20M	>20M
0.0-0.5	762	96	53	48	6	1	1
0.5-1.0	280	39	22	28	2	2	1
1.0-1.5	126	13	13	5	2	1	0
>1.5	8	2	1	0	0	0	0



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



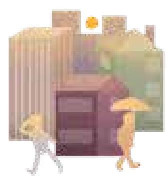
Temperature Increase(⁰C)	50k -250k	250k -500k	500K -1M	1M -5M	5M -10M	10M -20M	>20M
0.0-0.5	1682	199	88	77	6	3	4
0.5-1.0	2180	267	129	81	2	2	4
1.0-1.5	78	12	5	2	2	1	0
>1.5	0	0	0	0	0	0	0



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)

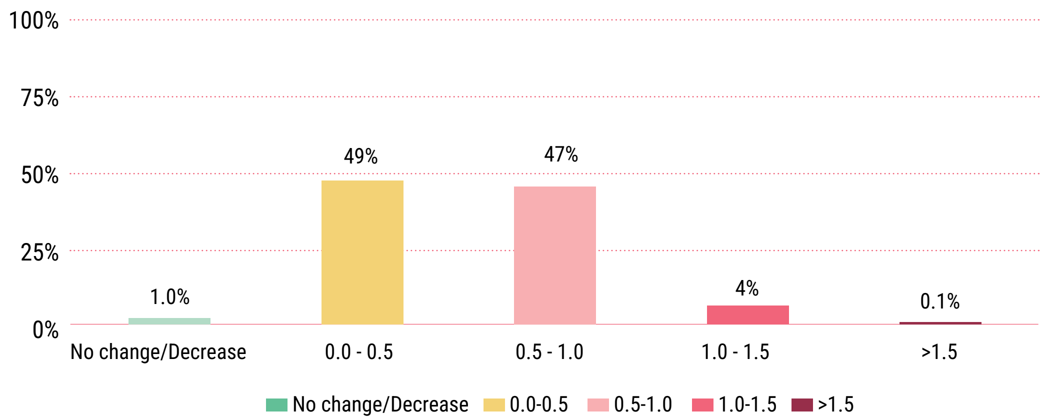
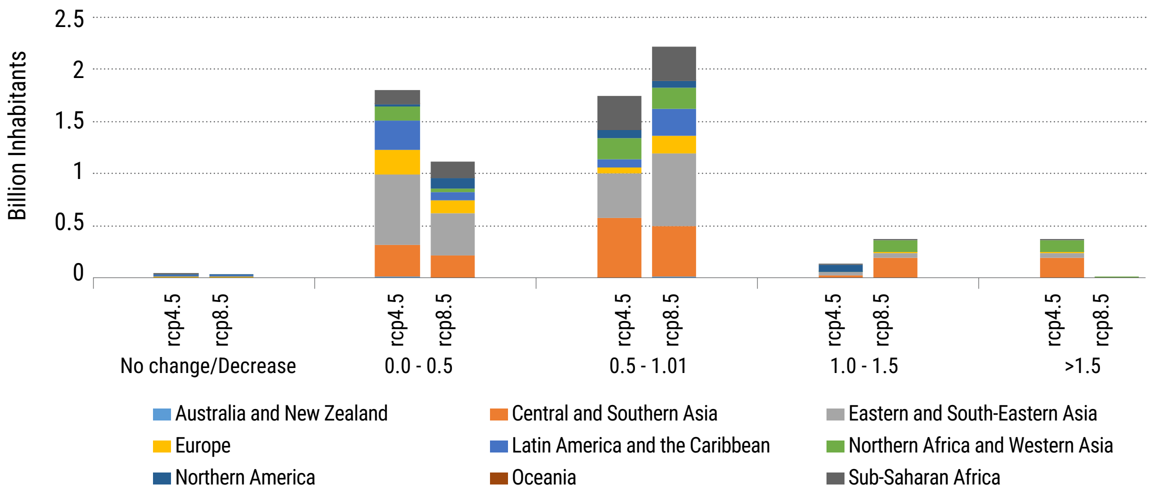


Figure 3.11: Population in cities by region of the world experiencing warmer temperatures, 2025-2040, by RCP



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

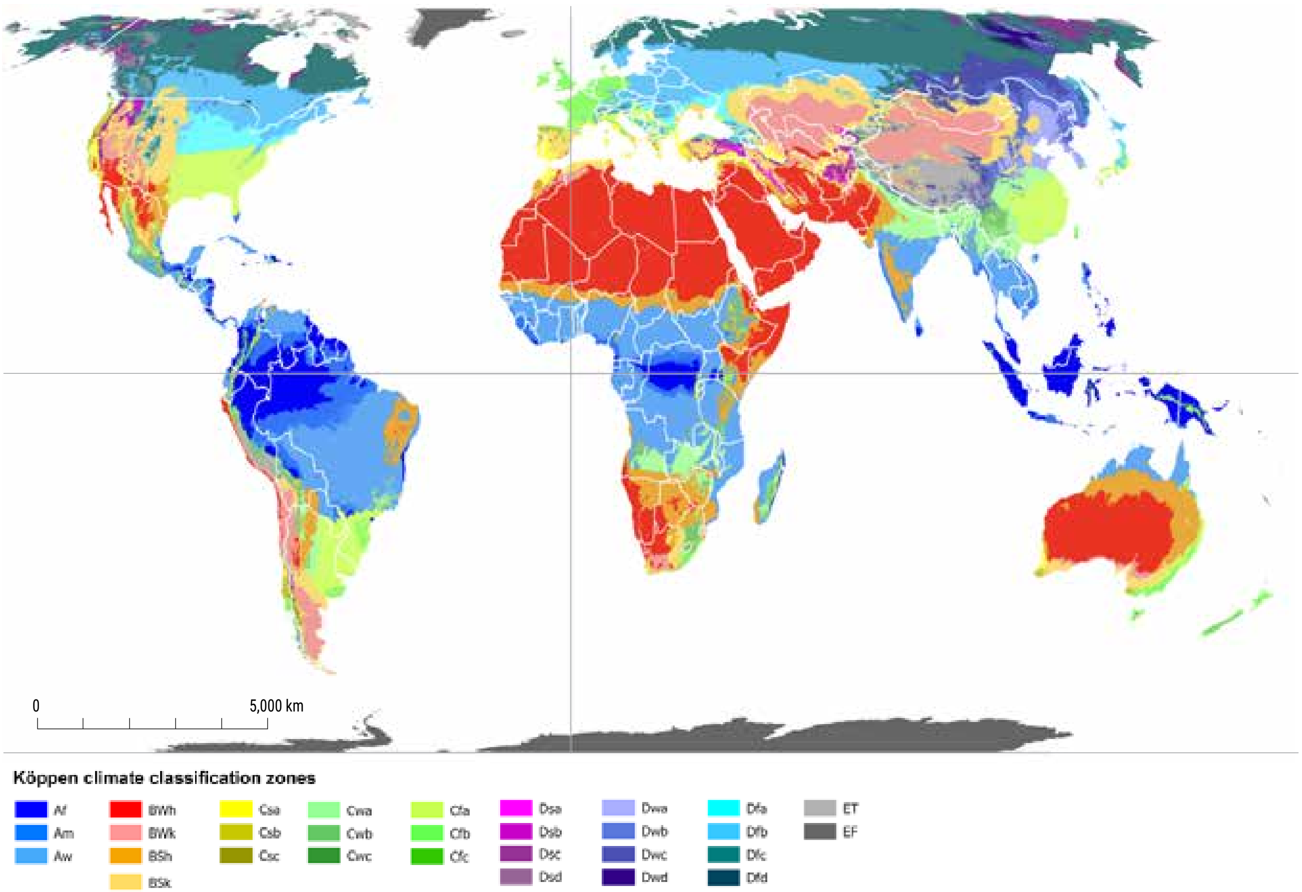
Global warming is among the most notable impacts of climate change. As the previous section demonstrated, temperatures are rising in cities, with significant impacts on the health and well-being of urban communities. But climate change also involves complex changes in the composition of the atmosphere, 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

