

# Climate Change Adaptation Guide for Practitioners

## Urban Environment Risks and Solutions

On behalf of:



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for the Environment, Climate Action,  
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## Foreword



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Communities around the world have undergone a widespread process of urbanisation which accelerated markedly during the 20th century. Since 2007, the global urban population has exceeded that of its rural counterpart. This rapid urban expansion necessitates climate adaptation and mitigation strategies that address the evolving nature of climate risks in urban environments.

Cities are highly complex and interconnected systems, reliant not only on their immediate natural surroundings but also on external infrastructure networks. As a result, climate risks can affect urban areas both directly and indirectly. Heatwaves, flooding, and extreme weather events – among other hazards – can threaten the health and safety of urban populations, as well as triggering cascading impacts on energy and transport systems, public utilities, healthcare services and broader socioeconomic structures. In some cases they can also have long lasting impacts on equity, displacement and economic activities.

This report outlines climate risks and hazards that specifically impact urban environments. It also provides examples of cities employing solutions to combat these risks and the enabling governance efforts that facilitated their success. Finally, the inclusion of best practices, novel tools, and cross-cutting recommendations can be used to enhance urban adaptation efforts.

I look forward to the insights of this report being applied to urban environments across geographies, inspiring robust adaptation and risk governance in cities across the world.



## Foreword



### XU Huaqing

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Cities are increasingly exposed to the impacts of climate change. More than half of the world's population lives in urban areas, where people, infrastructure, and economic activity are concentrated, making cities particularly vulnerable to frequent and severe climate hazards. Rising temperatures, intense rainfall, flooding, and resource pressures are no longer distant threats; they are shaping the way cities operate today. Strengthening adaptation in urban environments is not just about resilience; it is essential for sustainable and liveable cities.

In China, cities are already experiencing the consequences of climate change, facing heatwaves, heavy rains and storms. For example, in 2024, Beijing recorded around 50% more precipitation than the long-term average. In 2022, extreme heatwaves coincided with upstream water shortages in western Sichuan province, reducing hydropower generation. This, in turn, limited electricity supply to major urban centres and made it more difficult to meet cooling needs. These examples show how climate risks can cascade through interconnected systems in densely populated regions, triggering chain reactions in urban lifeline infrastructure.

China is implementing a national strategy to actively respond to climate change. To advance the National Climate Change Adaptation Strategy 2035, 39 pilot cities have been designated to pioneer climate-adaptive initiatives. Since climate impacts vary widely, cities and provinces must develop context-specific adaptation action plans based on their distinct vulnerabilities and resources. Adopting tailored policies and measures is essential to developing long-term, effective solutions.

The scale and speed of climate change demand swift and decisive action. Cities around the world must strengthen adaptation measures, share lessons, and integrate resilience into all aspects of urban planning and policy. As part of a series of Climate Change Adaptation Guides for Practitioners, this report provides a foundation for doing so, bringing together international case studies, best practices, and recommendations to help urban practitioners, decision makers, and city authorities. I hope this guide will serve as a practical and hands-on resource for practitioners in China and beyond, supporting cities in building safer, healthier, resilient, and more sustainable urban futures.

徐华清

# Executive Summary

## Purpose and Scope

The intensifying impacts of climate change highlight the continued importance of meeting the Paris Agreement's goal, limiting warming to no more than 1.5° C. It is becoming increasingly clear that even under the most ambitious emissions reductions scenarios, irreversible impacts are likely to persist, necessitating a robust and dual strategy that prioritises climate mitigation and climate adaptation. This report shares approaches for adapting to urban-related climate risks showcasing international case studies, best practices, and recommendations. It is intended to provide a starting point for urban adaptation practitioners, decision makers, and city authorities. By synthesising international frameworks, best practices, support tools, and external resources, this document can form the basis for planning, implementing and monitoring adaptation strategies in any city.

We highlight some of the risks that urban environments face under climate change, referencing recent scientific understandings and literature, and how these risks can be managed through robust strategies, solutions, and policies. Highlighting the importance of cross-sectoral risk assessment, we provide multiple opportunities and entry points for various actors to get involved in the adaptation process.

In addition to setting the context for climate change impacts, non-climatic risks, and the need for adaptation, we introduce suggested methods for risk assessment, guidance on data collection, and practical advice to prioritise and determine solutions.

Governance and policy frameworks are key to addressing risks in the urban environment, as they provide useful guidelines for stakeholders and decision makers to align efforts and strategies while reducing overlap. At the urban level, these frameworks can help in overcoming capacity and financial constraints, while promoting multi-stakeholder and multi-level involvement.

This report on Urban Environment Risks and Solutions is part of a series of three Climate Change Adaptation Guides for Practitioners that can be accessed [here](#).

The other two reports focus on Natural Environment Risks and Solutions, as well as the Adaptation Policy Cycle.



## Key Findings

The box below highlights some major risks and the proposed solutions that can be implemented to address the identified risks.

Area	Characteristics	Proposed Solutions
Urban Setting	<ul style="list-style-type: none"> <li>• Population density</li> <li>• Concentrated infrastructure</li> <li>• Dependency on other systems for food production</li> <li>• Energy generation</li> <li>• Increased vulnerability to heat and flooding</li> </ul>	<ul style="list-style-type: none"> <li>• Integrated adaptation planning for urban areas</li> <li>• Nature-based in a multi-scalar way, both temporally and spatially</li> <li>• Climate-proofed urban infrastructure</li> </ul>
Social Dimensions	<ul style="list-style-type: none"> <li>• People</li> <li>• Industries</li> <li>• Government</li> <li>• Informal settlements</li> </ul>	<ul style="list-style-type: none"> <li>• Enactment of policies by urban authorities</li> <li>• Incentives for adaptation tailored to different groups e.g private sector</li> <li>• Facilitation of dialogues between seemingly disparate objectives and across stakeholder groups</li> <li>• Public awareness and communication</li> </ul>
Robust and Multi-pronged Solutions	<ul style="list-style-type: none"> <li>• Evolving urban environment</li> </ul>	<ul style="list-style-type: none"> <li>• Iterative urban adaptation processes</li> <li>• Promote multiple individual adaptation solutions which have an impact when considered together</li> <li>• Consideration of adaptation as part of a long-term strategy</li> </ul>
Adaptation, Mitigation, and Development	<ul style="list-style-type: none"> <li>• Interlinked concepts with synergies and trade-offs</li> </ul>	<ul style="list-style-type: none"> <li>• Assess the links between adaptation, mitigation and sustainable development</li> <li>• Optimize and prioritize solutions with co-benefits</li> </ul>

## Recommendations

**Urban planning and governance** are key levers to implement urban-level adaptation. Existing channels for capacity building, policy making, and financial resources should mainstream and prioritise robust climate risk management principles. Cross-sectoral and multi-city collaboration can further reinforce adaptation efforts.

**Health and human wellbeing** outcomes in cities are often closely linked to climate impacts, and adaptation efforts can often be formulated to deliver co-benefits for both. Protecting citizens from climate hazards and reducing economic damages should be highlighted as important goals of adaptation.

**Innovation, research, and technology** are often highly developed in cities, and high educational and professional capacity allow for the development of novel solutions. Urban policymakers should work to encourage, finance, and scale such efforts.

**Public participation and support** for climate-focused policies can determine the efficacy of such measures. Involvement of local populations and consideration of needs based on social and geographical vulnerabilities should inform policy development. It is crucial to not only provide urban populations with knowledge on climate risk, but to provide direct services and opportunities for them to manage such risk.

**Nature and biodiversity** are often overlooked in the urban environment, but play an important role in reducing risk and contributing to human wellbeing. Often, the protection, management, and introduction of nature (through nature-based solutions for example) can prove to be a cost-effective, politically popular, and easily implemented solution in the urban environment.

## Key Definitions

**Exposure** - Who or what is affected by events. Defined as “the presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected” (Intergovernmental Panel on Climate Change (IPCC AR6 WG1, 2023).

**Hazard** - Defined as “the potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources” (IPCC AR6 WG1, 2023).

We highlight two main categories of hazards in this report: primary and secondary. Primary hazards refers to direct and immediate consequences of a climate-related event (flood, heavy rainfall, heavy winds, drought, etc.) and secondary hazards refers to effects triggered by these primary events (riverbank erosion, infrastructure collapse, famine, etc.).

**Informal Settlements** - Places people live “generally characterized by high tenure insecurity, lack of proper infrastructure and services, precarious security and safety including exposure to environmental and health hazards, and socio-economic marginalization.” (United Nations High Commissioner for Refugees, 2024).

**Representative Concentration Pathways (RCPs)** - Climate change scenarios that “include time series of emissions and concentrations of the full suite of greenhouse gases (GHGs) and aerosols and chemically active gases, as well as land use/land cover (Moss et al., 2008)” (IPCC, 2014).

**Risk Driver** - Aspect, agent or process that influences a component of a natural or human system (IPCC AR6 WG1, 2023). In this report, we mention two types: Climatic and Non-Climatic. The first one refers to aspects within the climate system that are directly related to, and influenced by, global climate trends (e.g.: sea level, mean temperature, precipitation patterns, etc.); while the second, refers to aspects outside of it that may still exert influence on either system, or both (e.g.: land use, pollutants release, infrastructure and design, institutional aspects, demographic and population trends, etc.).

**Shared Socioeconomic Pathways (SSPs)** - Climate change scenarios showcasing “possible trajectories for future societies in terms of global or regional socioeconomic development. These pathways were named, from SSP1 to SSP5, as follows: Sustainability, Middle of the Road, Regional Rivalry, Inequality, and Fossil-fuel Development” (Ohara, K., 2022)

**Urbanisation** - Process of transformation of rural or semi-dense areas (towns) into fully urban areas. The concept of “degree of urbanisation” is used in this report and it aims to recognize the continuum between urban and rural areas and to provide a nationally relevant yet internationally comparable definition (European Commission. Statistical Office of the European Union, 2021)

**Vulnerability** - Defined as “the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt” (IPCC AR6 WG1, 2023).

# 1

## Introduction



# 1 Introduction

## 1.1 Context of Climate Change in Cities

Cities are at the frontline of climate change, facing escalating risks from extreme heat, flooding, sea level rise, and water stress—all of which intensify with every increment of global warming. According to the latest IPCC assessments, limiting warming to 1.5°C under the Paris Agreement remains critical to reduce the scale and severity of urban impacts. Yet even at 1.5°C, many cities—especially in low-lying coastal zones and arid regions—will confront hard and soft limits to adaptation.

Understanding the risks of climate change on cities is essential also because of growing urban populations and densities that can exacerbate climate risks. Research on the urban-climate interface is being shaped on the international stage. At the time of this report, the IPCC is currently working on a special report on climate change and cities, as part of its 7th assessment cycle. The report, which will have contributions from 97 experts representing 56 countries, is set for release in March 2027. It will synthesise the latest scientific research on climate impacts, risks and vulnerabilities, as well as urban-specific adaptation and mitigation strategies. The report will also provide global insight into urban climate impacts and set the stage for further policy and research interventions.

Assessing future climate risks in cities is exceedingly difficult due to challenges associated with projecting urban-scale hazard scenarios at smaller spatial and shorter temporal scales, compared to the large-scale assumptions underlying Global Climate Models (GCM) and Shared Socioeconomic Pathways (SSP) (IPCC AR6 WG1, 2023). However, cities are often located in areas prone to cyclones, heat stress, coastal flooding and similar events (UN-Habitat, 2024).

According to the 2023 CDP-ICLEI Track, which collected data from 1,131 cities, 83% reported experiencing significant climate hazards. The most common were flooding (58%), extreme heat (54%), drought (35%), heavy rain (25%), and wildfires (22%) (Carbon Disclosure Project, 2024). Therefore, any increase in magnitude or frequency of such events could severely compromise the well-being and lives of large populations.

### Social Trends

Urbanisation trends (which will be illustrated later in this report) overwhelmingly show that the global urban population is increasing in contrast to the rural counterpart. One important and related phenomenon is the so-called climate gentrification, whereby vulnerable communities are excluded from safer areas that offer better services such as housing and green public spaces, and are displaced to others with increased climate risks and fewer service availability (UN Habitat, 2020). The process of urbanisation is highly resource-intensive and it may result in the spatial fragmentation of the urban periphery, depletion of its ecosystem services, and exacerbation of cascading risks (IPCC AR6 WG1, 2023). New climate conditions may thus be a determinant factor in the reconfiguration of urban infrastructure, of social relations and of other consequential aspects of designing future urban environments.

### Urban Climate Hazards

In terms of temperature, floods and water availability, the following are the findings of IPCC's AR6 report.

Urbanisation results in elevations of the local air temperature and in the exacerbation of heat island effects, which disproportionately impacts vulnerable communities such as low income, ethnic minorities, children, elderly and disabled people (IPCC AR6 WG1, 2023). It is important to state that the levels of confidence in this report will make use of IPCC's calibrated language as explained in AR6's WG1 Synthesis Report (IPCC AR6 WG1, 2023).

IPCC's AR6 WG1 also reports with high confidence that the heatwave risks to cities, settlements and infrastructure will worsen: Heat stress in mid-latitude cities is estimated to be potentially double that of surrounding rural areas in all RCPs by 2050 and in the Middle East and North Africa (MENA) region, 90% of the people exposed to super- and ultra-extreme heat waves, estimated in 300 million, will live in urban areas (IPCC AR6 WG1, 2023).

When it comes to flooding in urban settings, several types must be considered, such as fluvial, pluvial, sewer, coastal, glacial lake and flash floods. It is estimated that global warming will increase the frequency and intensity of extreme precipitation, and, with medium confidence, that it will likely expand the area affected by flood hazards (IPCC AR6 WG1, 2023). Even excluding the impacts of climate change, it is estimated that the urban area exposed to flood hazard will increase 2.7 times between 2000 and 2030 (Güneralp et al., 2015).

In addition to heat stress, it is estimated that between 2016 and 2050, the urban population facing water scarcity will rise from a third of the global urban population –933 million– to up to half of the urban population –1,693 to 2,373 million – and that the number of cities exposed to this phenomenon will increase from 193 to up to 284 (He et al., 2021).

## Future Urbanisation

Global population has nearly doubled in just 45 years, climbing from an estimated 4 to slightly under 8 billion between 1975 and 2020. Although it is estimated that this rate will eventually decrease by the end of the century, projections suggest that there will be over 10 billion people by 2100 (UN Department of Economic and Social Affairs - Population Division, 2024). In the same period, built-up area worldwide has passed from 176,000 to 464,000 square kilometers and people living in cities have climbed from 32% to 45%, which represents an almost threefold increase from 1.3 to 3.5 billion (European Commission. Joint Research Centre., 2024). In 2007, for the first time, the global urban population equaled the global rural population and since then, the former has remained larger than the latter (Ritchie et al., 2024). In fact, extreme events are likely increasing urbanisation in areas such as Sub-Saharan Africa due to prolonged droughts (IPCC AR6 WG1, 2023).

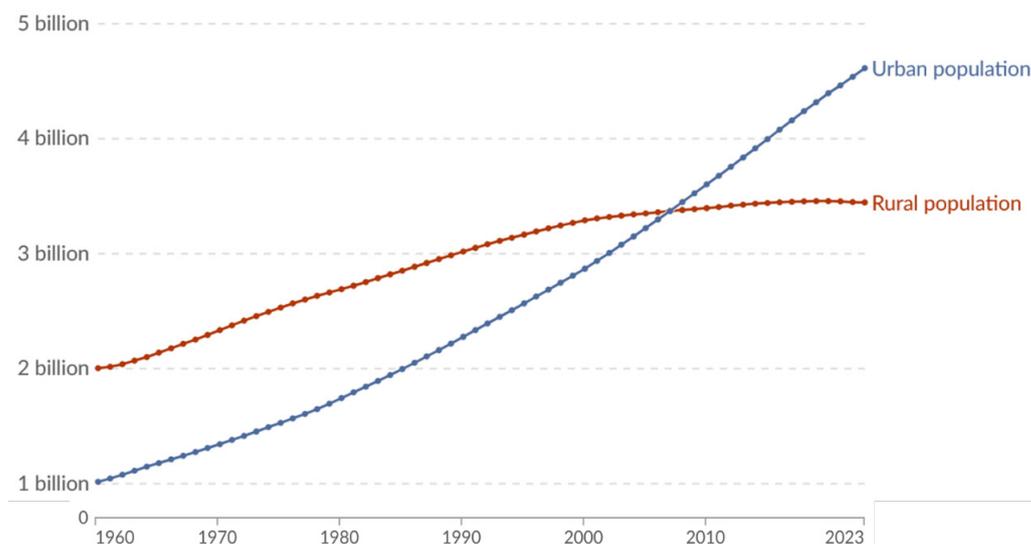


Fig. 1. Evolution of global urban and rural populations through time.

Source: Ritchie et al. (2024), based on data from the UN Population Division (2025)

## 1.2 Degree of Urbanisation

Although a global urbanisation trend is clear, there is no global consensus on what constitutes an urban area. Countries use different metrics such as absolute population size of an administrative area, population density or even presence of infrastructure and services to define it. This has led to the broader concept of “degree of urbanisation”, which aims to recognise the continuum between urban and rural areas and to provide a nationally relevant yet internationally comparable definition (European Commission. Statistical Office of the European Union., 2021).

