# Handbook on Urban Heat Management

## in the Global South

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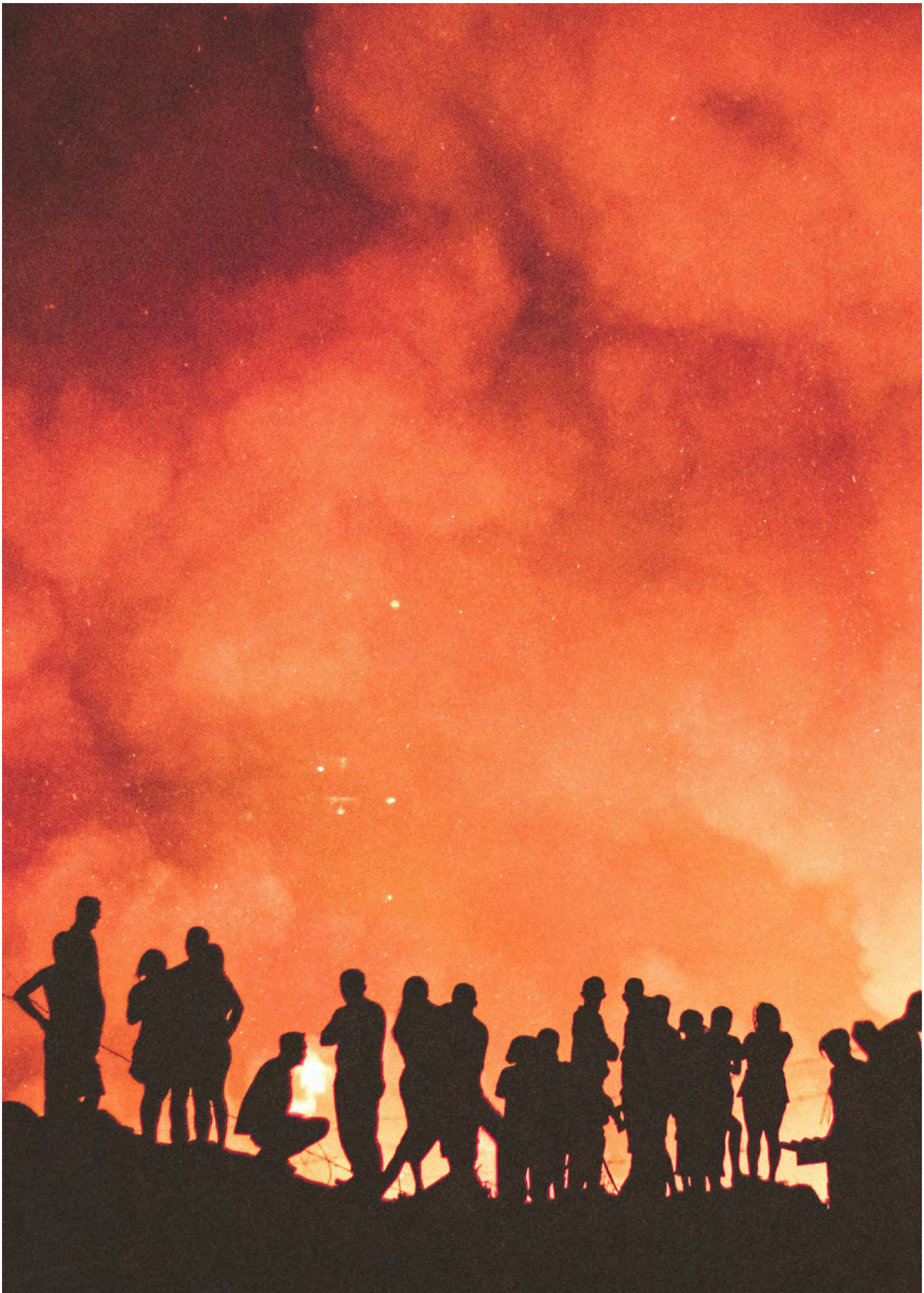

Residents watch as a fire destroys Favela do Piolho. Photo by Unsplash.

# FOREWORD

Extreme heat is reshaping life in cities. For millions of people, especially in fast-growing urban areas of the Global South, higher temperatures are making it harder to earn a living, attend school, access healthcare, or move safely throughout the day. Extreme urban heat and lack of sustainable cooling is threatening productivity, deepening inequality, and increasing the risk of displacement when communities can no longer cope.

Cities cannot afford to treat extreme heat as a seasonal inconvenience. Without action, heat will erode livelihoods and overwhelm urban infrastructure and services. It will fuel unemployment, drive internal and cross-border migration, and put massive demands on energy systems. Cities must act now to manage rising temperatures before it is too late.

The Handbook on Urban Heat Management in the Global South, developed by the World Bank in partnership with the United Nations Human Settlements Programme (UN-Habitat) and the United Nations Environment Programme (UNEP), offers a practical response. It brings together real examples and strategies from cities that are already tackling extreme heat. It focuses on powerful solutions that are feasible, affordable, and easy to adapt—especially those that expand access to accessible, sustainable cooling.

This Handbook is intended to support national and local leaders. It consolidates diverse resources, tools, and lessons learned to support decision-makers in managing and mitigating extreme urban heat in the near and long term. It is not a blueprint, but a resource that can be tailored and expanded through continued learning and collaboration. City leaders and their partners are encouraged to adapt these tools to their local contexts, and to share new practices that can inform future editions.

Cities are getting hotter—but with the right tools, policies, and investments, urban heat can be managed to protect lives, safeguard economies, and build a cooler, more resilient future.

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# Handbook on Urban Heat Management in the Global South

## *Volume I*
## *Summary for Policymakers*

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# *Abbreviations and Acronyms*

| | |
|---|---|
| °C | degree centigrade |
| HAP | heat action plan |
| NGO | nongovernmental organization |
| UHI | urban heat island |
| UNEP | United Nations Environment Programme |
| UN-Habitat | United Nations Human Settlements Programme |

# 01 Introduction

*Cities in the Global South are Heating Up*

**As cities in the Global South grapple with increasing temperatures and more frequent heatwaves, action on extreme heat is the need of the hour. This Handbook is a comprehensive resource for city governments to assess heat risk and implement solutions for heat resilience.**

**The year 2024 was the warmest on record, coming on the back of a record-breaking decade of escalating global average temperatures (WMO 2025)**. Global temperatures have risen by nearly 1.5 degrees Celsius (°C) above pre-industrial levels causing more extreme temperature peaks—making heatwaves more common, more intense, and longer-lasting (Lee et al. 2023). On average, globally, a heatwave that would have occurred once in 10 years in the pre-industrial climate will now occur around every three years, and that heatwave will likely be 1.2°C warmer (WMA 2024). Meanwhile, if the world hits 2°C of global warming, heatwaves would, nominally, occur every two years and be 2.6°C hotter.

**Even small increases in mean temperature have detrimental effects on people's health and livelihoods—especially of vulnerable groups, local economies, urban infrastructures, and the environment** (Lee et al. 2023). Extreme heat is a silent killer and one of the deadliest climate risks. Estimates show that, between 2000 and 2019, approximately half a million heat-related deaths occurred globally each year, with many remaining unreported in official statistics (Ballester et al. 2021). High temperatures reduce productivity, resulting in increased economic costs and a slowdown in sustainable development. Economic losses range from 8 percent of gross domestic product (GDP) per capita per year in the poorest regions to 3.5 percent in the wealthiest regions (Callahan & Markin 2022). Everyone is at risk, but impacts are unevenly distributed across the population with respect to physical and socioeconomic factors. Low-income families, very young and old people, people living with chronic health conditions, pregnant women, and outdoor workers are some of the groups that are particularly vulnerable to extreme heat.

**Cities are at the heart of the issue.** Cities tend to be hotter than their surroundings; this phenomenon is measured and described as the urban heat island (UHI). Cities can be up to 10°C hotter than their surroundings (Alonzo et al. 2021). These pockets of higher temperatures develop when built-up areas, like tarmacked roads and buildings, store heat while narrow streets with high buildings trap heat. The process is exacerbated by heat-producing human activity, for example, the use of vehicles and air conditioners as well as industrial processes and construction. Further, cities often lack green spaces that would naturally cool down urban areas. The impacts of extreme temperatures are aggravated in urban areas because cities are home to over 50 percent of the global population—a figure that is expected to increase to 70 percent by 2050—and generate most of global GDP (Dodman et al. 2022).

**Extreme heat is a global challenge but cities in the Global South face the highest risk.** Low- and middle-income countries in tropical and arid regions are expected to experience severe impacts, making climate adaptation an urgent priority despite limited resources. By 2050, studies predict a staggering 700 percent global increase in the number of urban poor living in extreme heat conditions, with the largest increases expected in West Africa and Southeast Asia (United Nations 2024). Rapid urbanization in cities, particularly across Asia and Africa, already places immense strain on people, resources, infrastructure, and natural systems. Without proactive measures to adapt and mitigate extreme heat, cities in the Global South will face numerous challenges, including increased energy demand for cooling, overstressed water systems, reduced productivity, and higher mortality and morbidity rates. People living in informal settlements are particularly affected, often experiencing even higher temperatures due to poor planning, lack of green infrastructure, and the use of heat-trapping building materials.

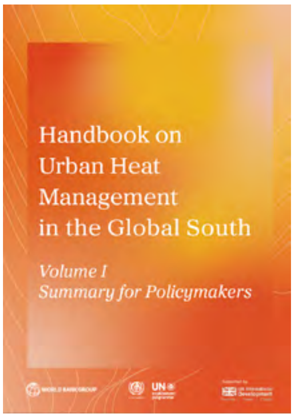
**Urban heat requires action at the global and local levels.** In 2024, UN Secretary-General Antonio Gutierrez published a call to action to address the impacts of extreme heat. He highlighted the need to care for the vulnerable, protect workers, boost the resilience of economies and societies using data and science, and limit temperature rise through decarbonization (Lee et al. 2024). In line with these priorities, the World Bank Group, the United Nations Human Settlements Programme (UN-Habitat), and the United Nations Environment Programme (UNEP are supporting the effort to build resilience against heat in low- and middle-income countries through investments, technical assistance, and knowledge development.

**To protect urban populations and economies, local governments need to manage rising temperatures in cities strategically.** Urban heat management aims to build long-term resilience against urban heat risk. Rather than only responding to heatwaves as they occur, holistic heat management focuses on addressing urban heat risk through response as well as strategic long-term actions to build resilience, reduce impacts, and maintain urban functions throughout periods with extreme temperatures.

**Cities across the globe are scaling up efforts to address urban heat.** Many cities in low- and middle-income countries, such as Ahmedabad in India, have developed heat action plans (HAPs) to respond to extreme heat events, complemented by increased capacity in assessing and forecasting heat risk. Similarly, Johannesburg is testing community-based heat stress mapping—measuring wet bulb globe temperatures and ordinary air temperatures, comparing different townships and residential areas. Dhaka is integrating heat management into its city government and New Delhi is raising awareness of heat risks at scale. Medellín is greening heat hotspots across the city, while Cairo is using roof gardens to cool down homes. Despite these inspiring successes, heat management remains ad hoc in many cities, lacking a clear strategy for building long-term resilience. Mandates and responsibilities are dispersed across institutions without sufficient cooperation. With limited budgets, compounding risks, and competing development needs, cities need a comprehensive and systematic approach to heat risk management to ensure efficiency while focusing efforts where they have the most impact. This Handbook offers such an approach.

**This Summary for Policymakers is the first volume of the Handbook on Urban Heat Management in the Global South.** The Handbook is a practical resource for local governments that want to address heat risk in their city. It adds to the existing body of literature on urban heat by distilling technical approaches into a step-by-step, action-oriented process. It is aimed at city governments in low- and middle-income countries, focusing on their specific challenges and opportunities. The Handbook consists of three volumes as summarized on the following page.

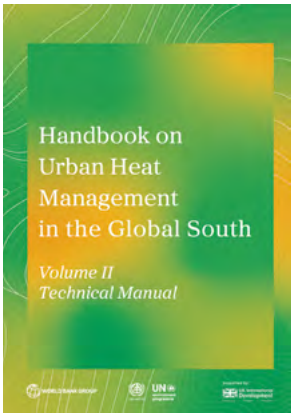
### *Volume I: Summary for Policymakers*




A concise document designed to support decision-makers in national and local governments along the journey towards urban heat resilience.

- Targets **government policy- and decision-makers**, such as mayors or heads of departments at relevant national ministries.
- Contains a **consolidated overview of key concepts, principles, and best practices** to support strategic decision-making, agenda-setting, partnership-building, and fundraising.
- Guides decision-makers **in setting the strategic direction for their cities' heat resilience journeys**.
- Provides an **overview of the heat management process** including how to assess heat risk, plan for heat resilience, and respond to heatwaves.

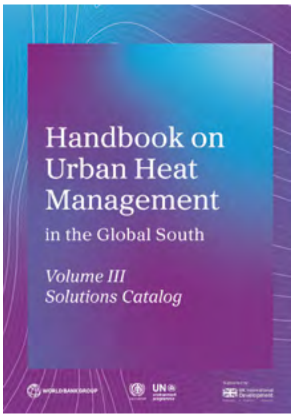
### *Volume II: Technical Manual*




Action-oriented, step-by-step, context-specific guidance to support local governments to carry out urban heat management activities.

- Targets **technical staff within local governments** (such as government planners or disaster risk/emergency response managers), and **urban practitioners**.
- Contains **detailed guidance for understanding and communicating key concepts, assessing heat risk, planning for resilience, and responding to heat waves**.
- Guides technical staff within governments to **implement short- and long-term actions for heat resilience, and emergency measures to address heat waves**.

### *Volume III: Solutions Catalog*




Collection of global examples on how to assess and respond to heat stress.

- **A detailed catalog of solutions that support implementation** of heat resilience actions at urban, neighborhood, household, and individual scales.

# 02 Principles

*What can urban policymakers do to address extreme heat?*

**Drawing on success stories from cities around the world, city leaders, urban policymakers, and key stakeholders can apply five key principles to set the strategic direction for heat management in their cities. Together, these principles move urban heat management from an ad hoc response to a strategic process that builds resilience to urban heat risk comprehensively with long-term benefits.**

PRINCIPLE

*1*

### *Start Now – if Needed, Start Small*

In many cities, extreme heat is already a significant and recurring problem. Due to financial, technical, and human resource capacity constraints, city decision-makers are often burdened by the perception that initiating action would be too costly, complex, or challenging. However, with climate change, the impact of extreme heat will only worsen; avoiding action now will significantly increase future costs of addressing heat risk.

Local governments must not be daunted by the enormity of the task and begin the journey toward heat resilience immediately, even if the first steps seem quite small. Steps such as highlighting the importance of heat management among decision-makers, creating awareness within urban communities, or carrying out high-level assessments will make a difference, and bring the additional benefit of building capacity for more complex aspects of urban heat management.

**INSPIRATION**
Review Nepalgunj's heat resilience journey that has catalyzed action on extreme heat across cities in Nepal (see Chapter 4 of Volume 2 of the Handbook).

PRINCIPLE

2

## *Make the Journey Together*

The impacts of extreme heat are visible at all scales—from city residents, institutions, and businesses to regional infrastructure and natural assets. Local governments must engage stakeholders across the board in holistically addressing heat risk and explore partnerships to build implementation capacity. By working together, cities can leverage collective expertise and resources to address heat-related challenges more effectively.

Local governments can partner with civil society organizations and academia to create awareness of heat risks within the city's communities, co-create solutions, and engage in collective action on heat risk. Pooling and sharing resources with neighboring cities will not only address capacity challenges with activities like heat assessments but also ensure a comprehensive approach to managing urban heat. Collaborating with the national government can open new funding streams, identify additional levers (e.g., through national meteorological agencies and national departments of health), and is crucial to create enabling conditions for local action.

**INSPIRATION**
Learn about a partnership between local government, news and social media, and community organizations in Bangladesh to increase awareness around extreme heat (see Chapter 4 of Volume 2 of the Handbook).

PRINCIPLE

3

## *Establish Clear and Funded Mandates for Long-term Action*

As a cross-cutting topic that relates to urban planning, health, disaster risk management, social welfare, among others, responsibility for urban heat management is often dispersed and fragmented within local and national government. It is essential that policy- and decision-makers establish clear institutional mandates for urban heat management to ensure accountability and drive effective long-term implementation.

Local governments are often best positioned to take the lead on heat management in their cities and should consider governance structures that enable holistic and timely decision-making and encourage cross-departmental coordination for action. Roles and responsibilities across various government departments should be clearly defined to ensure accountability and effective implementation. The responsible authority or coordination committee for heat management must have a robust understanding of funding and financing streams available for action, through private and public, domestic and international sources. Funding should be available to respond to heatwaves, e.g., to operate cooling centers. Local governments could also consider supporting insurance products to mitigate short- and long-term impacts of extreme heat, such as parametric income insurance that is activated one certain temperature thresholds are crossed.

**INSPIRATION**
Understand how Cape Town has anchored an integrated approach to assess, plan and act for heat resilience across local government and resident communities (see Chapter 4 of Volume 2 of the Handbook).

PRINCIPLE

4

## *Tailor Heat Management to the City*

Context-specific approaches tend to be the most effective in tackling extreme heat. Actions and solutions that address extreme heat must be relevant to a city's specific needs with a focus on the impacts for the most vulnerable groups, identified hotspots, climatic context, size, and institutional capacity.

Local governments should base heat management on a thorough assessment of heat risks and impacts, and leverage all quantitative and qualitative data available for this purpose. Policy- and decision-makers should champion solutions that tackle the root causes of urban heat in their context, including updating planning codes and building guidelines to incorporate measures that mitigate the UHI effect (UHEI). Often, actions aimed at building heat resilience generate economic and environmental co-benefits or improve quality of life—these co-benefits could be leveraged to secure stakeholder buy-in and support the most vulnerable communities in the city.

**INSPIRATION**
See how Medellín's 'Corredores Verdes' project tackles urban heat while enhancing biodiversity, improving air quality, and creating livelihoods (see Chapter 4 of Volume 2 of the Handbook).

PRINCIPLE

5

## *Build on What Has Worked Well in the Past*

Within urban heat management strategies, local governments should prioritize scaling-up of effective solutions that already exist in their city—for example, buildings that deploy heat-resilient traditional construction techniques, or community-led initiatives for households to respond to heatwaves. By building on tried and tested approaches, cities can anticipate implementation risks and make effective use of limited technical or financial capacity.

A city's urban heat management strategy should also incorporate a robust process to monitor implementation and evaluate impacts of interventions, to enable learning from successes and failures. Learning from an existing successful intervention provides a solid foundation for future heat management strategies. By linking monitoring to heat risk assessment and learning from past experiences, cities can refine their strategies and enhance their resilience to future heat events.

**INSPIRATION**
Learn how architects in Laayoune and Burkina Faso are utilizing traditional design approaches and construction materials to proactively address extreme heat (see Chapter 4 of Volume 2 of the Handbook).

# 03 Steps

*How can cities build resilience to extreme heat?*

**Building resilience to extreme heat in cities is a complex challenge. It impacts individuals, households, infrastructure and natural assets. It requires both short-term, emergency measures during a heatwave and long-term interventions that may take years to plan and implement. It needs collaboration and coordination across a range of government, civil society, academic and private sector actors.**

However, policy- and decision-makers can address the scale of this challenge by deploying a step-by-step approach to understand and communicate key concepts around heat resilience, assess heat risk, plan long-term interventions and effectively respond to heatwaves. This chapter summarizes how your city can follow a collaborative and outcome-focused approach to enhanced heat resilience. Detailed guidance for each stage and activity is contained within the Technical Manual (Volume 2 of this Handbook), as summarized in Table 1.

| | 1 UNDERSTANDING HEAT RESILIENCE | 2 ASSESSING HEAT RISK | 3 PLANNING FOR HEAT RESILIENCE | 4 RESPONDING TO HEATWAVES |
|---|---|---|---|---|
| | Introduction to key concepts and terms around urban heat resilience and management | Creating an evidence base to inform action on heat resilience | Developing heat management plans and implementing interventions for heat resilience | Implementing actions to respond to heat waves and reduce heat-related impacts |
| ACTIVITIES AND TOPICS | 1.1 *What is heat risk?* | 2.1 *Assess Context and Capacity* | 3.1 *Communicate Heat Risks and Impact* | 4.1 *Preparing for Heatwaves* |
| | 1.2 *What are the impacts of extreme heat in cities?* | 2.2 *Assess Hazards* | 3.2 *Set Objectives for Heat Management in your City* | 4.2 *Respond during the Heatwave* |
| | 1.3 *Why is heat risk becoming more important?* | 2.3 *Assess Exposure* | 3.3 *Outline and Prioritize Heat Resilience Solutions* | 4.3 *Learning from the Heatwave* |
| | 1.4 *How are cities in the Global South particularly affected?* | 2.4 *Assess Vulnerability* | 3.4 *Develop Prioritized Heat Resilience Solutions for Implementation* | |
| | | 2.5 *Assess Impacts* | 3.5 *Monitor and Evaluate Heat Risk and Resilience* | |
| | | 2.6 *Combine Heat Risk Assessment* | | |

**Table 1-1.** Structure of the Technical Manual of Urban Heat Management

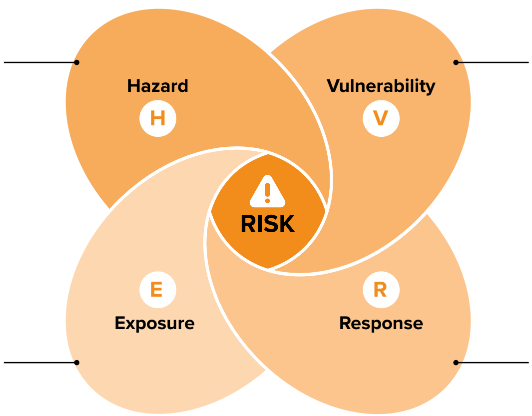
# UNDERSTANDING HEAT RESILIENCE

## *What is heat risk?*

**Heat risk signifies the potential harm experienced by people, infrastructure, economies, and environments due to heat exposure.** Heat risk can be represented as a function of hazard, exposure, and vulnerability as shown in Figure 1-1. Adaptive capacity is the inverse of vulnerability. It can be defined as the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. For example, having access to cooler spaces during a heatwave increases the adaptive capacity of a person and reduces their vulnerability to heat.

**Hazard**
Refers to high temperatures that can be extreme heat episodes or slow-onset increases in temperature combined with high humidity, and its physical characteristics, such as magnitude, duration, timing (day and night time) and spatial extents.

**Vulnerability**
Refers to the susceptibility of people, infrastructure, economy, and ecosystems to the negative effects of the heat hazard. The vulnerability of people depends on age, gender, and health conditions.




**Exposure**
Refers to the degree to which people, infrastructure, economy, and ecosystems are exposed to heat hazards. The exposure of people is influenced by their activities and employment, e.g., outdoors or in factory settings.

**Response**
Refers to human responses to extreme heat, which affect the three components of affect hazard, exposure and vulnerability. Heat adaptation responses have the potential for positive or negative impact on heat risk.

**Figure 1-1.** Heat risk equation

How we experience heat does not only depend on temperature but also on climatic factors, such as wind and humidity. Generally, two types of heat can be distinguished—acute heat episodes and chronic heat exposure.

- **Acute heat episodes** (heatwaves) can be defined as a period when local excess heat accumulates over a sequence of unusually hot days and nights (WMO 2025). While heatwave definitions vary across countries and cities and should be localized for your city or region, all definitions note a sudden, significant, and time-limited departure from average or recent climatic conditions. These short-term spikes in temperature can cause immediate and delayed health emergencies, disrupt daily activities, damage infrastructure, and significantly reduce workplace productivity.
- **Chronic heat exposure** is the prolonged or repeated experience of high temperatures over an extended period. Temperatures may gradually increase, for example, due to climate change. This gradual rise can affect energy consumption, health, and productivity. In particular, the tropical and subtropical regions are chronically exposed to extreme heat (Oppermann 2021).

See Chapter 1 in the Technical Manual (Volume 2) for further details on key concepts related to urban heat risk and resilience.

# *How to address heat risk?*

**Local governments can manage extreme heat risk by improving the heat resilience of their cities, for example, through green infrastructure, early warning systems, or sustainable cooling.** Heat resilience refers to the capacity of an urban system to anticipate, withstand, adapt to, and recover from acute heat episodes (heatwaves) and chronic heat exposure in ways that maintain its essential functions, such as the local economy, healthcare, water supply, or public transport (amongst others). Key components of urban systems are considered to be people's health and livelihoods, local economy, infrastructure, and the environment. Figure 1-3 illustrates the concept of heat resilience.

Building heat resilience requires urban heat management constituted of urban heat mapping and UHI assessment, assessing heat risk, planning for heat risk mitigation and adaptation, and responding effectively during heatwaves. Effective heat management avoids maladaptation, referring to situations where solutions intended to build heat resilience or respond to other hazards end up increasing the vulnerability of residents, local economies, urban infrastructure, or environmental assets to heat.

See Chapters 2, 3, and 4 in the Technical Manual (Volume 2) for detailed step-by-step guidance on the three stages of heat management.

**CHALLENGE**

Heat resilience is the ability of urban/rural systems to operate effectively despite growing risks of extreme heat and other hazards due to climate change and rapid urbanization.

It considers threats to people, infrastructure, economy, and the environment from chronic and acute heat risks.

As climate change is with us now, it involves urgent short-term resilience measures as well as longer term adaptation plans.

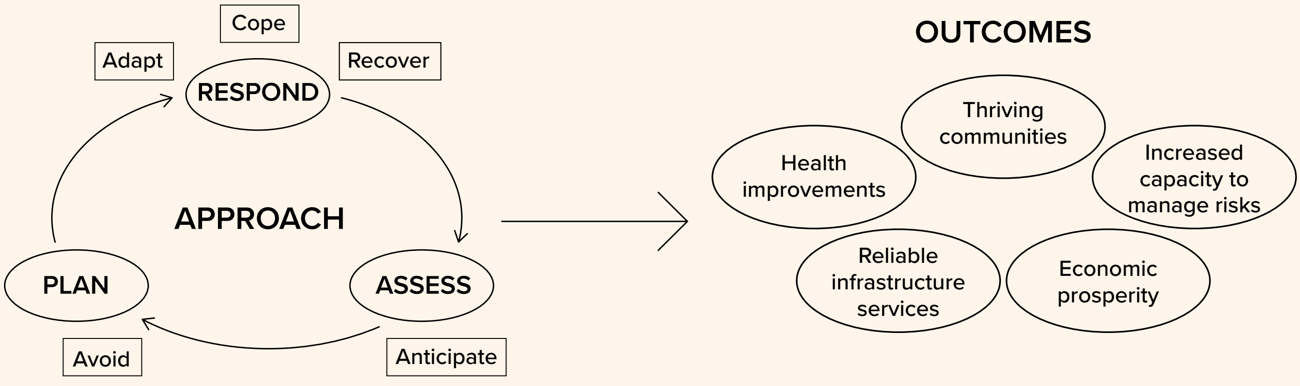



**Figure 1-2.** How Heat Resilience is Delivered. **Source:** AtkinsRéalis 2025.

# ASSESSING HEAT RISK

**Successful urban heat management requires a solid information baseline for heat risk in your city.** The impacts of urban heat on local people, the economy, urban infrastructure, and the environment differ in every city and depend on hazard characteristics, exposure and vulnerability to heat, and the local capacity to cope. Being able to clearly articulate the heat risk profile of the city facilitates access to funding and financing for urban heat management and utilization of resources for maximum impact. Heat risk assessment covers the three key activities outlined in Table 2.

| 1 ASSESS CONTEXT AND CAPACITY | 2 EVALUATE COMPONENTS OF HEAT RISK | 3 ASSESS HEAT RISK |
| --- | --- | --- |
| Every heat risk assessment starts by analyzing the context and capacity for heat management in the city. Setting the right parameters for assessment helps ensure an approach that strikes a balance between usability, feasibility, and viability. This process must be based on a good understanding of available financial and technical resources, existing policies and gaps, institutional responsibilities, and the stakeholder landscape. | The parameters adopted determine the choice of a heat risk assessment approach that works for the city. There is no one right way. Existing approaches to heat risk assessment range from participatory methods based on qualitative data and lived experience to advanced geo-spatial data analysis combining various quantitative datasets including remote sensing, local weather station, and socioeconomic data to model heat risk spatially and over time, considering the effects of climate change. All these options should comprise an evaluation of hazard, exposure, vulnerability, and impacts. | An evaluation of the combined evidence of hazard, exposure, and vulnerability of communities and infrastructure, and the resulting direct and indirect impacts is critical. This will contribute to a well-informed assessment of heat risk and support the development of adaptation actions and solutions that directly address the identified exposure and vulnerability characteristics of communities and infrastructure. |

**Table 1-2**. Key Aspects of Heat Risk Assessment

# PLANNING FOR HEAT RESILIENCE

**Building heat resilience in your city requires proactive and strategic planning.** Many local governments in the Global South are overburdened by rapid urbanization, climate change, limited access to funding and financing, and a lack of human resources.