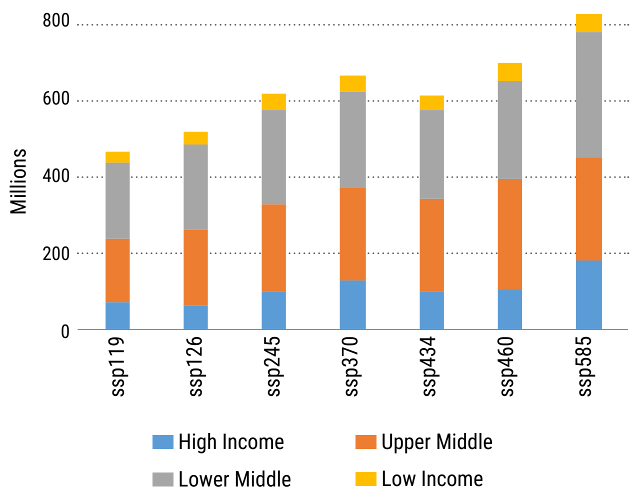
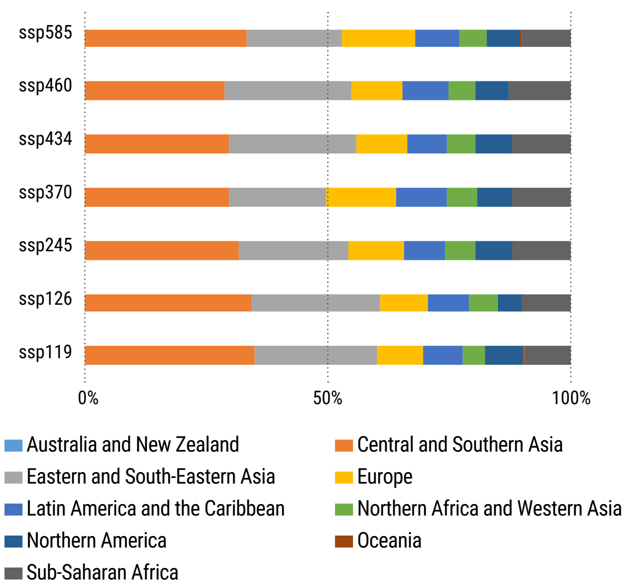


Figure 3.14: Share of population (as of 2025) in cities projected to change climate type by 2040, by region and SSP



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):

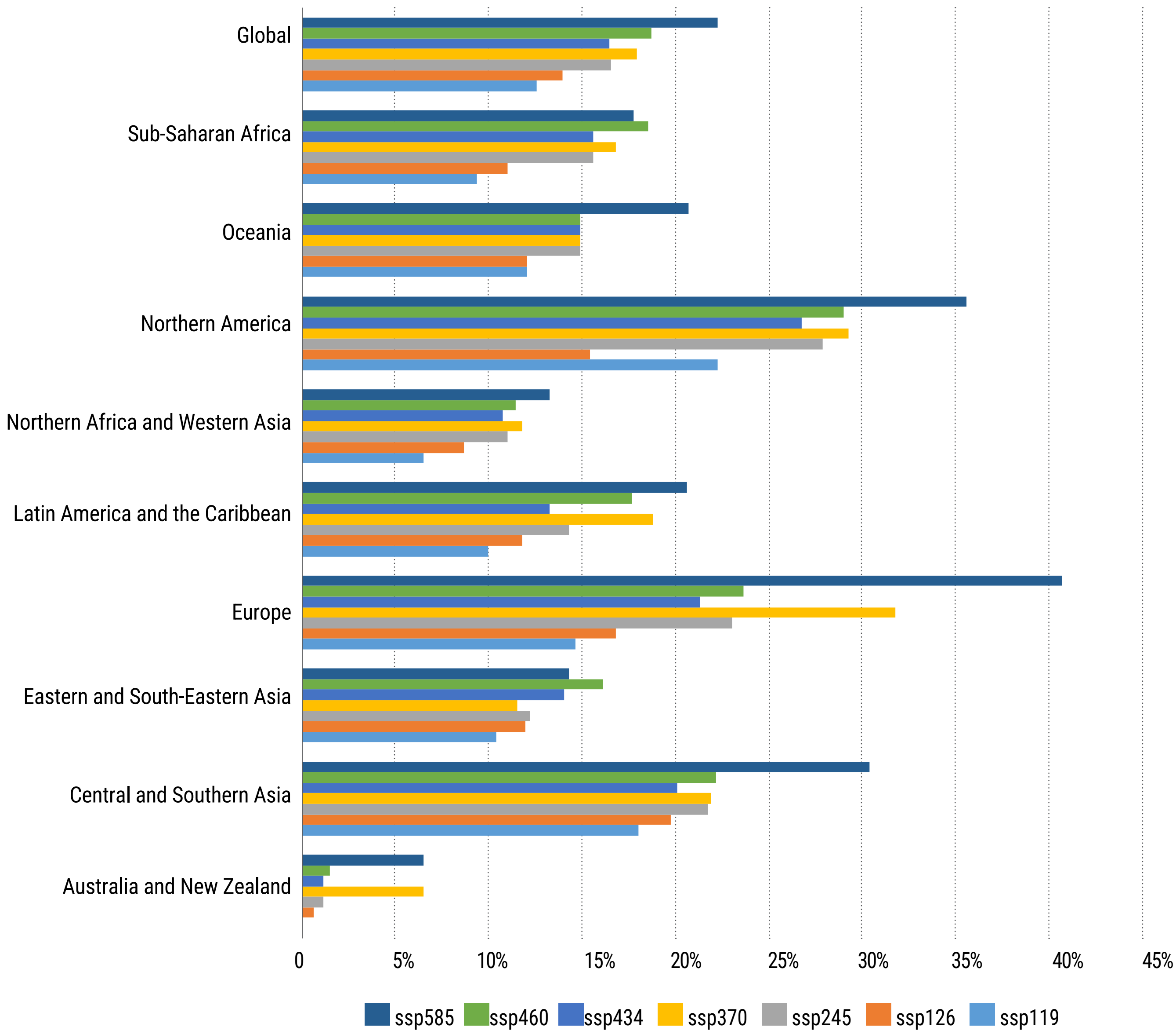
- Under SSP1, Asia would accommodate 55 per cent of the city population projected to change climate type by 2040, with 10 per cent each for Europe and Sub-Saharan Africa and 8 per cent each for Northern and Latin America. However, the relative weight of Asia would decline in scenarios with higher emissions, 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.

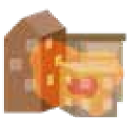
- The income group with a significant susceptibility to SSP scenario variation is Europe, where for example under a scenario to meet the Paris agreement pledges (SSP1), 15 per cent of the population in cities globally would be exposed to climate type change, while under SSP3 up to 32 per cent would face 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