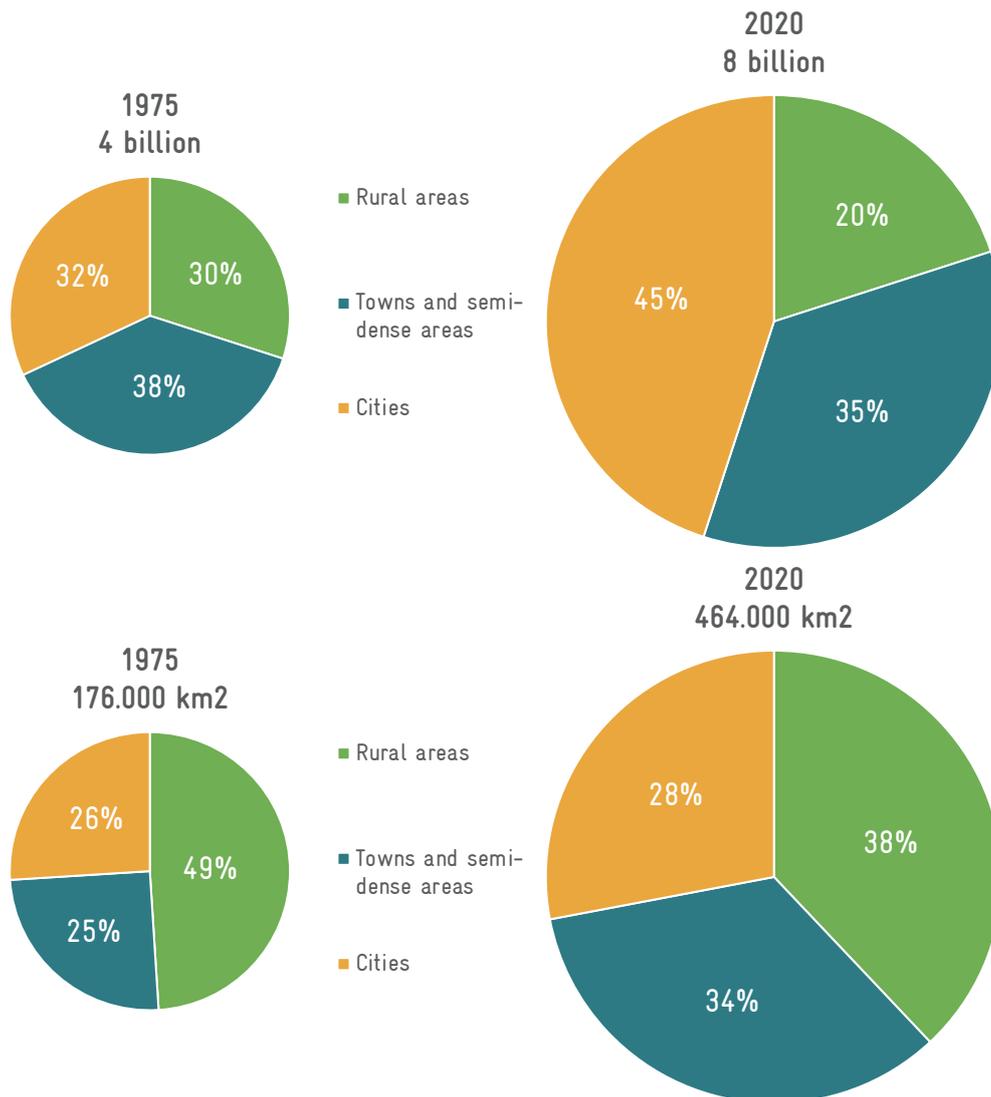


Fig. 2. Population (above) and built-up area (below) estimates in cities, towns and semi-dense and rural areas for 1975 and 2020. Source: Authors of the report, based on the European Commission. Joint Research Centre. (2024).

This framework divides inhabited areas into three categories, namely cities, towns or semi-dense areas, and rural areas, which are defined by UN-Habitat (2024) as follows.

- 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).

- 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 urbanisation, 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.

Cities often use different types of administrative units, which can complicate comparisons across borders. For example, China uses Provinces, Prefectures, Counties and Townships to bin demographic information. One way to standardise population and demographic data is through the use of population grids, as demonstrated in Figure 3.

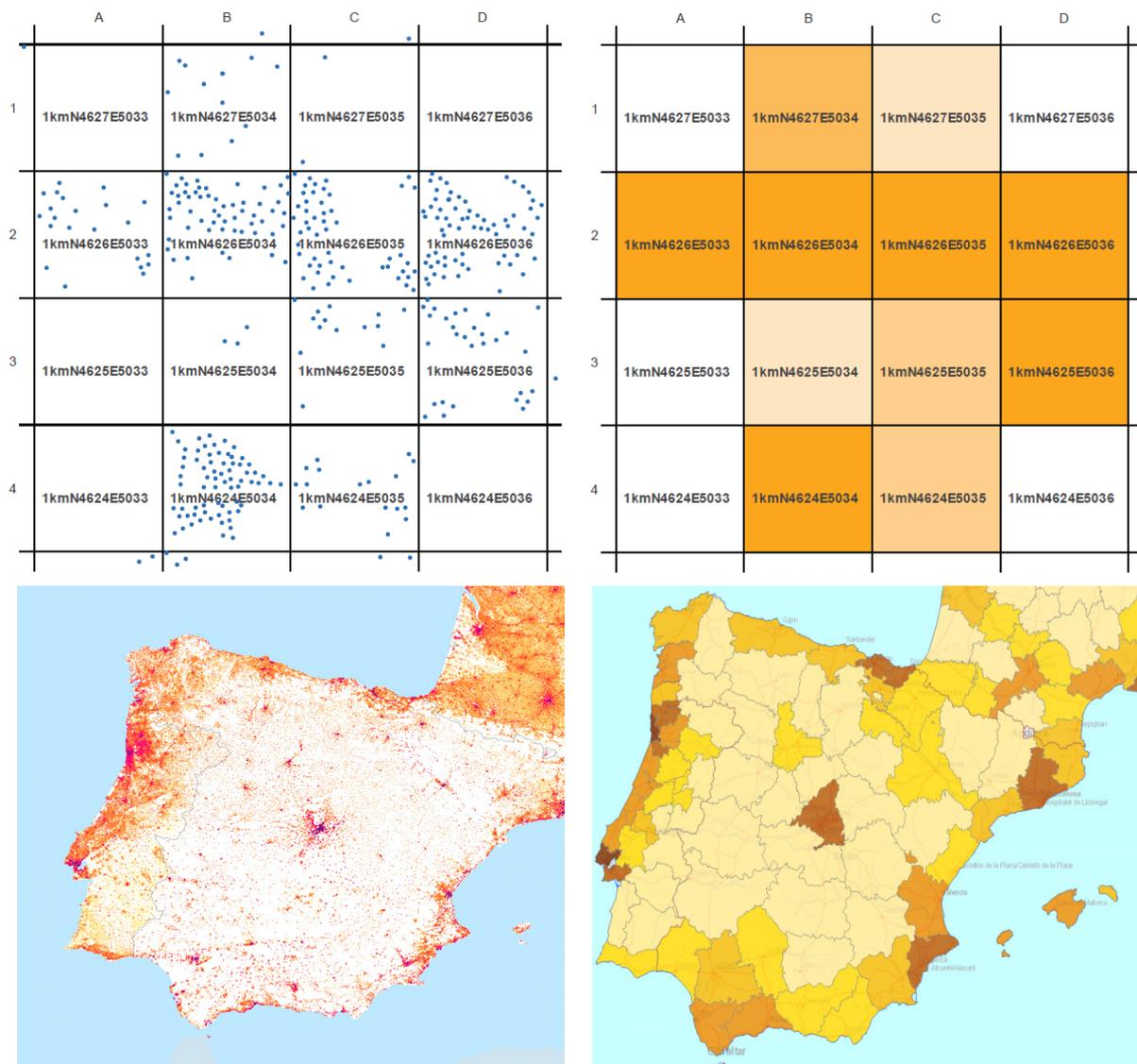


Fig. 3. Upper left: Geocoded population grid (1 km<sup>2</sup>) over point-based population data (codes). Upper right: Population grid shaded according to point locations. Lower left: Population density map of Spain as seen in a 1 km<sup>2</sup> population grid. Lower right: Population density map of Spain as seen at the Province level.

Source: European Commission and Eurostat. (European Commission. Statistical Office of the European Union, 2021), (Eurostat, 2025).

Population grids reduce bias generated by heterogeneous spatial units, guarantee stability through time, integrate easily with other data and allow for different arrays to reflect specific purposes (catchments, metropolitan areas, etc.). More information about the use of grid statistics and guidance on population grids is available at Eurostat (2025) and European Commission Statistical Office of the European Union (2021). The Global Human Settlement Layer Programme collects relevant data on population, built-up areas and other indicators, which is freely available at its [website](#). It is noteworthy to mention that the Global Human Settlement Layer dataset was used in the context of IPCC’s AR6 to estimate baseline exposure of people and built-up areas to climate exposure. Figure 4 illustrates how this data source can be used for the city of Chengdu.



Fig. 4. Population density map of the city of Chengdu and its surroundings in 2020 considering the categories of the degree of urbanisation framework (no contiguity criterion). Grid resolution: 100m2/pixel. OpenStreetMap in the background for spatial reference. Source: Authors of the report. Based on: Schiavina et al. (2023) and OpenStreetMap

### Toolbox for practitioners Researching cities - Networks and institutions



The Urban Climate Change Research Network (UCCRN) at Columbia University and the Beijing City Lab (BCL) are two institutions that research the urban environment and provide very relevant and freely-available resources.

UCCRN is a global consortium of more than 2,000 urban-focused researchers and practitioners representing more than 150 cities worldwide. It provides essential knowledge to urban decision makers, ensuring science-backed policy and practice. Their Assessment Report Series ‘[Climate Change and Cities](#)’ constitutes a robust reference source for practitioners.

BCL offers urban research about the city of Beijing, focusing on spatial planning, urban heat islands, flood management, transportation infrastructure and even the development of a digital twin of Beijing itself. The lab also provides access to [high-resolution data](#) for the city, as well as other cities around the world.

Similar international networks of urban labs that provide data, showcase research projects, and case studies for urban approaches around the globe and are worth highlighting are the [Urban Climate Future Lab](#) and [Climate-Resilient Cities Lab](#)

## 1.3 Urban Climate Action

Cities, which are responsible for more than 70% of global energy-related GHGs, have a high potential for decarbonisation, contributing greatly to global mitigation efforts at relatively smaller geographical scales. With such high potential for both adaptation and mitigation, cities have increasingly taken the lead in urban-level climate policy and diplomacy.

With the presence of numerous educational and financial institutions, cities often have greater capacity, financial resources, and political support than their semi-urban and rural counterparts. As a result, many cities can engage in climate solutions, commitments, and agreements that may even rival their national counterparts. This sub-national action is important, especially when national policies are insufficient or leaders impose roadblocks to decarbonisation.

An example of this city-level leadership was recently illustrated during the period when the United States left the Paris Agreement in 2017. In response, hundreds of cities such as New York, Los Angeles, Chicago, Boston, and Washington DC remained voluntarily committed to the Agreement's goals, implementing local emissions reductions targets. Many of these cities are part of the [Climate Mayors](#) network, a coalition of US mayors representing 46 states and 60 million residents across the country. The network aims to reinforce local climate action and build strong support for national policy through facilitation of intercity cooperation.

Such sub-national engagement with international climate policy is not exclusive to the U.S.. In fact, [C40](#), a global network of almost 100 mayors from cities around the world, has played an critical role in promoting international climate emissions targets. C40 works to facilitate knowledge transfer between cities, scale climate action, and encourage adaptation measures. To standardise and evaluate urban adaptation efforts, the network developed a [framework to monitor, evaluate and report \(MER\)](#), providing an opportunity to understand and measure the success of local actions. In 2021, UN-Habitat, the Global Center on Adaptation (GCA), World Resources Institute (WRI) and Resilient Cities Network came together to initiate the [1000 Cities Adapt Now \(1000CAN\)](#) initiative. The goal of 1000CAN is to amplify climate adaptation in 1,000 cities throughout the coming decade. This will be accomplished through urban water management, Nature-based Solutions, capacity building and knowledge transfer between cities.

### Bottom-up approach: Covenant of Mayors

The Covenant of Mayors (CoM) was first launched as a European-level initiative in 2008, with the goal of bringing together local governments and offering an opportunity for authorities to voluntarily agree to implementing climate and energy objectives based on the pillars of climate mitigation, adaptation, and energy poverty alleviation. The CoM represented the beginning of a bottom-up cooperative network to address energy and climate issues.

Due to its success, in 2015 a [Global Covenant of Mayors](#) was launched to include participation from across the world. Today, the Global Covenant of Mayors includes more than 13,000 cities representing 1.2 billion people across the world.

# 2 Risk Assessment



# 2 Risk Assessment

## 2.1 The Integrated Approach

Risk identification, risk analysis, solution design, and monitoring, evaluation, and learning are elements of an iterative cycle that is critical in addressing urban risks. These 4 stages are described next.

Risk identification entails the determination of specific threats such as floods, heat extremes, or disease outbreaks as well as vulnerabilities, thus informing the process of risk analysis (Keller, Helgeson, and Srikrishnan 2021). Risk identification and management also relies on monitoring, evaluation, and learning information to address any emerging issues.

Risk analysis is a prioritisation tool to determine the dimensions of likelihood and impacts for threats, e.g. “high likelihood, low impact”, or “high likelihood, high impact” etc. (IPCC, 2022).

Based on such an analysis, the phase of solution design involves the development of possible interventions and strategies to address identified risks –especially those categorised as highly probable and damaging. For example, designing greening urban areas to manage water flow and mitigate flood risks (Coger, Corry and Gregorowski, 2021; IPCC, 2022; Krisan, 2022; IISD, 2024a, 2024b).

Monitoring, evaluation, and learning seeks to track outcomes from the implementation of solutions emerging from the previous solution design phase (Noltze et al., 2021). Tracking ensures that the interventions work as intended and that any arising issues are addressed timely. This too can work as an iterative process, where emerging issues can be identified as risks, go through its own risk analysis and eventually lead to new or different solutions. Monitoring, evaluation, and learning is critical for identifying and highlighting what works best within the specific context, thus informing future planning and strategies.

These processes are all interlinked and must be seen as elements of the same iterative cycle. Across all elements, stakeholder engagement and flexibility are important to ensure that the process captures and integrates new inputs. Additionally, it is important to ensure that all elements of the process are resourced.

## 2.2 Risk Identification

### Key Risks to the Urban Environment

Some climate risks are unique to cities. Climate impacts on certain sectors are especially damaging to livelihoods and economic processes, resulting in consequences that are often unaccounted for by traditional risk assessments. These additional risks are called cascading impacts and they amplify the impacts of a hazard through chained interdependencies (Table 1).

Table 1. Examples of climate risks and interdependencies by sector in an urban environment.

Sector	Risk	Interdependencies
Industry	<ul style="list-style-type: none"> <li>Physical damage from extreme weather</li> <li>Reduced labour productivity in extreme heat</li> <li>Supply chain disruptions and reduced availability of raw materials (i.e. timber) due to climate change</li> </ul>	<ul style="list-style-type: none"> <li>Loss of livelihood</li> <li>Reduced economic output</li> </ul>
Housing	<ul style="list-style-type: none"> <li>Physical damage from extreme weather</li> <li>Higher cost of insurance from increased frequency of extreme weather events</li> </ul>	<ul style="list-style-type: none"> <li>Reduced urban population capacity</li> <li>Emergence of informal settlements</li> </ul>
Infrastructure	<ul style="list-style-type: none"> <li>Physical disruptions due to extreme weather</li> <li>Wastewater sanitation disruptions due to fluctuating water resources</li> <li>Failures of roads and train tracks under extreme temperatures</li> </ul>	<ul style="list-style-type: none"> <li>Disruption to essential public services</li> <li>Reduced economic output</li> </ul>
Energy	<ul style="list-style-type: none"> <li>Physical disruption to the energy grid during extreme weather</li> <li>High energy usage for cooling during heat waves</li> <li>Reduced energy output from hydroelectric sources during drought</li> </ul>	<ul style="list-style-type: none"> <li>Disruption of economic and industrial processes</li> <li>Lack of electricity for cooling infrastructure (such as air conditioning) may increase health risks</li> </ul>
Health	<ul style="list-style-type: none"> <li>Extreme heat increases health risks</li> <li>Flooding and sanitation disruptions spread disease</li> </ul>	<ul style="list-style-type: none"> <li>Reduction in urban livability</li> <li>Increase in medical interventions</li> </ul>

Source: Authors of the report.

In addition to cascading impacts, cities may be particularly prone to heightened risk from compound events, that is when two or more concurrent climate hazards interact to exacerbate their individual impacts. These events may have a causal relationship (such as a heat wave causing a drought) or may be randomly linked (a heavy precipitation event followed by drought).

Compound events can also be determined by processes evolving at different time scales. For example, a long-term drought followed by a sudden heavy precipitation event may result in flooding, because the extended dry conditions compacted the soils and made them hydrophobic, reducing their ability to absorb and store water (Barendrecht et al., 2024).