A systematic approach to planned heat resilience allows governments to overcome these barriers and move from understanding the challenge to implementing solutions. Heat resilience planning covers the five key components listed in Table 1-3.

| | |
|---|---|
| 1 COMMUNICATE HEAT RISK AND IMPACTS | Start by advocating for political buy-in and public support for implementing heat resilience solutions. Communicating the findings from the heat risk assessment, highlighting the urgency of the issue and its impact on health and well-being, will drive the call to action and push the issue on the political agenda. Raising awareness of heat risk with the public helps to educate stakeholders about the risk associated with urban heat. A clear strategy to engage the community, especially the most vulnerable community members, should be followed through the planning process. |
| 2 SET OBJECTIVES FOR HEAT MANAGEMENT AND SUSTAINABLE COOLING | Define clear objectives for heat management and sustainable cooling to set the strategic direction of the heat resilience journey. The right planning approach to building heat resilience could include developing a strategic HAP, integrating the concept into existing plans, and engaging the community to pilot specific solutions. It is important to set strategic objectives against priority challenges with metrics and targets to measure success of interventions and create accountability and trust. |
| 3 OUTLINE AND PRIORITIZE HEAT RESILIENCE SOLUTIONS | Prioritize solutions that are best suited to the city to maximize benefits. Develop a long list of options, build on existing plans and initiatives, identify urban hot spots through urban heat mapping, and consult the Solutions Catalog (Volume 3 of this Handbook) and narrow it down to the most impactful options using a multicriteria assessment, informed by the risk assessment findings, climate modeling, and stakeholder feedback. |
| 4 DEVELOP PRIORITIZED HEAT RESILIENCE SOLUTIONS FOR IMPLEMENTATION | Develop the technical details of short-listed solutions to move them closer toward implementation. Assign responsibilities and identify partners for implementation. Assess and initiate access to funding and financing, blending different mechanisms and instruments to create a diverse and stable financial base for implementation. Develop clear timelines for implementation that align heat resilience efforts with broader urban development plans and policies, maximize resource efficiency, and build resilience incrementally at the most appropriate pace for the city. |
| 5 MONITOR AND EVALUATE HEAT RISK AND RESILIENCE | Undertake robust monitoring and evaluation of heat risk metrics and targets, and monitor implementation progress on solutions and their actuals benefits. This vital activity allows impact assessment of solutions as well as identification of areas that require effort and resources to bolster implementation. It provides valuable insights into what works and what does not, and lessons that can be applied to improve heat management and heat resilience planning. |

**Table 1-3**. Key Components of Heat Resilience Planning

# RESPONDING TO HEATWAVES

**Heatwaves are emergencies that require local governments to respond rapidly.** In the absence of strategic long-term planning, the three activities outlined in Table 1-4 provide a checklist for local leaders to manage heatwaves effectively, save lives, protect livelihoods and ensure the functioning of urban services and infrastructure.

| 1 | 2 | 3 |
|---|---|---|
| PREPARING FOR THE HEATWAVE | RESPONDING DURING THE HEATWAVE | LEARNING FROM THE HEATWAVE |
| Before seasons with elevated heat, preparation should prioritize effective communication to sensitize and prepare the population. Ensure that news agencies are briefed, information materials are available, and response infrastructure is maintained. Immediately before a heatwave, confirm the scale of the emergency and issue a warning, especially in hotspots and to vulnerable groups at highest risk. Communicate key focal points for response and ensure an open line of communication. Continue raising awareness with households and mobilize and allocate necessary resources for immediate response. | Once a heatwave is underway, it is paramount that all actors know what to do, act swiftly, and follow procedures to protect lives and infrastructure. This may include issuing public health advisories, activating clinical and emergency protocols, implementing transport safety measures, or ensuring access to drinking water. While the vast majority of the response is pre-scripted, limited adjustments may be necessary for dynamic scenarios—such as large public events—that require flexible and situational planning. | After a hot season is over, evaluating the response and identifying gaps is crucial for improving future preparedness. This includes analyzing data—such as heat-related morbidity and mortality—and assessing the effectiveness of actions taken across all sectors. The post-season review should examine the roles and performance of designated stakeholders, identify gaps, and update protocols to strengthen future responses. This cycle of reflection and adjustment is critical for building progressively more robust extreme heat preparedness systems. |

**Table 1-4**. A Checklist for Heatwave Emergencies


GOLDEN
HARVEST

# 04 Learning

*How have other cities addressed extreme heat?*

**Local governments around the world have been leading efforts to address heat risk and build heat resilience locally. This chapter showcases success stories from Medellín to Nepalgunj, from Laayoune to Cape Town, providing inspiration for local governments to initiate their heat resilience journey.**

## NEPALGUNJ

*Catalyzing a movement to build urban heat resilience*

The Nepalgunj heat action plan engagement. **Source:** © Nepal Red Cross Society.

Nepalgunj, a business hub in Nepal, faces rapid urbanization and amplified impacts of climate change including recurrent and severe heatwaves. The absence of systematic tracking of heat-related deaths made it challenging to gauge the full extent of the impact of heatwaves.

What started with a heat risk study in Nepalgunj has catalyzed action on extreme heat across cities in Nepal. In 2021, the Climate and Development Knowledge Network Asia in collaboration with Red Cross Red Cresent Climate Centre conducted a heat risk study for Nepalgunj. The small study presented an opportunity for additional partners (for example, the UK Met Office) to join the effort, turning the rapid assessment of heat hotspots into a comprehensive analysis of heat risk.

Leveraging the findings from previous studies, with support from the Norwegian and Finnish Red Cross, the Nepalgunj city authority and Nepal Red Cross Society developed and published a comprehensive Nepalgunj HAP. The HAP covers seasonal heat risk reduction, focuses on the actions required before, during, and after the hot season, as well as strategic urban planning, including measures such as urban greenery and cool rooftops. The city authority has already implemented several heat risk mitigation solutions, including installation of water ATMs, for outdoor workers during peak heat time and a cooling center for vulnerable population groups.

The development and implementation of the Nepalgunj HAP resonated beyond the city, sparking interest from other urban centers that expressed a desire to develop HAPs for their respective cities. This work has also led to nongovernmental organizations (NGOs), specifically the International Federation for Red Cross, supporting heat awareness campaigns and capacity-building programs and developing further HAPs across the country.

# DHAKA

## *Collaborating to increase awareness around urban heat risk*

Awareness creation on heat risks in Dhaka. **Source:** © Bornil Amin

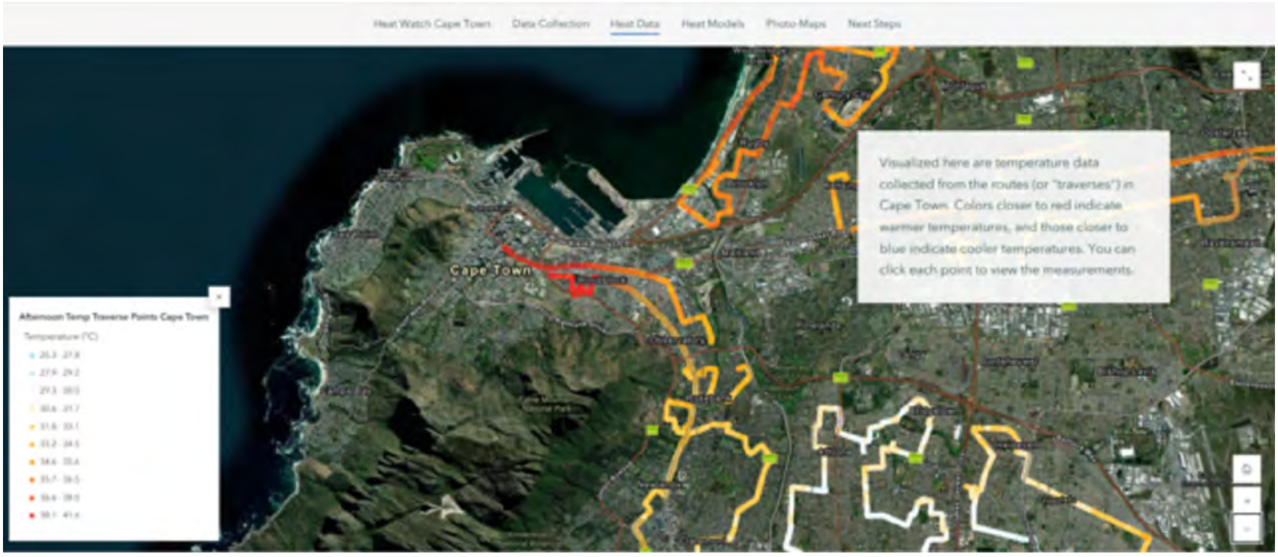
Dhaka is experiencing an increase in extreme heat events, which poses significant health risks for its population. The health impacts of extreme heat are often underestimated, leading to a lack of adherence to individual protection measures. This issue is particularly acute among low-income families, that face the difficult choice between losing income and protecting their health. Effective communication about urban heat risk is crucial to mitigate these challenges and safeguard public health.

In Bangladesh, a partnership between local governments, news and social media, and community organizations ran a campaign to increase awareness around extreme heat. A 16-day media campaign, aimed at enhancing awareness on extreme heat, was run by BBC Media Action in 2017. The campaign's primary goal was to educate people about the dangers associated with high temperatures and to promote strategies to mitigate the risks. A series of short videos with practical messages was created, ensuring accessibility and relevance. The campaign also partnered with a popular national YouTube star, who developed engaging content that was broadcast on Facebook. In addition, Facebook live chats with health professionals and government officials provided direct engagement of people with policymakers and experts. The campaign successfully reached 3.9 million people, encouraging them to adopt individual measures to reduce heat risk during Bangladesh's hot season. The campaign highlighted specific actions to protect vulnerable groups, emphasizing the need for community-wide efforts to address extreme heat.

Dhaka City North, in partnership with the Bangladesh Meteorological Department and support from Save the Children, developed a regional integrated multi-hazard early warning system and heatwave warning portal. This portal provides advanced heatwave forecasts up to five days in advance, enabling the Bangladesh Meteorological Department and Dhaka North City Corporation to issue timely alerts. By offering detailed forecasts down to the ward level, the portal empowers the public to take essential precautions and emphasizes the need for a city-specific HAP. To enhance community resilience, the initiative also includes awareness campaigns and resource distribution, such as cooling shelters and umbrellas. The impact of the heatwave warning portal has been significant, improving Bangladesh Meteorological Department's ability to issue timely alerts and equipping communities with the knowledge and tools to better withstand heatwaves. Collaboration among government bodies, NGOs, and international organizations highlights the importance of cooperation in addressing climate-related challenges. This initiative not only safeguards public health and productivity but also represents a proactive approach to mitigating the adverse effects of climate change in Bangladesh.

# CAPE TOWN

## *Developing an integrated approach to building heat resilience*




The Heat Watch Cape Town ArcGIS storyboard. **Source:** World Bank City Resilience Program, Community Organisation Resource Centre (CORC) and CAPA Strategies (2004).

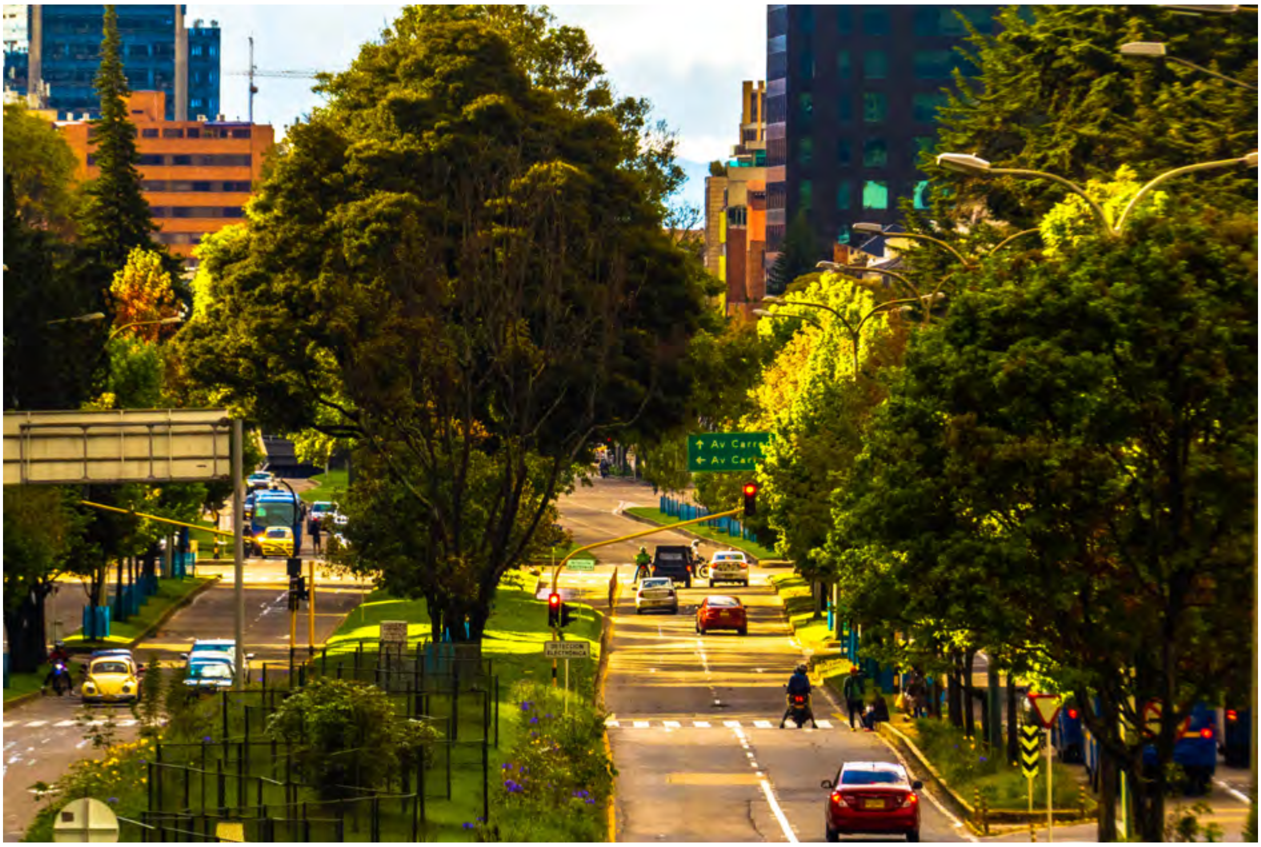
Cape Town in South Africa is subject to a wide range of complex climate risks, including drought and associated water shortages, flooding and resultant impact on people and infrastructure, coastal erosion and sea-level rise, and heat stress and its health impacts on vulnerable people.

The city has anchored an integrated approach to assess, plan and act on building heat resilience across local government and resident communities. The city's climate action plan now includes heat considerations, aiming to reduce health risks during heatwaves and mitigate heat impacts through urban greening. Building on the Climate Action Plan, the local government developed an accompanying HAP in November 2023 which outlines further details related to the action, responsibilities, timelines, economic models, and monitoring strategy specifically relating to building heat resilience (Capetown.gov 2024).

The city also undertook heat mapping to measure heat in public spaces across the city, helping to lay down the foundations for deeper engagement. The assessment used heat sensors fitted to vehicles that community volunteers drove around their cities to capture a high-resolution snapshot of temperature disparities across neighborhoods to identify heat hotspots in both informal settlements and more affluent areas. By integrating this heat data with socioeconomic factors, the city identified areas of high vulnerability, including informal settlements where access to cooling infrastructure is limited. Findings were presented in an ArcGIS StoryMap—a web-based report with interactive maps—making them accessible to a broad (including non-technical) audience.
The results informed implementation of urban greening projects, creation of cooling zones, and development of HAPs, including public awareness campaigns on heat risks (Capetown.gov 2024).

# COLOMBIA

*Co-benefits from passive cooling*



An example of the Medellín Green Corridor under a viaduct. **Source**: Getty images

Medellin, Colombia, has been facing rapid urbanization for over 50 years, leading to the interlinked challenges of poor air quality, limited green spaces and urban heat islands.

Medellin's 'Corredores Verdes' project reduces urban heat, enhances biodiversity, improves air quality, and creates job opportunities. Medellín launched an ambitious initiative in 2016 to create interconnected green corridors across the city. The project, known as 'Corredores Verdes,' was aimed at reducing temperatures, improving air quality, and enhancing urban biodiversity.

The initiative involved planting 8,800 trees and palms as well as over 90,000 smaller plants along 30 corridors covering 65 hectares. These green corridors and spaces were designed to mimic natural forests, featuring layers of low, medium, and high vegetation, including native and tropical species adapted to the local environment. The corridors connected various green spaces across the city, including parks, vertical gardens, green sidewalks, and forested hills. By 2019, the project was shown to successfully reduce average city temperatures by 2°C and improve air quality by helping to capture particulate matter and sequester significant amounts of carbon dioxide. The initiative also provided employment for 75 people from disadvantaged backgrounds who were trained as gardeners and plant technicians. The initiative was recognized for its innovative approach to urban cooling and won the 2019 Ashden Award for Cooling by Nature.

# LAAYOUNE AND KOUDOUGOU

## *Passive cooling through traditional construction techniques*

Heat is not a new phenomenon, and affected communities have refined coping strategies over centuries. Such traditional methods of addressing the challenges posed by rising temperatures are often some of the most suitable and effective solutions for cooling buildings without having to rely on modern energy-intensive systems.

Architects in Laayoune and Burkina Faso are utilizing traditional design approaches and construction materials to proactively address extreme heat. In Laayoune, a technology school was strategically designed with fragmented buildings to maximize natural ventilation throughout the site. The complex is interconnected with paths, squares, covered areas, and mineral gardens. Various sun protection devices, such as sun breakers and overhangs, double-layer cladding, and protected walkways, are employed. Materials are minimized to ensure abstraction, coherence, sustainability, and easy maintenance.

In Koudougou, Burkina Faso, the Burkina Institute of Technology was designed to feature walls made from locally sourced clay combined with concrete to enhance the thermal mass of the building, helping to keep interior spaces cool. The building's design includes staggered modules to facilitate airflow, shaded corridors, and eucalyptus wood screens, which together improve ventilation and reduce heat accumulation. This approach not only leverages local materials but also integrates sustainable design principles to create a comfortable and environmentally-friendly educational facility.

# Turning Heat into Action

Extreme urban heat is straining lives and economies and driving soaring demand for electricity, but with the right planning and tools, cities can manage its impacts. The guidance in this Handbook is designed to help cities shift from responding to heatwaves as they occur, toward building resilience to heat that protects people and economies.

Whether you are a mayor, national policymaker, or local decision-maker, your next step is simple: share this Handbook with the teams in your administration who work on urban planning, health, transport, disaster response, sustainable cooling, and the environment. Ask them to review the guidance, spot opportunities in existing plans, and agree on priority measures to address local heat challenges.

The next two Handbook sections offer clear, step-by-step support. The Technical Manual explains how to assess heat risks and design coordinated resilience and cooling measures. The Solutions Catalog highlights inspiring examples from cities across the Global South that have tackled heat with green infrastructure, improved building design, and sustainable and passive cooling strategies.

This Handbook is a joint effort by the World Bank, UN-Habitat, and UNEP. Each organization stands ready to help—whether through funding, technical advice, or planning frameworks. Contact your nearest local office to explore the support that best fits your city's needs.

As urban heat intensifies, the choices you make today will determine whether your city weathers the challenge or struggles under rising temperatures. Use these pages to guide your colleagues, protect your citizens, and build a cooler, more resilient future.

**MING ZHANG**

**RAFAEL TUTS**

**INGER ANDERSEN**

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# Handbook on Urban Heat Management in the Global South

*Volume II*
*Technical Manual*

WORLD BANK GROUP

UN-HABITAT

UN environment programme

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# Abbreviations and Acronyms

| | |
|---|---|
| °C | degree centigrade |
| Arsht-Rock | Atlantic Council's Climate Resilience Center |
| AT | apparent temperature |
| C3S | Copernicus Climate Change Service |
| CAP | Climate Action Plan |
| CDC | Centers for Disease Control and Prevention |
| CHO | Chief Heat Resilience Officer |
| CMA | Chennai Metropolitan Area |
| CSO | civil society organization |
| EHF | Excess Heat Factor |
| EHRA | Extreme Heat Resilience Alliance |
| EWS | early warning system |
| FDG | focus group discussion |
| FFP | Fit For Purpose |
| FWI | Fire Weather Index |
| GDP | gross domestic product |
| GHG | greenhouse gas |
| GIS | Geographic Information System |
| GIZ | German Corporation for International Cooperation |
| HAP | Heat Action Plan |
| HI | heat index |
| IBRD | International Bank for Reconstruction and Development |
| IPCC | Intergovernmental Panel on Climate Change |
| LoD | Level of Detail |
| LST | land surface temperature |
| M&E | monitoring and evaluation |
| NDC | nationally determined contribution |
| NDMA | National Disaster Management Authority |
| NGO | nongovernmental organization |
| RCCC | Red Cross Red Crescent Climate Centre |
| SDC | Swiss Agency for Development and Cooperation |
| SSP | shared socioeconomic pathway |
| UHI | Urban Heat Island |
| UHIa | Urban Heat Island Index |
| UHIE | Urban Heat Island Effect |
| UTCI | Universal Thermal Climate Index |
| WBT | wet-bulb temperature |
| WBGT | wet-bulb globe temperature |
| WHO | World Health Organization |

# INTRODUCTION

This Technical Manual forms the second volume of the World Bank's Handbook on Urban Heat Management in the Global South, a practical resource for local governments that wish to address heat risk in their city. It adds to the existing body of literature on urban heat by distilling technical approaches into a step-by-step, action-oriented process. It is aimed at city governments in low- and middle-income countries, focusing on their specific challenges and opportunities.

The Handbook consists of three volumes:

- **Volume 1 Summary for Policymakers,**
- **Volume 2 Technical Manual, and**
- **Volume 3 Solutions Catalog.**

This Technical Manual provides a comprehensive overview of key concepts, step-by-step guidance on activities, and specific measures for urban heat management, organized in four chapters:

- **Understanding Heat Resilience (Chapter 1)** introduces key concepts around urban heat resilience and management, serving as a conceptual baseline for subsequent chapters.
- **Assessing Heat Risk (Chapter 2)** and **Planning for Heat Resilience (Chapter 3)** cover step-by-step actionable guidance for local governments to develop a solid evidence base for heat management and develop plans and strategies to implement heat management solutions.
- **Responding to Heatwaves (Chapter 4)** is targeted at local governments that face an imminent heat emergency and provides checklist-style activities to consider before, during, and after the heatwave.

## *Adapting guidance to your context*

Shaped by their geography, environment and climate, people and history, economy and politics, no two cities are the same. In recognition of the complexity and uniqueness of cities in the Global South, the guidance presented in this Handbook is accompanied by tips on adapting approaches and solutions to your context.

City size and capacity context can affect what is prioritized while addressing urban heat risks, the motivations influencing change, who holds responsibility for building urban heat resilience, and what resources are available to implement actions. For example, small cities with limited resources within municipal government may want to consider assessment techniques that do not require costly equipment or complex modeling to inform their decision-making.

Climate context can affect the type of heat experienced, its consequences, and therefore the need to tailor assessment approaches and solutions. For example, cities with hot and arid environments may find the use of water features a more effective solution to address seasonal heat compared to cities in tropical and humid environments.

While the primary users of this Handbook are local government technical staff, the guidance can also help other city stakeholders in their efforts to address urban heat risks. For example, the guidance around raising awareness of heat risk within the public could be used by community groups to shape their campaigns on safeguarding against extreme heat.

| | 1 UNDERSTANDING HEAT RESILIENCE | 2 ASSESSING HEAT RISK | 3 PLANNING FOR HEAT RESILIENCE | 4 RESPONDING TO HEATWAVES |
|---|---|---|---|---|
| | Introduction to key concepts and terms around urban heat resilience and management | Creating an evidence base to inform action on heat resilience | Developing heat management plans and implementing interventions for heat resilience | Implementing actions to respond to heat waves and reduce heat-related impacts |
| ACTIVITIES AND TOPICS | 1.1 *What is heat risk?* | 2.1 *Assess context and capacity* | 3.1 *Communicate heat risks and impact* | 4.1 *Preparing for heatwaves* |
| | 1.2 *What are the impacts of extreme heat in cities?* | 2.2 *Assess hazards* | 3.2 *Set objectives for heat management in your city* | 4.2 *Responding during heatwaves* |
| | 1.3 *Why is heat risk becoming more important?* | 2.3 *Assess exposure* | 3.3 *Outline and prioritize heat resilience solutions* | 4.3 *Learning from heatwaves* |
| | 1.4 *How are cities in the Global South particularly affected?* | 2.4 *Assess vulnerability* | 3.4 *Develop prioritized heat resilience solutions for implementation* | |
| | | 2.5 *Assess impacts* | 3.5 *Monitor and evaluate heat risk and resilience* | |
| | | 2.6 *Combine heat risk assessment* | | |

# 01 Understanding Heat Resilience

Urban heat is a growing challenge in many cities around the world due to unintended urban development and consumption patterns. Climate change is an exacerbating factor, driving up average temperatures and the frequency of extreme heat events. This chapter provides an overview of the key concepts related to urban heat risk and resilience, highlighting the impact of heat on urban systems, and the specific challenges of cities in the Global South. Technical terms are explained in the Glossary of Terms.

## 1.1 WHAT IS HEAT RISK?

**This Handbook aims to empower local governments to manage extreme heat risk by improving the heat resilience of their cities.** In this Handbook, heat resilience refers to the capacity of an urban system to anticipate, withstand, adapt to, and recover from acute heat episodes (heatwaves) and chronic heat exposure in ways that maintain its essential functions, such as the local economy, healthcare, water supply, or public transport (amongst others). Key components of urban systems include human health and livelihoods, local economy, infrastructure, and the environment.

**Strengthening of urban heat resilience depends on efficient urban heat management.** Urban heat management deals with mitigation of heat in cities through strategic built environment interventions that reduce heat risk, as well as heat wave adaptation, for example, through assessment of local heat risk and effective response during heatwaves. Chapters 2 to 4 cover the three components of heat management.

**Effective heat management avoids maladaptation.** Maladaptation refers to situations when solutions intended to improve climate resilience or respond to other hazards—including data and technology solutions or infrastructure developments—end up making residents, local economies, urban infrastructure, or environmental assets more vulnerable. For example, an improved drainage system for flood prevention may remove vegetation and thereby increase outdoor ambient temperatures. Maladaptation is more likely to occur when there is an insufficient understanding of risk and poor planning of interventions. The guidance provided in this Handbook on assessing heat risk and planning for heat resilience helps city leaders reduce the risk of maladaptation (Schipper et al. 2020).