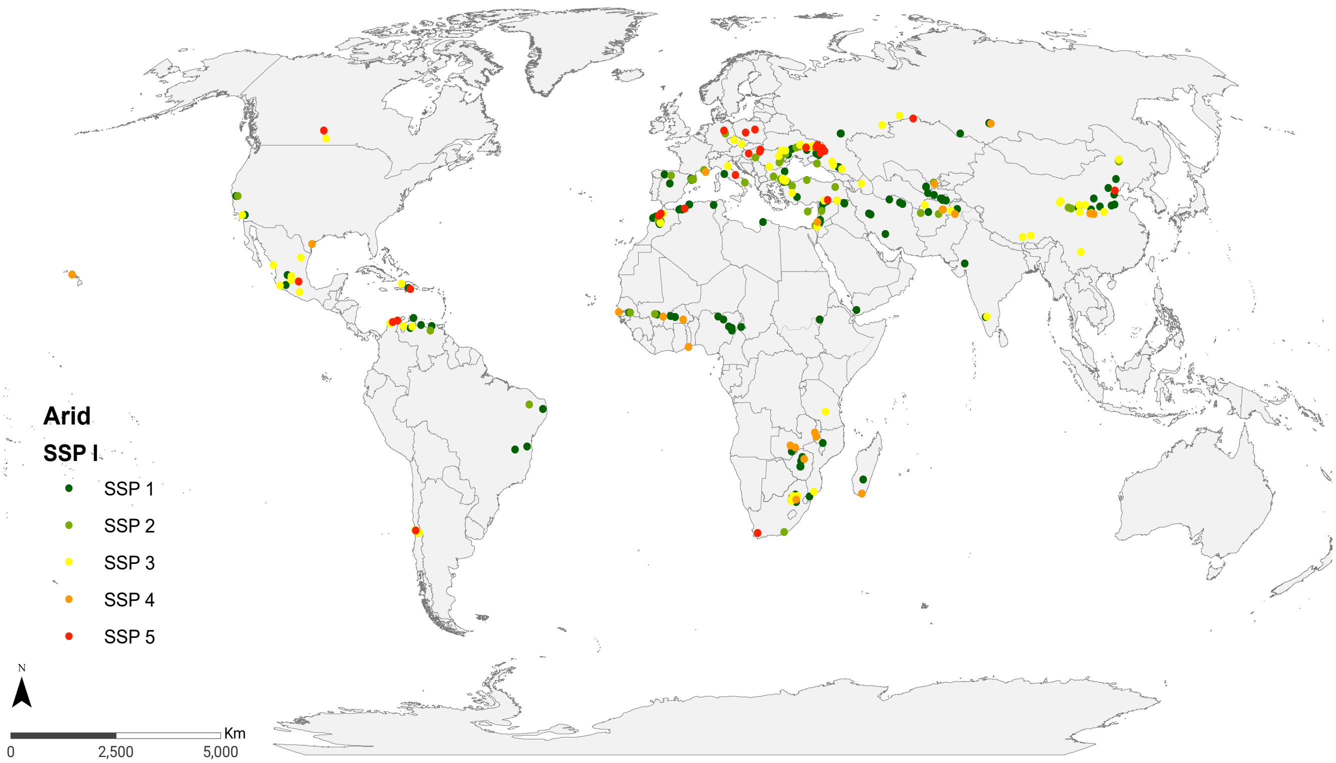
3.3.2 Transitions to arid or humid climate types

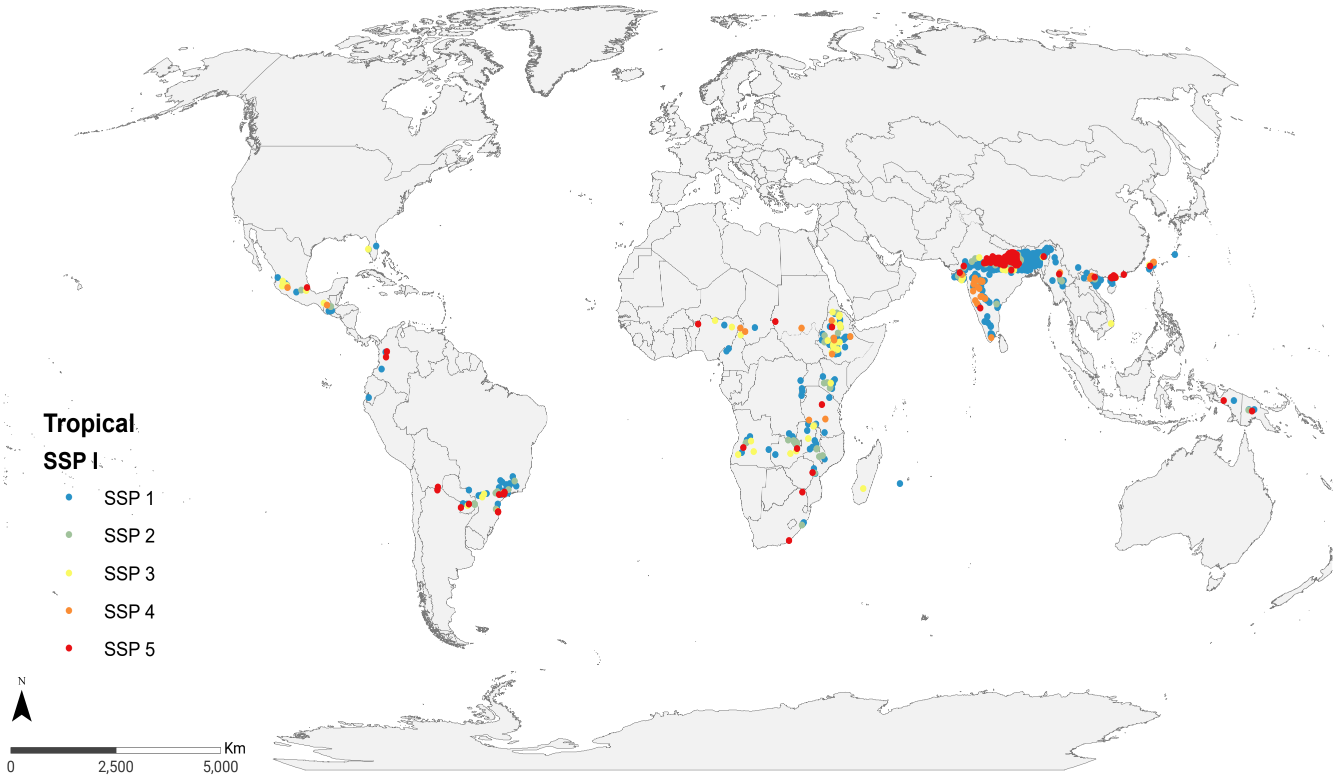
The transition to warmer climate types affects cities globally, but significant regional variation exists in terms of transitions towards more arid or more humid climates (Figure 3.16). At least 600 cities across the world could be transitioning to drier climates by 2040, exposing more than 180 million 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.