In cities, compound events can emerge from a combination of climate and non-climate factors. Of particular significance in this context is the interlinkages between urban heat and air pollution – both of which pose severe health threats, but their combined effects being even more harmful (Su et al., 2025).

## Drivers of Risk

Cities are engineered spaces. As a human construct, they carry the limitations associated with human institutions. Regardless of their geographical location, historical evolution, affluence, size or quality of

infrastructure, urban areas are complex and interconnected systems with a background of formal and informal institutions that determine their evolution and are constantly interacting. Therefore, besides the climatic risk drivers, the urban environment comes with its own specific pool of non-climatic risk drivers that require attention.

Drivers may be deeply rooted in cultural and historical contexts, which may make their mitigation difficult. For example:

- **Unplanned urbanisation:** Increasing the degree of urbanisation (European Commission. Statistical Office of the European Union., 2021) of an area without adequate provision of goods and services can amplify climate risks – i.e. not allowing adequate mitigation and adaptation measures in high-risk zones (coasts, slopes, floodplains, proximity to volcanoes, earthquake-prone areas). Unplanned urbanisation can become an obstacle to climate protections as well – i.e. urban sprawl decreases the quality of natural elements that contribute to risk mitigation (by changing fundamental hydrology systems for wetlands, mangrove forests, or destroying ecologically sensitive areas, forests, etc.).
- **Governance weaknesses / lack of institutional capacity:** Weak city governance may favour unplanned growth, corruption may compromise the quality of projects and provision of services, and poorly informed policies may result in suboptimal decision-making, all reduce the capacity of cities to adapt to risks.
- **Socioeconomic circumstances:** Excessive economic inequality, precarious access to health, sanitation or transport infrastructure and a marked digital divide may exacerbate the impacts of climate risks.
- **Demographic and population dynamics:** Migration from rural to urban areas, rapid population growth (and increased demand of goods and services) or demographic stagnation and resulting population aging are examples of demographic drivers that can exacerbate climatic risks.

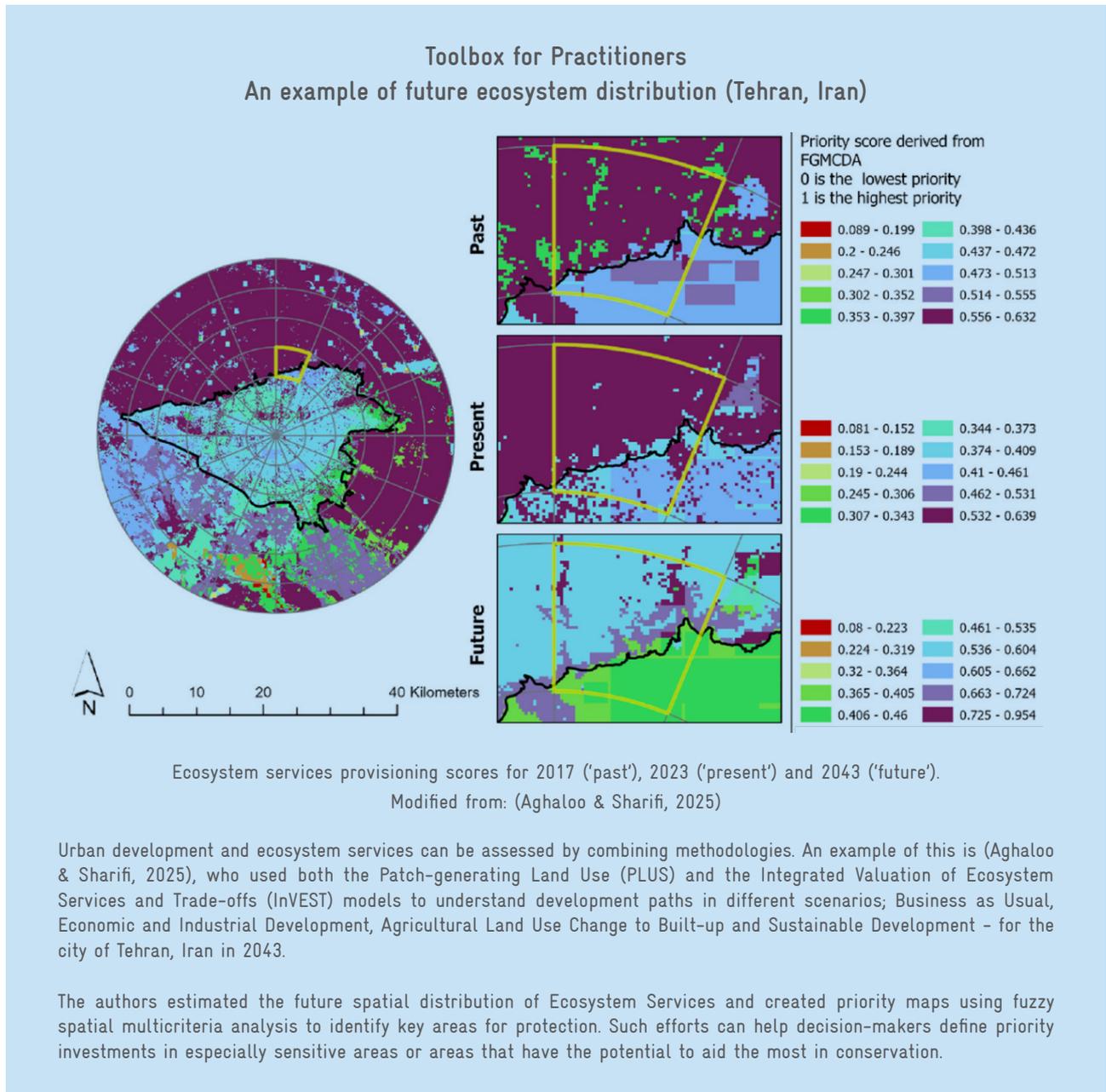
## 2.3 Risks to Ecosystem Services in Urban Areas

### Urbanisation, Land-Use Change, and Ecosystem Services

The glossary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) compiles a list of definitions for the concept of ecosystem services (IPBES, 2025). This includes that of 2021's IPBES Core Glossary, which describes them as “benefits people obtain from ecosystems”. Since these benefits also emerge to different extents and in different magnitudes in urban areas, it can be stated that ecosystem services are present in cities too and are not restricted to the natural environment. Such ecosystem services are provided by natural areas embedded in cities, such as rivers, creeks, wood remnants, wetlands and other potential habitats. Moreover, there are human-made interventions that can replicate similar services, and are usually labeled as Green Infrastructure in the literature. Such services can be understood as risk management elements, acting by decreasing vulnerability and increasing resilience.

Provisioning services, such as food, freshwater and construction materials can be sourced by natural wood remnants, riparian forests, community gardens, green roofs and rainwater harvesting systems. Regulating services, especially those related to the climate such as carbon sequestration, air quality regulation, temperature regulation, stormwater management and others can be enabled by urban trees and parks, permeable surfaces, natural and artificial wetlands and others. Supporting and cultural services like pollination, soil formation, habitat provision, recreation, heritage, sacred spaces preservation and aesthetical value are also provided by some of the elements listed above.

Ecosystem services are closely linked to Land Use and Land Cover (LULC) and therefore, frameworks like the Patch-generating Land Use (PLUS) model, proposed by Liang et al. (2021), are useful to project the condition of future ecosystem services. Liang et al. also present an applied case study in Wuhan. Other aspects, such as quantitative spatial measures of imbalances between supply and demand of ecosystem services and optimisation issues have been explored in a recent scientific publication by Gao et al. (2025), with an applied case in Xiamen, in the Fujian Province.



Ren et al. (2023) estimated future urban land demand based on the LUSD-urban model and assumptions from IPCC's 5 Shared Socioeconomic Pathways (SSP) concluding that global urban area will pass from 280,000 km<sup>2</sup> in 2016 to 490,000 km<sup>2</sup> in 2050. According to the authors, this loss would decrease between 110,000 to 190,000 km<sup>2</sup> of natural habitats globally and compromise global targets under the 2050 Biodiversity Conservation Goals in 310 out of the 825 terrestrial ecoregions.

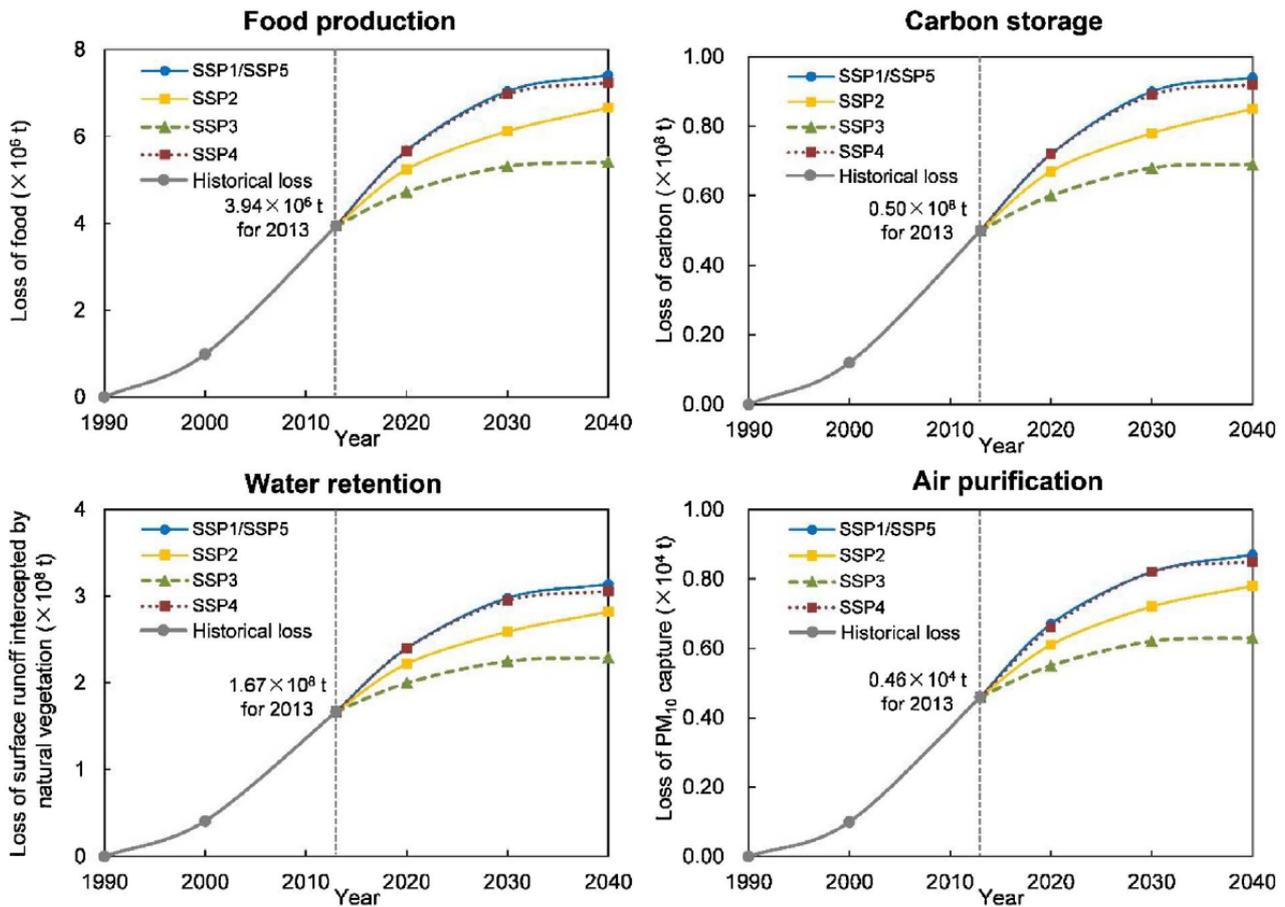


Fig. 5. Ecosystem service losses estimated between 2013 and 2040 under different SSPs.

Source: D. Zhang et al. (2017)

Along with loss or degradation of natural habitats, all SSPs project decreases in ecosystem services provisioning. However, since these are complex multifactorial processes, the magnitude of such reductions is difficult to predict. A notable effort in estimating it was conducted by D. Zhang et al. (2017), who estimated in their study the impacts of urban expansion on ecosystem services for the Beijing-Tianjin-Hebei (BTH) urban agglomeration. They calculated an increase from 7605 km<sup>2</sup> to at least 9402 km<sup>2</sup> and at most 11936 km<sup>2</sup> between 2013 and 2040. Using a similar methodology as Ren et al. (2023) (see figure 6), they estimated the following decreases in four ecosystem services: food production (1.34%-3.16%), carbon storage (0.68%-1.60%), water retention (0.80%-1.89%) and air purification (0.37%-0.87%) respectively (see Figure 5).

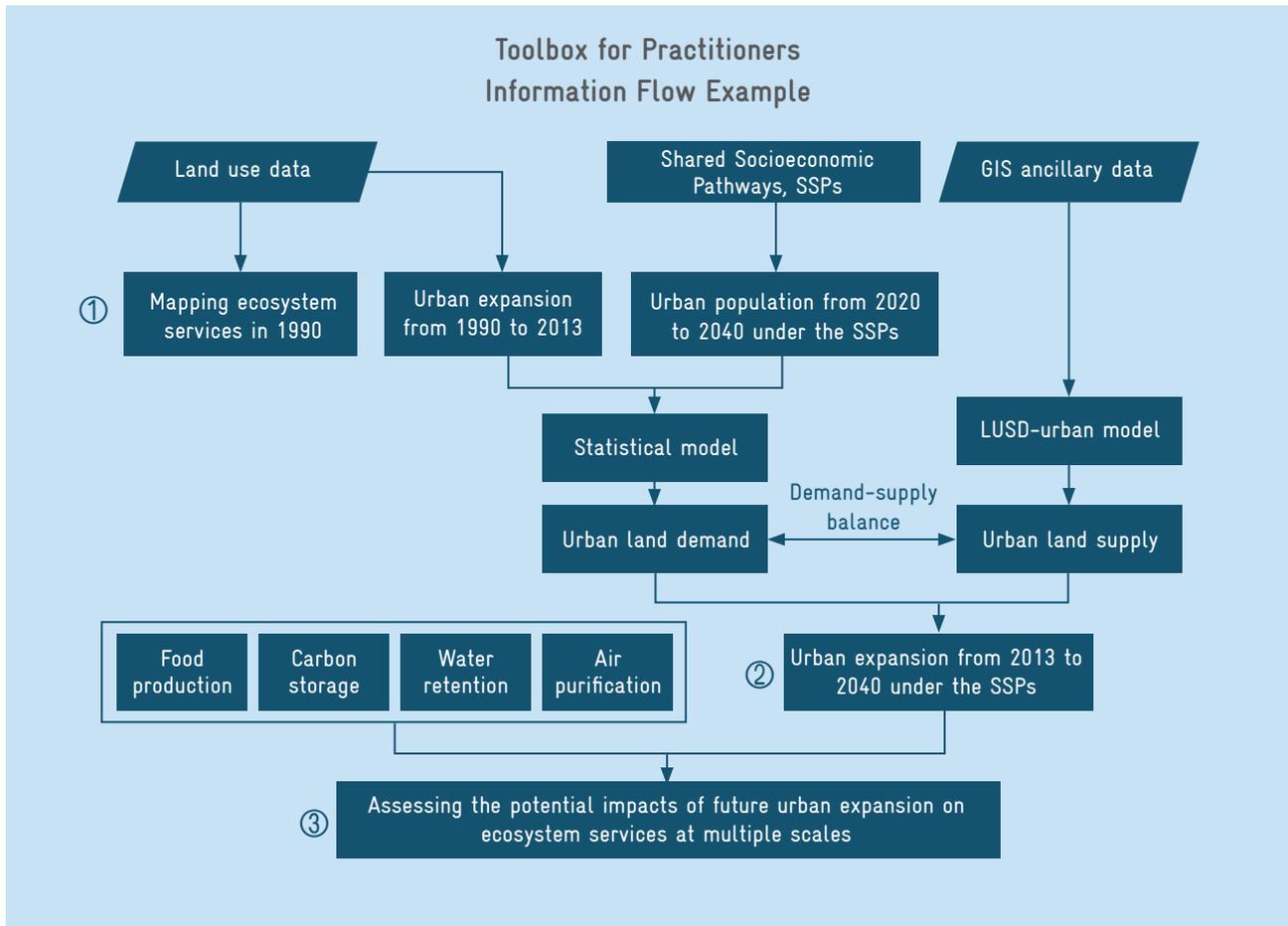


Fig. 6 Integrated Assessment Frameworks like the one represented in the flowchart in Ren et al. (2023), help estimating potential future environmental impacts of urban expansion. Inputs such as land use data, ecosystems services mapping, historical demographic data, future pathway scenarios and land use models are key to provide useful insights.

## 2.4 Risk Assessment in the Urban Environment

There are several examples of local authorities and regional organisations assessing different urban environments to deliver context-sensitive diagnostics, model future scenarios, and propose tailored recommendations. Some have developed overarching methodologies and conceptual frameworks for the study of climate–urban dynamics. As climate change hazards and risks grow, Climate Risk Assessments (CRAs) at the municipal level are gaining popularity among decision-makers.