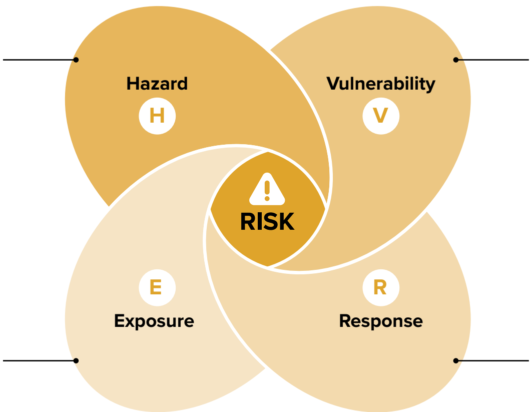
**Heat risk refers to the potential for harm or adverse effects on people, infrastructure, the economy, and the environment from heat exposure.** Heat risk can be represented as a function of hazard, exposure, and vulnerability as shown in Figure 2-1. In this equation, vulnerability is characterized by an inverse relationship between sensitivity and adaptive capacity.

Throughout the Handbook, two types of heat—acute heat episodes and chronic heat exposure—have been referred to:

- **Acute heat episodes** (heatwaves) can be defined as periods when local excess heat accumulates over a sequence of unusually hot days and nights (WMO 2025). Heatwaves are characterized by temperatures that are significantly higher than the average records for a specific time and location on a regional scale in combination with elevated humidity. What is considered a heatwave in some places may not be considered as such in others (Paolini et al. 2022). National meteorological services often adapt specific climate variable thresholds to define heatwaves and issue heat alerts. For example, in London, UK, the UK Met Office declares a heatwave based on four

**Hazard**
Refers to high temperatures that can be extreme heat episodes or slow-onset increases in temperature combined with high humidity, and its physical characteristics, such as magnitude, duration, timing (day and night time) and spatial extents.

**Exposure**
Refers to the degree to which people, infrastructure, economy, and ecosystems are exposed to heat hazards. The exposure of people is influenced by their activities and employment, e.g., outdoors or in factory settings.




**Vulnerability**
Refers to the susceptibility of people, infrastructure, economy, and ecosystems to the negative effects of the heat hazard. The vulnerability of people depends on age, gender, and health conditions.

**Response**
Refers to human responses to extreme heat, which affect the three components of affect hazard, exposure and vulnerability. Heat adaptation responses have the potential for positive or negative impact on heat risk.

**Figure 2-1.** Heat risk equation

heatwave temperature thresholds which vary across all the UK counties (UK Met Office, n.d.). In contrast, in the plains of India, a heatwave is defined as at least two consecutive days over 40°C (NDMA, n.d.). Despite the differences, all heatwave definitions note a sudden, significant, and time-limited departure from average or recent climatic conditions. These short-term spikes in temperature can cause immediate and delayed health emergencies, disrupt daily activities, damage infrastructure, and significantly reduce workplace productivity.

- **Chronic heat exposure** is the prolonged or repeated experience of increased temperatures over an extended period. Temperatures may gradually increase, for example, due to climate change. This gradual rise can affect energy consumption for cooling, health, and productivity. In particular, the tropical and subtropical regions are chronically exposed to extreme heat, especially due to gradual rise of temperature, where the hot season can come with nearly permanent very high temperatures lasting for two to four months (Oppermann 2021). Such gradual temperature changes will reduce the number of "normal" days and increase the number of "caution" and "dangerous" heat days and are therefore closely linked to acute heat episodes.

**How we experience heat does not only depend on temperature but also climatic factors, such as wind and humidity.** Relative humidity is the amount of water vapor in the air compared to the amount of water the air can hold at a specific temperature. This impacts how hot a temperature feels to the body. With higher humidity, water does not evaporate as easily, making it harder for the body to cool itself down through sweating (Vanos et al. 2023). The **wet-bulb temperature** (WBT) index is a heat stress measure that indicates the human cooling capacity through sweating. The **wet-bulb globe temperature** (WBGT) index also considers humidity, wind speed, sun angle, and cloud cover. It is measured in direct sunlight. Extreme heat indicators often refer to specific thresholds that are known to cause harm (Oppermann 2021). [Refer to Activity 2.1.2 Assess hazard characteristics for more detail on how to characterize and measure heat.]

While heatwave definitions are often relative, there are also absolute physiological limits related to heat tolerance. Most studies estimate human survivability limits to extreme heat (the threshold above which the human body can no longer adapt) at 35°C WBT with six hours of exposure leading to death. Recent studies suggest that survivability limits are lower for older populations, in humid climates and when exposed to the sun (Vanos et al. 2023).

Heat risk varies across the city and the population. Urban landscapes are complex. Neighborhoods in the city have different temperatures according to their geographic, socioeconomic, and physical characteristics, causing local microclimates. Similarly, at the building scale, indoor temperatures vary according to the design and materials of the buildings. Urban heat risk is often exacerbated in low-income neighborhoods, aggravating existing inequalities. In these neighborhoods, inadequate housing fails to protect residents from extreme heat. Informal labor, outdoors or in over-heated buildings, chronically exposes workers to extreme heat. Moreover, unstable incomes and a lack of savings tend to reduce the coping capacity of low-income households (for example, access to healthcare or investment in indoor cooling). Understanding the variability of heat risk across the urban area and across different scales (city, neighborhood, and building) is therefore important for addressing these risks effectively (World Bank 2023a). [Chapter 2 Assess heat risk covers this aspect in more detail.]

# *The Urban Heat Island effect*

**Cities are often hotter than the surrounding rural areas, a phenomenon referred to as the urban heat island effect (UHIE).** There are different types of UHIE, most importantly surface and atmospheric, which influence one another and require different ways of assessment (Oke et al. 2017).

- **Surface UHI** refers to higher temperatures on the city's surface (land surface temperature or LST). The sun heats dry and exposed urban surfaces, such as roofs or pavements, during the day. They can become up to 10°C hotter than the air temperature around them depending on the region, while moist or shaded surfaces, such as forests, maintain a similar temperature to the air around them (Adão et al. 2023). The difference between air and surface temperature tends to be highest during the day (Oke et al. 2017). LST can be observed from space, making it possible to identify surface UHI through remote sensing technologies.
- **Atmospheric UHI** refers to higher temperatures of the air in cities, which is measured locally in weather stations or local sensors. Atmospheric UHI is further divided into canopy and boundary layer UHI. Canopy layer UHI refers to the air where people live (between ground and rooftops). Boundary layer UHI refers to the air above the city, starting from the rooftops and extending to the point where the city has no more influence on the atmosphere (2 kilometers from the surface). The Handbook focuses on the canopy layer UHI. Atmospheric UHI is usually weaker throughout the day and becomes pronounced after sunset due to the slow release of heat from urban surfaces, buildings, and infrastructure. High nighttime temperatures have negative effects on health as they prevent the body from cooling down overnight (Oke et al. 2017).

**The intensity of UHI and its effects are dependent on the way the city is built, including the factors listed below.** An understanding of how the built environment influences heat in your city is important for mainstreaming heat considerations in urban planning, design, and construction decisions.

- Many cities lack green space and thereby lose out on the natural cooling effect of vegetation from shade and evaporation.
- Buildings and streets tend to be made of materials that contribute to UHI such as concrete, tarmac, and steel, which absorb the sun's energy, and tend to store this heat thus increasing the indoor temperatures, especially during the night.
- Urban geometry refers to the dimension and spacing of buildings, which influence ventilation (wind flow) and the ability of surfaces to release heat. For example, heat can get trapped in narrow streets with high buildings common in downtown areas of large cities.
- Human activities generate heat, referred to as anthropogenic heat, for example, from cars, air conditioners, or industrial activities. Further, poor air quality worsens the effect of the UHI.
- Other factors include weather (UHI is higher in certain weather conditions, like clear skies and calm winds) and geography (Oke et al. 2017).

# 1.2

# IMPACTS OF HEAT IN CITIES

**Cities around the world are increasingly impacted by urban heat.** By 2050, the number of cities that experience average summer temperatures of 35°C is projected to triple to 970 cities, which means that the urban population exposed to these temperatures will increase by 800 percent, reaching 1.6 billion by the same year (Atlantic Council 2023). Extreme heat has negative impacts on urban systems including their residents, the local economy, urban infrastructure, and its environment as summarized below.

| PHYSIOLOGICAL FACTORS | SOCIOECONOMIC FACTORS |
| --- | --- |
| **Pre-existing physical illnesses**<br>such as cardiovascular illness (the primary cause of death during heatwaves), and pre-existing respiratory illnesses. These illnesses are most common among older people but also exacerbate vulnerability among younger adults or children (Ebi et al. 2021). | **Poverty**<br>Low-income households are disproportionately vulnerable to urban heat. Evidence shows that the indoor air temperature of housing occupied by poor communities is between 4°C and 5°C hotter than the outdoor air temperature (Dodman 2022). |
| **Pre-existing mental health illnesses**<br>Heat can intensify symptoms related to mood disorders and interact with medications in ways that make it more difficult to cool off. In the US, hospital admissions for people with mood disorders increase on hot days by up to 40% (Wallace and Euler, 2024). | **Informality**<br>Vulnerability is exacerbated for people living in informal settlements and working in informal employment. A lack of security of tenure and social protection, and unstable income prevent workers from adapting occupational habits to extreme temperatures which also results higher heat-related workplace injuries. |
| **Pregnancy**<br>Extreme heat increases the risk of obstetric complications which are significant drivers of maternal morbidity (Baharav et al. 2023). | **Gender**<br>Analysis of mortality data of the 2010 Ahmedabad heatwave revealed significantly more female heat-related deaths (Azhar et al. 2014). Heat-related health risks can be exacerbated for women by the pressure of expected gender roles (Euler 2023) or heat-driven aggressive behavior partially directed toward women (Simister and Cooper, 2005). The effect of gender on heat risk is context specific. |

**Table 2-1.** Factors that Increase Vulnerability to Heat Risk

# *Health and equity*

**Extreme heat is associated with adverse health impacts.** Heat stress is the leading cause of weather-related deaths (WHO 2023). Moreover, extreme heat and poor air quality are linked, where a combination of both can lead to severe respiratory and cardiovascular issues, thereby increasing mortality rates. The impact of heat on people varies according to their physical and socioeconomic characteristics.

Broadly the following population groups are most vulnerable to heat:

- **The elderly:** According to the World Health Organization (WHO), heat-related mortality for people over 65 years of age increased by approximately 85 percent between 2000–04 and 2017–21 (WHO 2023). Increased mortality during heatwaves is particularly linked to factors such as being bedridden, living alone, limited self-care capability, restricted mobility, dehydration risk and pre-existing physical and mental health issues (Ebi et al. 2021).
- **Children and infants:** Children are more vulnerable to heat due to their higher water content and smaller surface-to-body ratios. Heatwaves worsen allergens and air pollution, further endangering their developing respiratory and immune systems (Ebi et al. 2021). Extreme heat adversely affects unborn babies and infants causing long-lasting impacts on their health throughout their lives (Baharav et al. 2023). Additionally, heat impacts children's education and learning. Without air conditioning, each 0.56°C increase in school-year temperature reduces the amount learned that year by 1 per cent (Goodman et al, 2020).
- **Urban poor:** The urban poor often reside in densely populated, informal settlements with limited access to cooling infrastructure. They are more likely to work in outdoor or poorly ventilated environments, which increases their exposure to heat stress. Additionally, limited social support with lack of job security and low financial reserves as well as lack of access to information and services further worsen the impacts of heat. These factors make them more vulnerable to climate impacts and less capable of coping when they occur (Chaudhry, 2024).
- **Heat-exposed workers:** Heatwaves and chronic heat exposure significantly affect outdoor workers, such as construction workers, market vendors, open-air vehicle riders or drivers (e.g., rickshaw drivers), and waste collectors, as well as people working in overheat indoor spaces, e.g., industrial workshops without cooling. The combination of high metabolic heat production (heat produced in the body) from manual labor and high temperatures exacerbates heat strain. A meta-analysis of over 447 million workers from 40 occupations in 30 countries found that about one-third of those exposed to occupational heat stress faced increased risks of hyperthermia as well as cardiovascular and acute kidney disease (Ebi et al. 2021). Exposure to extreme heat typically reduces productivity as workers need to pace themselves and take regular breaks to manage heat strain. For low-income and informal workers, reduced productivity can quickly worsen their financial situation, reinforcing poverty (Ebi et al. 2021).

Within these groups, specific—often intersecting—physiological and socioeconomic factors exacerbate vulnerability.

# *Livelihood and economy*

Extreme heat significantly impacts local economies in cities due to reduced productivity. Heat can cause direct work interruptions due to more frequent breaks for rest or hydration. Heat stress slows down workers' movements as their bodies conserve energy, leading to more mistakes and reduced decision-making capacity (ILO 2019). When public transport networks are interrupted due to extreme heat, employees struggle to get to work. Reduced productivity leads to substantial and increasing economic losses. Table 2-1 provides an overview of the impact of heat on the local economy of seven selected cities, highlighting which sectors are most affected, based on an analysis conducted by the Arsht Rockefeller Foundation. In Dhaka, for example, economic losses due to heat are estimated at 8 percent of the city's gross domestic product (GDP) currently and are estimated to increase to 10 percent by 2050 (Atlantic Council 2023).

| CITY | LABOR PRODUCTION LOSS (US$) | | MOST IMPACTED INDUSTRIES | TOTAL INCREASE OF EXTREME HEAT DAYS BY 2050 |
|---|---|---|---|---|
| | BASELINE CONDITIONS | BY 2050 | | |
| **BANGKOK** | 8.6 billion | 16 billion | Logistics, public services, leisure | 2X (3X for extreme hot days) |
| **BUENOS AIRES** | 115 million | 355 million | Manufacturing, logistics, business administration | 2X |
| **DHAKA** | 6 billion | 12 billion | Manufacturing, logistics, public services | 2X |
| **FREETOWN** | 30 million | 150 million | Agriculture, logistics, public services | 1.3X (4 months as hot as the 10 hottest days to baseline climate) |
| **MONTERREY** | 1.8 billion | 4 billion | Construction, manufacturing, logistics | 4X |
| **NEW DELHI** | 3.9 billion | 6.1 billion | Constructions, logistics, business administration | 2X |
| **SANTIAGO** | 100 million | 200 million | Logistics, business administration, public services | 3X |

**Table 2-2.** Economic Effect of Heat-related Productivity Loss in Seven Cities Across Regions of the Global South.
**Source:** Arsht-Rock 2022. Hot Cities, Chilled Economies. Impacts of extreme heat on global cities.

## *Urban infrastructure*

**Extreme heat can subtly yet significantly impact infrastructure, leading to increased failures and complex challenges.** As temperatures rise, roads can develop cracks, power lines may sag and increase risk of fires, and buildings often struggle to maintain cool temperatures. Water supply may become less reliable, very dry soil can contribute to pipe bursts, and prolonged heat periods may contribute to water scarcity. The surge in air conditioning use can push energy generation to its limits, leading to rolling blackouts. Extreme heat causes concrete degradation impacting buildings and infrastructure. These small failures can quickly escalate into larger issues, making city- and state-wide infrastructure challenges difficult to manage. Transportation infrastructure, including pedestrian paths, transit stations, and air travel, also faces significant risks from extreme heat. Integrated planning is essential to enhance urban heat resilience and manage these impacts effectively (APA 2022).

## *Environment*

**Extreme heat impacts the urban environment and ecosystems, particularly urban landscapes and ecology.** Rising temperatures can limit the diversity and richness of urban vegetation and negatively affect the growth of urban trees. Many plants that have historically thrived may struggle in higher temperatures. Extreme heat alters urban ecology, favoring different plants and animals. Warmer urban areas can support species not typically found in cooler climates, such as tropical mosquitoes, which can introduce new diseases. Extreme heat in cities affects water availability and quality. It causes thermal pollution by heating stormwater runoff, which raises water temperatures in natural bodies of water, reducing water quality and increasing the risk of waterborne disease and affecting aquatic life (Eder et al. 2018, US ESA 2014, WAREG 2023).

# 1.3

# HEAT IS BECOMING A BIGGER ISSUE

**Climate change refers to long-term shifts in average weather patterns, driven primarily by human activities** which release large amounts of carbon dioxide and other greenhouse gases (GHG) into the atmosphere, trapping heat and leading to a steady rise in global temperatures. Unlike short-term weather events, climate encompasses average conditions over extended periods—typically 30 years or more (Paolini et al. 2022). As these GHG accumulate, global temperatures continue to rise, altering natural habitats and human environments alike. Figure 2-2 illustrates the increased probability of hot weather and record hot weather when global mean temperatures increase due to climate change.

**While climate change is gradually increasing global temperatures, it also amplifies extreme weather events.** Heatwaves have become more frequent, intense, and prolonged since the mid-20th century (Lee et al. 2023). Between 2023 and 2024, climate change added an average of 26 days of extreme heat (nominally, across all places in the world) than there would have been without a warmed planet (Climate Central 2024). As global temperatures increase, even by increments as small as 0.5°C, the probability of heat hazards rises significantly. Each additional degree of average warming makes heatwaves more severe and frequent, leading to longer periods of extreme heat with noticeable impacts on human health, agriculture, and infrastructure. Life-threatening heat and humidity are expected to impact between half to three-quarters of the global population by 2100 (Mackres et al. 2023).

**The effects of climate change are not uniform across the globe.** Central and South America, Sub-Saharan Africa, Middle East, South and Southeast Asia are the regions expected to experience the greatest increases in extreme heat. Low- and middle-income countries, particularly in the Global South, will face the highest frequency of extreme heat days. Cities in these regions, which often have limited resources to adapt, are expected to bear the brunt of these changes, making climate adaptation even more urgent.

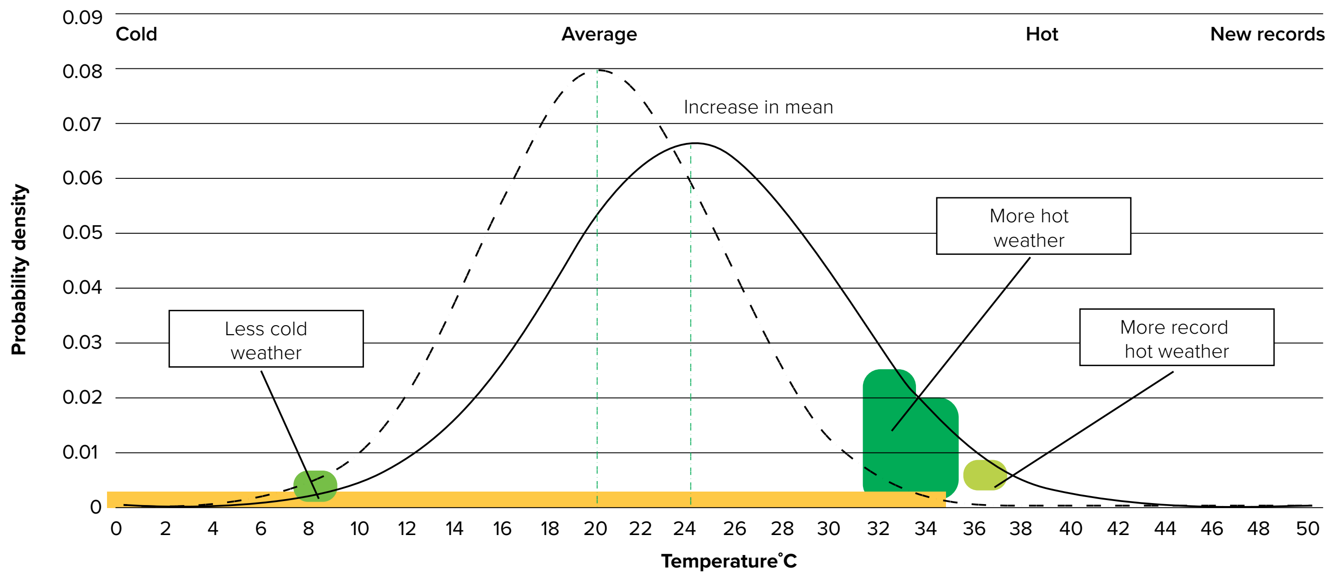



**Figure 2-2.** Schematic global changes in the probability of extreme weather events due to climate change.
**Source:** © AtkinsRéalis data

# 1.4

# HIGHER IMPACT ON CITIES IN THE GLOBAL SOUTH

**Extreme heat is affecting cities around the world, but the impact is disproportionately severe in the Global South.** Cities in the Global South are not just more exposed to heat hazards, they are also more vulnerable to urban heat due to socioeconomic factors, the way the city is built, and governance arrangements.

## *Informal settlements and work*

**Around one billion people worldwide live in informal settlements, most of them in Global South cities.** Informal settlements tend to be in hotter areas of the city, often with high population densities and lack of green spaces that lead to even higher temperatures. Buildings often fail to protect residents from extreme heat, since they usually feature metal roofs and no or poor insulation and ventilation. In Mumbai and Ahmedabad, India, the outside air temperatures of informal settlements are 5-7°C warmer than the surrounding areas (Mackres et al. 2023).

**A lack of stable income combined with insecurity of tenure (risk of eviction) prevents residents from investing in their homes and adapting them to higher temperatures.** Informal settlements rely on fragile services (for example, poor water supply network), which further reduces their residents' capacity to cope with heat (ADB 2022). For the urban poor in many low- and middle-income countries, access to healthcare is limited (out-of-pocket spending). An increasing proportion of refugees and displaced people live in urban centers, and their characteristics also make them vulnerable to heat (Dodman et al. 2022).

**While productivity loss is a common impact of heat around the world, local urban economies in the Global South are more vulnerable due to the dominance of the informal sector.** In parts of South Asia and Sub-Saharan Africa (for example, India and Sudan), the share of informal employment is over 85 percent (ILOSTAT 2025). Figure 2-3 shows the working hours lost to heat stress by subregion between 1995 and projections for 2030, highlighting that South Asia, West Africa, Southeast Asia, and Central Asia are higher than the world average. Informal labor tends to be more exposed to heat, including activities such as working in overheated homes and factories (domestic workers, garment industry) or working outdoors (market vendors, rickshaw drivers, or construction workers) with little protection from heat.

**Informal workers are also less able to adapt.** The lack of social protection and savings does not allow informal workers to adjust working hours to cope with heat (ADB 2022). As productivity falls, wages decrease, especially for hourly or informal workers, who may face more frequent work stoppages or dangerous working conditions. Women face additional challenges due to their limited adaptive capacity and fear of loss of income (Atlantic Council 2023). A World Bank study on Southeast Asian cities shows that a temperature increase of more than two standard deviations above a city's historical norm for any given month reduces its nighttime light intensity, which is a proxy for economic activity, by nearly 4 percent during that month (World Bank 2023a).

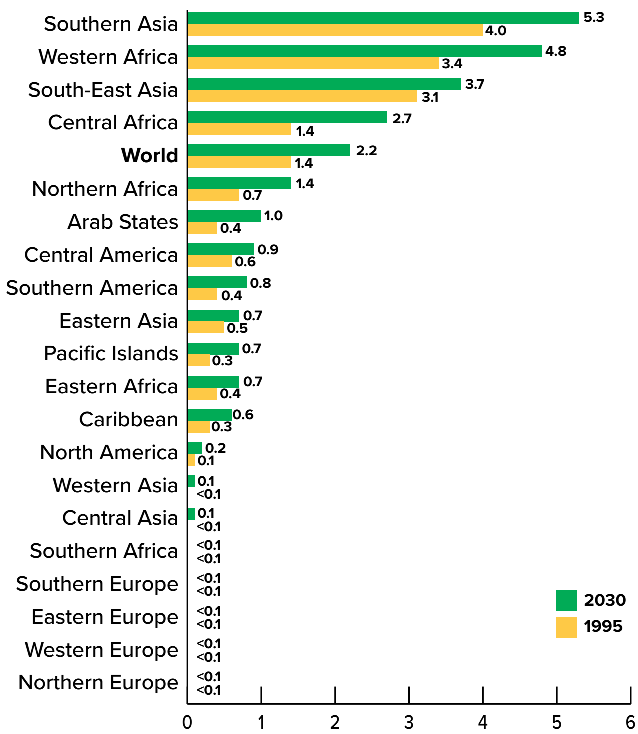



**Figure 2-3.** Working hours lost to heat stress by subregion, 1995 and projections for 2030 (percentages)
**Source:** World Bank 2023a © International Labor Organization 2019.

# *Rapid growth and infrastructure gaps*

**Many cities in the Global South lack basic infrastructure and services with large infrastructure needs and investment gaps**; for example, Mexico, Myanmar, Guinea, and Argentina need to approximately double their infrastructure investment to meet forecasted needs by 2040 (Global Infrastructure Hub, 2018). Such gaps increase the vulnerability of cities and their inhabitants to extreme and slow-onset heat risks. The following infrastructure gaps and inequalities have the largest effect on heat risk in cities in the Global South:

- **Dense unplanned urbanization** which can lack ventilation and cooling elements, and informal settlements that can be particularly vulnerable;
- **A high proportion of impervious surfaces and limited green infrastructure** means that cities are made from materials that often absorb and store heat. Insufficient green spaces decrease natural cooling, shade, and evapotranspiration while cities closer to the equator have relatively weak cooling capacities (Li, Yuxiang et al 2024).
- **Unreliable access to (clean) electricity and cooling** results in many people being unable to benefit from fans and air conditioning to provide indoor cooling, this can also be exacerbated among vulnerable groups such as the elderly (Jessel, Sonal et al. 2019). Therefore, many rely on passive cooling strategies such as ventilation, shade, and trees; however, these can often be lacking in cities in the Global South.
- **Inadequacy of water management systems** results in limited water supply so that people lack access to safe drinking water to cool down, and poor drainage that increases humidity during rainy seasons. In addition, poor surface water management leads to the drying up of ponds, lakes, streams, rivers, and canals resulting in a lack of water for various purposes, such as irrigation and drinking. This is often a major issue and dilemma in water-scarce regions of the Global South.

# *Barriers to heat management*

**The capacities of local governments to manage urban heat risk and protect many cities in low- and middle-income countries are more constrained** (UN-Habitat 2023). The following governance hurdles pose a barrier to local heat management:

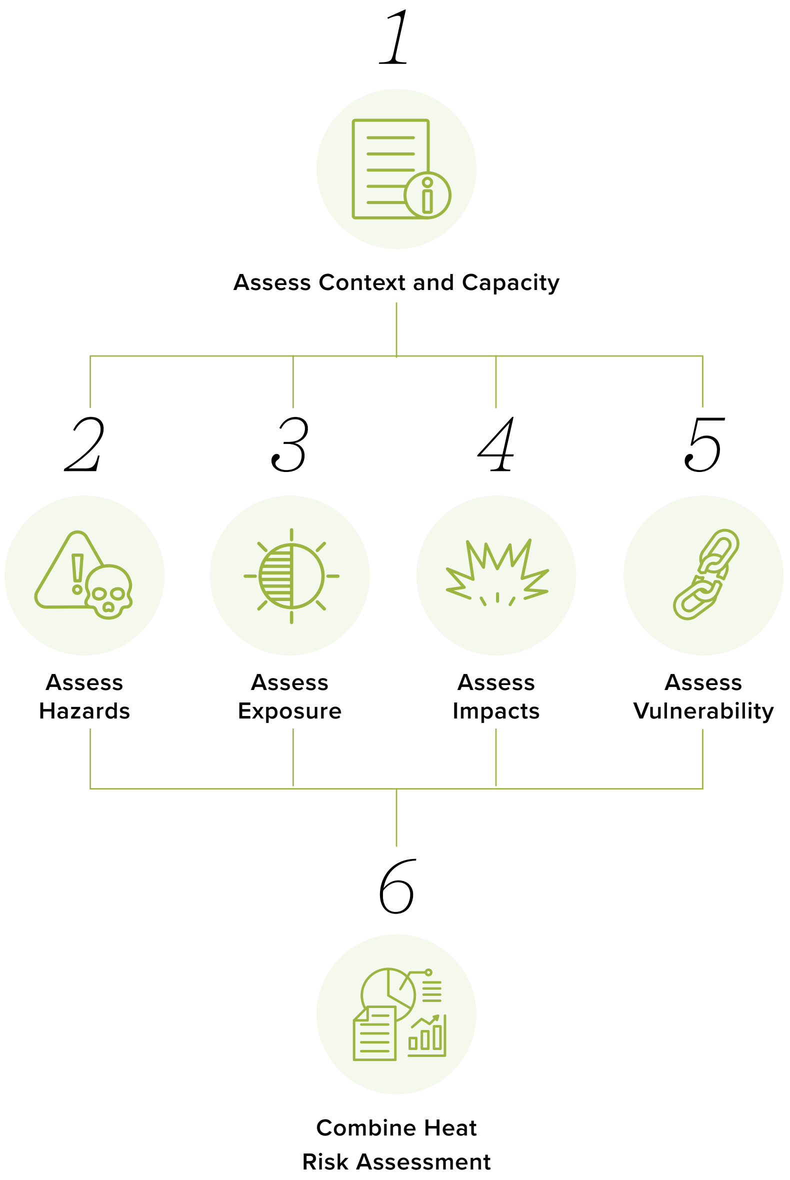
- Limited political mandates for urban planning and own source revenue generation;
- Limited access to funding and financing for delivering projects;
- Limited technical capacities of municipal staff and/or lack of human resources in local authorities; and
- Lack of quality local data, including temperatures and the impact of heat.