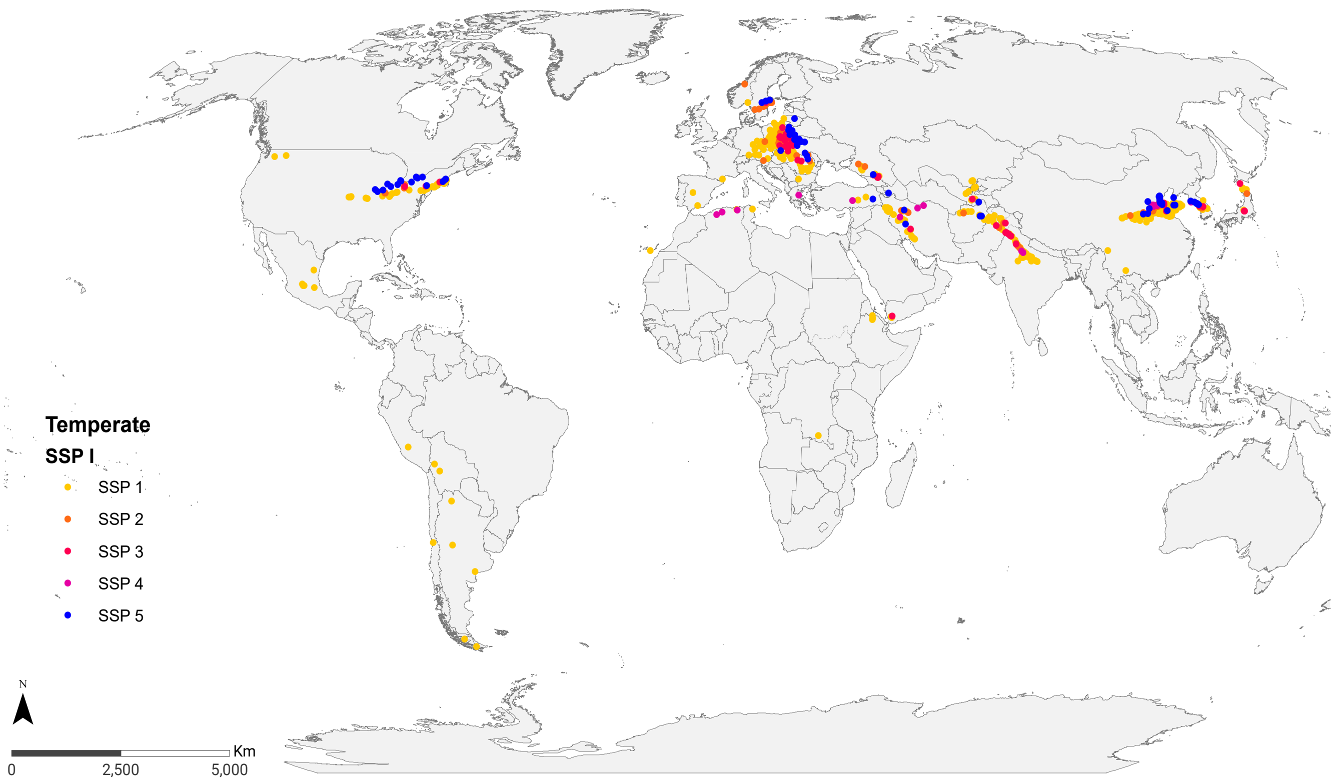


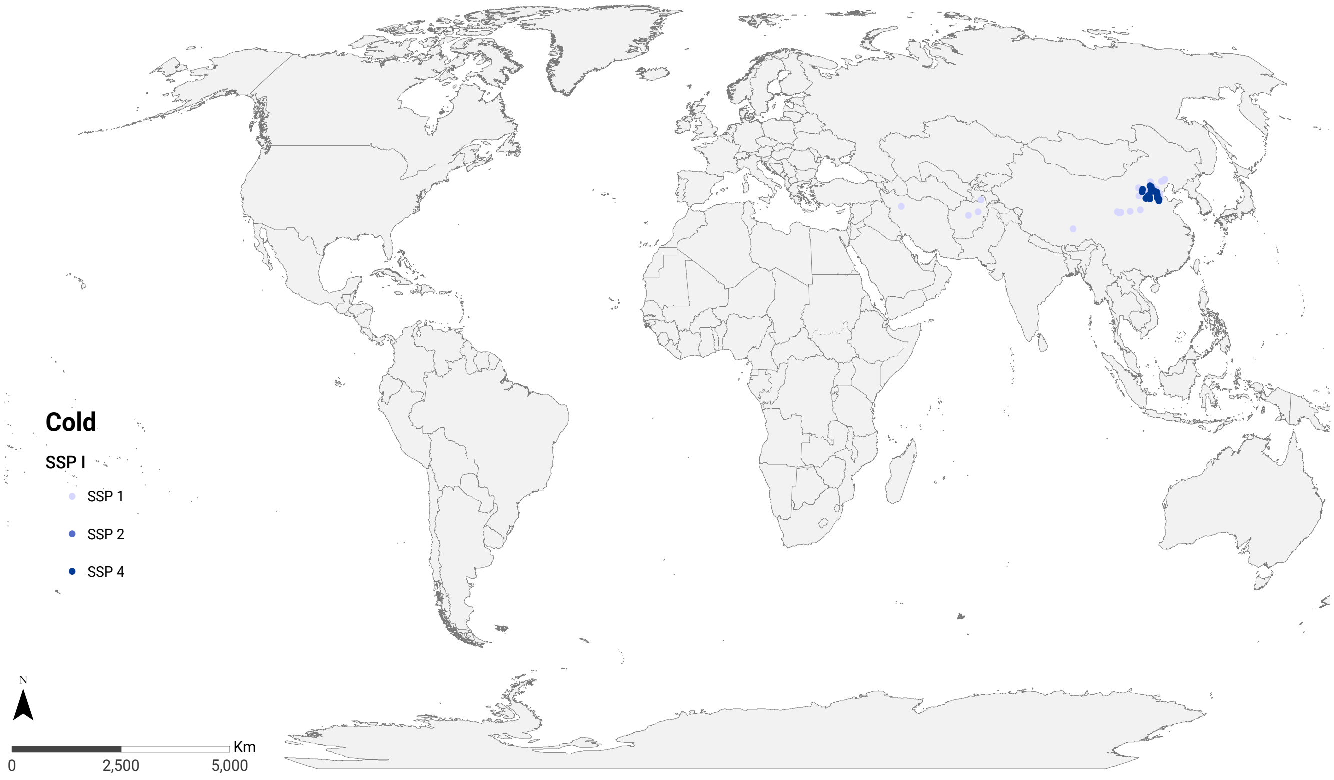
A transition to a more arid climate will impact cities in profound ways, especially with regard to water scarcity

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









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

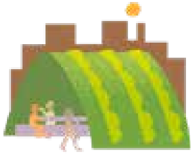
Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

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.



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

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).

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.

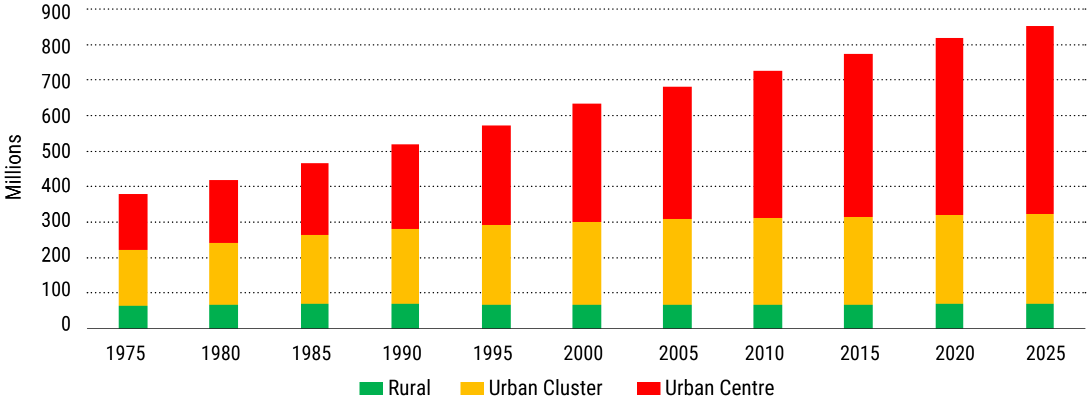
3.4.1 Increasing exposure in coastal cities