CRAs add value by providing systematic foundations for targeted and planned decision-making that increases resilience to climate change. Such cross-sectoral analyses help identify areas that create synergies on planning and adaptation (see figure 7).

The German Environmental Agency ([Umweltbundesamt](https://www.umweltbundesamt.de)) issued a report in 2022 with recommendations for implementing CRAs (Porst et al., 2022). The report guides the CRA process into three stages (preparation, implementation and communication) and recommends steps to perform a successful CRA (Figure 7). Although there are many frameworks that can be used, this one is particularly useful for local authorities, due to its orientation towards the fulfilment of the International Standard on Adaptation to Climate Change (ISO 14091:2021).

Toolbox for practitioners		
Stage 1. CRA Preparation		
Step 1. Identify objectives and expected outcomes	Step 2. Evaluation of the situation	Step 3. Establish a project team and determine cooperation methods
Step 4. Determine the scope and methodology		Step 5. Preparing an implementation plan
Stage 2. CRA Implementation		
Step 1. Screen and identify impacts	Step 2. Develop impact chains	Step 3. Compile data and identify indicators
Step 4. Analyse and evaluate climate change effects	Step 5. Analyse and assess adaptive capacity	Step 6. Interpret and evaluate findings
Stage 3. Communicating climate risk assessment results		
Step 1. Gather key findings and messages		Step 2. Communicate results to specific target groups

Fig. 7 Stages and steps to perform a successful Climate Risk Assessment (CRA)  
 Source: Authors of the report with information from Porst, L. et al. (2022)

Several schemes aid cities, especially in the Global South, with their adaptation efforts. Examples include the Urban Climate Action Plan (UCAP), a programme by the Government of the United Kingdom and the C40 Cities Climate Leadership Group. Between 2018 to 2021, the German Development Agency (GIZ) supported cities in Africa, Asia and Latin America through funds from C40 Cities, the Department of Business, Energy and Industrial Strategy (BEIS) of the United Kingdom and the Commonwealth and Development Office (FCDO) (C40 Cities, 2025) (Government of the United Kingdom, 2021).

The city of Salisbury, Australia (a local suburb north of Adelaide, South Australia) finalised its Climate Risk Assessment in 2024. The report issued by the local authority in accordance with both the City Plan 2035 and the Sustainability Strategy 2035 identified 53 high-level risks, which were assessed against three future time horizons: 2030, 2050, and 2090. These were in turn defined by the concept of decision lifetime, referring to the timespan for which the effects of a decision are felt (Climate Cavalry, 2024).

The concept of decision lifetime is particularly useful in planning and it also reflects the systemic and complex nature of the urban environment, in which agents can take individual and collective decisions depending on their preferences and capacity for short- and long-term planning, which can be either fostered or hindered by the institutional framework surrounding them (see figure 8).



Fig. 8. Decision lifetimes in years for different actions in the urban environment.  
 Source: Modified from Climate Cavalry (2024)

In this methodology, each risk is classified as acute (short-term and extreme), chronic (long-term change), liability (sources of responsibility, e.g.: penalties, litigation, compliance) or transitional (policy changes, technological innovation or social changes) and the consequences associated are rated from low, medium, high and very high or not relevant for each decision lifetime.

Another relevant and recent example is that of Quezon City, in the Philippines. Its Climate Risk Assessment Report, dated 2022, contains a thorough review of climate change hazards with both baseline data and projections as well as specific sections for landslide, earthquake and flood hazards. Based on return periods of the latter and RCPs, it contains estimations of displaced population affected buildings and health and emergency-related, security and safety-related facilities and transport infrastructure impairment per each district of the city as well as land uses (EMI & Quezon City, 2022), offering detailed and useful information for decision-makers. The extensive use of geographic information is another strength of this report.

More comprehensive versions of these reports, called Rapid Climate Risk Assessments (RCRA) for urban adaptation and resilience have been conducted by the Global Center on Adaptation for cities like Nairobi and Kisumu in Kenya; Djibouti City, Djibouti; Marrakech, Morocco and others (Global Center on Adaptation, 2025).

## 2.5 Risk Assessment Methods

Risk assessments draw upon and synthesise different types of data in order to quantify risk, incorporating vulnerability, exposure, and hazard. A variety of qualitative and quantitative methodologies can be used and integrated, enhancing the reliability and complexity of the assessment.

### I. Qualitative Methods

Qualitative approaches incorporate diverse stakeholder and sectoral input, and consideration of theoretical and conceptual implications and interactions. They also help frame narratives or stories around issues such as the key risks being experienced thus unpacking quantitative data and in some cases provide a basis for further quantitative analysis. Such elements may be difficult to capture with just quantitative data alone. Some examples of qualitative approaches are briefly highlighted below:

- **Case studies** provide examples of real-world impacts in specific contexts, sectors, and locations. Case studies can highlight particular vulnerabilities and weaknesses that contribute to heightened risk. One example of a case study that is widely used as the basis for risk assessment was the [2003 French heatwave](#), which broke records and led to thousands of deaths. A key benefit of case studies is that instead of describing theoretical risk, they highlight tangible stories that are easily communicated to the public, potentially increasing general awareness and participation.
- **Focus groups** involving a wide range of stakeholders, community leaders, and experts can help to provide insight into particular climate risks, highlighting vulnerabilities, observations, differentiated and gender disaggregated outlooks and human behavior patterns that are otherwise difficult to obtain. This approach helps to ground risk in a local context, ensuring that solutions are appropriate and co-owned by the population. In cities, focus groups can target specific neighborhoods to better understand how risk varies across the urban landscape. In the United States, the Delaware Valley Regional Planning Commission utilised focus groups to understand the effects of climate change from different communities. These inputs were used to help develop the [Comprehensive Climate Action Plan](#) for the region.

- **Self-assessments and risk classification** encourage sectoral experts, decision makers, and researchers to reflect on worst-case scenarios, impacts, and outcomes. These approaches allow for climate risk researchers to standardise research through predetermined investigative questions while obtaining expert insight. The World Bank provides a free interactive [Assessment Tool](#), which can be filled out by practitioners to create a custom risk report.

Qualitative approaches, which categorise, rank, contextualise, and translate risk can also be useful in policy planning and advocacy. These are sometimes integrated with values and referred to as semi-quantitative (see figure 9).

	Consequence				
Likelihood	Negligible	Minor	Moderate	Major	Extreme
Highly likely	moderate	high	extreme	extreme	extreme
Probable	moderate	high	high	extreme	extreme
Possible	low	moderate	high	high	extreme
Unlikely	low	moderate	moderate	high	high
Very rare	low	low	low	moderate	moderate

Fig. 9. A likelihood and consequence matrix to effectively translate and communicate theoretical risk.

Source: Authors of the report

## II. Quantitative Methods

Quantitative approaches to risk assessment integrate scientific and systematic approaches in order to quantify climate risks. The provision of concrete values can help support broader narratives and determine key thresholds for adaptation goals. Typically quantitative analysis builds upon previous literature and existing data sources. We provide some examples of quantitative methods and associated tools below.

- **Geospatial analysis** highlights risk variation across space. It plays an important role in identifying regions and systems that are of increased vulnerability. In urban areas, quantifying spatial analysis can highlight areas of high vulnerability or exposure of human populations, infrastructure and ecosystems leading to better decision making with local stakeholders. An example of a tool that can be used for this in urban areas is the [Global Human Settlement Urban Centre Database](#). (UN Habitat, 2024)
- **Scenario analysis** considers how different actions and decisions will manifest over time. This approach considers how risk may vary in the future based on different scenarios. While scenarios are not exact predictions of the future, they represent distinct possibilities that may alter key outcomes. The IPCC's 6th assessment report scenarios based on SSPs can be used to generate information for urban areas. The IPCC's [working group I \(WGI\) Interactive Atlas](#) is a useful tool to understand these different scenarios. The Climate Risk Dashboard also demonstrates this capability in its '[avoiding future impacts](#)' mode, with a variety of indicators and impact thresholds, allowing decisionmakers to better link emissions and impacts.
- **Vulnerability index assessments** work by establishing a given system, geography, or sector and selecting a variety of relevant indicators as proxies for vulnerability level. These indicators are then

normalised based on available data and aggregated to provide a score or average. Results can then be mapped across space or ranked according to vulnerability level. This approach is especially useful in identifying policy interventions for at-risk groups and regions. The [LGCCS Vulnerability Assessment Tool](#) is an example of a vulnerability assessment tool that can be used by municipalities and other urban authorities.

### III. Multi-Hazard Analysis

With increasing climatic change, multiple interacting and co-occurring hazards are becoming more common, resulting in more extreme impacts. Climate risk assessments are increasingly moving from single-hazard to multi-hazard analysis. However, interactions between hazards are still poorly understood and difficult to model. Multiple hazards may interact positively, exacerbating impacts and leading to non-linear responses. To complicate this, multiple hazards may affect risk on different spatial and temporal scales, with impacts distributed across space and time.

To model multi-hazard risk, one should first consider the relationship between hazards (i.e. does one event trigger another, intensify its effects, or merely coincide?). In the case of simultaneous but independent events, there is no causality, but there may still be increased risk. For example, a flood and a heat wave may occur simultaneously by chance, but will result in worsened impacts on local populations, biodiversity, and infrastructure compared to only a single hazard occurrence. A good starting point in understanding multiple hazards is the review of case studies and historical records of other regions where multiple hazards have already been studied.

### IV. Attribution Science

Climate change attribution is a growing scientific field crucial for policymaking and climate litigation. It helps address key challenges that hinder climate action:

- Global dispersion (emissions affect the planet beyond their origin)
- Agency fragmentation (dispersed stakeholders with coordination barriers)
- Institutional inadequacy (limited jurisdiction, enforcement, or resources)
- Temporal delay (delayed impacts reduce urgency and psychological proximity)

Attribution science links human-induced climate change to extreme weather or long-term trends by comparing climate model simulations with and without anthropogenic greenhouse gas emissions. These comparisons help estimating changes in environmental conditions, including the likelihood and intensity of extreme events.

The findings support decision-making, enabling targeted mitigation policies, and play a key role in climate litigation by establishing causality, harm, and liability for damages. However, attribution studies carry model-based uncertainties, which must be transparently reported.

Organizations like the [World Weather Attribution](#) regularly publish peer-reviewed analyses of extreme weather events and their links to climate change, helping quantify the estimated role of anthropogenic influence in such occurrences.

## V. Uncertainty

Some level of uncertainty in climate risk assessment is inevitable, especially when considering future impacts of climate change. Whether it be uncertainty in observational data, or the inherent uncertainty associated with modelling complex processes, unknowns can be reduced but never eliminated.

In order to address uncertainty in a systematic way, the IPCC AR6 follows a framework of assessing available evidence, evaluating confidence based on agreement and evidence type, and translating quantitative results into likelihood thresholds. The full overview of this framework can be seen in Figure 10. While this process may be overly-comprehensive and impractical for contexts with limited research or data, it provides the basis for a standardised approach to uncertainty assessment. The representation of uncertainty by categories, thresholds, and probabilities is a useful way to communicate findings in a consistent and easily-understood manner.

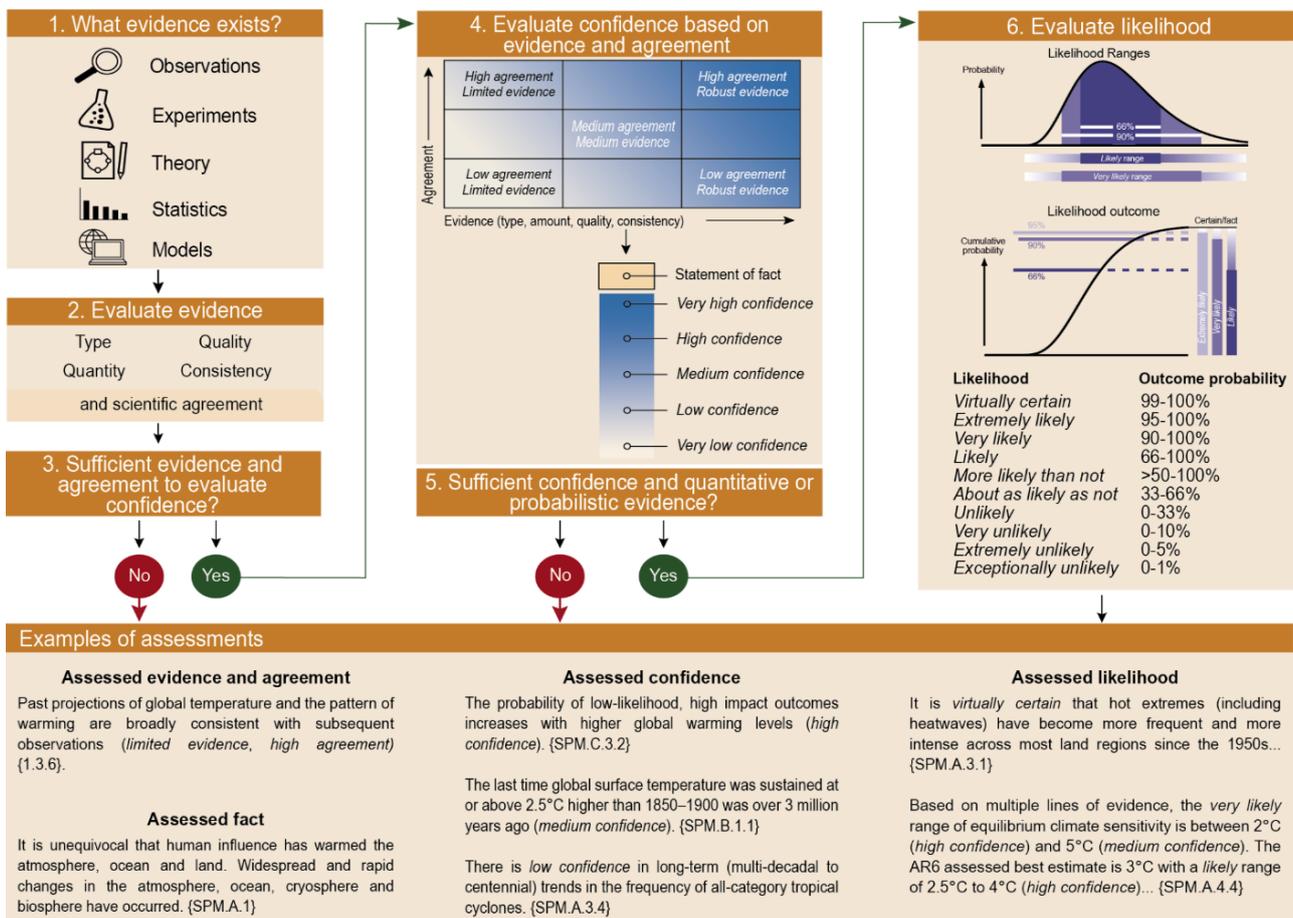


Fig. 10. Evaluation and communication of degree of certainty in AR6 findings

Source: IPCC, 2021

When assessing future risks, it is important to not only communicate uncertainty along with results, but to highlight the significance of it for policy and adaptation. Often, results will be associated with moderate-to-high levels of uncertainty. Here, it is useful to consider the role of effective science communication in transmitting information to non-climate experts. Particularly when discussing high-impact future trends, the mention of uncertainty can sometimes cause stakeholders to undermine potential impacts, interpreting uncertainty as limited impacts. On the other hand, uncertainty may also confer alarm at the possibility that a given risk is more severe than expected, occurs more frequently, or that an unexpected risk may evolve.

In such a context, high uncertainty may be a risk. Fundamentally, risk assessments should highlight that uncertainty is never a reason for inaction.

## VI. Integrating Methods

Regardless of the methodology used, risk assessment is best done with a variety of data, tools, and methods to understand a fuller picture of the future. Often, multiple tools and approaches are used for multi-hazard analysis and the attribution of extreme events in urban areas. Figure 11 provides a summary of how to determine methodology for risk assessment in urban areas.

Determining Methodology		
<p>Considerations:</p> <ul style="list-style-type: none"> <li>• Is sufficient quantitative data available?</li> <li>• What is the end goal of the assessment (policy, litigation, communication)?</li> <li>• What technical infrastructure and expertise is available?</li> </ul>		
<p><b>Method:</b></p> <ul style="list-style-type: none"> <li>Case study</li> <li>Focus group</li> <li>Self assessment</li> <li>Geospatial analysis</li> <li>Scenario analysis</li> <li>Vulnerability index</li> <li>Multi-hazard</li> <li>Attribution</li> </ul>	<p><b>Type:</b></p> <ul style="list-style-type: none"> <li>qualitative</li> <li>qualitative</li> <li>qualitative</li> <li>quantitative</li> <li>quantitative</li> <li>quantitative</li> <li>both</li> <li>quantitative</li> </ul>	<p><b>Use Benefit:</b></p> <ul style="list-style-type: none"> <li>Useful for public dissemination</li> <li>Insight from various interest groups</li> <li>Encourages expert reflection</li> <li>Considers risk variation across space</li> <li>Policy-relevant, mitigation focused</li> <li>Highlights at-risk groups</li> <li>Highlights relationships between hazards</li> <li>Establishes liability, relevant for litigation</li> </ul>

Fig. 11. Determining methodology for risk assessment in urban areas

Source: Authors of the report

# 3 Adaptation Strategies and Solutions



# 3 Adaptation Strategies and Solutions

Climate risk assessments identify and quantify emergent impacts of climate change, paving the way for solutions to reduce impacts. When determining which solutions to pursue, it is preferable to prioritise solutions that combine mitigation and adaptation, are low cost and highly effective, and offer various co-benefits to society.