The step-by-step guidance on urban heat management provided in sections 2.2 to 2.4 takes these governance challenges into account and focuses on approaches that are suitable within a Global South context.

# 02 Assessing Heat Risk

**Developing a solid information baseline on heat risk in your city is a prerequisite for successful heat management. The impact of urban heat on local people, the economy, urban infrastructure, and the environment differs in every city and is dependent on hazard characteristics, exposure and vulnerability to heat, and the local capacity to cope.**

**This chapter presents guidance on assessing heat risk in your city across the following activities:**




**The objective of this chapter is to enable the reader to implement an assessment of heat risk by themselves or become a well-informed client to procure services for more complex heat risk assessment approaches.**

# *Assessment Approach*

Assessment of heat risk helps to respond to and reduce heat-related impacts. The process should be co-led with community partners and bring together diverse actors across sectors to increase coordination in preparation, response, and recovery stages of heat management. There are many best-practice methodologies for assessing components of risk that will help develop effective solutions in your city. Each can be assessed across a range of temporal and spatial scales, and varying degrees of technical ability.

Heat risk assessments should generally follow the logic set out in Figure 2-4. This chapter covers the following key activities:

- **Context and capacity:** Evaluating the city's context and capacity to undertake an assessment, which includes a review of the institutional and policy framework, key actors, and stakeholders.
- **Hazard:** Identifying chronic and acute heat hazards, defining a city-specific baseline of the hazards, and developing an understanding of changes in the future.
- **Exposure:** Identifying communities or infrastructure that may be impacted, where they are situated in your city, and how that might change in the future.
- **Vulnerability:** Evaluating people's sensitivity to the heat risk hazard as well as their capacity to adapt.
- **Impact:** Identifying direct and indirect consequences by developing impact chains and, where applicable, quantifying them based on past events. Assessment of impact supports the prioritization of risks.
- **Heat risk:** Analysis of urban heat risk, from the above components, and establishment of a monitoring framework.

For each activity, cross-cutting assessment themes include consideration of baseline versus future trends, use of different data types, and varying spatial scales. Value-based judgments are often necessary for climate change risk assessments. If impacts cannot be measured in the same units (that is, monetary losses, reduced life expectancy in years), guidance would typically point to using categories to classify relative or absolute hazard, exposure, vulnerability, or impacts. This scoring can be agreed upon by stakeholders or established by expert elicitation and supported by any available relevant information, including national and regional climate risk assessment.

Solutions for building heat resilience will rarely be standalone; they are often integrated with other projects or mainstreamed into wider policies and plans to avoid maladaptation. For example, green space development and tree planting will need to be integrated into land use planning to balance the needs for housing or infrastructure development. Heat management is therefore a collaborative process between various actors and stakeholders. An understanding of this ecosystem of heat management will enhance the efficiency of developing and delivering solutions.

The following solutions cards presented in the **Catalog of Solutions (Volume 3)** support the guidance in this chapter:

- **Establishing an early warning system (EWS) for heatwaves;**
- **Heat risk mapping using global and local temperature data and including climate change modeling; and**
- **Heat risk mapping using stakeholder engagement and locally available information.**

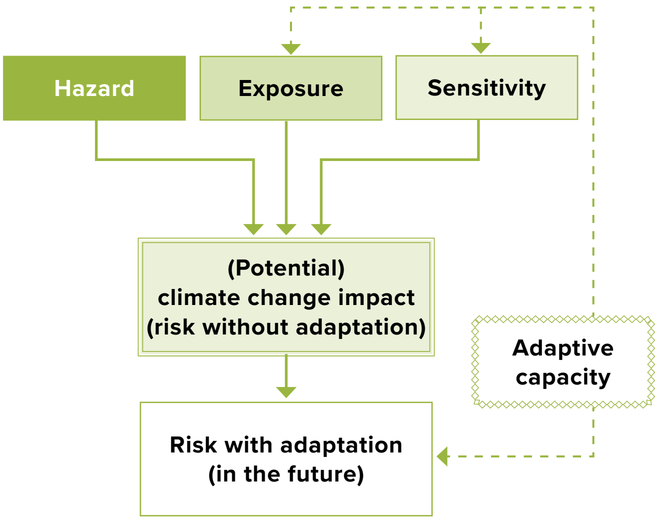



**Figure 2-4.** Activities for assessing heat risk
**Note:** Risk components based on IPCC AR5 concept of climate risk. **Source:** ISO 14091: 2021.

**ASSESMENT APPROACHES**

| HIGH EFFORT / LOW COMPLEXITY | | LOW EFFORT / HIGH COMPLEXITY | |
|---|---|---|---|
| **PARTICIPATORY APPROACHES** | **ANALYSIS BASED ON EXISTING DATA, USING EMPIRICAL APPROACHES** | **URBAN CLIMATE MODELS** | **REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM (GIS) BASED MODELLING** |
| **Description**<br>Involving local communities to identify heat risks and co-develop solutions<br>**Pros**<br>Context-specific and socially inclusive<br>**Cons**<br>Time-intensive and may lack scientific rigor depending on implementation | **Description**<br>Using observed temperature data combined with demographic and health data to identify vulnerable populations<br>**Pros**<br>Simplicity and low data requirement<br>**Cons**<br>Requires high-quality socioeconomic and health data.<br>Univariate models (using temperature only) have limited ability for assessment of climate scenarios | **Description**<br>Satellite data, meteorological data, urban planning information, environmental data, climate scenarios, high resolution models<br>**Pros**<br>Simulating and analyzing climatic and atmospheric processes through modelling approaches for scenario testing<br>**Cons**<br>Computationally intensive and requires high-quality urban, meteorology and environmental data. Requires skilled practitioners | **Description**<br>Satellite data, GIS tools, high resolution models<br>**Pros**<br>Rapid assessment over large areas is useful where ground data is scarce<br>**Cons**<br>Computationally intensive and requires high-quality urban, meteorology and environmental data. Requires skilled practitioners |

**Table 2-3.** Potential Approaches to Risk Assessment. **Source:** World Bank, 2025.

# *How to Adapt this Guide to Your Context*

The assessment of heat risk in this chapter is based on the intersection of hazard, exposure, and vulnerability. Evaluation of each can be undertaken at varying levels of detail, dependent on the resources available to your city, that is, the combination of technical knowledge and capacity, and availability of funds. A summary of potential approaches is presented in Table 2-3 based on increasing capacity requirements (low to high).

Local governments in the Global South should consider the approaches mentioned in Table 2-3, alongside the following recommendations:

- **Make use of existing data set indicators, and models:** A wide range of global temperature-based indicators are available for initial assessments, including data from Copernicus Climate Change Service (C3S), the World Bank Climate Data Portal, and selected research papers.
- **Focus on an inclusive approach** that combines local data, stakeholder knowledge, and GIS-based assessments for a well-rounded assessment. Validate findings through participatory engagement.
- **Capacity building:** Strengthen local expertise and infrastructure for urban climate modeling and vulnerability mapping.
- **Prioritize data collection:** Work with national meteorological services to invest in weather stations/urban observatories, remote sensing validation, and socioeconomic surveys to improve model calibration.
- **Policy integration:** Align climate risk assessments with urban planning, zoning laws, and public health strategies.

# 2.1

# ASSESS CONTEXT AND CAPACITY

**Analyzing the local context and capacity for heat management helps to understand the institutional arrangement, stakeholder landscape, and parameters of heat management in your city.** This activity includes five steps:

1. **Setting the parameters for the heat risk assessment;**
2. **Selecting climate change scenarios and timeframes;**
3. **Assessing the institutional arrangement and capacity for managing urban heat;**
4. **Mapping the stakeholder landscape; and**
5. **Planning for engagement as well as review of existing policy,** plans and initiatives at local and national levels.

## *Activity Information*

| | |
|---|---|
| **SOURCES OF INFORMATION** | • National legislation, policies, plans, and strategies for climate resilience, urban development, disaster preparedness or emergency response (e.g., national determined contributions (NDCs), national adaptation plan, national urban development framework, building code, etc.), health strategies and statistics, economic strategies, economic, housing statistics.<br>• Local policies, plans, and strategies for climate resilience, urban development, disaster response, and emergency response (e.g., masterplan, climate action plan (CAP), annual city budget, etc.).<br>• Documentation of past, planned, or ongoing initiatives and projects related to urban heat (e.g., annual progress reports of development assistance projects).<br>• Workshops, interviews, and focus group discussions (FGDs) with key actors and stakeholders. |
| **EXPERTISE REQUIRED** | • Good knowledge of the local and national institutional and policy context.<br>• Access to key actors and informants in the city government, civil society, public sector, and academia.<br>• Experience of working on urban development and climate change issues with key actors and stakeholders in the city. |
| **OUTCOMES** | • Responsibilities/ mandates for heat management are confirmed. Capacity development needs are identified.<br>• Key stakeholders involved and contributing to heat management are identified and an engagement plan is in place.<br>• The policy framework is documented with opportunities for mainstreaming and alignment as well as gaps are identified. |

**Source:** World Bank, 2025.

## 2.1.1.

### *Set parameters for the heat risk assessment*

**Before starting, you should define the parameters for your assessment to ensure that the approach you adopt strikes a balance between usability (being fit for your purpose and tailored to your audience), feasibility (an appropriate level of technical rigor), and viability (a balance between cost and gains).**

Before starting, answer the following questions:

- What is the purpose of your heat risk assessment?
- Who will use your heat risk assessment?
- What is your budget for the heat risk assessment?
- What study area will your heat risk assessment cover? Are you looking at the whole city or just a specific area?
- What timeline do you want to set for your heat risk assessment? Are you looking at the status quo or also the future?

The following chapters will provide options for heat risk assessment methods; based on your answers to the above, consider which will be more suitable to your context.

***Resources***

Chapter two "Getting your city ready for addressing heatwaves" in the "Heatwave Guide for Cities" developed by the Red Cross Red Crescent Climate Centre (RCCC) to access detailed guidance on actors and roles in heat management.

## 2.1.2

### *Select climate change scenarios and timeframes*

If you are considering future heat risk in your city, you can use climate scenarios to help you estimate the scale of climate change. Climate change scenarios are a way of describing possible future changes to climate variables and hazards.

Four main Representative Concentration Pathways (RCP) span a broad range of climate forecasting by 2100 (2.6, 4.5, 6.0, and 8.5 watts per meter squared), these RCPs are coupled with five Shared Socio-Economic Pathways (SSPs), which represent the different ways in which the world might evolve in the absence of climate policy and how different levels of climate change mitigation could be achieved when the mitigation targets of RCPs are combined with the SSPs (Keywan et al. 2017).

| RCP (W/M2) | 8.5 | 6.0 | 4.5 | 2.6 | 1.9 |
|---|---|---|---|---|---|
| SSP1 SUSTAINABLE DEVELOPMENT | | | | | |
| SSP2 MIDDLE-OF-THE-ROAD DEVELOPMENT | | | | | |
| SSP3 REGIONAL RIVALRY | | | | | |
| SSP4 INEQUALITY | | | | | |
| SSP5 FOSSIL-FUELED DEVELOPMENT | | | | | |

**Table 2-4.** Common climate scenarios, based on socioeconomic pathways (SSPs) and climate forcing (RCPs), used in climate risk assessment. (IPCC AR6)

It is recommended that risk be assessed over a minimum of two scenarios to support decision making for an uncertain future. Consider choosing a realistic scenario (higher probability and lower consequences) and a worst-case scenario with higher levels of warming (lower probability and higher consequences).

# 2.1.3

## *Assess the institutional arrangement and capacity for managing urban heat*

**Institutional arrangements for heat management are complex.** In most cities, there is no dedicated public institution or government department responsible for heat management. Decision-making power is dispersed, and heat management is missing or carried out by a range of different actors in multi-level and cross-sectoral partnerships. City governments, meteorological agencies, and health and emergency departments all play different roles in heat management. When mandates and responsibilities are not clearly defined, coordination and decision-making become challenging. Especially, in the context of heatwaves, acting swiftly and in a coordinated manner saves lives. Therefore, **identifying relevant institutions involved in heat management and understanding their specific roles and responsibilities is an important step.**

**Identify all actors that have an active role in urban heat management in your city.** Consider both governmental and nongovernmental organizations. In some countries, specific national departments may have mandated roles in disaster risk management, and delivery of climate services, including extreme heat. Ensure that you are engaging with the national-level actors. You may find it useful to make a table noting down all relevant institutions and their roles/responsibilities and then prioritizing the most critical ones. Take a step back and ascertain if there are any gaps.

- For each of the prioritized actors, **assess to what extent they can fulfill their role/responsibility.** Consider their technical and financial capabilities, human resources, and equipment.
- Next, **assign ownership and responsibilities for the heat risk assessment and the heat resilience planning process.** For example, you could set up a steering committee that reviews the assessment and plan and provides feedback.
- **Agree and formalize roles and responsibilities with key actors**, for example, by organizing a stakeholder meeting.

| ACTOR / INSTITUTION | ROLE / RESPONSIBILITY IN CONTEXT | CAPACITY TO PLAN FOR HEAT RESILIENCE | | | | NOTES |
|---|---|---|---|---|---|---|
| | | TECH | FIN | HR | EQUIPMENT | |
| Municipal Department of Planning | Prepare, implement, and monitor local development plans, and carry out land use and infrastructure planning activities | High | Low | Low | NA | Knowledge of heat resilience is high, but the team is understaffed and does not have a consistent budget allocation for the implementation and monitoring of plans |
| Regional Department of Finance | Allocate funding for large infrastructure projects in the city | Low | High | Low | NA | Controls funding allocation for heat resilience infrastructure projects. Many demands on time and resources, and insufficient knowledge of climate budgeting |
| Local academic institution | Collect data on local temperature | High | Low | Low | High | Holds data on local temperature and high technical capacities for heat risk assessment |

**Table 2-5.** Example Template for Assessing the Institutional Arrangement and Capacity. **Source:** World Bank, 2025.

# 2.1.4

## *Map the stakeholder landscape to plan for engagement*

An inclusive approach to heat management, where diverse actors participate, is the cornerstone of successful heat management. There is a need for both vertical and horizontal integration among internal and external departments and agencies, including national-level policy and planning. This integration is essential because cities require funding to implement their activities.

- **Identify actors impacted by urban heat in your city.** Involving those affected by urban heat helps to understand community needs and target actions where they are most needed. Chapter 2 provides a list of vulnerable groups as well as physical and socioeconomic factors that affect vulnerability. Consider how they apply to your context. Engaging these actors throughout the process enables access to sources of information and local knowledge, provides opportunities for raising awareness of urban heat, and builds community cohesion. By including those that are disproportionately affected by urban heat in the heat management process, you can reduce vulnerabilities and increase social equity.
- **Identify actors who influence urban heat management.** Involving those that can influence urban heat management, for example, researchers, from the start is equally important. It opens information sources and increases stakeholder buy-in and support for selected actions.
- **Plan for how you can reach and engage stakeholders.** You may need to tailor your engagement strategy to different groups, ranging from sharing information on social media to public stakeholder meetings and FGDs. Many of the vulnerable groups are harder to reach and not necessarily part of urban planning processes. Consider how you can reach them and design safe spaces for sharing their experience and needs.
- **Develop a stakeholder engagement plan,** a short document including stakeholder mapping and types and dates for engagement.

***Resources***

C40 Playbook for Inclusive Community Engagement for detailed guidance and specific tools for mapping the stakeholder landscape and planning for engagement.

| STAKEHOLDER | ROLE / RESPONSIBILITY | ENGAGEMENT | | | | NOTES |
|---|---|---|---|---|---|---|
| | | RESPONSIBLE | ACCOUNTABLE | CONSULTED | INFORMED | |
| Local University – Climate Science Department | Conduct regular local temperature measures | | | ● | | Consult and collaborate with on heat risk assessment |
| Association of Local Market Vendors | Organize the local market, equipment, opening hours, etc. | | | ● | ● | Consult and inform, ask for information on vulnerabilities and options for reducing them. |

**Table 2-6.** Example Template for Mapping Stakeholder Landscape and Level of Engagement. **Source:** World Bank, 2025.

# 2.1.5

## *Review existing policies, plans, and initiatives at local and national levels*

Heat management is a cross-cutting initiative and ties into policy, plans, and initiatives at the local and national levels in a range of sectors from climate resilience to urban planning and public health. Understanding the status quo of heat management is important so that efforts are not duplicated and synergies between different initiatives are used effectively. It is also important to understand national priorities, aligning with which can provide access to international and national funding.

| STEP | WHAT TO REVIEW? | QUESTIONS TO CONSIDER |
|---|---|---|
| Policy review | **National**<br>Long-term development plan, NDCs, national adaptation plan, national urban policy and/or spatial plan, disaster response plan.<br><br>**Local**<br>Urban development plan, CAP, local disaster response plan/ procedures | • Is urban heat risk covered/addressed in national/local level policies/ strategies? If so, how?<br>• What objectives and strategic actions are set?<br>• Can you identify gaps?<br>• How well are the national and local levels integrated? |
| Review of initiatives | **National**<br>planned/ongoing government programs.<br><br>**Local**<br>planned / ongoing initiatives in your city by local government, civil society, private sector, or academia. | • What projects/programs/ initiatives are planned and ongoing?<br>• Who is leading them (e.g., which ministry or city department)?<br>• Who is funding them?<br>• Are they relevant to your city?<br>• Are there opportunities for synergies? |

**Table 2-7.**Assess the Status Quo of Heat Management at the National and Local Level. **Source:** World Bank, 2025.

CASE STUDY 1

### A successful start to the Nepalgunj heat action planning journey

Nepalgunj Sub-Metropolitan city, a business hub in Nepal, faces rapid urbanization and amplified impacts of climate change such as recurrent and severe heatwaves The absence of systematic tracking of heat-related deaths made it challenging to gauge the full extent of heatwaves' impact.

In 2021, the Climate and Development Knowledge Network Asia, in collaboration with RCCC, conducted a heat risk study. The small study presented an opportunity for additional partners (for example, the UK Met Office) to join the effort, turning the rapid assessment of heat hotspots into a comprehensive analysis of heat risk.

Leveraging the findings from previous studies, with support from the Norwegian and Finnish Red Cross, the Nepalgunj city authority and Nepal Red Cross Society developed and published a comprehensive Nepalgunj heat action plan (HAP) 2023.

In 2024, the Nepalgunj city authority, responding to positive feedback from stakeholders and the community, allocated resources to implement several prioritized measures outlined in HAP. A key initiative was the installation of water ATMs for laborers, street vendors, and auto drivers during peak hot time.

The detailed steps of the Nepalgunj HAP journey are illustrated in Figure 2-5.

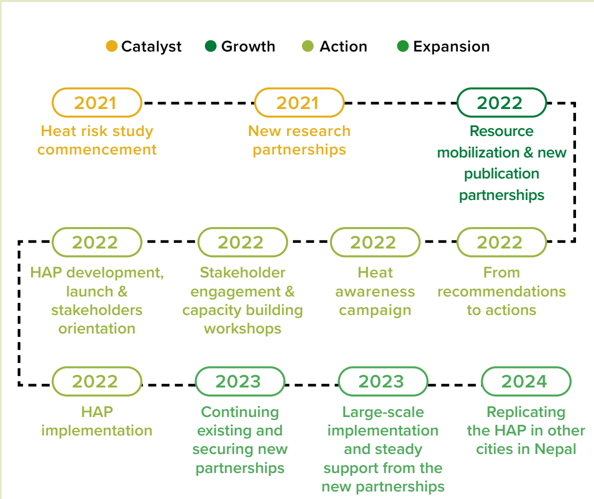



**Figure 2-5.** The Nepalgunj heat action journey. **Source:** © Nepal Red Cross Society.

# 2.2 ASSESS HAZARDS

**This activity contains guidance on understanding and characterizing heat hazards in your city, including the use of climate projections to understand how they might change in the future.** Heat-related hazards 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 2021). Understanding the attributes of heat risk in your city will ensure adaptation solutions are targeted and scalable to the magnitude and type of hazard. The following steps present a guide for characterizing heat hazards in your city:

1. **Identify and understand heat hazards for your city or local context;**
2. **Determine city-specific heat thresholds;**
3. **Understand historical frequency trends; and**
4. **Consider future changes in climate.**

## *Activity Information*

| | |
|---|---|
| **SOURCES OF INFORMATION** | • National and regional climate risk/hazard assessments<br>• Local weather station data (hourly or daily temperature datasets)<br>• Climate observations from national meteorological services or climate model reanalysis data sets from regional or global climate centers<br>• Satellite remote sensing data on LSTs<br>• Workshop/stakeholder engagement |
| **EXPERTISE REQUIRED** | • Understanding of past extreme heat events in your city, their frequency and severity<br>• Subject expertise in, for example, applied climate science or urban planning |
| **OUTCOMES** | • Understanding of types and magnitude of heat risk in your city<br>• Definition of a baseline for heat hazard in your city and completion of a historical trend analysis<br>• Understanding of climate change's influence on heat hazards in your city |

### *2.2.1*

### *Identify and understand heat hazards for your city or local context*

To identify the types of hazards that are relevant to your city or local context (Table 2-8), consider historical heat-related impactful events and hazard information sourced from national, regional, or local climate risk assessments and bespoke hazard investigations.

| HEAT TYPES | |
|---|---|
| **Extreme Heat** | Acute period of high temperature (and humidity) that can be dangerous to human health and overload infrastructure (e.g., air conditioning, railway buckling, etc.). |
| **Heatwave** | A sustained period of abnormally hot and uncomfortable temperatures, typically several days to several weeks. |
| **UHI** | Where urban areas experience significantly warmer temperatures than surrounding rural areas, exacerbating heat-related effects in an urban setting. This is due to heat absorption and retention of urban infrastructure in combination with warmer temperatures. |
| **Fire Weather Conditions** | The growing prevalence of climatic conditions that are conducive to wildfires. This includes low seasonal rainfall, lower humidity, and changes in wind patterns. |
| **Increased Average Temperatures** | A sustained increase in average temperatures (minimum, mean, maximum) over time. While not classified as an acute hazard, this trend may increase energy demand and shift the balance of days toward a larger number of extreme heat days. |

**Table 2-8.** List of Dynamics to Consider in Heat Assessments

# 2.2.2

## *Determine city-specific heat risk thresholds*

Define city-specific heat hazard thresholds, above which an alert or action may be required to respond to the hazard so that real-time monitoring, annual reporting, and historical climate datasets interrogation can be achieved.

Commonly used indicators for heat risk thresholds are presented in Table 2-9. Select the indicator(s) that best represent heat-related risks in your city's context and what your city currently monitors concerning climate and meteorology.

No single indicator is universally best. The choice of which metric to use depends on what data is available in your city along with what heat hazard you are interested in monitoring or measuring. Humid regions should consider using indices that include a humidity factor (AT, WBGT, UTCI). Heat thresholds depend on local temperatures and coping capabilities of the at-risk elements (Eunice Lo, 2023).

| METRICS | Extreme heat | Heatwaves | Urban Heat Island | Increased Fire Weather | Increased average temperatures |
|---|---|---|---|---|---|
| HEAT INDEX (HI)<br>A combined measure of air temperature and relative humidity that estimates how hot outside conditions feel to the human body. | ● | | | | |
| APPARENT TEMPERATURE (AT)<br>A combined measure of air temperature, humidity, and wind speed. Also known as "feels like" temperature and HI. | ● | | | | |
| UNIVERSAL THERMAL CLIMATE INDEX (UTCI)<br>Metric describing how the human body experiences atmospheric conditions, such as air temperature, humidity, wind, radiation. | ● | | | | |
| WET-BULB GLOBE TEMPERATURE (WBGT)<br>WBGT combines air temperature, humidity, wind, and solar radiation, and is widely used in occupational safety, sports, and disaster risk management to guide heat exposure limits. | ● | | | | |
| TEMPERATURE-BASED EXCESS MORTALITY RISK<br>Excess mortality risk factor for daily maximum temperatures. | ● | | | | |
| HEATWAVE DAYS<br>Count of consecutive days, for example, at least three, where the maximum temperature is above a threshold. | | ● | | | ● |
| CLIMATOLOGICAL HEATWAVE DAYS<br>Count of days that exceed the 99th percentile of daily maximum temperatures during a reference period. | | ● | | | ● |
| EXCESS HEAT FACTOR (EHF)<br>Quantifies the intensity of heat waves relative to long-term climate averages, considering both recent (3-day average temperature) and long-term (30-day average temperature) temperature anomalies. | | ● | | | |
| URBAN HEAT ISLAND INDEX (UHIA)<br>The difference in atmospheric temperature of a city compared to surrounding rural reference locations. | | | ● | | |
| FIRE WEATHER INDEX (FWI)<br>Estimate of the meteorological danger of fires, which comprises a measure of temperature, humidity, wind speed, and rainfall. | | | | ● | |

**Table 2-9 .** Common Heat Hazard Indicators

# 2.2.3

## *Understand historical frequency and trends*

Using the hazard definition and thresholds, it is possible to understand how often events have occurred in the past and underlying trends by analyzing historical climate datasets. Metrics to consider when characterizing the frequency and trends of heat hazards from climate datasets include:

- Annual frequency of heat hazard events: Count of defined events per year;
- Trend analysis: Increasing or decreasing trend in year-on-year events;
- Duration and magnitude of individual events: Maximum length and temperatures of events; and
- Seasonal variations: Within which months do hazard events commonly occur.

A comprehensive assessment of heat hazards might also consider spatial variation at this stage, including where heat hazards are occurring at the highest magnitude. This information can be sourced through participatory methods (stakeholder engagement or interviews) or more comprehensive remote sensing heat mapping (Toolbox).

TOOLBOX

### *Urban climate models and remote sensing*

Climate-related heat hazards can be assessed using geospatial analysis to identify areas of relatively higher risk within the city. Heat mapping methods include air and surface temperature monitoring, ground observations, satellite remote sensing, citizen science, and mobile mapping, participatory methods (Mougiakou & Paraskevopoulou 2025). Resources for heat mapping, including global data sources include:

- Resources on urban climate models are available on the website of the International Association for Urban Climate, the main association of urban heat island researchers.
- USGS EarthExplorer provides open-source satellite images, aerial photographs, and cartographic products through the U.S. Geological Survey.
- The Global Surface UHI Explorer | Center for Earth Observation (yale.edu) is a Google Earth Engine Application for mapping the Surface UHIE in urban areas.

# 2.2.4

## *Consider future changes in climate*

Use available climate projections to understand how heat hazards might change in the future. Consider the frequency, duration, and magnitude of the hazard, using projections from agreed climate scenarios (e.g., SSP1-2.6, SSP2-4.5, and SSP3-7.0) and timeframes (mid-century, end-century).

Identify climate variables relevant to heat hazards (average temperature, days above 30°C, and so on) to assess whether they will change in the future and by how much. This will provide insights into whether current management strategies are suitable or whether increased frequency and magnitude of the hazard require further action to reduce the risk in the future.