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

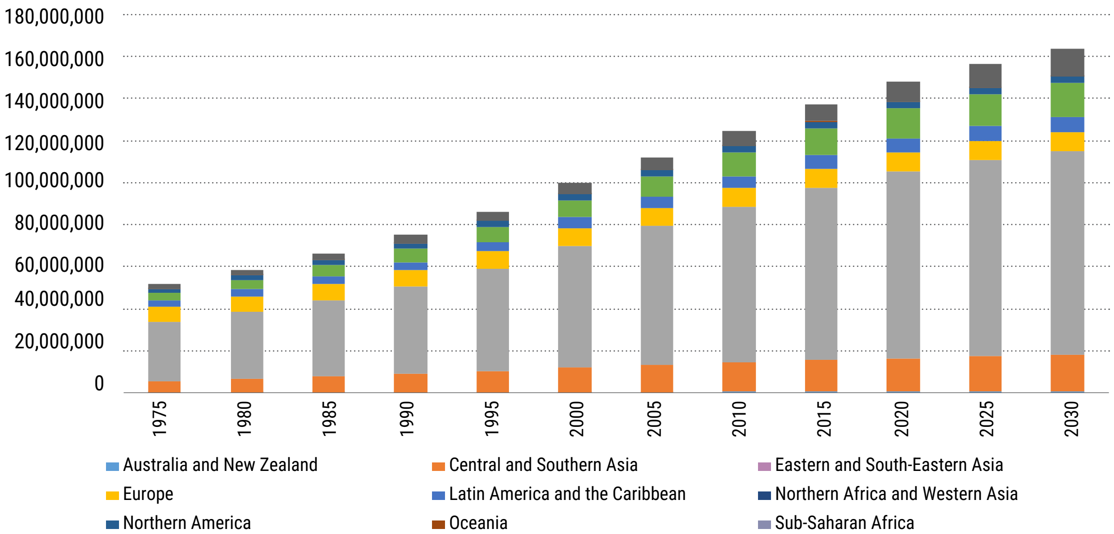
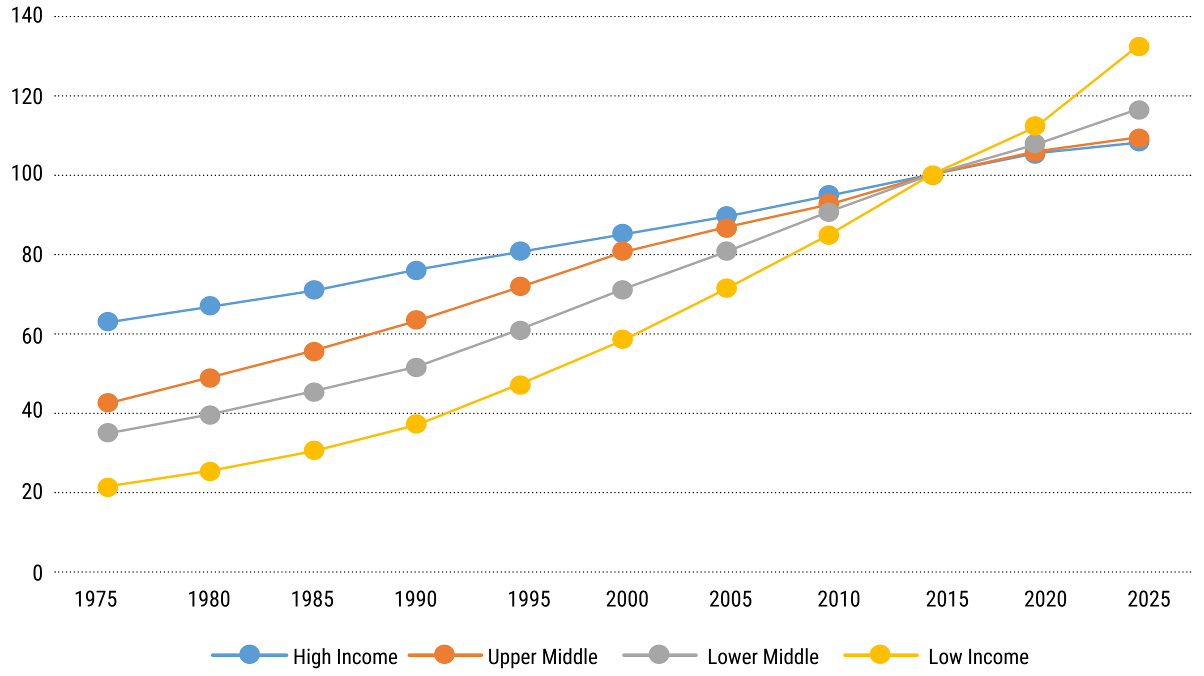
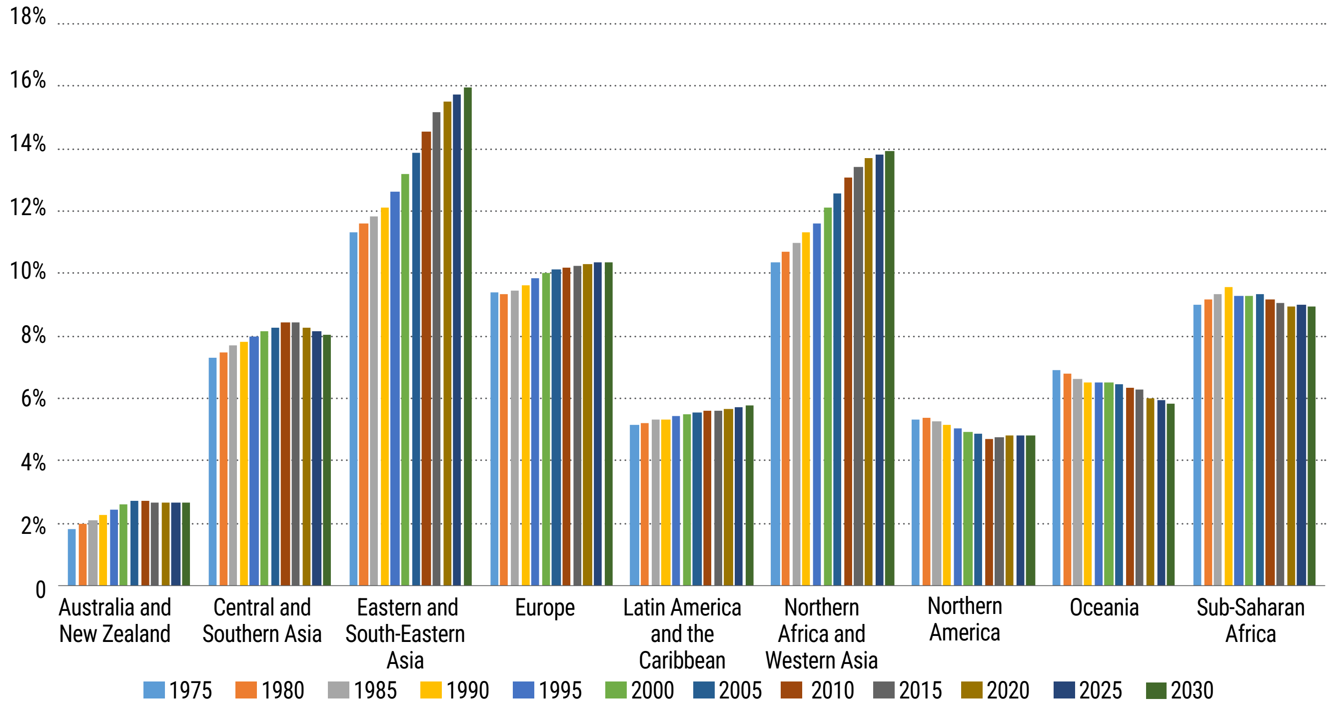


Figure 3.19: Population growth in cities in LECZs less than 5 metres above sea level, by income groups (2015=100)



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



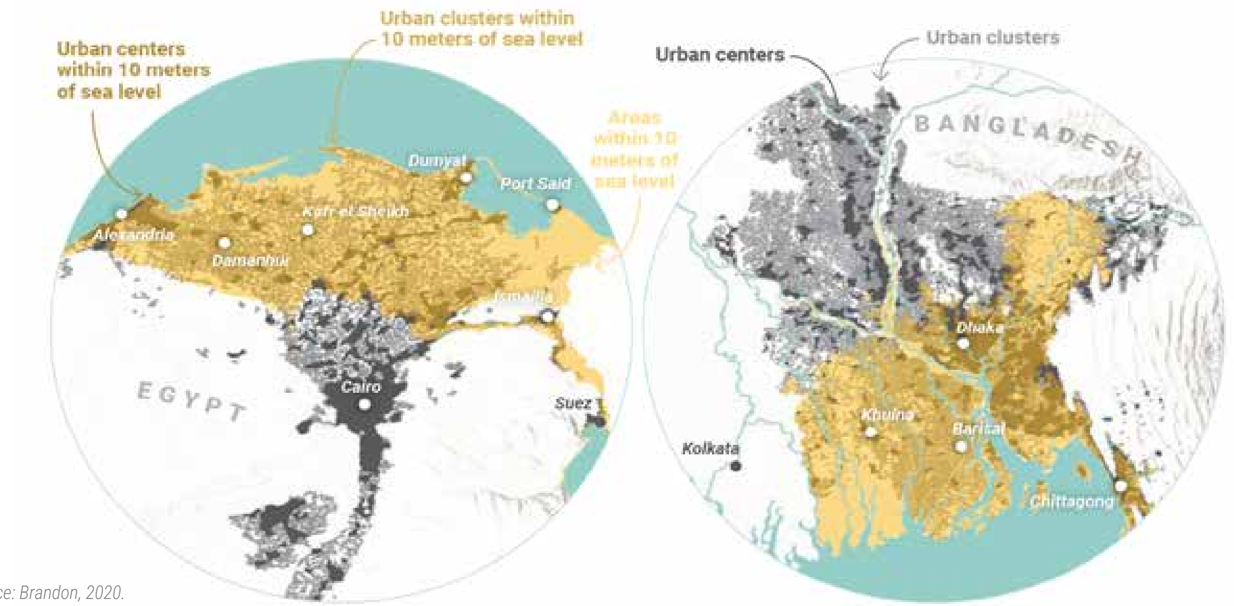
Looking at the share of the population living in cities in LECZs less than 5 metres above sea level, Eastern and South-Eastern Asia stand out again as the most exposed. In total, about 25 cities worldwide have all their population under 5 metres of elevation: half of these cities are in Eastern and South-Eastern 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