Here we highlight three major types of solutions that are particularly relevant for the urban context. These include urban Nature-based Solutions, social adaptation, and technological approaches. While there are many other types of solutions, these examples were chosen because they represent a diverse range of sectors, and offer multiple co-benefits.

## 3.1 Nature-based Solutions (NbS)

NbS are “actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits” (IUCN, International Union for Conservation of Nature, 2020). They have the potential to help urban regions adapt to climate hazards such as heat stress and flooding, and to promote a host of co-benefits for humans and nature, making cities healthier, livable, and biodiversity-friendly.

The IUCN, in its “Global Standard for Nature-based Solutions”, lists eight criteria for the design and implementation of nature-based solutions (IUCN, 2020). The standard is aimed at both the public and private sectors and it is meant to be applied at all scales. Criterion 2 highlights the importance of a scale-informed design, which is particularly relevant to the urban environment. It entails three indicators namely:

- A design that recognises and responds to the interactions between economy, society and ecosystems.
- A design integrated with complementary interventions seeking cross-sectoral synergies.
- A design that incorporates risk identification and management beyond the intervention site.

Examples of urban-scale NbS typologies are green infrastructure (e.g. urban tree planting, construction of rain gardens and bioswales and green roofs), ecosystem restoration (e.g. urban wetlands restoration, establishment of ecological corridors and riparian buffer zones, mangrove restoration) and sustainable management (e.g. natural drainage pattern restoration, urban forest conservation).

## Toolbox for Practitioners

### Self-Assessment for Nature-based Solutions

IUCN's Online Self-Assessment Tool for Nature-Based Solutions allows users to evaluate the alignment of specific projects with IUCN's Standard, including the eight criteria and their individual indicators.

Criterion	Criterion Score	Maximum Criterion Score	Normalized Criterion	Final Output
1. Societal challenges	4	9	0.44	44
2. Design at scale	4	9	0.44	44
3. Biodiversity net-gain	2	12	0.17	17
4. Economic feasibility	5	12	0.42	42
5. Inclusive governance	5	15	0.33	33
6. Balance trade-offs	2	9	0.22	22
7. Adaptive management	3	9	0.33	33
8. Sustainability and mainstreaming	4	9	0.44	44
<b>Total</b>				<b>40</b>
Key				Output
	4	≥75%	Strong	Intervention adheres to the IUCN Global Standard for NbS
	3	≥50% and <75%	Adequate	
	2	≥25% and <50%	Partial	
	1	<25%	Insufficient	Intervention does not adhere to the IUCN Global Standard for NbS

This is a free tool that requires registration.

Example results from an assessment conducted by Le Gouvello et al. (2023)

## Urban Green Infrastructure

Since cities represent highly built-up areas with reduced vegetation cover, the reintroduction and protection of healthy plant life is a promising nature-based solution to promote sustainable and adapted cities. Unlike in their rural counterparts, urban areas have limited resources and space available for greenery. As a result, careful planning and connection of different urban habitats and settings becomes important. Urban Green Infrastructure refers to networks of interconnected green spaces such as parks, green roofs, urban gardens, and green corridors that are embedded within the urban fabric of the city. While these green spaces may be comparatively small as compared to natural reserves and protected areas outside of the city, their connectivity and multifunctionality can provide significant benefits to biodiversity, human health, and climate adaptation.

Naturally, urban green infrastructure can exist on different scales with varying levels of benefits. For example, at the individual-level, interventions such as green roofs and green walls (also called living walls) may provide energy savings and protection against noise pollution, while providing cooling and aesthetic benefits to residents. One study found that in Mediterranean climate zones, green walls could reduce summer surface temperatures by up to 16° C (Koch et al., 2020). However, the efficacy of green walls may depend on climate region, building orientation, sun exposure, and plant variety (Cardinali et al., 2023). There is also some evidence that green walls and roofs can reduce particulate matter and gaseous pollutants from the air. In some cases, PM2.5 [reductions](#) were found to range from 25% up to 99% (Cardinali et al., 2023).

Similarly, individual and small-scale interventions, such as planting trees near buildings for shade, or installing urban gardens can offer unique benefits particularly to building owners and nearby residents. In fact, the direct benefits for urban tree planting can be quantified utilising information such as tree type, proximity to building, tree age, and geographical location. The [MyTree](#) tool is a free web-based platform, developed by the United States Forest Service (USFS), which estimates the financial and health impacts of individual trees over a 20 year timespan.

While these individual interventions may confer benefits to property owners and can be easily incentivised through subsidies, energy rebates, and building codes, they should also be seen as part of a larger and interconnected network of greenery across the urban environment. On a larger scale, urban governments will likely need to also establish city-wide approaches, involving public parks and urban forests.

### Case Study: Green Corridors in Medellín

In order to combat a strong urban heat island effect, the city of Medellín, Colombia, created a series of 30 green corridors, interconnecting dense green spaces throughout the urban environment. The \$16.3 million initiative has planted 8,800 trees and 90,000 species of plants over 65 hectares. The city involved residents in the process by training and hiring 75 citizens from disadvantaged backgrounds to plant and maintain the corridors, offering them full-time and permanent employment. A unique approach of the plan was to specifically target high-pollution areas for planting. The approach has been widely hailed as a success story due to the social, health, and environmental benefits of the initiative. In fact, the urban heat island effect has already been reduced by 2°C and officials expect an additional 4–5°C decrease in the next 30 years.



Source: C40 Cities

## Urban Blue Infrastructure

Urban Blue Infrastructure refers to networks of waterways, wetlands, drainage and retention ponds throughout the city. Similar to urban green infrastructure, the presence of water bodies in urban areas may alleviate heat stress and provide significant cooling in addition to reducing urban flooding (Veerkamp et al., 2021). A study in Sheffield, UK found that an urban lake had a daytime mean cooling effect of 1.5° C in the spring (Hathway & Sharples, 2012), while a meta-analysis of urban cooling options found urban wetlands to be one of the most efficient approaches, with ambient temperature changes of  $4.9 \pm 3.2^{\circ}\text{C}$  (Kumar et al., 2024) (see figure 12).

This cooling is largely due to the physical qualities of water, such as its ability to retain heat and evaporative cooling potential. However, these properties may conversely pose important challenges to the desired cooling effects. For example, water bodies often release their stored daytime heat during the night, potentially leading to increased nighttime heat stress. Additionally, the presence of water may increase local humidity, which can exacerbate heat stress. A study of two subtropical Chinese cities found that while urban lakes effectively reduced daytime urban heat, they worsened nighttime heat stress through heat radiation and humidity (Yao et al., 2023). The authors also found that weather patterns affected the efficacy of the measures, and that urban blue infrastructure may be less effective as a cooling measure in subtropical climate types. Some evidence even suggests that the size and shape of water bodies may affect their cooling potential, with rounder water bodies preferable in places of evenly distributed wind, and more elongated shapes in cases of uniform unidirectional wind (Ampatzidis & Kershaw, 2020).

### Best Practice

Test the cooling effectiveness of Urban Blue Infrastructure considering seasonal fluctuations, humidity, and nighttime heat radiation before implementing large-scale measures. Approaches can include urban modelling or case studies of existing water bodies in cities with similar morphology and climate types.

Despite these important caveats, urban blue infrastructure can play an important role in cooling the city if implemented in the proper contexts and locations. Often, urban blue and green infrastructure are considered as combined solutions, especially since they can mutually benefit each other. For example, green ‘buffer zones’ between the urban environment and waterways can help filter out pollution leaching from streets and roads. There is still important research needed on the combined and interactive effects of heat-stress reduction of urban blue-green infrastructure, but existing evidence points to high potential.

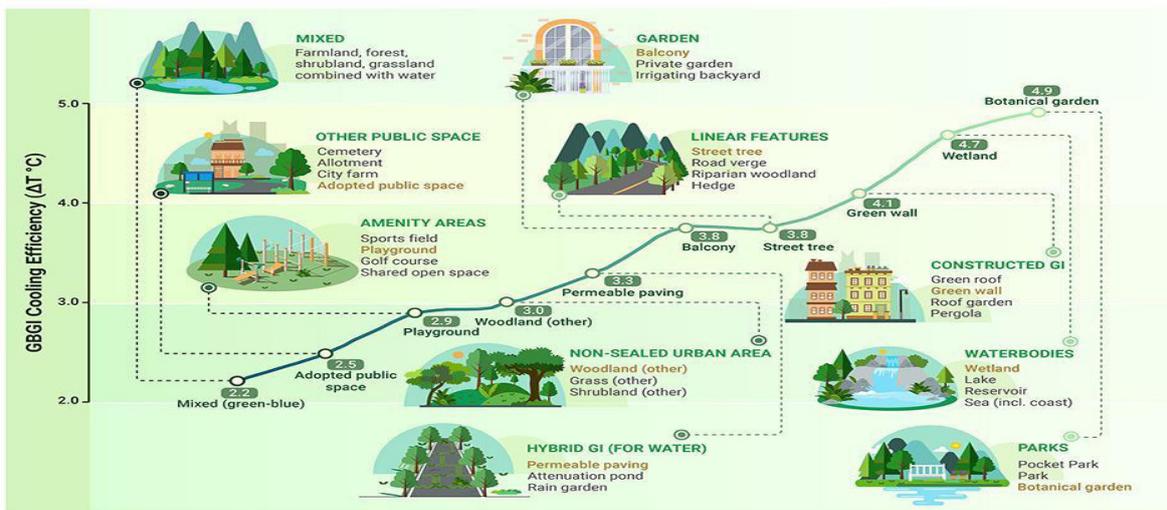


Figure 12. Assessment of green and blue infrastructure effectiveness on urban heat mitigation, showing botanical gardens, wetlands, and green walls as the most effective solutions.

Source: Kumar et al. (2024)

## Toolbox for Practitioners

### Nature-based Solutions

<p><b>Benefits:</b></p> <p>Relatively low cost, co-benefits for nature and society, increase liveability</p>	<p><b>Considerations:</b></p> <p>Understanding of local ecology, climate, and seasonality required for successful implementation</p>	<p><b>Policy Opportunities:</b></p> <p>Energy rebates, construction codes, public health, water management, urban forestry, public works</p>
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**Guiding Frameworks:**

[IUCN Global Standard for Nature-based Solutions](#)

**Supporting Tools and Data:**

[Nature-based Solutions Evidence Platform](#) – compare Nbs effectiveness and options

[MyTree](#) – discover the future benefits of individual trees

[LIFE @ Urban Roof Calculation Tool](#) – optimise costs and benefits of a multi-functional roof

**Communities of Practice:**

[NetworkNature](#)

[CitiesWithNature](#)

[UrbanByNature](#)

[IUCN](#)

## 3.2 Social Adaptation

As areas of high population density, cities must consider the social component of climate adaptation. While the sheer number of people in cities represents a high exposure to climate hazards, there are also specific demographics with unique vulnerability to climate change, thereby increasing risk even more. Social adaptation entails understanding how communities will be impacted by climate change, and determining which solutions can ensure just and equitable outcomes. Awareness, identification, and involvement of groups that are highly exposed or vulnerable to climate risk is an important approach to improving the adaptation of the city as a whole.

### Urban Heat Vulnerability Indexes

Heat stress is the leading cause of weather-related deaths and can exacerbate underlying cardiovascular and respiratory conditions, diabetes, psychiatric conditions, and can induce heat stroke, pregnancy complications, and occupational accidents (Heat and Health, WHO 2024). Due to climate change, the population exposed to extreme heat is increasing around the world, with heat-related mortality being highest on the continents of Asia and Europe (Zhao et al., 2021). Cities typically experience higher temperatures as compared to their rural counterparts, due to the urban heat island effect, caused by human heat generation and the high buildup of impervious and low-albedo surfaces that absorb and retain heat.

The confluence of increased urbanisation and climate change has led to cities being at the forefront of heat stress, posing a unique hazard at the urban-level. To complicate this, variation in demographics, urban morphology, and proximity to social services creates intra-city variation, with neighborhoods varying in their vulnerability level to urban heat (Derakhshan et al., 2024). While city centers typically have the highest levels of heat stress, vulnerability depends on a host of social, physical and economic factors. One study found that vulnerability in low-vegetation residential neighborhoods of Moscow were 6 times higher than in the urban center (Shartova et al., 2024).

To understand how vulnerability varies across a landscape of varying demographics, urban development, socioeconomic factors, and microclimates, many regions have developed urban heat vulnerability indexes. These indices combine multiple data points and indicators, such as percentage of the population above 65 years old, prevalence of underlying disease, average distance to cooling centers and hospitals, and vegetation prevalence. These factors can then be standardised to produce a score, allowing urban officials to locate regions of high vulnerability and assess intervention options.

In New York City, USA, an interactive index combining surface temperature, air conditioning usage, green space coverage and median income is made available on the [Environment & Health Data Portal](#). The index indicates which neighborhoods have low or high risk of heat vulnerability. This data can be used to inform interventions in public health, environmental quality, and planning.

On a larger scale, urban vulnerability indexes can be used to compare multiple cities within a country or region. The [European Environment Agency's Urban Adaptation Map Viewer](#) (see Figure 13) provides users the ability to compare urban heat, health, and energy usage data across European cities. This provides a unique opportunity to understand current and future urban heat projections between cities with different climate types and policies.

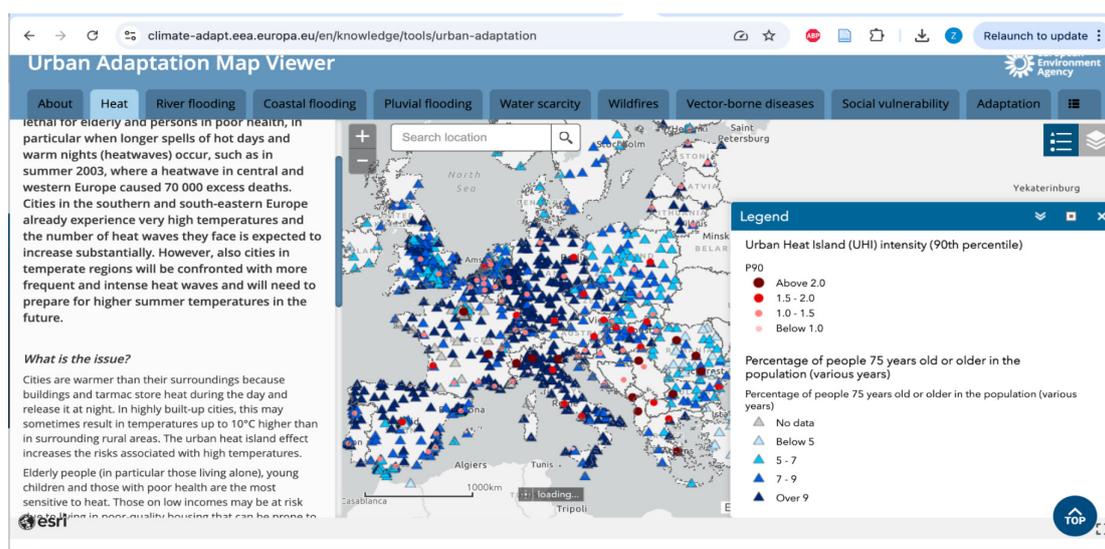


Figure 13. The Urban Adaptation Map Viewer provides urban heat and population vulnerability data for many different European cities.  
Source: European Environment Agency (2025)

## Housing and Settlements

By understanding the factors that contribute to vulnerability within a city, officials can begin to develop targeted interventions. One key area for interventions is the improvement of urban living conditions. For many of the urban areas of the world, informal settlements and slums comprise a large component of the urban population. Additionally, as migration into cities increases (often from rural areas), there are growing populations with lower socioeconomic backgrounds and opportunities that end up living in unsafe and precarious conditions. As a result, improving conditions for the poorest and most vulnerable populations is an important way to enhance overall adaptation.

### Best Practice

Improving conditions for vulnerable residents can reduce overall climate risk, while simultaneously advancing on Sustainable Development Goals. Work with, not against, the residents of slums and informal settlements, and actively involve them in urban decision making, planning, and slum upgrading.

Those living in slums and informal settlements are some of the most vulnerable to climate change (Núñez Collado & Wang, 2020). Policy and economic interventions addressing living standards and sustainable development in slums, can significantly reduce a population's exposure to climate risk, while contributing to local climate adaptation and mitigation. In Latin America, where long-term urbanisation has created vast slum areas, the concept of 'slum upgrading' has been a popular and successful narrative framework to improve socioeconomic conditions for the urban poor. Slum upgrading relies on a series of principles such as improving infrastructure and providing long-term housing, while increasing connectivity of the slum-dwelling population with the rest of the city (Núñez Collado & Wang, 2020). These principles often require multi-pronged efforts and long-term coordination with the local city government.