CASE STUDY 2

### Citizen-led heat mapping in Johannesburg and Ekurhuleni, South Africa

South Africa's rapidly urbanizing cities, including Johannesburg and Ekurhuleni, are increasingly facing the impacts of extreme heat due to climate change. Sprawling informal settlements, high population density, and poor infrastructure make vulnerable communities in these cities particularly susceptible to heat stress. Temperature in most of the city areas have been 3-4°C higher as compared to the countryside. However, in neighbourhoods with dense buildings, little vegetation, and where most residents are black, the temperature differential reaches 6°C. In response to these challenges, citizen-led initiatives, including innovative heat mapping using personal vehicles, have emerged as valuable tools for understanding and mitigating UHIs and informing local HAPs.

As part of the South African National Treasury's Cities Program with technical support from the World Bank's City Resilience Program and in collaboration with local government bodies, researchers, and environmental organizations, residents have deployed temperature sensors on their vehicles to map heat distribution across urban and peri-urban areas. This grassroots initiative, driven by community participation, aims to produce real-time temperature data that can be used to identify heat hotspots, monitor daily temperature variations, and assess how heat is distributed within different parts of the city. The citizen-led mapping project is particularly focused on marginalized communities, where heat stress has the greatest impact.

The heat sensors, installed in cars, collect temperature data while citizens drive around their neighborhoods, particularly targeting areas that are difficult for traditional sensors to reach, such as informal settlements, unpaved roads, and narrow alleyways. The data collected are uploaded to a central platform and shared with municipal authorities, researchers, and climate adaptation organizations.

The data gathered from citizen-led heat mapping shall be integrated into the city's HAP, which aims to reduce heat-related health risks and improve resilience to climate change. This action plan will guide local governments in addressing heat stress, especially in informal settlements and underserved areas.

As more data are gathered and analyzed, the project can evolve into a comprehensive EWS for heatwaves, providing crucial information for emergency response teams and local authorities to act more swiftly in protecting vulnerable populations.

**Source:** Souverijns et al. 2022, World Bank Blogs (2022)

## HOW TO ADAPT THIS ACTIVITY TO YOUR CONTEXT

The activity and its steps will help you to identify appropriate heat-related hazards relevant to your city, determine thresholds for heat hazard analysis, and understand future climate changes. Depending on your city's capacity to undertake climate analysis, this step can be undertaken at several tiers.

**City Size and Capacity (Low): Readily available global projections**

Existing global climate tools can be used to gain a basic understanding of future climate change in your city or region. Sources for global climate projections include:

- World Bank Climate Change Knowledge Portal (Country and Watershed) Climate Projections
- IPCC WGI Interactive Atlas
- Copernicus Interactive Climate Atlas
- KNMI Climate Explorer

**City Size and Capacity (Medium): Uplift of baseline analysis using climate projection datasets**

Projected changes in average or maximum temperatures from climate models can be applied to observed data as uplifts or change factors at seasonal or monthly scale to assess future risks. For more advanced studies statistical methods like statistical downscaling, time series analysis and extreme can be applied.

**City size and capacity (high): Modelled assessment of climate change hazards**

If necessary, downscaled climate modeling or bespoke analysis will allow for a more robust analysis of climate projections and heat-related hazards. Climate models, including those from CMIP6, can be applied in the following ways for city-scale, extreme heat assessments:

- Downscaling global climate models: Using regional climate models to refine global climate model outputs at finer spatial resolutions, incorporating local topography, urban features, and land-use characteristics.
- Urban climate models: Incorporating urban canopy models to represent urban morphology, surface characteristics, and anthropogenic heat emissions.
- CMIP6 provides improved physical representations of climate processes, longer historical simulations, and scenarios aligned with SSPs, allowing for better city-level scenario planning. Models like EC-Earth, MPI-ESM, or GFDL-CM4 can be downscaled and tailored for urban assessments.

Detailed city-scale modeling of extreme heat risks can provide improved climate scenarios, advanced physical processes, and longer-term projections. Existing services and off-the shelf products can support this approach.

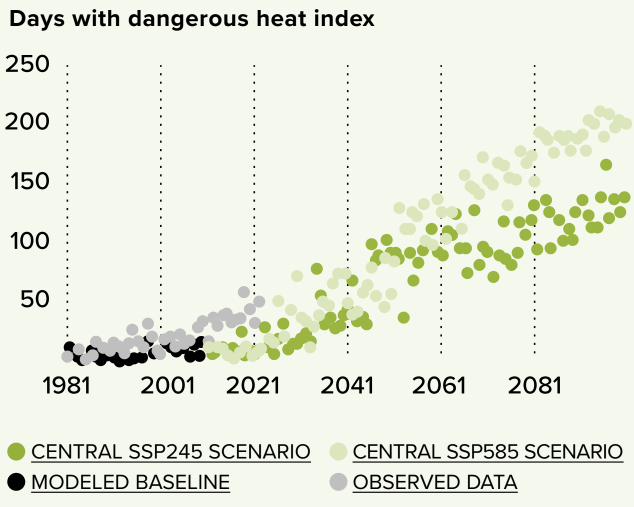



**Figure 2-6.** Number of dangerous heat days in Rajshahi, Bangladesh, across scenarios. **Source:** © AtkinsRéalis 2023.

# 2.3
# ASSESS EXPOSURE

**This activity presents guidance on identifying the potentially vulnerable communities in your city that may be subjected to the heat hazards identified in the hazard assessment. Communities and infrastructure include people, livelihoods, species or ecosystems, environmental functions, or economic, social, or cultural assets.** The exposure assessment includes identification of exacerbating factors that contribute to UHI. An assessment of exposure is generally made on a spatial scale, based on several urban factors that influence heat stress:

1. **Identify communities and infrastructure at risk of heat hazards.**
2. **Identify factors that contribute to high urban temperatures.**
3. **Map communities and infrastructure, factors of UHI, and heat hazard to evaluate exposure.**

## *Activity Information*

| | |
|---|---|
| **SOURCES OF INFORMATION** | • Workshops / stakeholder engagement<br>• Empirical data – census and historical and projected population data (for example, using NASA EARTHDATA), employment data, demographics, health, productivity, species distribution<br>• GIS data (building footprints, parks, linear infrastructure, cultural sites, etc.) |
| **EXPERTISE REQUIRED** | • Subject matter experts (people and culture, infrastructure, environment, economy), GIS specialists, data analysts<br>• Knowledge of areas within the city that are affected by heat |
| **OUTCOMES** | • Identification of communities and infrastructure at risk of heat hazard and how they might change in the future<br>• City-wide mapping of location and density of identified communities and infrastructure |

## *2.3.1*

### *Identify communities and infrastructure at risk of heat hazards*

In this step, identify effected communities and infrastructure and alter themes and groupings to suit the context of your city:

- People and culture (density, demographics, health, productivity, cultural events).
- Economy (construction, factory work, agriculture, etc.).
- Infrastructure (buildings, cultural heritage sites, linear infrastructure such as power, transport, water.
- Environment (livestock, flora, fauna, parks, and green spaces).

Urban centers are characteristically areas of high population (high exposure). Higher density living in certain areas across the city, religious festivals, sporting events, and other urban agglomerations should be considered in the exposure assessment.

## 2.3.2

### *Identify factors that contribute to UHI*

Key contributors to the UHIE that should be identified and mapped in your city include:

- Concrete and asphalt: These materials contribute to the urban heat island effect through their low albedo (reflectivity), high heat capacity, and thermal conductivity, causing them to absorb, store, and slowly release large amounts of solar heat.
- Buildings, structures, and materials: Certain building materials, such as dark-colored roofs and walls, absorb more heat, further exacerbating the UHIE.
- Decreased evaporative areas: Cities with limited green space and parks have less capacity to regulate temperature.
- Water bodies: Urban areas may have fewer or smaller water bodies, reducing this cooling effect.
- Anthropogenic heat: released mainly from airconditioned buildings and vehicles.
- The 3D urban geometry: Depending on the urban design, additional heat can be stored in vertical walls or more radiation could be trapped, while ventilation and wind speed might be obstructed or severely reduced.

## 2.3.3

### *Map communities and infrastructure, factors of UHI, and heat hazard to evaluate exposure*

Undertake a mapping exercise of communities and infrastructure relevant to your assessment and factors that contribute to UHI across your city. This information overlaid with the spatial hazard information (Activity 2.2) allows a city-wide assessment of heat risk exposure, helping to identify specific problem areas.

After identification and mapping, consider how these variables (communities and infrastructure, and UHI factors) might change in the future regarding population growth, urban planning, and city developments. Exposure ratings can be categorized by amount of the population exposed to hazards or frequency of events per year, and so on.

| | RATING | QUALITATIVE DEFINITION | QUANTITATIVE DEFINITION |
|---|---|---|---|
| EXPOSURE | **Extreme (4)** | Significant and widespread exposure of communities and infrastructure to the hazard | >75 percent of sector, community, or infrastructure is exposed to the hazard |
| | **High (3)** | High exposure of communities and infrastructure to the hazard | 50–75 percent of sector, community, or infrastructure is exposed to the hazard |
| | **Moderate (2)** | Moderate exposure of communities and infrastructure to the hazard | 25–50 percent of sector, community, or infrastructure is exposed to the hazard |
| | **Low (1)** | Isolated communities and infrastructure are exposed to the hazard | 5–25 percent of sector, community, or infrastructure is exposed to the hazard |

**Table 2-10.** Example of an Exposure Rating Scale

### HOW TO ADAPT THIS ACTIVITY TO YOUR CONTEXT

The activity and its steps will help you to identify communities and infrastructure in your city that might be impacted by heat-related hazards, and factors that exacerbate UHI effects, and map them to identify areas of higher risk. Depending on your city's capacity to undertake geospatial analysis, this step can be undertaken at several tiers.

**City Size and Capacity (Low): Participatory approaches**

Through targeted interviews and workshops with communities , identify where heat hazards have occurred in the past, and to what/whom. This might include dwellings, buildings and infrastructure, environmental assets, animal species, major transport hubs, hospitals, and schools, and identifying where people live and work.

**City Size and Capacity (Medium): Empirical statistical methods**

Use information from community or census data, such as the number of young, elderly, or unwell people to understand the areas in your city where these potentially vulnerable people are located or concentrated. Empirical methods might also consider use of statistical data to identify areas with higher energy demand, heat-related hospital admissions, more frequent operations and maintenance, etc.

**City size and capacity (high): Modelled assessment of climate change hazards**

Spatial data enables rapid assessment of large areas (see Figure 2-7), ideal for linear infrastructure, building footprints, and protected ecological areas. Empirical data such as census information from ward or suburb spatial scales can be incorporated. By intersecting community and infrastructure data with mapped hazard data (Activity 2.2), a comprehensive assessment of urban heat hazard exposure is achieved.

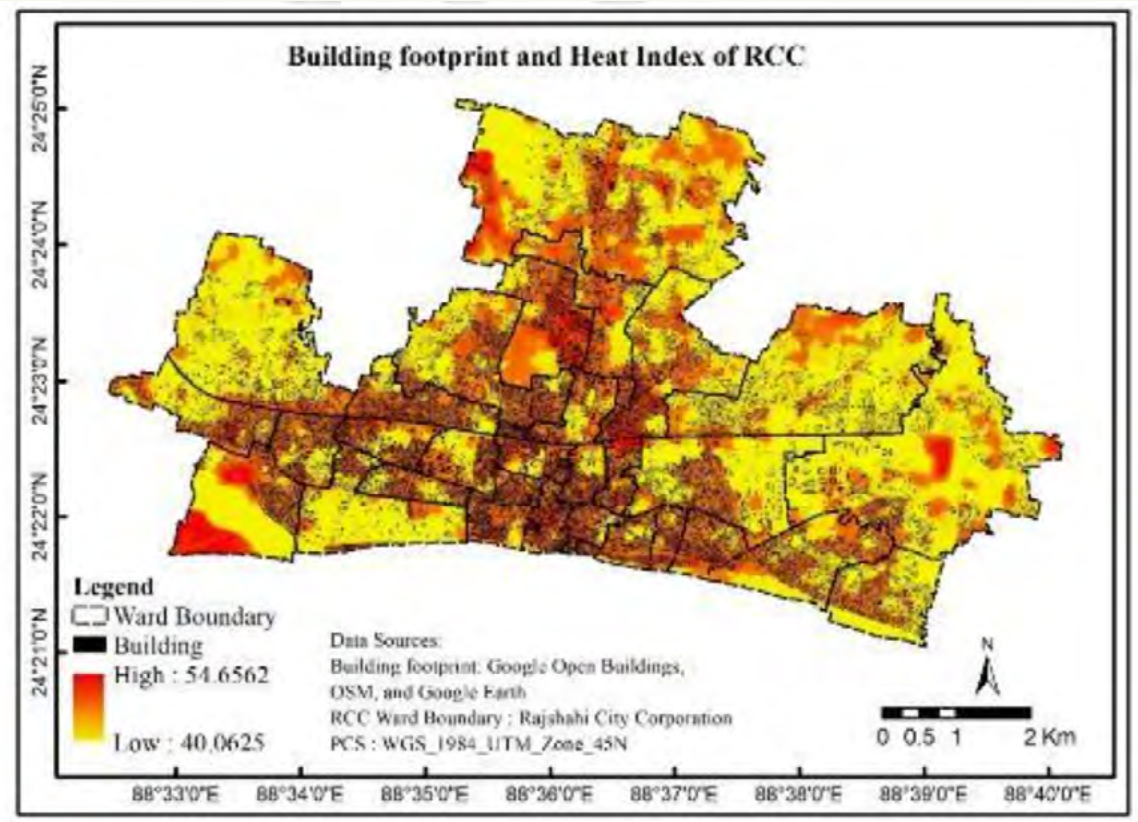



**Figure 2-7.** Building footprint and HI level in Rajshahi. **Source:** © AtkinsRéalis 2024.

CASE STUDY 3

## UNEP-CEPT UHIE assessment methodology

| STUDY PARAMETERS | | | | | | | |
|---|---|---|---|---|---|---|---|
| LEVEL OF DETAIL | Meteorology | Urban Infrastructure | Semantic | Operational profile | Energy consumption | Spatial resolution | Temporal resolution |
| **LoD 1** | Surface temperature | Land use land cover | Surface Characteristics | Deterministic - Single profile | Connected loads | 1000m | Decadal |
| **LoD 2** | **LoD1** + Air temperature | **LoD1** + Plot boudaries | **LoD1** + Building use and type | **LoD1** + Deterministic - Multiple profile | **LoD1** + Load profiles | 100m | Annual |
| **LoD 3** | **LoD2** + Relative humidity + Mean wind speed and direction + Solar radiation temperature | **LoD2** + Building footprint + Building height | **LoD2** + Age of property | **LoD2** + Stochastic-Space based | **LoD2** + Metered data | 30m | Monthly |
| **LoD 4** | **LoD3** + Wet bulb globe temperature + Cloud cover | **LoD3** + Sky view factor + Vegetation properties | **LoD3** + Building archetype | **LoD3** + Stochastic-Agent based | **LoD3** + Submeter end-use data | 10m | Daily / hourly |

**Table 2-11.** Level of Detail (LoD) Characterization for Fit for purpose (FFP) UHIE assessment framework. Source:© UNEP
**Note:** The huess of the colour become darker as the level of detail increases for the datasets concluded in each parameter for mapping and assessing the UHIE.

Cities must adopt urban heat reduction strategies to mitigate the negative impact of urban heat and reduce GHG emissions from building-related services. These strategies are essential to city-specific HAPs, the future planning process and should be derived from scientific UHIE assessments.

To support Indian cities in using a scientific, evidence-based approach to address urban heat while aligning with prevalent HAPs and future master plans, UNEP-CEPT developed a standardized methodology for UHIE assessment. This consensus-based methodology is grounded in two key frameworks: Fit for Purpose (FFP) and Level of Detail (LoD). This methodology enables cities to adapt assessments to available data, expertise, and resources while focusing on contextual and actionable outcomes. The FFP framework supports actions including developing a HAP; assessing the impact of urban planning on UHIE; improving outdoor thermal comfort, and reducing GHG emissions.

The LoD refers to the study parameters suggested for UHIE assessments. LoD ranges from 1 to 4, with LoD 4 representing the most detailed analysis. It includes detailed meteorological parameters (like air, surface temperature, humidity, wind, solar radiation, and WBGT), urban infrastructure data (such as land use land cover, building footprints, heights, vegetation, and sky view), semantic details (including surface characteristics, building type, building use and its age), operational profiles (from simple to stochastic behavior-based models), and energy data (electricity load profiles, sub-metering). Spatial resolution ranges from 1,000 to 10 m and temporal resolution from decadal to hourly. Table 2-11 presents various study parameters with their appropriate LoD characterization.

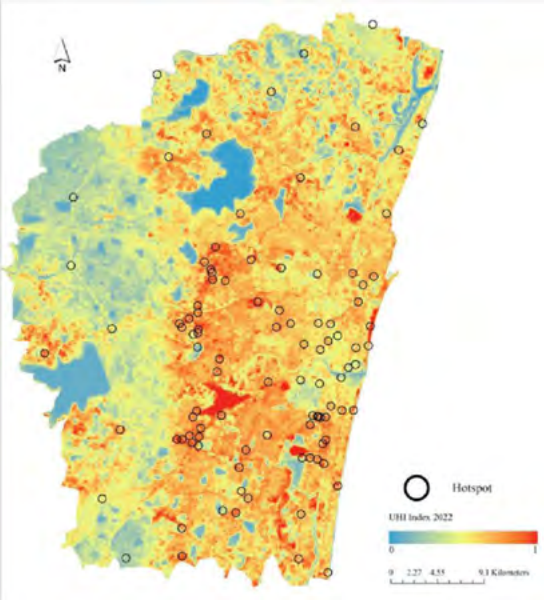
## *UHIE Assessment in Chennai*

The World Bank Group has been supporting development of Chennai Metropolitan Area's (CMA's) Third Master Plan (2026-47). To integrate climate responsive and climate resilient planning into the plan, UNEP supported UHIE assessments in Chennai. The UNEP-CEPT UHIE Assessment Methodology was applied in Chennai city for the development of 'Urban Heat Adaptation Guidelines for Chennai Metropolitan Area', which will be integrated into the Third Master Plan and the New Area Development Plan. By analyzing the spatial-temporal characteristics of the UHIE and its implications on urban climate, infrastructure, and public health, the study laid a scientific basis for climate-responsive urban planning. The study applied the FFP framework at detail levels between LoD 3 and LoD 4, using a multi-pronged approach to combine remote sensing, field-based meteorological measurements, and microclimate modelling. Historical LST trends were analyzed using satellite imagery (1980 to 2023) while real-time temperature, humidity, wind, and solar radiation data were collected over a year with five time stamps across 100 identified locations, of which 20 representative locations were selected for hourly measurements on the ground and detailed microclimate assessment.

The entire LoD-based assessment established the importance of how ground truthing and granularity in datasets can enhance the assessment of UHIE and other built environment indicators. LoD 4 was followed to collect information across meteorological parameters, urban infrastructure data, semantic details, administrative profiles and energy data. Based on real-time monitoring, there are a few areas which, consistently ranked highest in temperature indices due to their compact urban fabric, reduced airflow, and minimal cooling elements such as tree cover and water bodies. The study further highlights that locations with low sky view factor exhibit the highest UHI intensities, reinforcing the need for shading and ventilation strategies.

The study suggests that high-rise commercial and industrial zones show the highest urban heat intensities, while areas with tree-lined streets and green spaces remain cooler. It highlights the cooling benefits of blue-green infrastructure, with locations near the Adyar River showing

a)



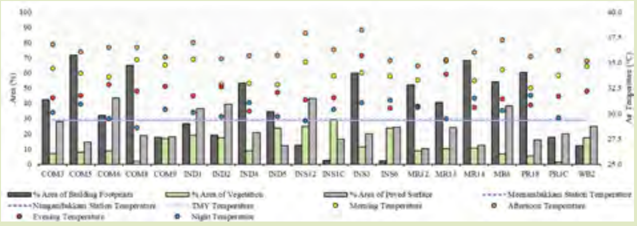



**Figure 2-8.** a) UHI index and the 100 spots selected across CMA; b) air temperature (field survey data) variation with the urban morphology indices and other metadata sources, mapped across the 20 spots in CMA. **Source:** World Bank n.d.

localised temperature drops of 2°C to 3°C. Cool roofs and reflective materials can further reduce temperatures by up to 4°C in dense commercial zones. However, it is only effective when combined with broader urban cooling strategies like shaded walkways, permeable pavements, and expanded green areas.

The study presents an actionable roadmap to mainstream heat adaptation into Chennai's urban planning framework, supported by global case studies and feasibility assessments. If fully implemented, the proposed interventions could lower city-wide temperatures by 1.5°C to 3°C and lead to a 15 to 30 percent reduction in heat-related morbidity.

This work has been supported by the Clean Cooling Collaborative, Danish International Development Agency and the Swiss Agency for Development and Cooperation (SDC). The project is being scaled nationally to five other states and 20 cities under the UNEP Cool Coalition 'BeCool' project funded by SDC.

# 2.4 ASSESS VULNERABILITY

**Vulnerability considers the combined characteristics of a community or infrastructure including its susceptibility to harm (such as age, health), social isolation in populations, material construction in infrastructure, species distribution, and response in natural systems.** This activity presents guidance on assessing the vulnerability of communities and infrastructure in your city identified in the exposure assessment, including consideration of characteristics that dictate the sensitivity and **adaptive capacity** of a community or infrastructure. The assessment should consider the following elements:

1. **Factors of sensitivity.**
2. **Factors of adaptive capacity.**
3. **Vulnerability of the community or infrastructure.**

## *Activity Information*

| | |
|---|---|
| **SOURCES OF INFORMATION** | • Workshops/stakeholder engagement<br>• People and culture (e.g., population demographics, poverty, health and epidemiology, etc.)<br>• Economy (construction, factory work, agriculture, insurance and finance)<br>• Infrastructure (e.g., age, informal dwellings, materials, access to services, etc.)<br>• Environment (species abundance and distribution data, vulnerability assessments) |
| **EXPERTISE REQUIRED** | • Social scientists and gender experts, environmental experts, and local government service providers<br>• Good knowledge of local socioeconomic factors, demographics, and environmental factors |
| **OUTCOMES** | • Understanding of the vulnerability context, the sensitivity of different groups, assets, building types, and infrastructure to heat. |

## *2.4.1.*

### *Consider factors of sensitivity*

In considering the sensitivity of a system, it is helpful to look at characteristics that influence its susceptibility to potential negative impacts. These characteristics or attributes can be bio-physical, socioeconomic, or other (for example, regulatory, administrative). The task is to identify attributes or properties that influence the extent of the potential impacts. The key question for this step is:

> **"Which characteristics of the community or infrastructure will exacerbate climate change impacts?"**

When specifying the sensitivity of a community or infrastructure, focus on its natural or physical characteristics. Many factors tend to be static and are inherent in the system while others might be altered through human activity. One example is resistance to drought in different crops which fare better or worse in the specified climate.

## 2.4.2

### *Consider factors of adaptive capacity*

Adaptive capacity is particularly important in the case of a comparative risk assessment that considers diverse systems, communities, and infrastructure at risk with different levels of adaptive capacity.

A detailed assessment of adaptive capacity can identify ways to reduce overall vulnerability to climate change impacts. The key question for this step is:

> **"Which characteristics of systems, communities, and infrastructure will reduce climate change impacts?"**

To structure your approach, refer to the four dimensions of adaptive capacity (knowledge, technology, institutions, economy). All dimensions have the potential to contribute to reducing risk. Methods for assessing adaptive capacity are often qualitative or semi-quantitative.

Identify datasets or knowledgeable stakeholders that provide information to answer these guiding questions for each dimension of adaptive capacity:

- **Knowledge:** is there knowledge or expertise which might aid adaptation?
- **Technology:** are there technical options available and affordable that could enhance adaptive capacity?
- **Institutions:** how does the institutional environment contribute to adaptive capacity?
- **Economy:** which economic and financial resources are available for enhancing adaptive capacity or implementing adaptation measures

In identifying adaptive capacities, consider aspects directly linked to the impact as well as more generic barriers to adaptation. Primarily, the adaptive capacity factors identified should explicitly contribute to reducing the vulnerability of a community or infrastructure to heat-related hazards. The adaptive capacity assessment should integrate local knowledge and establish consensus between experts and stakeholders. When the risk assessment considers risks for several communities and infrastructure (such as different suburbs or sectors), the assessment of adaptive capacity should be carried out for each community or infrastructure separately.

## 2.4.3

### *Evaluate the vulnerability of communities and infrastructure, data uncertainty, and knowledge gaps*

Undertake a vulnerability assessment by synthesizing the information collected on sensitivity and adaptive capacity. Communities and infrastructure considered to have low sensitivity and high adaptive capacity are less vulnerable to hazards. Conversely, high sensitivity and low adaptive capacity of a community or infrastructure indicates higher vulnerability and is thus a priority for intervention while recording certain aspects of data uncertainty and knowledge gaps.

The key question at this stage is:

> **"What characteristics should get more attention because they pose the greatest risk to the community or infrastructure?"**

Vulnerability information, both quantitative and qualitative, requires an informed judgment of vulnerability. Vulnerability classes can be categorized by the level of susceptibility due to high or low sensitivity and low or high capacity to adapt.

| | SENSITIVITY | | | |
|---|---|---|---|---|
| | Low (1) | Moderate (2) | High (3) | Extreme (4) |
| LOW (1) | Moderate | High | Extreme | Extreme |
| MODERATE (2) | Low | Moderate | High | Extreme |
| HIGH (3) | Low | Moderate | Moderate | High |
| EXTREME (4) | Low | Low | Moderate | High |

**Table 2-12 .** Example Vulnerability Matrix (Combining Sensitivity and Adaptive Capacity). **Source:** World Bank, 2025.

### HOW TO ADAPT THIS ACTIVITY TO YOUR CONTEXT

Depending on your city's resources and capacity to undertake the assessment, this activity can be undertaken at several tiers.

**City Size and Capacity (Low): Participatory approaches**

Community-based surveys or workshops to assess vulnerabilities should aim to consider the heightened risk of heat-related impacts, discomfort at work (for instance, factories), or access to basic services during a heatwave event. Engagement techniques help to explore personal experiences with heat, coping mechanisms, and other issues.

**City Size and Capacity (Medium): Statistical approaches**

Indicator-based vulnerability assessments use sets of predefined indicators that can be both quantitative and qualitative and can be assessed through stakeholder consultation, statistical methods, or modeling:

- GINI Index: A measure of income inequality that determines if areas with lower inequality are less socially vulnerable (World Bank 2025).
- Climate Change Vulnerability Assessment Tools: Used to evaluate vulnerability to major climate impacts across several sectors.
- Social Vulnerability Index: Constructs community rankings based on census tract-level data and is organized into four themes: socioeconomic status, household composition and disability, minority status and language, and housing type and transportation (Saulsberry et al. 2023).
- Neighborhood Deprivation Index: commonly used in public and environmental health literature including eight variables across domains of income, employment, housing, and education (Deziel et al. 2023).

**City size and capacity (high): Geospatial approaches**

Vulnerabilities can be mapped through satellite imagery of green cover, overall land use pattern, slum location, and so on. Superimposed maps can subsequently be prepared to identify specific administrative wards (zones) that are more vulnerable to climate risks.