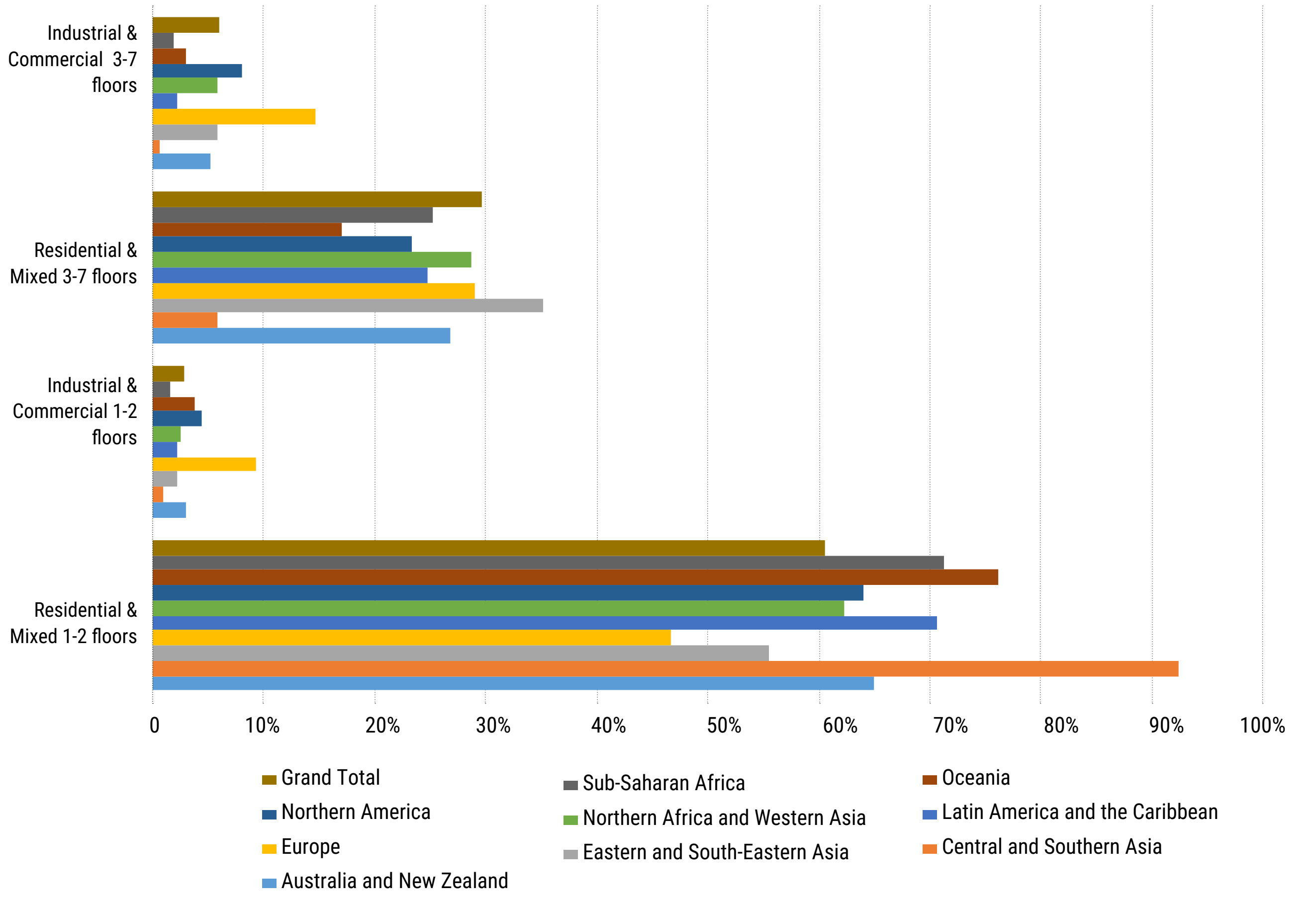
Source: Brandon, 2020.

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



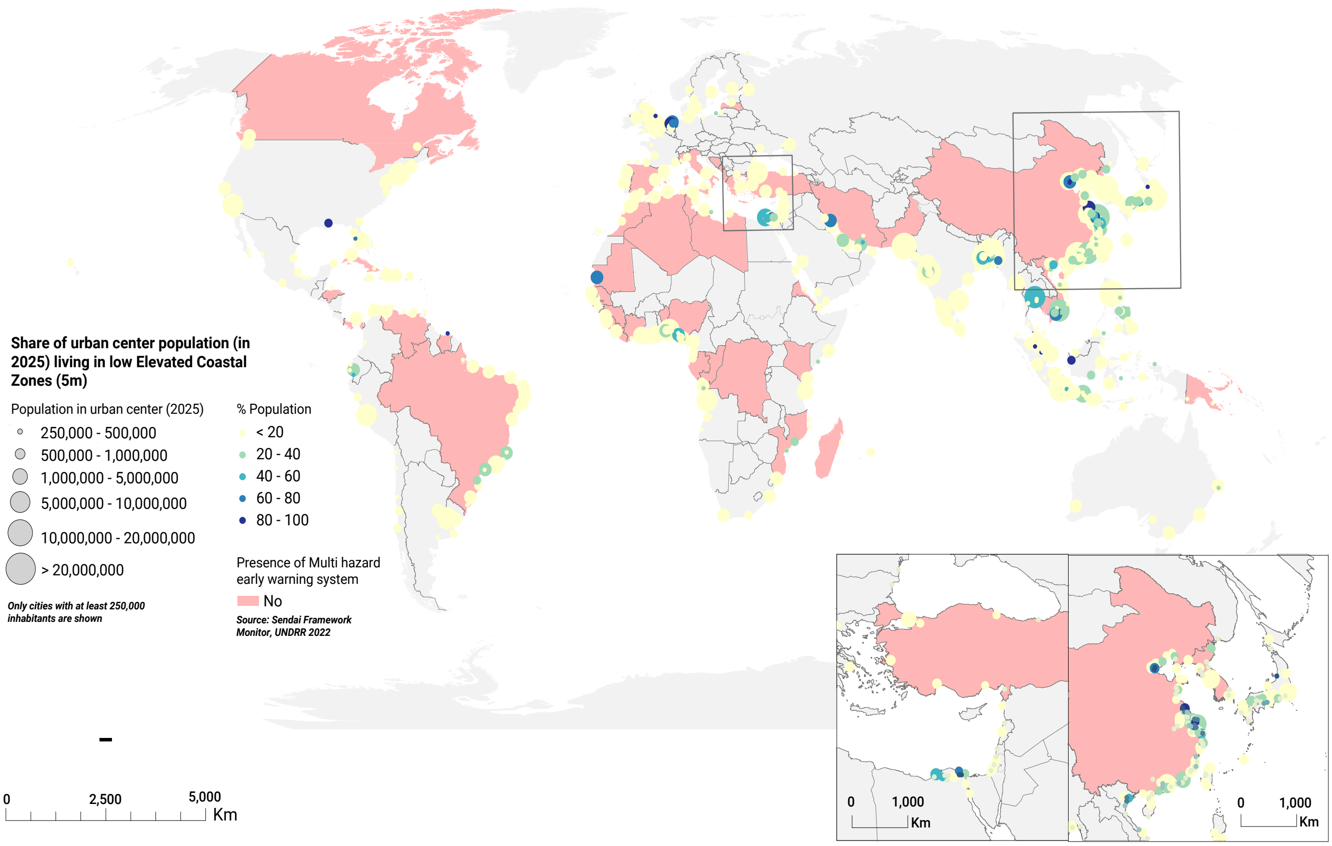
Note: class 8+ floor accounting less than 1 per cent is omitted