## Case study: Social Housing in the Philippines

Approximately 4.5 million residents of the Philippines are either homeless or live in informal settlements. In Quezon City (part of Metropolitan Manila) the most populous city of the Philippines, many of these informally settled people lived in high risk areas, near flood-prone waterways. The city worked to solve this issue by implementing a socialised housing program aimed at reducing slum-dwellings and providing better, safer options for residents.

As a result of multi-stakeholder and multi-sectoral governance, the city was able to establish a project that included private developers, local governments, local NGOs, and international capacity building organisations. The city quickly built thousands of homes, all adhering to green building codes and indoor air quality standards, with at least 30% of the land used set aside for parks, community facilities, or public gardens.

The program successfully relocated 5,698 families from informal slums into permanent housing. The project's integration of social, economic, and environmental considerations provided a host of co-benefits. By locating the social housing projects near public transportation routes, schools, and workplaces, more families have access to social services, education, and economic opportunities. Additionally, the new housing developments provide sanitation services, better air quality, and reduced flood exposure. With a reduction in settlements along waterways, the city was able to increase flooding resilience by restoring rivers and removing debris.

Quezon City implemented urban policies such as the 'Socialized Housing Tax Ordinance' and the landmark 'Comprehensive Socialized Housing Code'. The local city government helped fund and support the program, while providing families with three different financing options based on their income level. As a result of the program, Quezon City was able to advance city-wide flood management, while promoting social benefits and economic stability for its poorest residents.



Source: C40 Cities

### Toolbox for Practitioners Social Adaptation

**Benefits:**  
Co-benefits for local development, socioeconomic opportunities

**Considerations:**  
Involvement of local populations and civil society

**Policy Opportunities:**  
Poverty alleviation, economic development, urban planning, public health outreach

### Guiding Frameworks: [Slum Upgrading](#)

### Supporting Tools and Data:

- [European Environment Agency's Urban Adaptation Map Viewer](#) – explore vulnerability and hazards across Europe
- [Cities indicators dashboard](#) – Access urban environment indicators for select cities around the world
- [Climate Risk Dashboard](#) – Explore future urban heat stress and overshoot scenarios at the urban level

**Communities of Practice:**  
[Slum Dwellers International](#)  
[Urban Public Health Network](#)  
[Cool Cities Network](#)

## 3.3 Technology

Emerging technology can be a component of the solutions to climate risk, by providing up-to-date, data-driven and on-the-ground information and forecasts, leading to better ability to reduce hazards and impacts in real time. In the urban environment, the high concentration of technological infrastructure, capacity, and innovation creates unique opportunities for effective technological approaches to adaptation.

### Early Warning Systems

One technological solution that is particularly promising is the application of Early Warning Systems, which can mitigate risk by reducing exposure ahead of time. The United Nations Environment Programme reports that providing 24 hours of notice prior to an impending hazard can reduce damages by 30% (UN Environment Programme, 2023). Approximately 20% of disasters can be classified as ‘multi-hazard’, i.e. cascading and interacting hazard events that result in unique, cumulative impacts. These multi-hazard disasters contribute 59% of global economic losses (Lee et al., 2024). Multi-Hazard Early Warning Systems (MHEWS), have been specifically introduced to effectively streamline identification and warning for one or more hazards. At the 2022 United Nations Climate Change Conference or Conference of the Parties of the UNFCCC (COP27) in Dubai, the UN Secretary-General established the Early Warnings for All Initiative (EW4All), which set forward a four-pillar approach to implementing MHEWS based on knowledge management, observation and forecasting, dissemination, and response preparation.

Table 2. Pillars of EW4ALL

Pillar	Leading Agency
Risk Knowledge and Management	United Nations Office for Disaster Risk Reduction (UNDRR)
Observations and Forecasting	World Meteorological Organization (WMO)
Dissemination and Communication	International Telecommunication Union (ITU)
Preparedness to Respond	International Federation of Red Cross and Red Crescent Societies (IFRC)

Source: Authors of the report, based on the EW4All initiative

#### Best Practice

Ensure that early warnings provide actionable guidance and opportunities to reduce risk. This can include nearby locations of cooling spots, clear instructions to stay in place, and evidence-backed tips to reduce risk, such as drinking more water during hot days.

These four pillars are each overseen by an international governing body and must be coordinated across sectors and levels of governance in order to be fully effective (UNDRR & WMO 2024). Furthermore, these MHEWS comprise ‘end-to-end’ services, starting with robust knowledge management and concluding with emergency response services. Integrated climate risk assessments play an important role in informing the risk knowledge management pillar by providing essential research on sectoral and geographic risk. In addition, many of the methods and data used to assess risk in the first place can also be incorporated in observing and forecasting hazards, providing a unique bridge between one-off risk assessment and continuous monitoring and forecasting.

While the first two pillars of the EW4All framework highlight the role and importance of data, knowledge, and preparedness, pillars 3-4 involve delivery of this information to relevant sectors alongside necessary support services. The EW4All urges that MHEWS must have a ‘people-centered approach’ which is accessible and

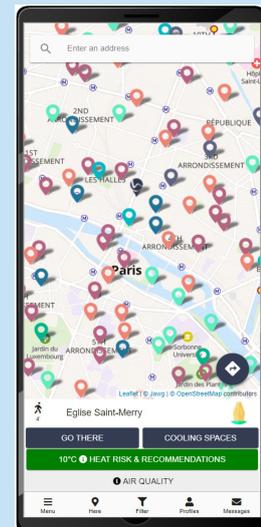
inclusive. Vulnerable groups (including women, rural and indigenous people, migrants, illiterate and people with disabilities) are at a higher risk during disasters (Multi-Hazard Early Warning System, ITU) and may have reduced ability to access or understand warnings and alerts. As a result, stakeholder involvement in the development of these systems can inform decisions to better ensure their efficacy and access. Initial risk assessments should also consider underlying social vulnerability factors (such as literacy rates, access to internet and cellular service, primary language spoken, etc.) that may affect the uptake and success of MHEWS.

### Case Study: Urban Heat in France

In 2003 a historic heatwave impacted France, resulting in thousands of casualties. As a response, the country developed a multi-pronged approach to anticipate future heat events and reduce their health impacts. Through a close collaboration between the French Weather Bureau, the National Institute of Health Surveillance, and the Ministry of Health, a nationwide Warning System was introduced in 2004. Based on multiple meteorological indicators and observational data from 14 cities across the country, the Heat Health Watch Warning System can predict heat waves up to three days in advance.

In addition to meteorological observations, the system also collects data on health records from funeral homes, hospitals, and emergency services, which further informs ongoing health risk. In the city of Paris, where heat-related mortality is the highest of the country, an additional service is available on a mobile-phone based application called Extrema. The app combines users personalised health information with real-time satellite-based weather conditions to provide health risk scores. In addition to warning users of risk, the app also notifies users of nearby 'cooling centers' to escape the heat.

The app's multi-user functionality allows users to monitor other's safety, which can help ensure that vulnerable populations such as the elderly and children are safe. Today the Extrema app is available for multiple cities across Europe.



Source: extrema-global.com

## Adaptation Decision Support Tools (ADSTs)

Today there is no shortage of ADSTs. These tools combine various types of data from diverse sectors, creating unique insights for end-users. This data includes population statistics, climate impact projections, physical assets, and natural systems to highlight unique interactions. ADSTs can also take the form of case studies, risk management frameworks, and decision trees. As the name suggests, ADSTs help simplify dynamic and complex processes, allowing for end-users to better make decisions, whether it be for sectoral-purposes, governance decisions, or policy implementation.

The functionality of ADSTs are targeted to groups or sectors based on their specific needs. Often, these tools are meant to assist practitioners and decision makers in their work, filling in key knowledge gaps, making sense of complex data, and providing insights into future impacts. In urban settings, these tools can help city-level officials to integrate and understand data from various sectors.

[FloodAdapt](#), developed by Deltares, is one such ADST. By providing physical modelling of flood events in an easy-to-understand interface, urban planners and decision makers that are non-flood experts can better understand current and future flooding events across the city, adaptation effectiveness, and future impacts. FloodAdapt is particularly useful in estimating flood-related damages down to individual buildings and roads, which allows for officials to make immediate decisions based on scientific understanding.

## Emerging Technologies

The Internet of Things (IoT) is a broad field of technology that can provide solutions to reduce climate risk.

Such technologies work by embedding physical objects and settings with sensors, which exchange data via the internet, allowing for real world processes to be digitally monitored. While there is overlap between IoT and early warning systems, allowing for unique opportunities to expand observations and forecasting, the capabilities of IoT go beyond predicting hazards for early warning, offering continuous data that can inform near-real-time decision-making. Monitoring energy usage in buildings, for example, can help to improve energy efficiency. The IoT has unique advantages in urban areas, since many natural assets, buildings, and infrastructure are already connected to the grid.

While IoT allows for continuous real-time data collection and monitoring, digital twin technology further utilises this data, creating a virtual replica of a real world object, setting, system or process. Digital twins differ from traditional simulations and models in that they incorporate real-life changes and patterns, based on constant updates from their physical counterparts. The integration of real-time data with historical records allows a more realistic understanding of how systems operate.

Digital twins are increasingly being developed for various urban sectors, as well as for entire cities. In Flanders, a highly-urbanised region of Belgium, a [digital twin](#) has been developed to monitor the region's traffic and air quality, contributing to real-time updates on congestion, mobility, and environmental health. Interestingly, the project involves collaboration across regional authorities and administrative regions, highlighting the potential for cross-cutting collaboration. Similar initiatives have been developed in other regions as well. In Barcelona, Spain, a [digital twin of the city's transport network](#) has been used to assess and evaluate urban planning of transportation networks. In Bologna, Italy a digital twin is being developed to monitor [transportation, biking infrastructure, and building energy usage](#).

Another cross-cutting technology that has garnered increased attention is Artificial Intelligence (AI). With the ability to simulate human learning, comprehension, problem solving, decision making, creativity and autonomy, AI can more effectively and efficiently make sense of urban data and identify solutions. In Europe, AI has largely been used to predict extreme weather events, respond to sea level rise, and evaluate urban heat mitigation.

The integration of emerging digital solutions in cities has led to the concept of 'Smart Cities', where data and real-time insights improve the efficiency and competitiveness of the city government, local businesses, and urban population.

Toolbox for Practitioners		
Technology		
<b>Benefits:</b> Opportunity for innovation, involvement of local businesses and universities	<b>Considerations:</b> Ethical, environmental, and legal consideration required, importance of cooperation, data sharing, and involvement of vulnerable groups	<b>Policy Opportunities:</b> Innovation, research & development Disaster response Education and training Data management & governance
<b>Guiding Frameworks:</b> <a href="#">UNDRR EW4ALL</a> <a href="#">Common Alerting Protocol</a>		
<b>Supporting Tools and Data:</b> <a href="#">Extrema App</a> – Informs of heat hazards and provides digital prevention services <a href="#">FloodAdapt</a> – Prepare for future flooding <a href="#">UHeat</a> – Determine urban heat 'hotspots'		
<b>Communities of Practice:</b> <a href="#">Smart Cities Marketplace</a>		

### 3.4 Monitoring, Evaluation, and Learning (MEL)

Understanding the factors that play a role in the success or failure of a policy, plan or programme is pivotal for conducting iterative enhancement cycles. Moreover, monitoring and evaluation processes along with improvement activities have the capacity to ensure effectiveness and efficiency. Such processes provide information on the causal mechanisms leading to different outcomes and improve accountability and transparency (OECD, 2020).

Key Performance Indicators (KPI) help describe changes attributable to a specific action or set of actions. KPIs can be defined as quantifiable metrics that convey relevant information on the advance of a goal. They trace their modern origins to management and business theory of the mid-20th century, which later were formalised in seminal papers like ‘Chief Executives Define their Own Data Needs’ (Rockart, 1979). These emphasized the need for clear measurable goals in project management, and although they were focused on the private sector, the practice started permeating the public sector later on.

KPIs can be applied to all sectors, including environmental projects, plans and programmes in the urban environment. Nature4Cities (N4C) developed a system of integrated multiscale and multi-thematic urban performance indicators for assessing urban challenges and NbS. It also recognises that the first step to achieve this is to develop a coherent indicator system (Nature4Cities, 2020) and that these indicators, in turn, can only be defined after the challenges have been previously identified. N4C uses a Europe-specific framework (Eclipse) to recognise specific urban challenges, then forms expert groups to identify core sets of indicators per challenge and applies the RACER method to arrive at Key Performance Indicators (see Figure 14).

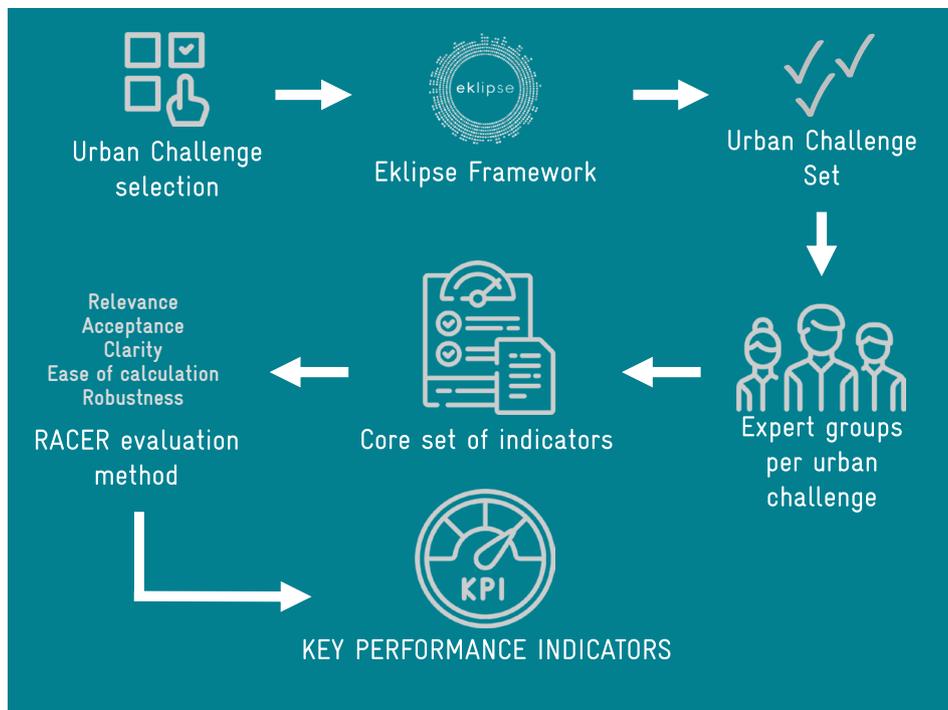


Fig. 14. Process of identification of Key Performance Indicators according to Nature4Cities (2020).  
 Source: Authors of the report. Graphic inputs from Flaticon (Freepik, Juicy\_fish) and eclipse.eu.

Adaptive management strategies are important in MEL. They help to address uncertainties during implementation that may arise from interactions between various factors, as well as changing climate risks and socio-economic aspects. Adaptive management strategies, also labeled adaptive pathways, support

flexibility and changes in time when these arise for instance when new risks emerge that need to be addressed, and new solutions designed and implemented (Noltze et al., 2021).

Such strategies also support the enhancement of resilience and learning in an iterative feedback loop. This ensures that outcomes are shared across different levels, including with community members and decision makers. Additionally, adaptive strategies are important for the participation and inclusion of different stakeholders (Noltze et al., 2021) such as communities in informal settlements in cities. This is because such adaptive adjustments can enhance values like equity and justice (Coger et al., 2021; IISD, 2024). These are also critical for placemaking by such communities in the design and implementation of place and context-specific interventions. Adaptive management strategies can also support early warning and response to climate risks and impacts across levels in the urban environment.

To ensure that adaptive management is included as part of the implementation and MEL, it must be provided for in the design of solutions, for example as relevant adaptive indicators in the framework (Silva Villanueva, 2011). Information from the MEL process is critical in supporting adaptive management that is evidence-based. Other aspects that can support adaptive management in MEL include stakeholder engagement, scenario planning and counterfactual analyses (Noltze et al., 2021; Juhola, S. et al., 2022; Ullah et al., 2021). Other authors have pointed out that adaptation pathways will benefit from bringing slow-onset impacts and sudden climate disasters together to the discussion and planning process (Zorita et al., 2025).

MEL enables the iterative improvement of solutions during the planning, implementation and review phases (Silva Villanueva, 2011). Given the interconnectedness of systems in urban areas such as waterways and water supply, drainage systems, buildings, transport, etc, continuous improvement is necessary for optimal outcomes. This is further enhanced by uncertainties due to climate change. Iterative improvement of solutions can result in cost-effective use of resources and value for money (Silva Villanueva, 2011).

MEL [dashboards](#) such as those provided by the South African Environmental Observation Network can be used as tools for sharing of knowledge and cooperation between stakeholders as well as across cities (European Commission, 2025). They can support fast, efficient and evidence-informed decision making in real time as well as provide transparency and drive greater stakeholder engagement in formulating and implementing solutions. Such platforms can also incorporate citizen science to ensure that urban communities and dwellers are involved in collecting data in real-time to support decision making (Malloy & Ashcraft, 2020; Chu & Cannon, 2021; Shi 2020).