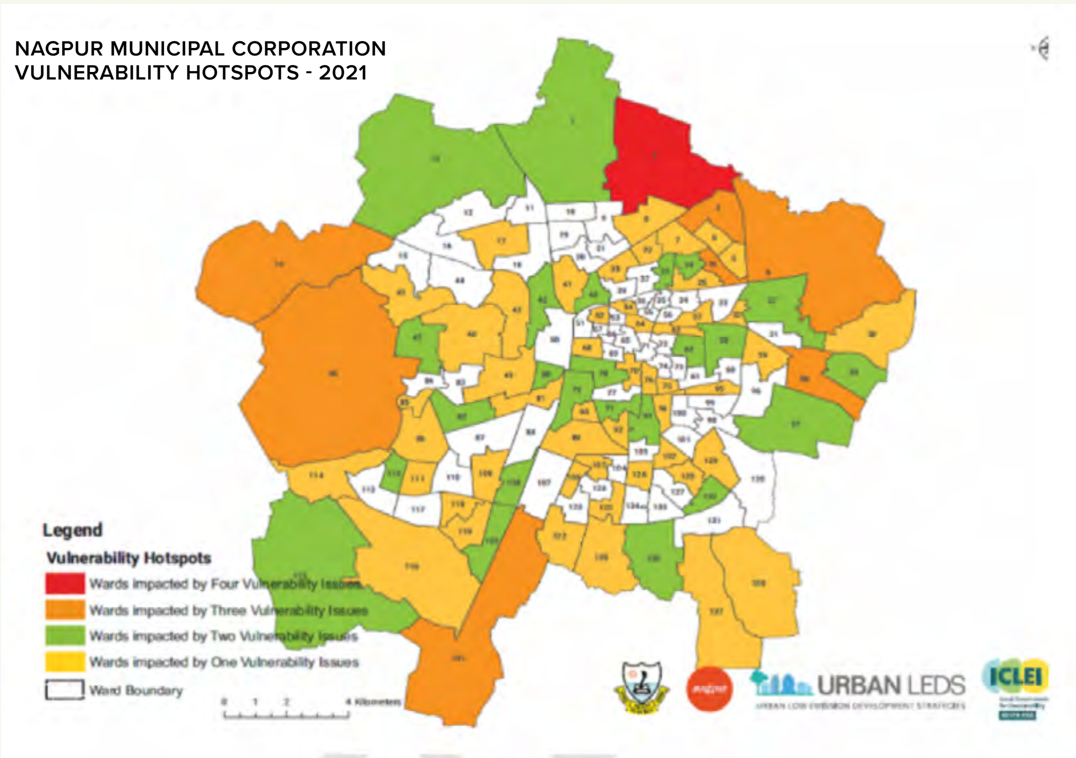



**Figure 2-9.** Climate vulnerability hotspots mapped for Nagpur city.
**Source:** ICLEI SA 2021. Copyright © 2021, Climate and Development Knowledge Network.

CASE STUDY 4

## Assessing heat-health vulnerability in Burkina Faso through community engagement

Burkina Faso, particularly urban areas like Ouagadougou, faces rising temperatures exceeding 40°C during the dry season when vulnerable groups are at heightened risk of heat-related health impacts. A community-based survey in Ouagadougou aimed to assess these vulnerabilities and identify coping strategies.

### *Survey methodology*

The study used a mixed-methods approach, combining quantitative surveys and qualitative data from interviews and FGDs. A participatory approach was employed to ensure community perspectives informed the findings.

### *Vulnerable groups identified*

- Low-income residents in informal settlements with limited cooling resources;
- Elderly individuals with preexisting health conditions;
- Children and pregnant women at higher risk of heat-related illnesses; and
- People with disabilities who face additional barriers to resources and mobility.

### *Engagement and data collection*

The research team worked with local community leaders and organizations to identify participants. Interviews and FGDs were conducted by local staff trained in participatory methods, ensuring cultural sensitivity.

- Interviews: In-depth conversations with vulnerable groups explored personal experiences with heat, symptoms of heat stress, coping mechanisms, and access to health services.
- FGDs: These discussions gathered collective insights, highlighting issues such as poor housing, limited access to drinking water, and reliance on informal cooling methods like fans.

### *Key findings*

- Heat exposure and health risks: Vulnerable groups in informal settlements reported high incidences of dehydration, fatigue, and heat exhaustion. Pregnant women expressed concerns about heat-related complications.
- Coping strategies: Strategies like staying indoors or using damp cloth were often ineffective due to overcrowding and inadequate housing.
- Access to health services: Many reported limited access to healthcare, either due to cost or lack of knowledge about heat-related health risks.
- Community needs: Participants emphasized the need for better infrastructure, including more green spaces and improved building materials, to reduce heat retention.

This direct engagement provided valuable insights into the specific heat-health vulnerabilities of marginalized groups in Ouagadougou.

**Source:** Under the Weather: Stories from Communities on the Front Lines of Climate and Health Adaptation, WHO in collaboration with the United Nations Framework Convention on Climate Change (UNFCCC).

# 2.5 ASSESS IMPACTS

This activity contains guidance on understanding and evaluating the broad range of impacts that urban heat risks can have on your city. This includes identification of monitoring indicators that will help to characterize impact when events occur in the future.

The following steps provide methods for assessing the impact of present and past heat hazard events, and recommendations to monitor future impacts:

1. **Characterize the impact of historical events.**
2. **Estimate current and future impacts.**
3. **Interpret and evaluate findings.**

## *Activity Information*

| | |
|---|---|
| **SOURCES OF INFORMATION** | • People (health): Hospital and public health department records, heat health warning systems<br>• People (social): Census data and surveys, local government and nongovernmental organizations (NGOs<br>• Economy: Local government and businesses<br>• Infrastructure: Utility companies, transportation agencies<br>• Environment: Satellite derived temperature data (NASA, Copernicus), ground-based weather stations for air temperature |
| **EXPERTISE REQUIRED** | • Thorough understanding of past heat events in your city, including exposure and vulnerability<br>• Climate change experts and other experts with an understanding of the community or infrastructure (e.g., scientists, insurance representatives, local authorities, representatives of affected sectors or communities)<br>• Experience in engaging with various stakeholders, including government officials, infrastructure service providers, the private sector, and the public |
| **OUTCOMES** | • Understanding of chronic and extreme heat impacts on socioeconomic groups, infrastructure, and environmental systems in your city<br>• Direction on monitoring framework for future data collection and characterization of impacts |

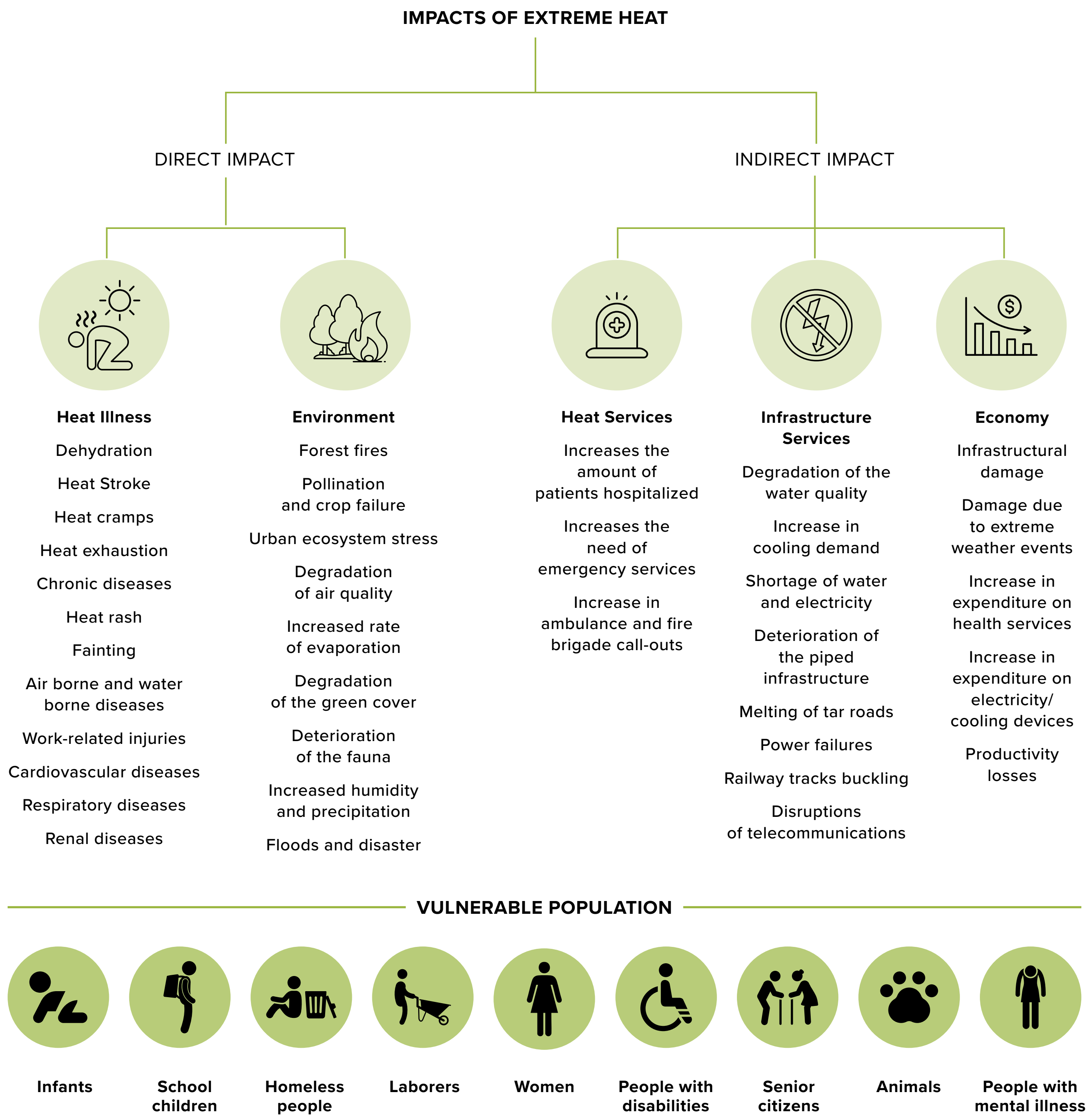



**Figure 2-10.** Impacts of heat stress and the vulnerable population. **Source:** Adapted from Ghanekar et al. (2021).

# 2.5.1

## *Characterize the impact of historical events of heat hazards*

Using the assessment of historical extreme heat events (Step 2.2.3), identify several previous extreme heat events that have impacted your city. Record the key dates and any other information about the event including name, location, and so on.

Identify and list downstream impacts from the identified events in an impact chain (known impacts and cause-and-effect relationships). Impact chains serve to better understand, visualize, and prioritize those factors that drive risk in a system (Fritzsche 2014), see Figure 2-11 for an example. Using available information (for example, news reports, historical datasets, stakeholder knowledge), further characterize the relevant impacts that have/are likely to occur in an event.

Useful questions for identifying impacts include how climate signals have impacted the community or infrastructure in the past and whether any new trends or changes in recent weather events have been observed. The information compiled in the hazard, exposure and vulnerability stages will help to identify the impacts of different extreme heat-related events.

In more complex cases, clustering the impacts by related or similar topics to form groups of impacts is the next step (Fritzsche 2014). These clusters help prioritize the key impacts/clusters that should be taken forward to consider adaptation. Identifying flow on impacts helps to define linked or cascading risks, and recognize crosscutting impacts between sectors, communities, and infrastructure.

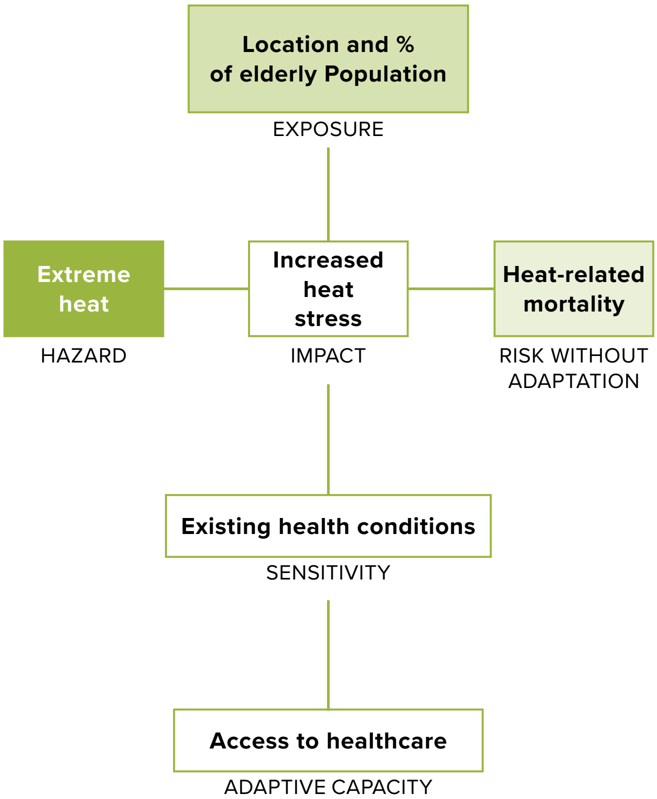



**Figure 2-11.** Simplified impact chain for heat risk to the elderly population in a community. **Source:** Fritzsche, 2014.

# 2.5.2

## *Estimate current and future impacts*

Where possible, assign quantified values to the impact chains characterized in the previous step. This could be the number of people affected, percentage of lost crops, or monetary values. Consider the impact metrics shown in Table 2-13, and their data sources, that may be available to estimate impacts of extreme heat events.

Quantifying impacts of climate and heat-related hazards is not always possible and significant assumptions should be noted where they are required. Where these data are not available, it is possible to conduct surveys and engage with focus groups to capture community experiences during heat events for a qualitative assessment of impact.

When you have established a baseline of impacts, and quantified this where possible, consider the projected changes in heat hazard (Step 2.2.4) to understand whether impacts are likely to increase in the future. This step should consider:

- Increased frequency of extreme events and impacts occurring more often;
- The magnitude of the risk escalation leading to more acute impacts; and
- Greater exposure across a region results in more widespread impacts.

Multipliers can be applied to the baseline impact assessment that estimates future impacts due to climate change. At this stage, you can also consider socioeconomic factors and how they might change in the future to influence exposure, sensitivity, and adaptive capacity.

| THEME | IMPACT METRICS | DATA SOURCES |
|---|---|---|
| PEOPLE | • Heat-related morbidity and mortality: track hospital admissions for heat-related illnesses (heatstroke, dehydration, etc.), number of deaths from heatstroke, heat-related excess mortality. Consider vulnerable groups (elderly, children, pre-existing conditions) in these statistics<br>• Social equity: measure disproportionate impacts on low-income populations and marginalized communities | • Hospital and public health records<br>• Heat health warning systems<br>• Local government and NGOs |
| ENVIRONMENTAL | • UHI intensity: measure the temperature difference between urban and rural areas during heat events<br>• Ecosystem stress: evaluate vegetation health using indices like normalized difference vegetation index | • Remote sensing imagery (NASA, Copernicus)<br>• Ground-based weather stations |
| INFRASTRUCTURE | • Energy demand: monitor peaks in electricity use for cooling during extreme heat<br>• Water: reduced quality and availability against increased demand<br>• Power outages: assess frequency and duration of blackouts<br>• Transportation disruptions: track delays or failures in public transport systems (e.g., buckling train tracks, overheated vehicles | • Utility companies<br>• Transportation agencies |
| ECONOMY | Economic losses: calculate losses in productivity and absenteeism or availability to work, especially for outdoor workers. | Local government and businesses |

**Table 2-13.** Impact Metrics for Monitoring Heat Risk Impacts

# 2.6 COMBINE HEAT RISK ASSESSMENT

Evaluate the combined evidence of hazard, exposure, and vulnerability, and the resulting direct and indirect impacts. This will contribute to a well-informed assessment of heat risk in your city and support the development of adaptation actions and solutions.

This three-step approach, based on each of the risk components evaluated in Activity 2.2, enables a comprehensive, reliable understanding of heat risks for your city and support targeted adaptation measures that are responsive to both current and future climate challenges:

1. **Interpret and evaluate findings.**
2. **Consider uncertainty and identify data gaps.**
3. **Develop a monitoring framework.**

TOOLBOX

## *Heat risk mortality and morbidity functions*

Heat risk functions for mortality and morbidity are used to assess heat risk to a population. Functions use statistical methods to establish a correlation between daily mortality or morbidity counts and daily temperature data. Typically this is a count that is in excess of what is expected at the same time of year for the same cohort group. The resolution of these functions can be increased by considering specific heat-related illnesses or vulnerable population groups (gender or age). Functions are generally U-shaped (Figure 2-13), whereby mortality increases in extreme cold and extreme hot temperatures (Madrigano et al. 2015).

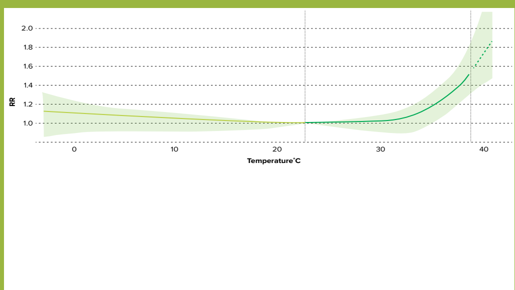



**Figure 2-13.** Exposure response curve for Thessaloniki, Greece (Parliari et al, 2023)

Once the relationship between temperature and mortality is established, health impact assessments can be used to estimate excess deaths related to heat, along with setting up well-informed early warning systems that are tailored to your location.

Further reading on heat-related mortality functions is presented below:

Bressler, R.D., F.C. Moore, K. Rennert et al. 2021. Estimates of country level temperature-related mortality damage functions. Sci Rep 11, 20282. https://doi.org/10.1038/s41598-021-99156-5

Masselot, P., M. Mistry, J. Vanoli et al. 2023. Excess mortality attributed to heat and cold: a health impact assessment study in 854 cities in Europe. The Lancet, 7 (4), https://doi.org/10.1016/S2542-5196(23)00023-2

# 2.6.1

## *Interpret and evaluate findings*

Use the assessments of hazard, exposure, and vulnerability to develop a combined heat risk assessment for identified communities and infrastructure. Record the results in a risk register, as a qualitative written description, or through mapped GIS outputs. In general, risk is higher where hazard, exposure, and sensitivity are high and adaptive capacity is low. Combine exposure and vulnerability ratings to produce a risk rating based on your four-point scale on a spreadsheet.

| | EXPOSURE | | | |
|---|---|---|---|---|
| | Low (1) | Moderate (2) | High (3) | Extreme (4) |
| LOW (1) | Low | Low | Moderate | High |
| MODERATE (2) | Low | Moderate | Moderate | High |
| HIGH (3) | Low | Moderate | High | Extreme |
| EXTREME (4) | Moderate | High | Extreme | Extreme |

**Table 2-14.** Example Risk Matrix of Vulnerability and Exposure.
**Source:** World Bank, 2025.

The aim of evaluating and interpreting findings is to understand the relative significance of heat risks in your city and pinpoint areas where adaptation is necessary:

- **Prioritize climate change impacts:** Decision makers should focus on climate change impacts that demand immediate attention, while considering adaptation strategies and stakeholders responsible for implementation; and
- **Cross-sector/area comparisons:** If the objective is to compare risks or impacts across different sectors or regions, integrate both qualitative and quantitative evaluations. Given the challenges of applying uniform quantitative criteria (e.g., normalized indicators, monetary values), qualitative methods often offer a more feasible means for drawing comparisons.

Alongside the assessment of risk to a community or infrastructure by hazard, exposure, and vulnerability, consider the impacts should a risk occur (Activity 2.5) and the criticality of the asset or infrastructure. Higher-scored risks to critical assets, with high impact, should be prioritized for adaptation.

| HAZARD | COMMUNITY/ INFRASTRUCTURE | EXPOSURE | | VULNERABILITY | | RISK (+2°C 2100) | IMPACT |
|---|---|---|---|---|---|---|---|
| | | PRESENT DAY | +4°C 2100 | SENSITIVITY | ADAPTIVE CAPACITY | | |
| Extreme Heat | Organization | 1 | 4 | Low | Moderate | High | High |
| | Rail infra | 2 | 4 | High | Low | High | Moderate |
| | Elderly pop | 2 | 4 | High | Moderate | Moderate | Low |
| Heatwaves | Organization | 1 | 3 | Low | Low | Low | Low |
| | Elderly pop | 1 | 3 | High | Low | High | High |
| Increased Mean Temp | Organization | 1 | 2 | Low | Moderate | Low | Low |
| | Elderly pop | 1 | 2 | Medium | Moderate | Opp | Low |

**Table 2-15.** Example Risk Reporting Register. **Source:** World Bank, 2025.

## 2.6.2

### *Consider uncertainty and identify data gaps*

Throughout all stages of the assessment, consider the reliability of data sources while identifying key knowledge gaps:

- **Uncertainty:** Evaluate the reliability of data sources used in assessing the components of risk. Are they credible and up to date?
- **Information Gaps:** Identify information gaps that could be crucial for future, more detailed assessments. Acknowledge where further research or data collection is needed to enhance accuracy.

## 2.6.3

### *Develop a monitoring framework*

A monitoring framework will help further understand heat risks and support evidence-based decision-making. This framework should consider:

- **Data collection:** Where gaps or uncertainties are identified, prioritize adaptation actions related to data collection, such as establishing urban weather stations, remote sensing technologies, or extreme heat monitoring systems; and
- **Event-based monitoring:** Incorporate metrics for monitoring extreme heat events, helping to track and record their impacts on urban environments and populations. Ensure monitoring systems are robust enough to observe and capture changes during periods of extreme heat.

TOOLBOX

### *Extreme heat impacts monitoring framework*

Tools that can help with developing a monitoring framework for extreme impacts in cities:

- Heat Action Platform: Finds resources and solutions to reduce the impacts of extreme heat.
- Heat Resilient Cities Excel-based tool: Helps quantify the health, economic, and environmental benefits of urban heat adaptation options.
- Monitoring, Evaluating, and Reporting: Helps cities assess the impacts of adaptation options (from the C40 Cities Climate Leadership Group and Ramboll Foundation).
- Heat and Health Tracker: Maps heat-related illnesses in real-time (from the Centers for Disease Control and Prevention (CDC)).

# 03 Planning for Heat Resilience

**Proactive planning for heat resilience enables cities to better integrate heat resilience within all aspects of the urban realm. Moreover, prioritization of heat resilience safeguards livelihoods and ensures urban environments remain livable as temperatures rise due to climate change.**

**Cities in the Global South already experience immense strain on their people, resources, infrastructure, and natural systems due to rapid urbanization. In addition, local governments often lack political mandates, funding and financing, capabilities and knowledge, as well as quality local data. In some cases, the risks associated with urban heat are underestimated, leading to inaction. Planning for heat resilience requires collaboration between multiple groups of stakeholders, city government departments and the regional and national government.**

**This chapter guides you through the sequential set of activities to plan for heat resilience, as illustrated in Figure 2-14. Monitoring and evaluation (M&E) can be viewed as a return point that should inform your work in resuming the planning process in a few years. This will allow you to reflect and build upon successes and failures incurred during the current planning process.**

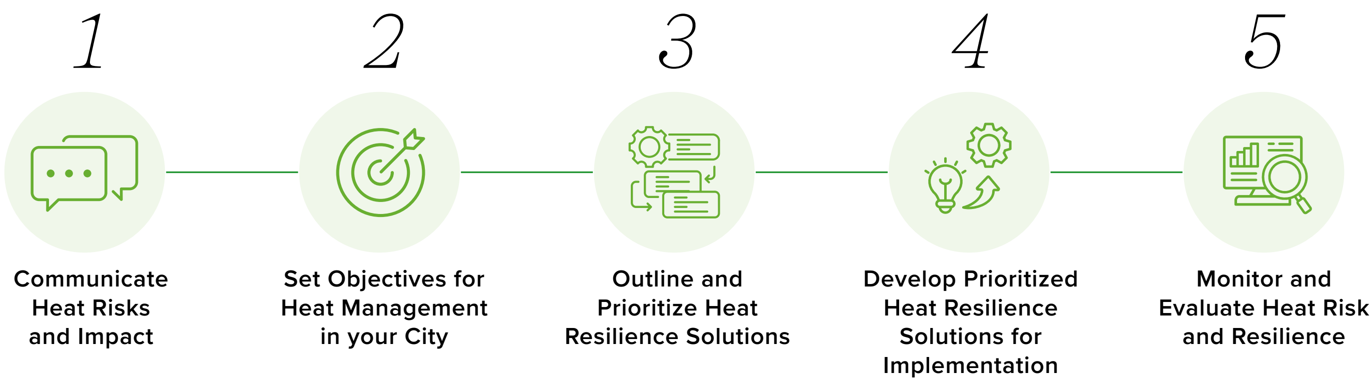



**Figure 2-13.** Steps in planning for heat resilience. **Source:** © AtkinsRéalis, 2025.

**As highlighted throughout this Handbook, several steps among these activities rely on and interlink with activities included in the Assessing Heat Risk chapter. Review these to ensure that planning for heat resilience is carried out in a robust and context-specific manner.**

# 3.1
# COMMUNICATE RISK AND HEAT IMPACT

The following activities will help you **gain political buy-in and public support for implementing heat resilience solutions.**

## *Activity Information*

| | |
|---|---|
| **SOURCES OF INFORMATION** | • Data and information acquired as part of the assessment of heat risk in your city.<br>• Examples of other awareness and engagement activities undertaken in your city and region that have worked well.<br>• Indigenous knowledge of local context. |
| **EXPERTISE REQUIRED** | • Thorough understanding of the heat risk context in your city, including heat hazard, exposure, vulnerability, and impacts.<br>• Good knowledge of local socioeconomic factors and demographics to inform the most appropriate methodology and delivery of awareness raising and outreach.<br>• Experience in engaging with various stakeholders, including government officials, academia, NGOs/civil society organizations (CSOs), for example the Red Cross and Red Crescent, the private sector, and the public. |
| **OUTCOMES** | • Gaining political support for heat resilience from officials within your governance structure and the public.<br>• Increasing awareness relating to heat risks and resilience among various stakeholders in your city. |

## *3.1.1*

### *Strengthen political ownership and will for heat management in your city*

**For city governments, strong political commitment is fostered by recognizing the long-term socioeconomic and environmental benefits of heat management**, such as improved public health, energy savings, and enhanced quality of life. This requires city leaders to understand that addressing urban heat is not merely a reactionary measure but a proactive investment in the city's resilience.

**Consider presenting heat resilience as a component of broader policy goals** to encourage political buy-in. Often, political leaders may have already identified goals or priorities that align with enhancing heat resilience – a review of these priorities (for example, in an election manifesto) will help identify additional entry points to secure political buy-in.

Communication regarding heat risk needs to be tailored to different groups of stakeholders to build awareness and political will:

- **Senior city government officials** – typically receive high-level information relating to the risks and impact of heat in your city. Check if responsibility for heat risk in your city already lies with an official or a department such as a dedicated heat resilience officer. Thereafter, you could hold a council meeting to present a summary of your findings or organize targeted meetings with politicians and policymakers who can influence change.
- **Technical experts** from city departments, academia, public infrastructure, and utility companies: Hold workshops and meetings on your detailed assessment findings including time for debate and discussion of the challenge at hand. This will help to validate your assessment findings while providing an opportunity for experts to formulate possible solutions, see Step 3.3.1 for further detail.
- **The public and NGOs/CSOs:** Disseminate high-level information by engagement through, for example, larger-scale information sessions at community events or using social media channels to disseminate infographic posters. See the next step of this Activity for further examples of tailoring your engagement approach to stakeholders in your city.

Gaining government, stakeholder, and public buy-in can translate into political pressure and accountability to help keep heat resilience initiatives on track while also fostering a sense of shared responsibility among residents and policymakers alike.

CASE STUDY 5

## Heat resilience officers in local governments

Chief Heat Resilience Officers (CHOs) are an institutional mechanism to accelerate existing heat protection efforts of city governments. The Atlantic Council's Climate Resilience Center (Arsht-Rock) and the Extreme Heat Resilience Alliance (EHRA) piloted the world's first CHO positions in seven cities, including Freetown (Sierra Leone), Dhaka North City Corporation (Bangladesh), and Santiago (Chile), among others.

### *What are the CHOs' core responsibilities?*

- Raise awareness of extreme heat risk and solutions among their constituents and peers;
- Identify communities and neighborhoods that are most vulnerable to extreme heat;
- Work to improve planning and response to heatwaves;
- Coordinate stakeholders; and
- Implement long-term heat risk-reduction and cooling practices.