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:
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: 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

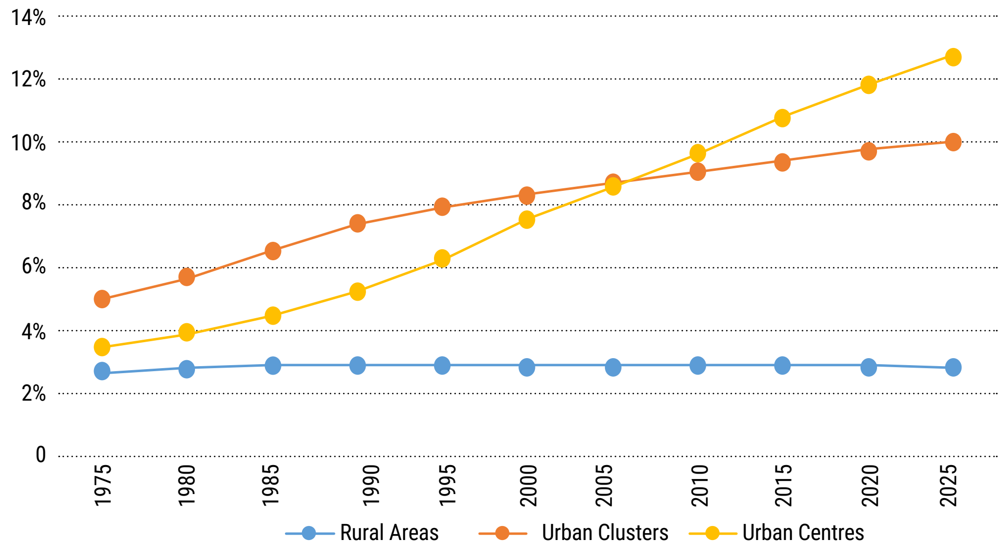
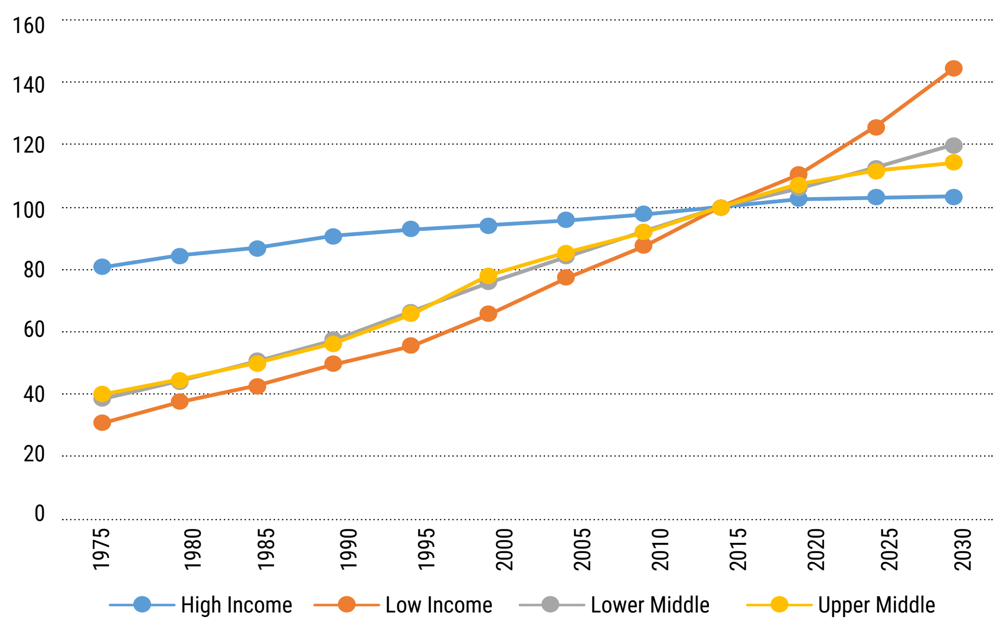


Figure 3.25: Population change (%) in cities exposed to riverine flooding by income group, 1975-2030 (2015=100)



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

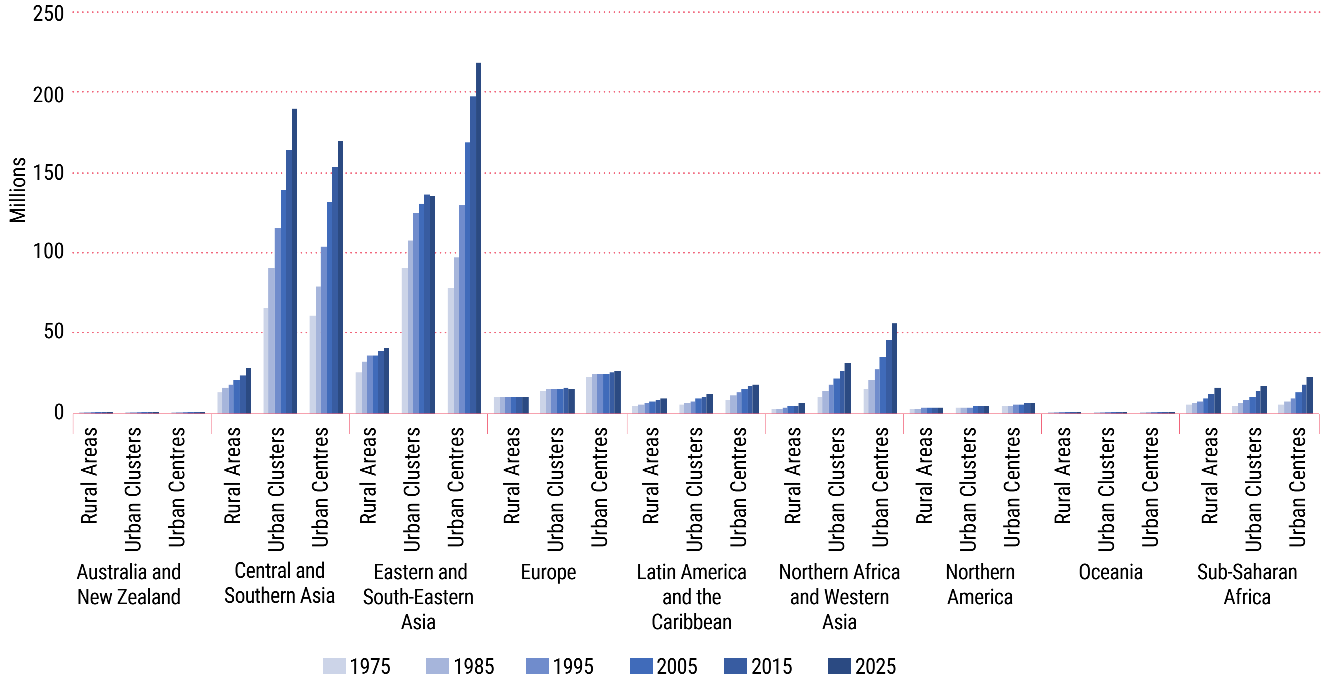
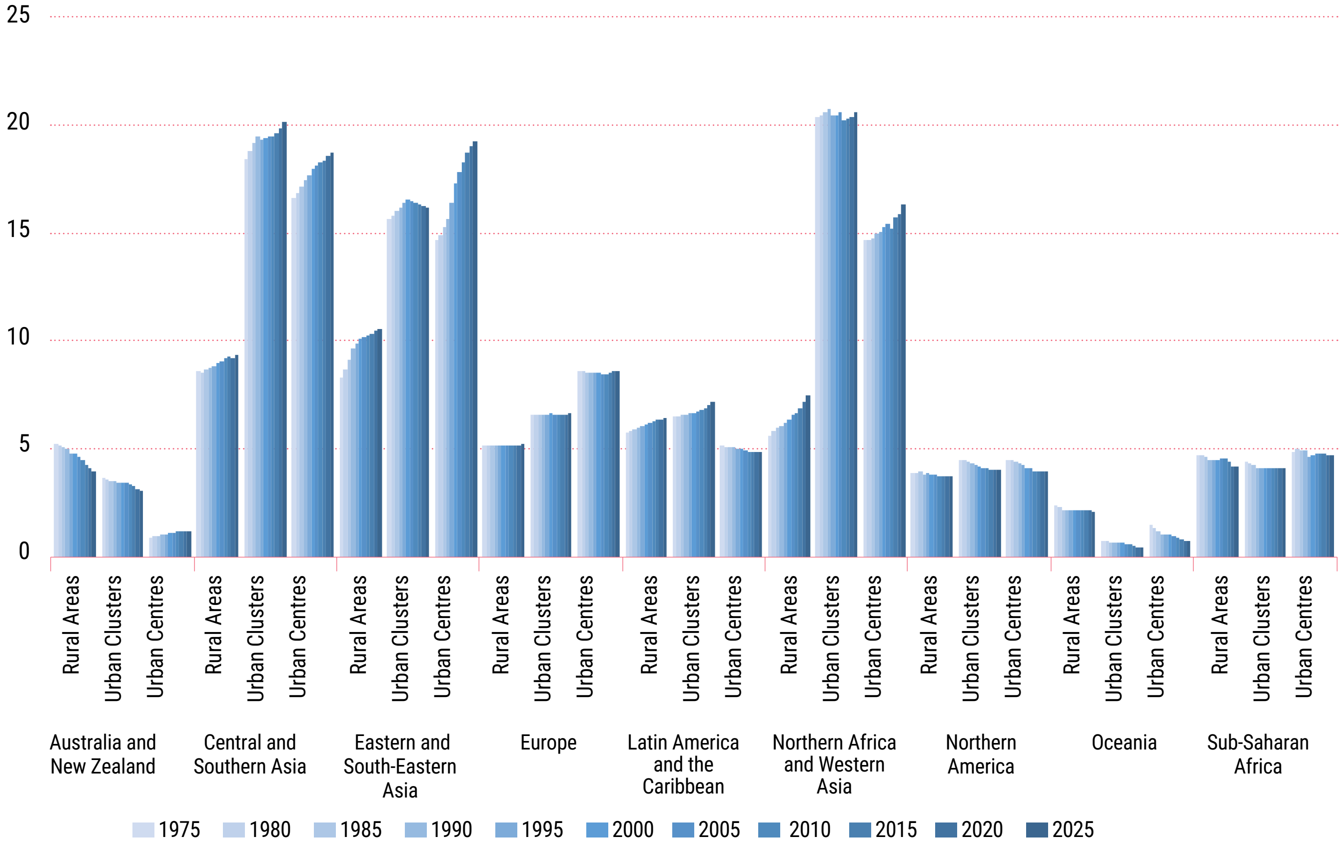