### **Platforms for international collaboration between cities**

Several platforms exist to support peer-learning and collaboration across cities. The [C40 cities](#) is one such initiative, bringing together 100 mayors of cities across the world that are committed to addressing climate change and contributing to reaching the 1.5°C Paris Agreement goal. [NetZeroCities](#) is another initiative that brings together over 100 European cities and has tools for MEL that can support cities in their net zero journey. This is in alignment with the EU mission of 100 climate-neutral cities by 2030.

COP 28's [UAE Framework for Global Climate Resilience](#) provides a framework for tracking adaptation. This is a helpful tool for MEL in cities and urban areas as it includes adaptive management and iterative approaches. Furthermore, the UNFCCC has [compiled](#) a cross-section of indicators from various countries that can be useful for seeking collaboration as well as peer-to-peer learning and exchange.

# 4 Urban Governance and Planning



## 4 Urban Governance and Planning

Urban governance and planning are key to supporting initiatives aimed at addressing risks in the urban environment. Urban areas in the Global South make up 52% of the population and are projected to make up about 66% by 2050 (UN-Habitat 2023). Urban areas are increasingly faced with growing risks of flooding, drought and water scarcity, sea level rise, pollution from industries and transport sector as well as the heat island effect etc. (Kumar and Singh, 2023). Setting in place robust climate risk frameworks for urban governance and planning aimed at limiting warming to 1.5°C is important in dealing with these risks and safeguarding urban populations. In order to achieve this level of stakeholder engagement, coordination, innovative and creative approaches are required (UN Habitat, 2024; The Global Goals, 2025; Thaler et al., 2021)

Equity, inclusion and justice are key criteria that ensure real success of initiatives in urban governance for climate adaptation (Chu, Anguelovski and Carmin, 2016; Klinsky et al., 2017; Chu and Cannon, 2021). Multi-level governance is important to ensure coordination and collaboration across agencies and levels. Some cities have established climate desks in charge of this. This is useful for coordination and designation of roles when climate extremes occur and multi-agency responses are required. It also helps with planning. An example of this is the manual published by the Ahmedabad Municipal Corporation called: “How-to Manual: Steps to Develop a Heat Action Plan Based on Ahmedabad’s Experience” (Ahmedabad Municipal Corporation, 2019)

Stakeholder engagement in urban governance cannot be overstated. Urban residents, especially those in informal settlements, persons with disability, youth, the elderly and civil society have to be engaged in the designing of solutions in urban areas. This is also linked to public awareness and capacity building for urban residents which must also be included in urban governance frameworks (UN Habitat, 2023, 2024; Suprayitno et al., 2024). This enables residents to understand the linkages between climate change and their lived experience. It also helps link future climate extremes to actions that can be taken now, and what residents’ roles could be – such as personally setting up urban gardens and green roofs in their residences, and ownership and support for solutions aimed at addressing climate risks. Capacity building also has to extend to all relevant urban departments so that their plans and strategies incorporate climate risk assessments and responses (UN Habitat, 2024).

Urban governance can assist by ensuring that robust regulations are in place around urban area zoning with respect to green spaces and buffer zones around water bodies (such as rivers, lakes and oceans in urban areas) so as to lessen the impact of flooding and other climate extremes. Ensuring these regulations are built flexibly, with iterative monitoring, evaluation and learning frameworks will help produce the best results (Kumar and Singh, 2023; UN Habitat, 2024). It is important that urban strategies include climate risk assessments in their zoning regulations. This has to include all the sectors ranging from buildings and roads, transport, water and sanitation among others to ensure service interconnection that is responsive to climate risks in the urban area. This is also important to ensure that green spaces are interlinked in the city. This can help to limit the impact of climate extremes, for example the reduction of the urban heat island effect as a result of green parks and other ecosystem based approaches such as nature-based solutions. The planning and implementation of green-blue infrastructure is imperative in ensuring this integration (Hughes, 2020; IPCC, 2022; Aboagye and Sharifi, 2023; UN Habitat, 2024).

There are common challenges that cities generally face in addressing climate risks in urban governance. They include the lack of political will, which can push back policies and systems that integrate this. There is

also the financing gap for adaptation, by which cities feel divided between the competing resource needs of development and climate concerns. This resource conflict can be helped by the integration of climate risk into development planning. There are also limitations around inadequate data in urban areas to support effective decision making on urban governance, including climate policies, thus it is imperative that there is enhanced investment and prioritization of research and observational infrastructure to generate relevant data for urban area decision makers and other stakeholders. With increasing intensity and frequency of extremes, urban areas have to embrace transformational approaches in addressing climate risks. (IPCC, 2022; UN Habitat, 2024)

The integration of technology is also critical: for instance, increasing observational networks (such as automatic weather stations), and remote sensing data with real time analysis and early response, especially to extreme events in cities such as [cyclones](#). Capacity building is another key element. It involves enhancing the knowledge of stakeholders in their understanding of climate risks or the integration of climate adaptation in urban plans and documented strategies, e.g. city master plans (Kumar and Singh, 2023; UN Habitat, 2024).

Some policy measures around finance, for example green bonds, can be adapted and deployed by cities to be able to fund responses to climate risks. In 2014, the city of Johannesburg piloted the [Johannesburg green bonds](#) to raise funds for the implementation of their green transport project, which involved hybrid buses and biogas-fueled buses. Such innovative financial tools when incorporated into policy can help to fund climate initiatives.

[C40 Cities](#) is an example of international collaboration across cities, to address climate risks in the urban environment. The initiative includes mayors of 100 cities in collaborative efforts. The [Curitiba BRT system](#) represents an evolving system that has continually changed to meet the needs of urban dwellers over the years. This is achieved through the review and update of its policies and implementation framework, taking into account the specific needs of the users in the city.

### Case Study: Urban Planning in Jena, Germany

The city of Jena is a medium-sized town (with a population of approximately 108,000 people) located in the Saale River Valley, Germany. Due to the presence of surrounding shell limestone slopes (contributing to high thermal storage) and coupled with high urban-land conversion, the city experiences some of the highest temperatures in central Germany. As a result, city officials have made strong efforts to combat the urban heat island effect.

In 2010, the city of Jena developed its climate change adaptation strategy (JenKAS) as part of a project funded by the German Federal Ministry of Transport, Building and Urban Development as well as the Federal Institute for Research on Building, Urban Affairs and Spatial Development. The purpose of JenKAS was to mainstream climate adaptation into ongoing urban planning efforts.

Initial applications of JenKAS included the redevelopment of a city square previously used as a parking area into a heat-adapted campus utilised by a local university. The redevelopment incorporated various adaptation interventions to reduce urban heat, such as nature-based solutions and highly reflective paint.

Some key aspects from Jena include:

- Use of probabilistic multi-criteria analysis (stochastic PROMETHEE II)
- Cost-benefit analysis for green roofs
- Ongoing urban development projects with a EU 188 million budget
- Linkage of extreme events to climate change for public awareness and stakeholder engagement
- Adaptation research supported by the city



Source: Climate ADAPT

In the following, we present examples of zoning and land use planning to enable climate adaptation in urban settings.

## 4.1 National Ecological Network, The Netherlands

The National Ecological Network of The Netherlands is a strategic biodiversity conservation and enhancement initiative that was formulated in 1990 and aims to be completely implemented by 2027 (Government of The Netherlands, 2025b) (see Figure 15). It consists of conservation areas of different categories (natural parks, Natura 2000 areas, etc.), new wildlife habitats, environmentally-friendly managed agricultural land and water bodies (lakes, rivers, coastal areas, etc.). The network was designed in a multi-scalar way so it could be implemented at the provincial level and then be linked with the Pan-European Ecological Network (PEEN) (Government of The Netherlands, 2025a).



Fig. 15. Left: The National Ecological Network of The Netherlands, Right: Ecoduct in The Netherlands.  
Source: Government of The Netherlands (2025a) and (Government of The Netherlands, 2025b)

A remarkable feature of this initiative is its concurrency with the Multi-Year Programme for Defragmentation. Launched in 2005, it consists of a permanent set of evaluation and implementation efforts for ecological defragmentation (the process of reconnecting fragmented habitats to improve landscape connectivity for plants and animals), which include the installation of ecoducts, ecoculverts, wildlife tunnels and banks to allow easy movement across the landscape for fauna (Government of The Netherlands, 2025b).

Finally, it is relevant to highlight that the National Ecological Network initiative also includes a strategy of land acquisition and conversion, mostly from agricultural land. This has been accomplished through a dual process of provincial land acquisition and 'self realisation' of private landowners. This latter approach of private conservation management involves a legal obligation to conservation, in exchange for financial compensation, in order to offset reduced land productivity. Notably, local provinces have recognized limitations with the self realisation approach and have shifted to direct land acquisition (Kuindersma et al., 2020). Until Jan, 1 2023, the National Ecological Network area had increased to more than 123,000 hectares aided by this programme. The current goal is to establish an additional 80,000 hectares by 2027 (Government of The Netherlands, 2024, pp. 1990–2022) (see figure 16).

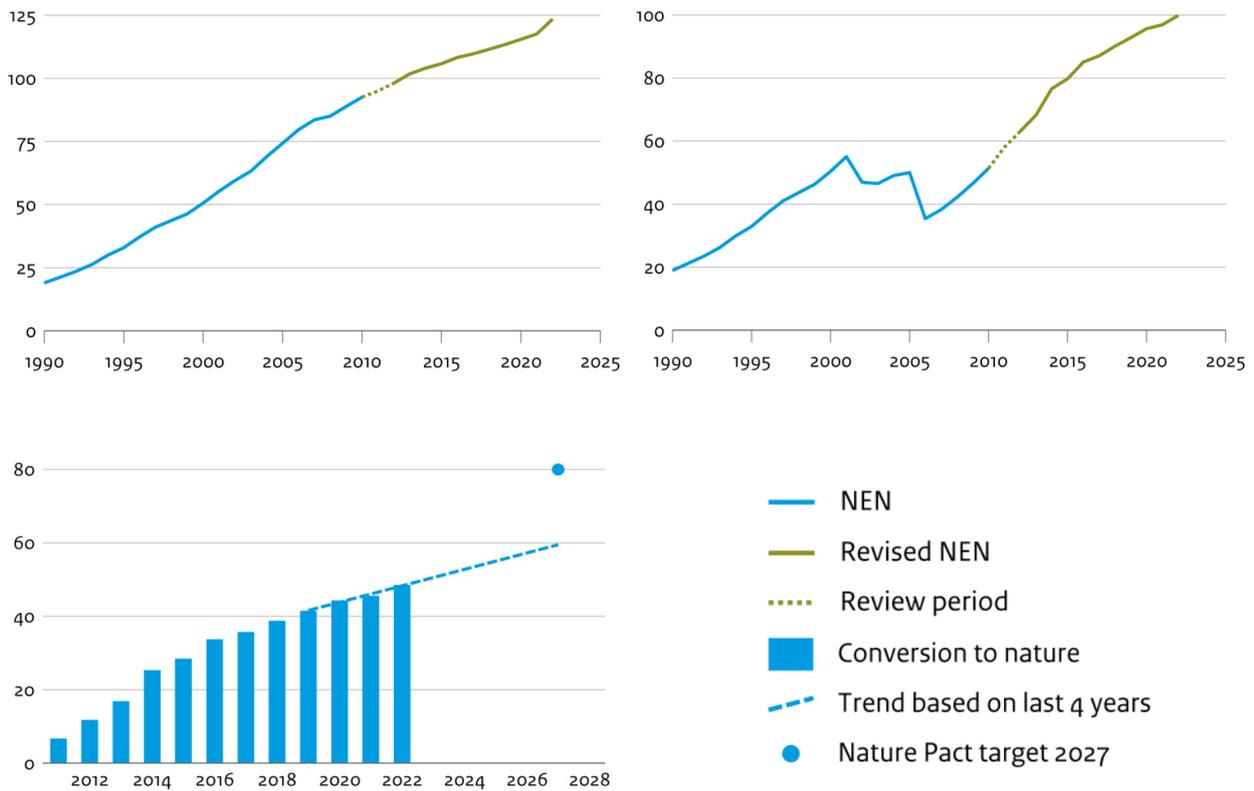


Fig. 16. Upper left: Land acquisition and change of use for the National Ecological Network (NEN); Upper right: Conversion to new nature; Lower left: Increase in area since 2011. All y-axis quantities in thousand hectares. Source: Modified from Government of The Netherlands (2024)

## 4.2 Main Ecological Structure, Bogota, Colombia

Similar to The Netherlands, Colombia has designated a network of areas with diverse degrees of legal protection, aimed to guarantee environmental sustainability. This framework, called “Estructura Ecológica Principal” (Main Ecological Structure - MES) is defined as “[a] set of biotic and abiotic elements that support the essential ecological processes of the territory, whose main purpose is the preservation, conservation, restoration, use, and sustainable management of renewable natural resources, which provide the carrying capacity for the socioeconomic development of communities” (Decree 3600 / 2007, 2007). Since its adoption, this concept has permeated the very norms that regulate entire ministries in the country, for example at the Ministry of Housing, City and Territory (Ministerio de Vivienda, Ciudad y Territorio).

The MES is conceived as a tool for decision makers to incorporate and manage ecosystems’ dynamics into natural resources and land use planning and it is legally defined as a determinant criterion for both. Colombia’s MES has three components: nuclei, corridors and afferent areas. These are respectively defined as:

- Habitat or ecosystem mosaics of high relative ecologic quality
- Binding areas that maintain ecological or environmental links indispensable for the flows of materials and energy, and that facilitate the movement and exchanges between organisms through landscapes; and,
- Transition zones between nuclei and corridors that provide protection and mitigate / filter external disturbances from broader transformed landscapes (Instituto de Investigación de Recursos Biológicos Alexander Von Humboldt, 2022).

The MES framework has been implemented at several scales, as a way to harmonize conservation efforts in Colombia. Cities like Bogota have included the framework at the local level in their planning to guarantee the internal sustainability of urban areas. Bogota has defined an extensive and detailed typology for its local-level constituent elements and it has clear use regulations and guidelines for each (see Figure 17). The Urban Governance Atlas (2023) has compiled basic information about the Bogota case study for further illustration.

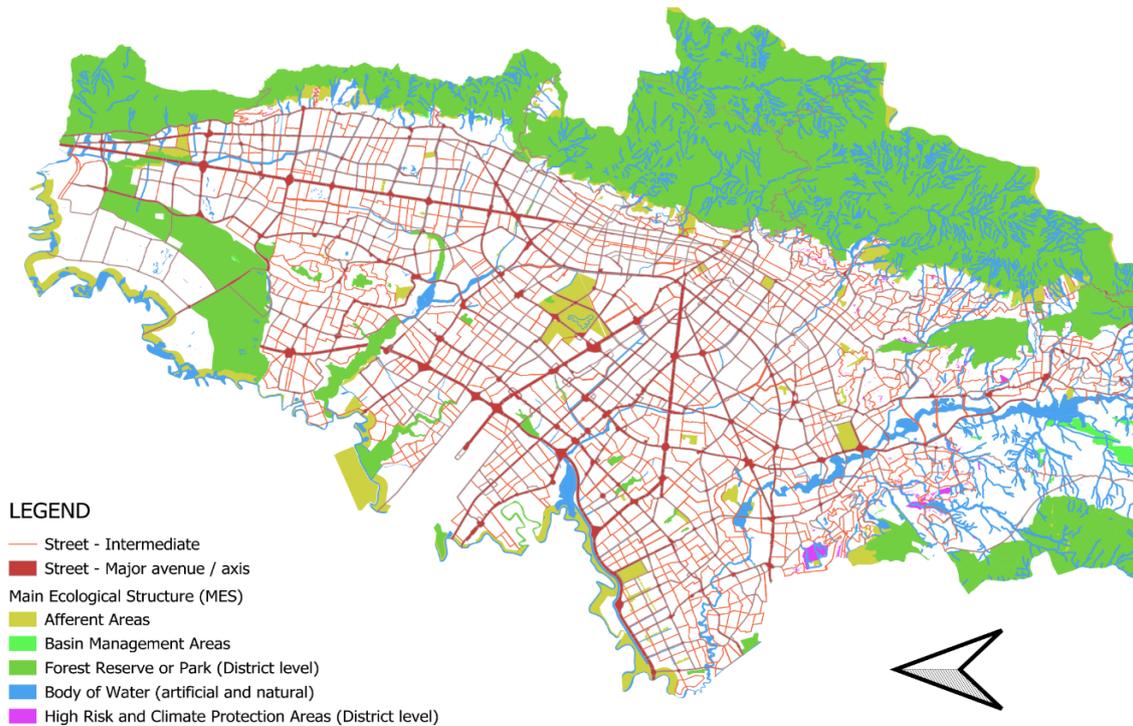


Fig. 17. Elements of the Main Ecological Structure and main streets of the urban area of the Capital District of Bogota. The elements have been grouped in categories for simplification.

Source: Authors of the report, with information from Alcaldía Mayor de Bogotá D.C. - IDECA (2024)

### 4.3 Urban Forest Strategy in Melbourne, Australia

There are several strategies to increase the resilience of urban ecosystems and guarantee the provision of their ecosystem services. In this regard, not only the definition of protected areas is important, but also the actions aimed at promoting and maintaining urban trees and green areas are key, even if they are outside of areas designated as protected.