### *How are CHOs appointed?*

The CHOs are appointed by city government officials and mayors. Arsht-Rock creates a job description for the post and involves EHRA members to support the CHO's mission and activities. Dhaka North City Corporation appointed its CHO in 2023 (Dhaka Tribune 2024) while in Freetown the CHO was appointed in 2021. In 2022, Arsht-Rock and UN-Habitat appointed a Global Chief Heat Officer.

### *What are the outcomes and impacts of appointing a CHO?*

The appointment of CHO strengthens political will and paves a road to further prioritizing heat actions. It helps identify the local voice that is aware of the institutional systems, and compensation being managed by Arsht-Rock reduces the dependency of CHO on local government in acting. The CHO also aids with the coordination of actions across different city government departments and organizations to maximize outcomes. CHOs have helped to implement cool pavement and roofs, categorized heatwaves to help residents prepare for extreme heat, and tree planting projects to increase canopy cover (Dhaka Tribune 2024).

**Source: Atlantic Council 2024b.**

# 3.1.2

## *Raise awareness of heat risk among the public*

Another key step is to raise awareness and educate stakeholders on the risks associated with urban heat while also helping them understand what tools and resources are available to safeguard their health. This is particularly important among vulnerable groups. Emphasizing the health impacts, economic costs, and quality of life impacts associated with heat risk in your city can help sensitize stakeholders for the dangers and motivate proactive engagement.

A critical first step to undertaking meaningful and impactful engagement is identifying who you should engage with; this should include the groups who are most vulnerable to heat (see Activity 2.1). Thereafter, aim to employ data drivers and tailored approaches to share relevant information and targeted messages with relevant stakeholder groups to raise awareness, for example:

**Public outreach and community engagement:** Organize presentations, workshops, and interactive activities to create visibility and awareness of the challenge among the public in targeted locations such as schools or retirement homes. Draw higher attention to the issue, for example, by planning events on a single 'Heat Activity Day' or designating a 'Heat Awareness Month' in early summer and coordinating related outreach activities with the support of community leaders and representatives.

**Social media campaigns:** Post targeted visual, audio, and text-based content and infographics on various social media channels.

**Traditional media campaigns:** Publish content on local newspapers, radio, or television channels.

**Visual aids and infographics:** Distribute leaflets and posters directly to people through postal services or in busy pedestrianized areas of your city; this could also involve targeted advertisements on busy streets or at local shopping centers.

Choose a high-impact approach that considers the demographic and socioeconomic makeup of the target population. For example, a social media campaign may not work if your city has a high population of vulnerable elderly people with no access to technologies. In most cases, a mix of stakeholder engagement approaches is recommended to reach a wide audience.

See the solution on Heat Risk Awareness Campaigns in the Solutions Catalog (Volume 3) for an overview of how to plan and undertake heat resilience awareness raising activities.

***Resources***

- "Heat Communication Guide for the Cities in South Asia" developed by RCCC to understand how to design a heat communication plan.
- "Heat Toolkit" website, a collection of resources on extreme heat and climate change developed by the Global Disaster Preparedness Center.
- "Develop an Education Strategy" Learning Module, part of the Arsht-Rock Heat Action Platform, for further guidance on how to raise awareness.
- Ahmedabad HAP awareness-raising posters.

**HOW TO ADAPT THIS ACTIVITY TO YOUR CONTEXT**

The activity and its steps will help you to establish heat risk and hazards as a major challenge in your city, drive policy change, maintain momentum to build heat resilience, and ensure the right stakeholders receive the correct level of information relating to heat risks and impact at the right time.

In undertaking this activity, you should think about the following to adapt the steps to your context:

| | |
|---|---|
| **CITY SIZE AND CAPACITY** | • Consider partnering with academic institutions or CSOs – to help you target your engagement activities or build your department's capacity to deliver awareness.<br>• Leverage existing media and communication channels – it is likely your city already has various communication channels to engage stakeholders, use these to your advantage. |
| **CLIMATE** | Often, you can use hot weather to your advantage to create awareness –you could think about organizing awareness events during hot days or in problem areas to emphasize the challenge. |
| **USER ROLE** | • Think about the methods of engagement you should use – ask yourself, who is your target audience? What level of information do they need and can digest? What are your goals in engaging with this group?<br>• Consider your existing relationships with stakeholders – you may have established relationships with politicians, technical experts or NGOs/CSOs; use these to your advantage and to enhance collaboration. |

# 3.2 SET OBJECTIVES FOR HEAT MANAGEMENT

**Setting objectives for heat management in your city will help prioritize where resources and solutions should be channeled to maximize benefits and impacts.** The following activities will help you to identify the best approach, strategic objectives against your priority challenges, and metrics and targets to measure progress against these.

## *Activity Information*

| | |
|---|---|
| **SOURCES OF INFORMATION** | • Data and information acquired as part of your assessment of heat risk in your city.<br>• National and local legislation, policies, plans, and strategies to identify existing priorities and strategic objectives.<br>• Any stakeholder input and information gathered up to this point.<br>• Indigenous knowledge of local context. |
| **EXPERTISE REQUIRED** | • Thorough understanding of the heat risk context in your city, including heat hazard, exposure, vulnerability, and impacts. |
| **OUTCOMES** | • Identified the most appropriate entry point to build heat resilience.<br>• A set of strategic objectives aligned with your city context and informed by assessments of heat risk as well as any stakeholder engagement.<br>• A set of metrics and targets to help assess the progress of solutions against strategic objectives and aid M&E. |

# 3.2.1

## *Identify the best approach for heat resilience planning in your context*

Identifying the best approach ensures that your efforts to build heat resilience align with broader urban development goals, leverage existing resources, and gain political and public support. Note that all approaches should be based on your findings from the **Activities undertaken to Assess Heat Risk**, informed by comprehensive stakeholder engagement, and well aligned with the existing policy and planning frameworks in your city.

You should consider the following entry points as a possibility to build urban heat resilience in your city:

a. **Integrating urban heat resilience into existing plans:** Your city may already have plans to address climate or disaster risk (for example, a CAP, adaptation or a disaster risk reduction plan) or to guide future urban growth (for instance, a development plan, a structure plan, or environmental plan). Such plans may also exist on the national level. Assess these plans and explore if they align with your goal of integrating heat resilience into urban development planning (see Activity 2.1). It may be more efficient to integrate heat resilience considerations into ongoing plans because they likely have political and stakeholder support and secured funding.

b. **Developing an HAP:** If your review of existing policies and strategies shows that they do not align with your goals, an HAP can act as a practical management tool to plan the way forward. A HAP may include both emergency response activities, including roles and responsibilities of stakeholders, as well as long-term heat resilience building through cooling and infrastructure solutions (Atlantic Council, 2024a).

An HAP would also help you identify specific heat resilience solutions that are tailored to your city's context and needs. **Refer to case study 6 on Heat action planning in Cape Town, South Africa for an example of approach a and b.**

c. **Developing and implementing a pilot project:** Developing a small-scale solution as a pilot project could be an effective way to start building heat resilience for cities with low capacity and resource availability. This can be an effective approach to demonstrate proof of concept, helping to drive support from politicians and the public for further heat resilience building, and identifying opportunities for upscaling.

d. **Targeting action in specific sectors:** Targeting action in a sector where the impacts of urban heat risks are most visible and present, such as the public health or the energy sector, can be an effective entry point for building heat resilience. For example, a city experiencing high heat-related illnesses and mortality could collaborate with the public health sector to establish cooling centers at key public buildings or aim to improve the healthcare infrastructure. A sectoral entry point can be effective in providing tangible results that demonstrate the value of heat resilience planning to stakeholders and decisionmakers.

e. **Community-driven heat resilience building:** Collaborating with NGOs and CSOs that play a role in urban development can help to identify areas and vulnerable communities at elevated risks of urban heat as well as potential projects and solutions to build heat resilience. Starting with community-driven projects can also build trust and pave the way for larger, more comprehensive planning efforts. **Refer to case study 7 on 'Urban Living Labs' in Satkhira, Bangladesh for an example of approach d and e.**

Regardless of the entry point, it is **important to assess how heat resilience can complement your city's current priorities,** whether through public health, energy efficiency, disaster preparedness, or environmental sustainability. **A well-chosen entry point not only addresses immediate heat challenges but also sets the stage for scaling up efforts to build heat resilience in the future.**

TOOLBOX

## *How is a HAP different from other plans?*

Unlike a CAP and other disaster risk strategies which you may be familiar with, a HAP focuses specifically on addressing the immediate and long-term impacts of extreme heat. It aims to provide a framework for implementing, coordinating, and evaluating heat resilience solutions and response activities to reduce the negative impact of extreme heat (Magotra et al. 2021).

A CAP may focus on both mitigation through reducing GHG emissions and adaptation to a wide range of climate hazards while a disaster risk strategy may focus on reducing risk, exposure, and vulnerability to a wide range of disasters. In comparison, some of the main objectives, actions, and outcomes that make HAPs unique include:

- Prevents heat-related illness and safeguards quality of life during extreme heat events;
- Protects citizens, in particular vulnerable groups and communities, from the negative health effects of urban heat;
- Better prepares health facilities and workers for heat-related emergencies;
- Increases heat resilience and builds adaptive capacity among people and infrastructure; and
- Define ways in which to measure the outcomes of action implementation, such as establishing time-bound goals, targets and/or indicators.

The contents of HAPs typically differ from city to city; however, some of the main components and themes often include (Magotra et al. 2021).:

- Building public awareness and community outreach on mitigative and adaptive measures to extreme heat;
- Potentially help to establishing frameworks for EWS and weather forecasting to predict extreme heat events;
- Present opportunities to enhancing capacity among healthcare workers and other professionals to recognize and respond to heat-related illnesses;
- Include heat and vulnerability mapping to understand areas of a city at risk of extreme heat;
- Propose long-term and short-term actions and solutions to deal with immediate and long-term extreme heat, potentially organized by thresholds triggered depending on the severity of the extreme heat event; and
- Propose heat emergency response measures and operationalize their implementation.
- The following are some examples of HAPs you could use for inspiration:
- Nepalgunj (Nepal) Heat Action Plan 2023: Focuses on the role and involvement of stakeholders in responding to heat risks and building long-term heat resilience. The plan sets out how stakeholders should act before, during, and after a hot season, how to build capacity on heatwave impacts and preventative measures, and suggests mechanisms for effective coordination between stakeholders.
- Jodhpur (India) Heat Action Plan 2023: Integrates an assessment of heat risk that identifies areas of the city with high exposure, sensitivity, and adaptive capacity into the HAP process. The plan also sets out strategies and activities for before, during, and after the heat season as well as long-term strategies to increase heat resilience.
- Vienna (Austria) Heat Action Plan: Defines proactive measures essential for both prevention of urban overheating and managing it. The plan elaborates 29 heat-related ad-hoc measures to better prepare for hot spells targeted at the general population and specific vulnerable groups. It also proposes several long-term measures to build heat resilience.
- Miami County (USA) Extreme Heat Action Plan: Showcases an impactful plan developed to address heat challenges on a county/regional level. The HAP is aimed at reducing the health and economic impacts of extreme temperatures and creating a baseline for further research and partnerships. The plan is built upon three main goals and 19 actions: (1) informing, preparing, and protecting people; (2) cooling homes and emergency facilities; and (3) cooling neighborhoods.

CASE STUDY 6

## Heat action planning in Cape Town, South Africa


**Figure 2-14**. Cape Town heat watch web map. **Source:** Heat watch Cape Town. 2024.

Cape Town is subject to a wide range of climate risks, including drought and associated water shortages, flooding and its impact on people and infrastructure, heat stress and its health impacts on vulnerable people, and coastal erosion and sea-level rise. As part of the South African National Treasury's Cities Program with technical support from the World Bank's City Resilience Porgram o address these climate risks, the city developed a CAP alongside prioritized actions for mitigation and adaptation (City of Cape Town, 2021). The city's approach is a mix of integrating heat resilience into existing plans and developing a standalone HAP (see approaches a. and b above).

Two strategic goals were developed:

- Reduce immediate risks to health during heatwaves and high-heat days; and
- Proactively reduce heat impacts on the city through urban greening.

The specific actions created to achieve these goals include:

- Draft and implement a heatwave and high-heat day action plan and standard operating procedures;
- Develop and implement a network of cooling centers;
- Develop and implement an EWS and real-time monitoring system for heat.
- Devise and implement an urban greening and tree-planting program to reduce the UHIE and provide shading.

Further, each action identifies lead and supporting government departments along with external stakeholders necessary to achieve these actions.

Building upon the goals and identified actions in CAP, Cape Town drafted and approved an accompanying HAP in November 2023 which outlines further details on the actions, responsibilities, timelines, economic models, and monitoring strategies specifically relating to building heat resilience (Capetown.gov 2024). The city also undertook heat mapping in February 2024 to identify and measure heat in public areas which has helped to lay down the foundations for deeper engagement. The results of the mapping exercise can be explored in an interactive web map.

CASE STUDY 7

## 'Urban Living Labs' enhancing resilience for urban poor in Satkhira, Bangladesh

'Urban Living Labs' is part of the CHALLENGE 2.0 initiative led by German Corporation for International Cooperation (GIZ), Cities Alliance and UN Habitat, which tests innovative solutions for sustainable planning and building, and contributes to the creation of climate-adapted, connected, and liveable neighborhoods (City Transitions 2024). Urban Living Labs demonstrates the blended approach of piloting projects and undertaking community-driven resilience building as discussed as part of approaches c. and e. above.

### *'Urban Living Labs' in Satkhira*

Satkhira is one of the several 'Urban Living Lab' locations around the world seeking to protect urban poor communities against the impacts of climate change and empower them to take individual action. Inhabitants of Satkhira are exposed to frequent floods and cyclones, and increasing high temperatures with indoor temperatures reaching 42 to 44°C for eight months of the year. Targeted capacity building was imparted to 150 families that participated in the lab. They were trained in climate resilient technologies for home-based horticulture including:

- Growing vegetables around their houses and on roofs utilizing vertical farming principles and bamboo structures to cultivate creeping plants; and
- Planting mahogany, lime, and betel nut trees around houses to provide shade and protection from strong sunlight.

In addition to building climate resilience, the initiative is helping to foster and stabilize livelihoods by providing beneficiaries with opportunities to sell the surplus vegetables at local markets. Such initiatives show the potential for small-scale pilot interventions to build heat resilience while fostering inclusive and sustainable practices.

# 3.2.2

## *Set strategic objectives for heat resilience in your city*

**Set strategic objectives that help you to identify your priorities and a potential long list of solutions to build heat resilience.** You should undertake the following exercises to identify or co-create your strategic objectives:

a. **Identify existing strategic objectives from policies, plans, and strategies** and use them to help accelerate your efforts to build heat resilience.

b. **Co-create new strategic objectives with technical experts** that are grounded in your assessment of heat risk in your city and informed by stakeholder engagements held thus far. Developing SMART strategic objectives can be a good way to ensure they are precise, easy to monitor, realistic, well aligned to wider goals, and time-bound to a reasonable timeframe (see the accompanying toolbox for further guidance).

c. **Co-create new strategic objectives with the public** in the form of a survey or contact with NGOs and CSOs who have deep-rooted connections with your local communities and vulnerable groups. This process can be more time-consuming as you may receive a vast amount of input; however, it can be more engaging and shows commitment to improving heat resilience outcomes for your community.

Regardless of how you create your strategic objectives, validate them with stakeholder engagement and seek city government approval to ensure public and political support. This will also help to build confidence and trust in your efforts to build heat resilience.

TOOLBOX

### *Drafting SMART strategic objectives*

SMART relates to:

- **Specific** – be as precise as possible;
- **Measurable** – ensure progress can be monitored to understand if the objective is met;
- **Achievable** – set realistic expectations given your city's resource and capacity limitations;
- **Relevant** – be well aligned with your overall direction of change as well as political agendas and current plans, strategies, and legislation; and
- **Timebound** – look ahead to the future but have an achievable timeframe, for example, 5 to 10 years.

**Examples could include:**

"Over the next **five years**, develop and implement a **Green Roof Program** for **elementary schools within vulnerable communities** to achieve a **20 percent increase in green roof** cover in the city."

"Within **10 years**, our city will **reduce rates of heat-related mortality and morbidity** by **10 percent** through the **implementation of targeted heat risk awareness campaigns** among **elderly citizens.**"

"**Reduce the average air temperature in urban areas in summer by 1°C** through the **implementation of nature-based solutions and heat resilient infrastructure** by **2030**."

# 3.2.3

## *Set metrics and targets for assessing progress against strategic objectives*

**Metrics and targets are measurable components that help to monitor progress and the impacts of your solutions against the strategic objectives you created.** They should be informed by the work you have already completed as part of activities to Assess Heat Risk in your city as well as any stakeholder engagement you have conducted.

a. **Identify existing metrics and targets from policies, plans, and strategies –** utilizing these may present opportunities to streamline data collection and therefore reduce the need for resources as part of your M&E efforts discussed in further detail as part of Activity 3.5.

b. **Use the metrics and targets developed as part of your assessment of heat risk –** as good starting points as you will most likely have a solid baseline against which you can monitor progress.

c. **Use any metrics and targets identified by stakeholders –** to incorporate stakeholder input into your planning efforts and show commitment to targets seen as important by stakeholders in your city.

d. **Develop new metrics and targets –** that could be climate-related (such as decreasing air or surface temperatures or number of days of extreme heat), socioeconomic related (reducing exposure to heat risk among vulnerable groups or lowering heat mortality and morbidity rates), or infrastructure related (increasing the number of buildings being retrofitted with heat-resilient materials or increased access to portable water).

**Note that the metrics and targets you set should be used to monitor progress and understand if the solutions you are implementing will result in beneficial outcomes** and help to achieve your strategic objectives. Alongside this step, you should therefore review Step 3.5.3 to gain insight into what sort of targets and metrics you may want to use to monitor and assess progress.

### HOW TO ADAPT THIS ACTIVITY TO YOUR CONTEXT

**The activity and its steps will help you to identify the most appropriate approach to build heat resilience in your context,** ensuring the strategic objectives, metrics, and targets you set are realistic, effective, and aligned with the unique characteristics of your city.

In undertaking this activity, you should think about the following to adapt the steps to your context:

| | |
|---|---|
| CITY SIZE AND CAPACITY | **Work within your means –** reflect on what your city can achieve in a realistic timeframe. If you are a small city with limited capacity, focus your efforts on small-scale and targeted efforts through pilot projects rather than a HAP or large-scale infrastructure projects. Ensure your strategic objectives and metrics reflect this. |
| CLIMATE | **Contextualize strategic objectives and metrics –** for example, if your city is in an arid climate, think about the role of water security in shaping your strategic objectives and metrics. |
| USER ROLE | **Everyone can play a role –** collaboration across departments and stakeholder is key; technical experts, CSOs and NGOs have insight into vulnerable groups whose needs should inform your strategic objectives and metrics and targets. |

# 3.3 OUTLINE AND PRIORITIZE HEAT RESILIENCE SOLUTIONS

**There are many solutions available to address heat risk and build heat resilience within cities.** However, you must shortlist solutions for your city to ensure the effective use of resources and capacity. The following activities will help you to identify and prioritize solutions into a shortlist as well as understand the detail needed to inform their implementation.

## *Activity Information*

| | |
|---|---|
| SOURCES OF INFORMATION | • National and local legislation, policies, plans, and strategies to identify existing solutions and projects as well as to help prioritize and detail the shortlist of solutions.<br>• Existing best practices and handbooks from other development institutions, and details outlined in the Solutions Catalog (Volume 3).<br>• Any stakeholder input and information gathered to this point.<br>• Indigenous knowledge of local context. |
| EXPERTISE REQUIRED | • Thorough understanding of heat risk context in your city, including exposure, vulnerability, and impacts.<br>• Technical expertise in various infrastructure sectors and crosscutting themes. |
| OUTCOMES | • A shortlist of solutions tailored to your city and its strategic objectives, targeted at reducing heat risk and building heat resilience. |

## *3.3.1*

### *Develop a long list of solutions*

**Developing a long list of solutions can help you to identify various options to build heat resilience in your city.** Your long list should be informed by the **Assessment of Heat Risks** in your city, the strategic objectives, metrics, and targets you developed as well as any contextual information from community leaders, subject matter technical experts, and other stakeholder engagement you have undertaken.

Consider the following when developing your long list:

a. **Identify and consolidate existing solutions –** consolidate any solutions that may have emerged from your work undertaken while **Assessing Heat Risks** and those that have emerged organically from previous stakeholder engagement.

b. **Develop new solutions –** consult with technical experts from across different departments in your city, as well as external stakeholders, for example, academia, to identify potential new solutions that can address any gaps you identified when **Assessing Heat Risks**.

When developing a long list of solutions, you should seek to obtain input from subject matter technical experts who can **provide input on governance and regulation, data and digital transformation, gender, and social inclusion, and broader climate and disaster resilience.** Explore and identify **any indigenous and local practices for combatting heat risk** as these will most likely already be practiced across your city and can lead to effective and well-tailored solutions. The Solutions Catalog, the third volume of this Handbook, can be used as a starting point to outline a long list of solutions.

TOOLBOX

## *Beware of maladaptation!*

**Maladaptation occurs when climate adaptation strategies unintentionally increase vulnerability to climate change, often due to poor planning, inadequate understanding of root causes, or failure to address social inequities** (Schipper 2020).

Examples of maladaptation include:

- Planting extensive and poorly adapted vegetation with a disregard for a local arid climate can lead to the vegetation requiring excessive irrigation, depleting water resources, and increasing long-term vulnerabilities, particularly during droughts (Schipper 2020). In this case, you should seek to plant native and drought-tolerant species to balance cooling benefits with sustainable resource use.
- Implementing housing design and regulation standards for informal settlements to reduce heat in internal spaces that do not consider lack of land tenure or local planning regimes and how this may impact the ability of individuals to implement such regulation. You should focus on community-led upgrading to offer the potential for resilience building with recognition of local hazards, reflecting community priorities and their ability to contribute to adaptive capacity (Satterthwaite et al. 2018).

Such outcomes are more likely in contexts with limited knowledge of local vulnerabilities, unequal power dynamics, and reliance on short-term solutions (Schipper 2020). When developing adaptation strategies, design flaws include ignoring the root causes of vulnerability, misidentifying beneficiaries, implementing rigid infrastructure with long-term negative impacts, and failing to account for broader development contexts or unintended consequences that need to be identified and avoided (Schipper 2020). Thorough assessments and inclusive planning are key to mitigating these risks.

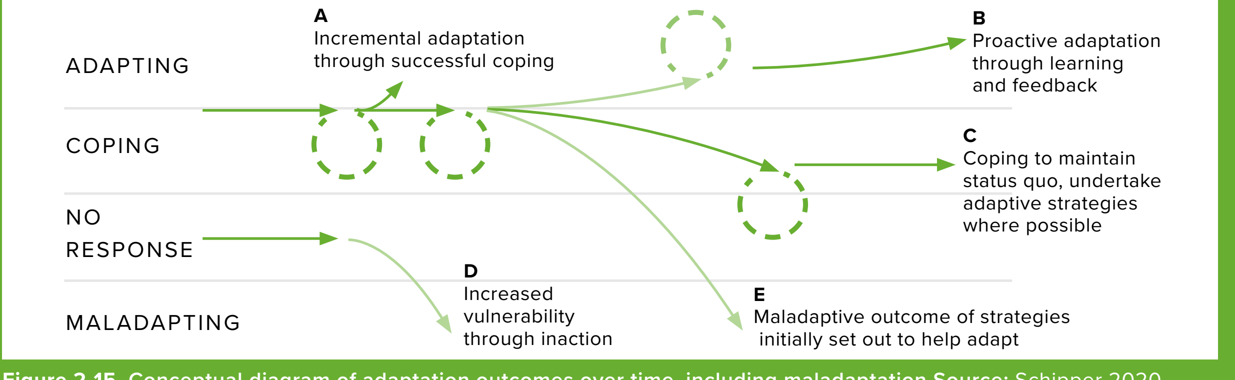



**Figure 2-15. Conceptual diagram of adaptation outcomes over time, including maladaptation Source:** Schipper 2020.

# 3.3.2

## *Prioritize solutions into a shortlist*

**You must prioritize your long list into a shortlist of solutions that should be implemented to build heat resilience.**

When prioritizing solutions, consider the following guiding questions:

- **Is the solution targeting the most important heat-related challenges?**
- **Does the solution align with the strategic objectives you created as well as existing polity, strategies, regulation, and any ongoing projects in your city?**
- **Will the chosen solution likely gain political support for its implementation from government officials and the public?**
- **Does your city have the necessary capacity and resources to implement the solution? If not who and what can help with implementation?**

Depending on your experience and capacity, you could prioritize a shortlist of solutions using the following approaches:

a. **Developing a bespoke multi-criteria assessment:** This could be in the form of a simple spreadsheet that identifies bespoke criteria, best suited to your city's needs, against which you can score your long list of solutions. However, resources such as the C40 Excel tool could be used to help measure the benefits of urban head adoption actions (see case study 8).

b. **FGDs and workshops:** Workshops with key stakeholders can be a useful way to gather feedback and gain consensus on which solution should be prioritized. The stakeholders you consult should be informed by **Activity 2.1** and include technical experts across local government, academia, public service and utility providers, and other institutions.

c. **Surveys and stakeholder ranking:** A survey to gather public and stakeholder opinion could aid with understanding stakeholder priorities and therefore which solutions you should prioritize for your shortlist.

**Applying multiple approaches to prioritizing your solutions into a shortlist may be appropriate for your context.** This will also provide richer results and justification for why you prioritized certain solutions over others.

CASE STUDY 8

### C40 Excel tool: measuring benefits of urban heat adaptation actions

The Excel Tool for Heat Resilience Benefits has been designed for decision-makers and planners to quantify the economic, health, and environmental benefits of heat resilience solutions (C40 2025a). Cities can use this tool to make cases for heat resilience solutions while identifying their wider benefits, thus helping to prioritize these into a shortlist.

#### *How the tool works*

Users can calculate the impact and benefits of parks, green infrastructure, water bodies, and vegetative surfaces. The data required to assess the impact of the heat action requires the following details:

- The nature of action, for instance, developing a park, planting trees, and so on, and the scale of development in terms of area coverage;
- Social inputs like population within the impacted area, demography, and their socioeconomic profile;
- Environmental input in terms of urban temperature profile, and climate scenarios for comparison; and
- Economic input like the cost of hospitalization due to heat events and lives lost.

The tool models the impact of heat adaptation actions on surface temperatures and, in turn, the impact of lower heat-related hospital admission and economic cost savings that lower temperatures generate. The results are indicative, not definitive, due to the range of necessary and generalizing assumptions that underpin the tool.

#### *Health and economic benefits of Medellin's Green Corridor*

Medellin, Colombia, built 36 green corridors between 2016 and 2019, adding green space for residents along with cycle routes. The results generated by running the Heat Resilient Cities Benefit Tool showed that the project would reduce urban heat by 2.7°C, reduce the number of days a year above the heat mortality threshold, and increase economic savings from reduced hospital admission (C40 2021a). Moreover, the tool supported the argument for further expansion the city's green infrastructure.

**Source:** C40 2021a.

CASE STUDY 9

## Community workshops to develop the Mumbai CAP

Glimpses of virtual and in-person community workshops to develop Mumbai CAP. **Source:** © C40 and Mumbai CAP.

One of the priority actions in Mumbai's CAP was mitigation and adaptation for urban heat stress. As part of that action, the Brihanmumbai Municipal Corporation organized workshops intended to develop coordinated and collaborative approaches necessary to implement greening solutions for long-term climate and community resilience. Over two days, representatives of citizens, NGOs and the government, as well as technical experts, and solution providers contributed to the discussions on addressing urban heat stress.

### *Workshop sessions*

Each of the workshop's five sessions focused on a question:

- What is the status of green infrastructure in priority zones within Mumbai?
- What are the scientific approaches, methods, and typologies of greening that can be adopted in vulnerable neighborhoods?
- How can community-based practices be embedded in local green design and governance?
- How can water-positive solutions, solid waste management, groundwater recharge, and food security be addressed through greening?
- What are the successes and failures of rooftop greening?