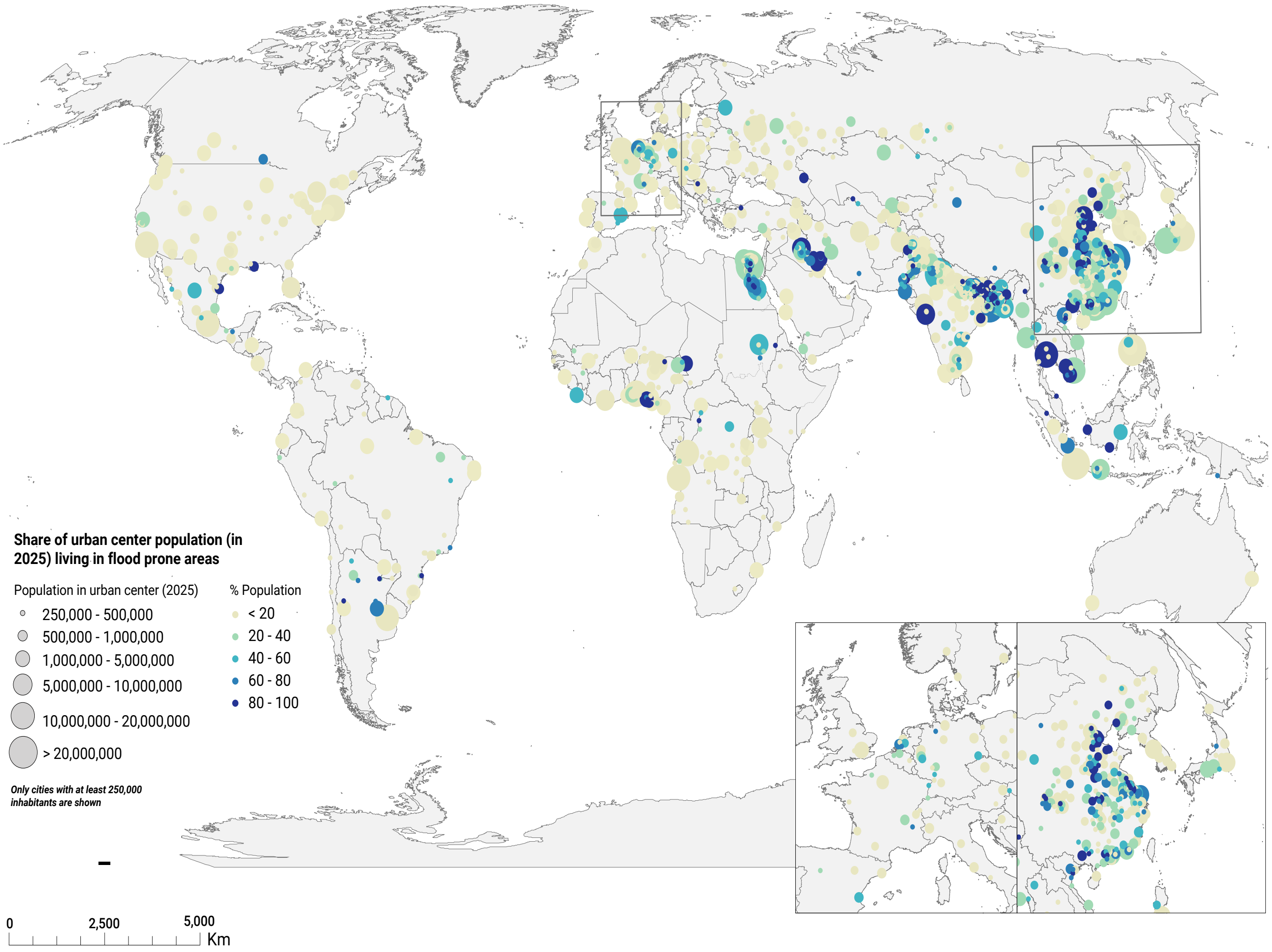
Figure 3.27: Share of the population exposed to riverine flooding, 1975-2025, by degree of urbanization and region



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:

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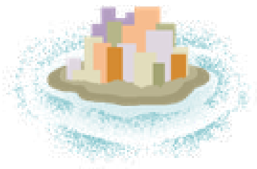
Final boundary between the Republic of Sudan the Republic of South Sudan has not yet been determined.

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: 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

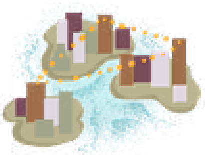
Physical	*Critical infrastructure*	Essential components to day-to-day business activities, such as roads and energy systems.
	Environmental	Green space, vegetation and other nature-based assets.
	General urban assets	Other physical assets that do not fall in categories above, including housing, emergency 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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