Strategies such as community greening, urban gardening and protecting landmark tree individuals can aid in the purpose of building a climate-resilient city. These are some of the strategies implemented by the city of Melbourne, Australia. It has a specific strategy, programmes and a fund (the Urban Forest Fund) dedicated to providing dollar-for-dollar grants for the opening of new green spaces, the construction of green roofs and vertical gardens as well as water sensitive urban designs and biodiversity-enhancing projects. This means that an individual, community or a company can apply for grants up to 50% of the cost of greening projects up to AUD 1 million (City of Melbourne, 2025).

Moreover, the city of Melbourne has created a cadastre of urban vegetation, which compiles location, age and species of the trees within the city. It also provides a visualiser, the [Urban Forest Visual](#), for citizens to consult such information (see Figure 18). Additionally, it contains relevant scientific information and projections of tree canopy coverage. It is estimated that the difference between urban canopy cover with and without tree planting can be as much as 19% by 2040 (City of Melbourne, 2020).

The provision of an urban tree inventory is a particularly useful example of technological integration of NbS, as it provides essential data that can monitor ecosystem health and assist in ongoing adaptation efforts. One study combined this tree data with high-resolution climate projections provided through the [Climate Risk Dashboard](#) to determine which species and locations were at high risk of die-off due to urban heat. Researchers found that 46% of urban species were already exposed to temperatures beyond their temperature tolerance, and that by 2050 this risk could impact up to 68% of species (Esperon-Rodriguez et al., 2024). Such research highlights that the long-term success of adaptation strategies (such as urban tree planting) also depends on strong and immediate mitigation efforts.

### Best Practice

Consider how future climate conditions, and particularly how future urban heat island effects and precipitation patterns will impact urban tree species.

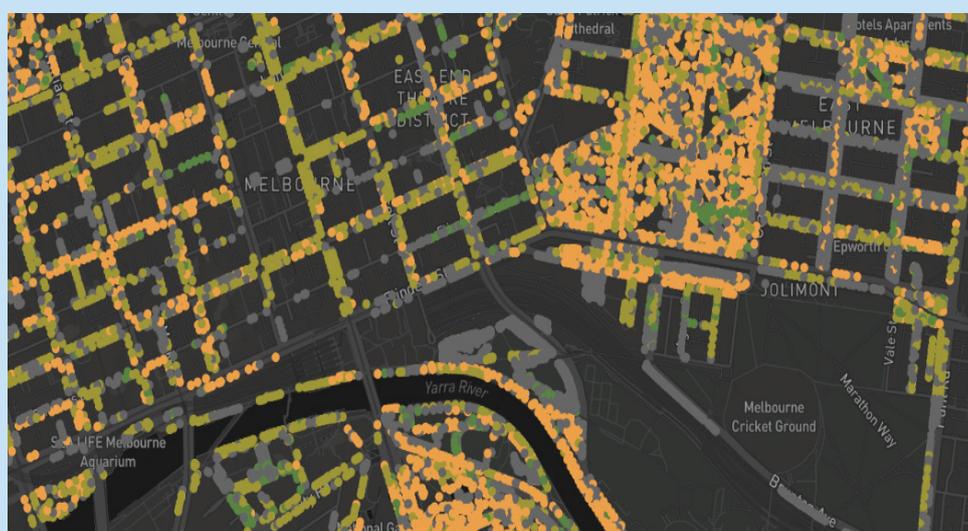


Fig. 18. Screenshot of the Urban Forest Visual showing the location and age of trees (dark green: juvenile, light green: semi-mature, orange: mature).

Source: City of Melbourne (2020)

## 4.4 Busan Eco Delta Smart City, Korea

The Busan Eco Delta Smart City is as a result of [urban planning laws, policies and plans](#). In 2008, Korea enacted the Ubiquitous City Act which led to the development of a comprehensive plan for ubiquitous cities<sup>1</sup> of 2009-2013 aimed at enhanced quality of life and 'urban competitiveness'. A revision of the second plan for 2014-2018 was put in place in 2013, followed by the revision of the Smart City Act in 2017. The Act was further amended in 2019 to establish and promote smart cities. In 2019, the 3<sup>rd</sup> Comprehensive Plan for Smart Cities (2019-2023) was completed. This plan aimed at providing innovative platforms for citizens within the smart cities through data, inclusivity and global cooperation for innovative systems. In 2024, the 4<sup>th</sup> Comprehensive Plan for Smart Cities (2024-2028) was finalized focusing on realizing connected smart cities that also connect citizens through digital accessibility, innovative and smart spaces that are global examples.

<sup>1</sup> Ubiquitous cities are cities that provide widespread services, technology and infrastructure available at any time and place throughout the urban setting.

In line with these plans, Korea developed the [Busan Eco Delta Smart City](#) as a national pilot. The smart city measuring 2,773m<sup>2</sup> is located in a low-lying area in Gangseo-gu, Busan where three rivers converge and it has a population of 76,000. It's development was implemented by the Busan Metropolitan City, K-water and Busan Metropolitan Corporation. It aimed at providing services such as housing, commerce, research and development, logistics, and more in a smart way with the use of technology. The city has incorporated smart urban innovation that includes a digital city platform, augmented city platform and a robot city platform. An AR platform is also included as part of its improved decision making process.

Some of the technologies adopted to address climate change and advance its goal of being a climate-resilient city include green infrastructure such as permeable pavements and green roofs to combat floods. It has also utilized flood-proof architecture and elevation of buildings in flood-prone areas. At the same time, urban trees and forests as well as green belts have been put in place to address floods and storm surges as well as heat extremes. Smart water management which incorporates AI supported drainage systems and flood monitoring sensors has also been adopted. The city's early warning systems include IoT (Internet of Things) sensors for monitoring weather, air pollution and water levels and alerting dwellers during extreme events. Additionally, bot applications are incorporated to ensure a sustainable environment that emphasizes harmony between nature and urban development including industry and the people.

There has also been emphasis on smart growth through spatial planning approaches that mesh accessibility with functionality with themed streets that serve to enhance cultural, leisure and daily living for communities. The [approach](#) has been people-led for innovations that are usable by the public complemented with the overall strategic objectives that cascade from national to city level. Living labs and data centres are developed to enhance innovation. Smart water, zero energy, smart healthcare, smart mobility, smart education among others, are some of the innovations being pursued for the smart city (see figure 18). The project was estimated to cost \$4.23 billion with the state committing over \$50 million while the rest of the financing is from private sector collaboration. Some aspects are still under implementation.



Fig. 18. Busan Eco Delta Smart City Strategic Innovation Priorities

Source: Atlas of Urban Tech, 2025

## 4.5 Experiences in China

Similar initiatives have been also implemented in China with concepts, frameworks and policy tools such as the Ecological Redlines (生态保护红线), the National Park System, the Green Ecological Corridors (绿色生态廊道) and the Major Function-Oriented Zoning (主体功能区). These and others have also been applied at the city level.

Examples of these provide a theoretical framework to assess connectivity at different scales in Chinese cities through the application of techniques such as the Cumulative Resistance Model, the Habitat Quality Model, and the Gravity Model, among others (Y. Zhang et al., 2024). These are used to calculate the degree of hospitality/hostility of an area towards ecological exchanges, to estimate the conditions appropriate for individual and population persistence, and to account for the inverse relation between distance and interactions, respectively. The authors recognise that more research is needed to enhance the conclusions at different scales.

Moreover, Y. Zhang et al. (2024) describe the structural framework of the multi-scale ecological network with three nested levels: 1) a large-scale ecological network that releases ecological functions into the urban space, 2) a mesoscale ecological network that acts as a relay for long-distance connections from the natural to the semi-natural and semi-social environments – conceptually similar to the areas between the urban and rural typologies – and 3) a small-scale ecological network closely related to the communities.

Another relevant example is provided by Zhou et al. (2024), who present a multiscale nested ecological network framework based on multiple methods such as morphological spatial pattern analysis, connectivity indexes, circuit theory, hydrological modelling and hierarchical nesting theories. Along with a granularity-specific optimisation method for analysis at different scales, in their publication they identified the key ecological components in the city of Chengdu.

# 5 Recommendations and Best Practices



# 5 Recommendations and Best Practices

The following recommendations are grounded on the context provided by this report and aim to inform the exercise of policymakers, local officials and civil society in general.

In this regard, it is important to differentiate between generalisable best practices and customisable approaches. The former refers to broadly applicable actions to any urban environment, while the latter describes practices that are tailored to specific contexts.

## 5.1 Generalisable Best Practices

The most important practice to address climate risks in the urban environment is to mainstream Climate Risk Assessments into local-level decision making instruments. Defining and implementing a suitable CRA allows the incumbents at the local level to conduct a clear and straightforward process that results in the effective management of climate risks (see figure 19).

An example of such a process is the CRA model presented in section 2.3.2., a three-stage plan that contains specific activities to which indicators can be associated. As a summary of the essential contents, we highlight the following:

- Preparation (gathering of baseline information, needs identification, objectives and outcomes definition, expert team building)
- Implementation (screening and impacts identification, impact chain development, data gathering, indicators definition, analysis of results and interpretation), and
- Communication (gathering of key findings and information provision to target groups).
- CRAs that identify key risk drivers and analyse sector-specific vulnerabilities – such as those in industry, housing, infrastructure, energy, and health – are essential for building resilience to primary hazards.

Identifying risk in the urban environment	Urban governance and cooperation	Nature-based Solutions	Technological solutions
<ul style="list-style-type: none"> <li>• Consider the multiscalar nature of risk and the respective differences in risk management approaches.</li> <li>• Integrate non-climatic drivers (pollution, land-use change, etc.) into risk assessments.</li> <li>• Account for interactions and feedback effects among climate and non-climate risks.</li> <li>• Incorporate sector-specific vulnerabilities, and consider interactions between sectors.</li> <li>• Consider cascading effects and compound events.</li> </ul>	<ul style="list-style-type: none"> <li>• Cities can overcome knowledge limitations through urban-networks and knowledge sharing platforms.</li> <li>• Develop strong partnerships across urban sectors.</li> <li>• Assess vulnerability across the urban setting, with special focus on most vulnerable groups.</li> <li>• A variety of tools, such as technology, policy instruments, and local capacity can contribute to effective risk management.</li> </ul>	<ul style="list-style-type: none"> <li>• NbS can contribute to both climate change mitigation and adaptation, in addition to a variety of socio-economic benefits.</li> <li>• Connect green and blue spaces into citywide networks</li> <li>• Follow frameworks such as the Global Standard for Nature-based Solutions to ensure that NbS are properly planned and managed.</li> <li>• The effectiveness of NbS may reduce under climate change.</li> <li>• Nbs may vary in effectiveness depending on local conditions.</li> </ul>	<ul style="list-style-type: none"> <li>• MHEWS can significantly reduce loss of life and assets</li> <li>• Emerging technologies such as IoT, digital twins, and AI can improve understanding, management and adaptation to climate change.</li> <li>• Technological solutions should be developed and implemented with careful consideration for data privacy, environmental impact, and relevance.</li> </ul>

Figure 19. Generalisable best practices for risk management in the urban environment

Source: Authors of the report

## 5.2 Customisable Approaches for Different Cities

While cities often share similar dynamics, comparisons should be leveraged to understand commonalities and differences, not to simply transfer policies or plans. Such replication often fails due to differences in assessment methods, baseline data quality, and context-specific conditions.

Overlooking social, cultural, and economic differences which shape both formal and informal institutions is a common pitfall that weakens the effectiveness of CRAs. In rapidly growing countries like China, the fast pace of urban development further challenges static assessments. CRAs that fail to account for dynamic urban change or lack mechanisms for regular updates risk becoming quickly outdated. Modular and flexible approaches, supported by protocols for iterative MEL and guided by Key Performance Indicators, help reduce update costs, maintain institutional memory, and improve long-term responsiveness.

The characteristics of the surrounding natural environment as well as the interdependencies with the urban system (water and energy provision, transport infrastructure, etc) need careful consideration as well. Rates of change in climatic risk drivers can be vastly different between urban environments. Proximity to mountain ranges, coastal areas and other types of systems, condition the likelihood of occurrence of climate risks.

## 5.3 Integrating Adaptation into Development Planning

Cities are centers of innovation, education and collaboration, possessing high concentrations of economic assets, human capital, and political will. As drivers of economic development and hubs in an increasingly interconnected global economy, climate risk to cities also threatens human development goals in surrounding regions and the world as a whole. Therefore, cities must integrate climate adaptation into long-term economic development considerations.

As seen in the example about future ecosystem services distribution and priority areas in Tehran, Iran (see Aghaloo & Sharifi, 2025), robust baseline information, a clear description of the evolution of the systems and reasonable assumptions are critical to facilitate assessments. These elements, along with analysis tools and methods – including adaptation decision support tools (ADSTs) and artificial intelligence – maximize the predictive capabilities of the models. Accurate models in turn constitute pillars of science-based decision making that can contribute to the long-term wellbeing and economic development of the city.

In addition to city budgets and support from the national level, international financing can make investments in climate-resilient development, especially in emerging economies. The [C40 Cities Finance Facility](#) (CFF) for example, connects cities to finance opportunities, mobilising investments in large-scale adaptation and mitigation projects, with a specific focus on infrastructure. C40 estimates that low and middle-income countries require \$4 trillion USD per year in infrastructure investment to transition out of fossil fuel-driven development patterns. The CFF works to embed sectoral experts within city administration to ensure successful co-operation and implementation of projects, while ensuring that cities maintain full ownership and decision making abilities throughout the process.

Integrating Adaptation into Urban Development	
<p><b>Key Concepts:</b></p> <ul style="list-style-type: none"> <li>• Reduction of social vulnerability for all citizens</li> <li>• Adaptation to limit risk to assets and financial systems</li> <li>• Cascading impacts affect a global network of interconnected actors</li> </ul>	
<p><b>Resources:</b></p> <p><a href="#">Integrating Climate Adaptation: A toolkit for urban planners and adaptation practitioners</a></p>	<p><b>Communities of Practice:</b></p> <p><a href="#">Climate &amp; Development Knowledge Network</a>  <a href="#">SDG Cities</a>  <a href="#">C40 Cities Finance Facility</a></p>

# 6 Conclusions



# 6 Conclusions

This report has highlighted the unique challenges and opportunities that urban environments have in response to climate risk. By understanding, preparing, and planning for climate risk, cities can reduce it while pursuing important economic and development goals. Throughout this report we have highlighted multiple cross-cutting themes that are unique to cities.

## 6.1 Findings

### Urban Setting

The unique characteristics of urban environments (population density, concentrated infrastructure, dependency on other systems for food production, energy generation, etc.) make their exposure and response to climate risk unique, especially as compared to rural regions. The physical conditions of the city increase vulnerability to heat and flooding, while a higher density of people and assets increases exposure. Limited physical space, sunlight, water, and other natural resources inside and around it mean that nature-based solutions need to be carefully and thoughtfully planned out in a multiscalar way, both temporally and spatially.

### Social Dimensions

Cities are full of agents (people, companies, government institutions) that may have partially incompatible or even directly conflicting interests. It is the role of municipal authorities to align these across stakeholder groups and promote cooperation. Urban authorities are uniquely positioned to enact policies, provide incentives, and facilitate dialogues between seemingly disparate objectives. Climate risk, as an overarching topic, must gain increasing importance in local decision making in the near future.

### Robust and Multi-Pronged Solutions

Urban adaptation is not a one-off action, but an iterative, evolving process. The urban environment is constantly evolving due to a variety of environmental, social and political factors. Additionally, individual adaptation solutions are much more effective when considered together than when acting alone, due to the synergistic effects. It is therefore pivotal that adaptation is considered as part of a long-term strategy.

### Adaptation, Mitigation, and Development

Adaptation actions have co-benefits that support sustainable development and mitigation goals. Solutions that address and integrate all three strategic dimensions should thus be prioritised, as they align and contribute to the Paris Agreement 1.5°C goal where countries are tasked with setting in place mitigation and adaptation measures and policies that achieve this goal. Such actions are also often easier to justify garner support for.

Considering and implementing them in isolation may lead to unseen opportunity costs and trade-offs or even partial redundancies with subsequent inefficiencies. It is therefore key, before decision making occurs, to assess the links between these dimensions.

## 6.2 Next Steps

This report highlighted the best practices and current state of knowledge on adaptation in the urban environment. Touching on various aspects of the risk management process – from risk assessment to solutions identification – we have highlighted important and generalisable best practices.

However, since adaptation is a locally-dependent process, more precise next steps require that local actors utilise and translate this broad information into their local contexts, considering the wide range of specific resources, local knowledge, limitations and opportunities available.

We call on researchers, officials and practitioners to consider the complexities of the local urban context from a perspective that integrates risk identification, assessment, solutions, policy, and monitoring, evaluation and learning. Research on specific risks as well as assessments on the effectiveness of individual responses is highly recommended.

Sectoral leaders have specific expertise and insights that they can contribute to better understand how urban climate risk may affect the economic resilience of the cities. One of the roles that we see for civil society in the context of urban climate risk management is that of oversight and advocacy. Actively proposing strategies from their viewpoint, highlighting their priorities in health, education and livelihoods can prove extremely valuable for the institutions in charge of adaptation, mitigation and development.

Finally, local decision makers must strive to form coalitions, develop task forces, and facilitate spaces that bring together these actors, identifying key needs and opportunities for policy interventions.

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