### *Opportunity actions*

Each session produced a list of actions and solutions, some of which included:

- Identification of micro- and community-spaces within informal settlements due to lack of open spaces.
- Different scales of open spaces to be acknowledged to serve different age groups and populations.
- Periodic ecological surveys to identify native plants and species to be incorporated into the city's planting schemes.
- Adoption of a circular approach to greening by using local materials and utilization of waste generated.
- Capacity building around ecological education, awareness, and scientific greening.
- Local citizen knowledge to be used within existing institutional capacity for neighborhood-level interventions.
- Creation of an inventory of existing open spaces and use of tools such as a People's Biodiversity Register to map biodiversity by involving citizens and adopting a plan based on the data collected.
- Decentralized systems for sewage water treatment and its reuse for irrigation within the greening initiatives.
- Identification of Greening Champions within the communities with the support from the local government.
- What are the successes and failures of rooftop greening?

**Source:** WRI (2023).

# 3.3.3

## *Detailing and tailoring short-listed solutions*

To enable smoother implementation, develop the shortlisted solutions with high-level details and align them to your city's context will. Stakeholders should understand the basic elements of your solutions; some elements, including responsibilities, financing, and timelines for implementation, will need to be elaborated upon by following the steps in Activity 3.4**.**

Consider the following questions to detail your solutions:

- **What is the rationale behind implementing this solution?** Why is the solution needed and what are its expected outcomes?
- **How would you best describe the solution and its components?** Provide a brief overview of the solution and key components to be developed during implementation such as feasibility and environmental assessment studies, detailed design, or specific infrastructure components. Consult technical experts to understand what components may be needed in your context.
- **Where and at what scale will the solution be applied?** Outline the scale and potential location of the solution, if possible. You may find that starting small and in a specific location will help to demonstrate results and allow you to pilot your solution.
- **What are the linkages with local and national plans and objectives?** Highlight links between the solution and relevant plans to demonstrate alignment against their objectives and identify opportunities to pool resources to aid implementation and resource efficiency.
- **Who or which institution will take ownership of delivery, and which stakeholders need to be involved?** This should be informed by the findings from Activity 2.1 and will help you to assign responsibility and identify partners for implementation as part of Step 3.4.1.
- **What are the estimated costs?** Outline a rough estimate of cost and resource requirements for the capital expenditure (CAPEX) as well as the yearly operating expenditure (OPEX) to operate and maintain the solution, and how do these relate to existing city budgets? Review Step 3.4.2 to help you identify possible sources and funding types for the heat resilience solutions.
- **What is a realistic timeframe for implementation?** Review Step 3.4.3 to help you with developing detailed timelines for implementation.
- **What key performance metrics and targets will you use to measure progress?** These should be informed by the metrics and targets developed as part of Step 3.2.3 and will be used to evaluate the implementation and impact of the solution when undertaking Activity 3.5.
- **What will be the key benefits and impacts of this solution?** It can also be useful to also highlight additional benefits that result from implementing the solution; these could relate to gender and social inclusion, smart maturity, GHG savings and climate, and disaster resilience.

***Resources***

- Solutions Catalog (Volume 3) which showcases and details a variety of heat resilience solutions.
- "Primer for Cool Cities", developed by the Energy Sector Management Assistance Program (ESMAP) / the World Bank, to help you detail your shortlisted solutions including descriptions, high-level estimated costs, and key benefits and impacts.
- Green City Action Plans, developed as part of the European Bank for Reconstruction and Development's Green Cities Program, for examples of how to detail your solutions.

### HOW TO ADAPT THIS ACTIVITY TO YOUR CONTEXT

The activity and its steps will help you to **develop and shortlist solutions** that **address the most important heat risks** and build heat resilience in the context of your city, while **being realistic and achievable,** with **appropriate capacity and resources allocated** for their implementation.

In undertaking this activity, you should think about the following to adapt the steps to your context:

| | |
|---|---|
| CITY SIZE AND CAPACITY | **Diligently assess resources**<br>Make sure you have a thorough understanding of the available resources, funds, and capacities to implement solutions. This could include speaking with your city's finance or budget departments to understand any budgetary constraints and therefore what solutions could be implemented.<br><br>**Set yourself focus areas or limits**<br>In cases where your capacity and resources are low, you should focus on a single activity, sector, or institution to begin building heat resilience. Your point of entry should help inform this. |
| CLIMATE | **Outlining and prioritizing solutions**<br>Your city's climate will have a high impact on the solutions you outline and prioritize. Use the information you gathered from Assessing Heat Risks to identify the types of solutions appropriate to your climate conditions. |
| USER ROLE | **Seek out partnership and support**<br>Reach out to technical experts and academia in your city to support you during the solution outlining and prioritization exercises.<br><br>**Obtain input and support for prioritizing and detailing solutions**<br>The technical expert, academic, or NGO/CSO you consult should be well-informed on heat-related challenges in your city and sector so that you receive valuable feedback on developing the solutions. |

# 3.4 PLAN IMPLEMENTATION OF HEAT RESILIENCE SOLUTIONS

The next step is to **assign responsibilities, initiate access to funding and financing, and develop detailed timelines for implementation.** This is critical to ensuring the successful implementation of solutions and limiting duplication of efforts and wasting of resources.

## *Activity Information*

| | |
|---|---|
| **SOURCES OF INFORMATION** | • National and local legislation, policies, plans, and strategies to identify appropriate partners and finance mechanisms.<br>• City government officials and legal advisors.<br>• Potential delivery partners, for example, international finance institutions or multilateral development banks.<br>• Best practices of implementing other projects and solutions across your city and wider region. |
| **EXPERTISE REQUIRED** | • Understanding of your city government structure and governance mechanisms as well as the powers and responsibilities of different stakeholders.<br>• Understanding of local procurement and potential routes to implementation.<br>• Understanding of sources and funding types available for funding solutions.<br>• Technical expertise in various infrastructure sectors and cross-cutting themes. |
| **OUTCOMES** | • Assign roles and responsibilities for the implementation of solutions.<br>• Identify the most appropriate financing mechanism and initiate work to secure finance and resources for the solutions identified.<br>• Develop a realistic and actionable timeline for implementing solutions.<br>• Develop the solution to be able to initiate feasibility studies, design and engineering work, and procurement to fully implement the solution. |

## *3.4.1.*

### *Assign responsibility and identify partners for implementation, maintenance, and operation*

**Assigning clear responsibilities and identifying the right partners for implementation is essential for the effective execution and ongoing maintenance of heat resilience solutions.** You should reflect on the solution details you developed as part of Step 3.3.3 to understand the capacity and resources required by the organization you assign to implement the given solution.

**Assigning a central coordination body,** such as your city's environmental, climate, public health, or urban development departments, **is a recommended step. The coordination body would oversee implementation, help to maintain momentum and ensure accountability.** This body could undertake the process of heat action planning and developing solutions, as outlined in Activity 3.2, coordinate resources, monitor and evaluate progress as part of Activity 3.5, and act as a hub that connects all the relevant partners.

Beyond this you should seek to assign responsibilities and identify implementation partners for specific elements and solutions; this could include:

- **City government officials and departments –** for example, your city's parks and recreation department could undertake a street tree planting solution, while the urban development and housing department could implement and enforce regulations relating to heat-resilient building materials.
- **Public service and utility providers (such as health and education institutions, water and energy supply companies) –** can play a critical role in public education, ensuring that residents understand heat risks and know how to stay safe during extreme heat events; they could also be key to implementing infrastructure solutions relating to their sector.
- **NGOs and CSOs –** can help to engage vulnerable groups in your city and offer unique insight into heat risks while also providing them with targeted resources and support.

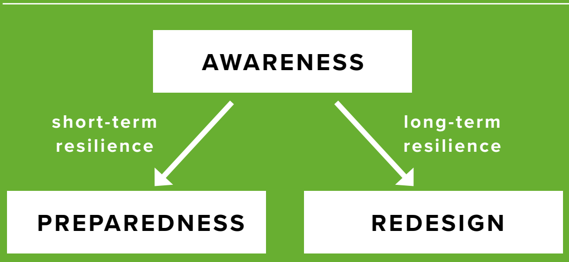
- **International finance institutions and development partners –** such as the World Bank, Asian Development Bank, or bilateral development agencies could be critical partners in developing, implementing resourcing, and financing the solution you identify.
- **Private sector partners –** local businesses and small and medium companies could have a role in implementing specific heat resilience solutions based on their background and experience.
- **Academia –** Universities and research institutions could help you to undertake further studies and assessments of heat risk in your city as well as provide technical expertise in developing your plan and detailing solutions.

**Assigning elements of the HAP and solutions to specific institutions and organizations ensures that each implementation partner knows its role in the broader implementation of HAP and solutions.** You should also interact with these various institutions during the solution development process to gather relevant information on detailing the solution and identifying possible routes to implementation, funding, and resourcing.

Moreover, joining networks of cities facing similar heat-related challenges, such as the UN Cooling Coalition, could help with sharing experiences and lessons learned in assigning responsibilities and identifying implementation partners.

TOOLBOX

## *Balancing short-term and long-term resilience*




To organize the solutions into a coherent action plan, UN-Habitat and UNEP developed a framework with three pillars: Awareness, Preparedness, and Redesign.

**Awareness**-raising solutions include knowledge production and dissemination activities. Awareness encompasses understanding and assessing heat risk globally as well as locally. Emphasis is placed on making knowledge accessible and relevant to different audiences to inspire behavioral change. From policymakers and service providers to urban populations at large, including vulnerable communities, concerns must be captured and addressed.

Awareness-raising works independently to inform policy and decision-making, but it also forms part of the solutions under the other two pillars: preparedness and redesign.

**Preparedness** refers to solutions that protect people, especially the most vulnerable groups, during heatwaves. These are policies, actions, and initiatives that are rather short-term in scope. They address heat as an extreme event, as an acute shock, rather than a long-term stressor or recurring risk. This includes: a) Preparing for the heatwave (e.g., defining thresholds for action and key response focal points; mobilizing resources; preparing redundancies), b) Responding during the heatwave (e.g., communicating protection measures and relief; mobilizing critical health and welfare providers and volunteers; modifying schedules and canceling events that increase exposure; allocating resources based on need), and c) Assessing success and failure afterwards (e.g., collecting data on what was effective and what was not; capturing best practices; documenting challenges).

**Redesign** addresses rising heat as a long-term stressor for our cities. Cities absorb heat and radiate it at night, disproportionately affecting the most vulnerable. It is critical to determine how to best design cooler and more livable urban environments. While awareness and preparedness are vital, redesigning urban systems is crucial for long-term resilience. This involves integrating climate-sensitive design principles into urban planning—from building codes with thermal performance standards and energy efficiency and sustainability criteria for building systems and equipment, to zoning and land-use regulations that promote permeable surfaces, blue/green infrastructure, and mixed-use development to increase walkability and access to public transportation. Finally, public space design guidelines that recommend how to best integrate nature, water, shading, and cool materials are essential. UN-Habitat and UNEP emphasize that by focusing on redesign, cities can become cooler and more sustainable, thereby mitigating the impacts of heatwaves.

CASE STUDY 10

## UN Cooling Coalition: city-to-city learning

The Cool Coalition is a global multi-stakeholder network of cities and governments and a range of international organizations, businesses, finance, academia, and civil society groups, aimed at facilitating knowledge exchange and joint actions toward a rapid global transition to climate-friendly cooling. Through urban form, better building design, energy efficiency, renewables, and thermal storage as well as phasing down hydrofluorocarbons, the Cool Coalition promotes 'avoid-shift-improve-protect' as a holistic and cross-sectoral approach.

The overall approach promoted by the coalition is to:

- **Reduce** the need for mechanical cooling through better urban planning and building design, and use of nature-based solutions such as green public spaces and green roofs and walls.
- **Shift** cooling to renewables, district cooling approaches, solar-powered cold chains, and so on.
- **Improve** conventional cooling by increasing the efficiency of air conditioning and refrigeration equipment and demand response measures.
- **Protect** vulnerable people from the effects of extreme heat and the consequences of unreliable medical and agricultural cold chains.
- **Leverage** cooperation between different actors in cooling to achieve a greater collective impact.

Cooling Coalition members work toward action to tackle urban heat stress, for instance, through events like COP29 where key actions were launched to ensure the inclusion of cooling in NDCs or the 12th World Urban Forum in which members discussed sustainable cooling solutions to address the extreme heat.

In achieving this mission, the Cool Coalition has worked with and helped to facilitate the following pilot projects:

- **Passive Cooling in Cambodia:** Cambodia is pursuing measures that will reduce cooling demand in buildings and cities through passive cooling solutions, including policy interventions for their inclusion in building regulations to demonstrate through application in buildings, and deliver awareness.
- **Beat the Heat, India:** Under the framework of the Cool Coalition, the United Nations Environment Programme and RMI, in partnership with the National Institute of Urban Affairs and Ministry of Foreign Affairs of Denmark under the India-Denmark Green Strategic Partnership, are developing a program to sustainably cool India's cities. Drawing on best practices from around the world, the program will deliver on-the-ground support to help cities "Beat the Heat".
- **Urban Cooling Action Plans, Vietnam:** The project will work across four key components to address urban heat stress: demonstration of a comprehensive urban cooling action, establishment of a national cooling fund, capacity building for replication of urban cooling strategies, and NDC implementation support through integrated policy approach.

**Source:** Cool Coalition 2024..

# 3.4.2.

## *Access financing for implementation, maintenance, and operation of the solutions*

Cities in the **Global South often experience financial resource constraints and the funding gap remains substantial** (World Bank 2024). Therefore, it is **essential to consider a range of sources and funding types to finance the implementation and maintenance of heat resilience solutions** (see toolbox).

TOOLBOX

### *Possible sources and funding types for heat resilience solutions*

Consider the climate finance instrument sources and funding types shown on the next page, available to local governments to build heat resilience.

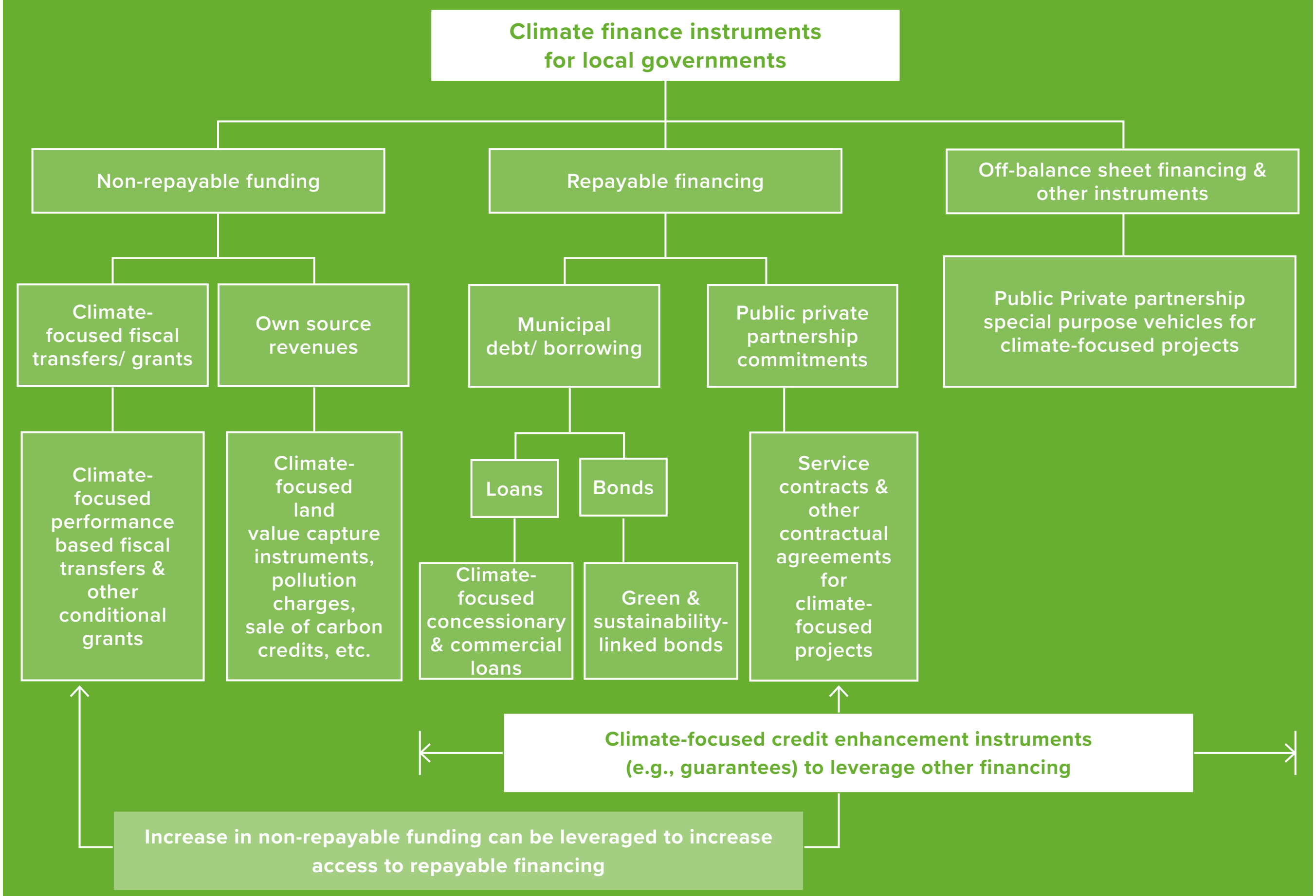



**Figure 2-16.** Climate finance instruments available to local governments. **Source:** World Bank 2024.

| SOURCES | FUNDING TYPES |
|---|---|
| INTERNATIONAL PUBLIC | • Global climate funds (e.g., adaptation fund, Global Facility for Disaster Reduction and Recovery, Green Climate Fund, Africa Climate Change Fund, Global Environment Facility, etc.).<br>• Grants, concessional and low-interest loans from multilateral development banks (e.g., the World Bank, European Bank for Reconstruction and Development (EBRD), Asian Development Bank, African Development Bank, etc.).<br>• Bilateral country financing. |
| DOMESTIC PUBLIC | • National development banks, if available.<br>• National climate funds, if available.<br>• Government transfers grants, or cost-sharing programs from ministries and government institutions.<br>• Municipal revenue (e.g., taxes, fees, fines, sale of city-owned land and assets, and cash reserves).<br>• Alternative finance instruments, subject to the legal and regulatory framework (e.g., land value capture, infrastructure levies, tax incentives for heat resilience solutions etc.) |
| INTERNATIONAL PRIVATE | • Debt market, if available (e.g., green bonds).<br>• Commercial banks and loans from balance sheet debt (municipal investment budget) or project debt through issuance of project bonds.<br>• Institutional investors (e.g., UN Capital Development Fund, International Finance Corporation, EBRD, CDC, etc.).<br>• Private investors/companies (e.g., pro bono contribution as part of corporate social responsibility commitments).<br>• Impact investors (e.g., pro bono contribution as part of corporate social responsibility commitments).<br>• NGOs and foundations (e.g., grants, donations, or pro bono contributions as part of corporate social responsibility commitments). |
| DOMESTIC PRIVATE | • Equity contributions in projects/project entities, subject to the legal and regulatory framework (e.g., through state-owned enterprises, public-private partnerships, municipal co-investment funds).<br>• Local commercial banks and loans from balance sheet debt (municipal investment budget) or project debt through issuance of project bonds.<br>• Debt market, if available (e.g., green bonds)<br>• Local institutional investors and insurance.<br>• Private investors/companies (e.g., pro bono contribution as part of corporate social responsibility commitments).<br>• Local impact investors (e.g., pro bono contribution as part of corporate social responsibility commitments).<br>• Local foundations (e.g., grants, donations, or pro bono contributions as part of corporate social responsibility commitments).<br>• Community-based financing (e.g., pooling money among residents in the community to fund resilience initiatives). |

**To ensure the longevity of heat resilience efforts, you should also plan for the maintenance and operational costs associated with these solutions**, including, for example, upkeep of shade structures, irrigation for green spaces, or staffing for cool centers. Explore opportunities to engage with the private sector to offer maintenance and operational services at competitive pricing, this could offer then potential revenue streams and lead to job creation in your city.

**Try to blend funding mechanisms where possible to create a diverse and stable financial base that allows for implementing heat resilience solutions and ensures their long-term effectiveness.** By combining the different funding sources, including international aid, public-private partnerships, community engagement, and dedicated national and local government budget allocations, your city can develop a sustainable financial ecosystem for heat management that adapts to changing needs over time.

Once you have identified the most appropriate mechanism for securing finance for your heat action solution, you should **begin consulting and engaging with relevant agencies and organizations**. In some cases, **this may include a formal application, consultation with the government, or donor/partner institution discussions.**

CASE STUDY 11

## Pioneering extreme heat index insurance in India

Promoting adaptive behavior is crucial but comes with risks like loss of income, increased expenditures and health costs. Parametric insurance, specifically extreme heat index insurance, can help mitigate these risks. This insurance triggers automatic payments when extreme heat thresholds are forecasted or reached, making it unsafe to work. Advantages of such insurance programs include:

- **Financial protection:** Provides automatic payments to cover lost income during extreme heat events.
- **Accessibility:** Designed for low-income urban women, with affordable premiums (up to US$2 per month).
- **Ease of use:** Payments are triggered automatically, based on clearly defined heat index thresholds.
- **Support for vulnerable populations:** Helps those most affected by extreme heat, particularly outdoor workers.

Mahila Housing Trust piloted heat index insurance for low-income urban women in India during the summer of 2023. Follow-up market research showed that women were willing to pay up to US$2 per month for heat index insurance and would want its design triggers to cover up to a few days of their lost income. Lessons learned from the pilot suggest that such insurance could be used in extreme heat risk adaptation if:

- The index and data sources are defined and accepted by all local parties.
- A strong local distribution channel is present.
- Strong capacity is built to deal with basic risk.

**Source:** Center for Financial Inclusion, 2023 and Tuinenburg, 2022.

### *Resources*

- 'Local Governments Climate Finance Instruments – Global Experiences and Prospects in Developing Countries' report from the World Bank for a detailed overview of available finance mechanisms and numerous case studies.
- 'How to Finance Urban Infrastructure' from C40 Cities to gain further insight into the different types of financing for urban infrastructure and heat solutions.
- The NDC Partnership 'Climate Finance Explorer' to find Climate Financing your city may be eligible for to support heat resilience.
- "Funding and Financing Heat Action" Learning Module as part of the Arsht-Rock Heat Action Platform.
- Arsht-Rock video to learn more about "what is disaster risk finance?" and how your city can be better prepared as a result of heat risks.

# 3.4.3.

## *Develop timelines for implementation*

Developing clear timelines for implementing heat resilience solutions allows you to align heat resilience efforts with broader urban development plans and policies, maximize resource efficiency, and build resilience incrementally at the most appropriate pace for your city.

An effective timeline for implementation considers synergies with existing plans, strategies, projects, and interventions and enables heat resilience to be integrated into ongoing work. For example, if your city is currently planning to expand the provision and quality of green space or update its building codes to increase resource efficiency, incorporating heat-resilient solutions, such as blue infrastructure or heat-reflecting materials on building facades, could drive dual benefits without requiring separate projects.

When developing timelines for implementing your heat resilience solutions, you should consider the following:

- **What are your city's priorities relating to heat resilience and how urgent are these?** For example, decreasing heat-related mortality may be your main objective and therefore you focus on health care provision. You should consider the strategic objectives you developed as part of Step 3.2.2 to help you identify which priorities are the most urgent for your city.
- **What are the quick wins, and which solutions require longer-term investment?** Identifying the quick wins, for example, raising awareness, and longer-term investments, for example,a green-blue infrastructure strategy, will help you to align your timeframe against your priorities, resource availability, existing projects, and initiatives.
- **What dependencies and synergies exist between different solutions, and how will they impact the timeline?** This could be related to the solutions you have developed and prioritized as part of Activity 3.3 as well as existing plans, strategies, projects, and initiatives that should be considered when developing implementation timeframes for heat resilience solutions.
- **What resources (including financial, human, and/or technical) are required for each solution and when will they be available?** This could be a critical limiting factor for solution implementation and should be considered when prioritizing solutions as part of Step 3.3.2 to ensure you are working within your city's means. In most cases, infrastructure solutions often require high capacity while soft measures such as policy and awareness raising require less capacity and resources.
- **Are there any key seasonal or climate considerations that need to be considered?** For example, when is the optimum planting season to ensure successful growth of trees and other vegetation?

Timeframes for implementation will be different from city to city; however, you should consider aligning your solutions to the following timeframes:

| | |
|---|---|
| SHORT-TERM/ QUICK WINS (0-2 YEARS) | • **Solutions that have been piloted** and can be **easily scaled up** or those that are **only missing singular elements to facilitate delivery**, e.g., securing financing or finding a location.<br>• **Implementing heatwave restrictions, developing cool centers, or distributing drinking water during heatwaves.** |
| MEDIUM-TERM (2-5 YEARS) | • Solutions that require **additional time to plan** and **develop multiple elements to facilitate their implementation**, or more resources than for quick wins and **additional coordinated efforts between stakeholders.**<br>• **Planting street trees, implementing indoor cooling measures, or EWS.** |
| LONG-TERM (5+ YEARS) | • Solutions that **require a lot of time to plan**, including c**hanges in regulatory environments** to facilitate implementation, **intense stakeholder engagement and collaboration** across multiple phases of the project, and often have **high resource and capacity requirements.**<br>• **Implementing complex green and blue infrastructure, cool roads and roofs, or designing heat-resilient buildings.** |

**You should keep in mind that some solutions may need to be developed across multiple timeframes as well as extend well beyond the planning timeframe for your HAP.**

Moreover, some solutions will have direct and immediate benefits whereas others, for example, planting street trees, will provide benefits at a later stage of their life. Some others may be undertaken on a yearly rolling basis which will help to exponentially increase heat resilience benefits over time.

## HOW TO ADAPT THIS ACTIVITY TO YOUR CONTEXT

The activity will help you **identify appropriate institutions and organizations** to lead delivery of solutions, potential **sources and types of finance** and **establish timelines for implementation** to **effectively utilize your resources and capacity.**

In undertaking this activity, you should think about the following to adapt the steps to your context:

| | |
|---|---|
| CITY SIZE AND CAPACITY | **Assign responsibility for implementation within your city's governance context**<br>Such as the greening department to implement green infrastructure, or the housing department to implement insulation in social housing. Also consider identifying organizations outside of your city government or request private businesses and CSOs to assist you with solution implementation.<br>**Financial capacity, regulation, and legislation**<br>This affects the types of sources and funding you could apply for, such as national government allocations, credit scores or green bonds and therefore can impact allocations for heat resilience. |
| CLIMATE | **Impact on implementation timelines**<br>Depending on the shortlisted solutions, consider the local climate when developing implementation timelines, for instance, planting of trees and vegetation or work patterns of construction workers delivering your solutions. |
| USER ROLE | **Seek out partnerships and support**<br>You may need partnerships and support to help you determine the right institutions to lead solution implementation, financing, and timelines for implementation.<br>**Solicit input and support for prioritizing and detailing solutions**<br>Ask an NGO/CSO, academic, or technical expert to assist in developing effective and timely solutions.<br>**Partner with potential implementation stakeholders**<br>Such as private businesses, local banks, or multilateral development banks, that can provide resources and funding. |

# 3.5

# MONITOR AND EVALUATE HEAT RISK AND RESILIENCE

**Undertaking robust M&E** of heat risk metrics and targets, and **monitoring progress on solutions is vital to understand the impact of your solutions** and **maximize success of solutions and actions by highlighting where additional effort and resources are needed to bolster implementation efforts**. The following activities will help you to identify the best approach and governance structure for M&E activities, monitoring against metrics and targets, and how to evaluate and communicate results and outcomes.

## *Activity Information*

| | |
|---|---|
| **SOURCES OF INFORMATION** | • Results from and any updates on heat risk assessments.<br>• Socioeconomic and demographic information.<br>• Stakeholder engagement and community feedback.<br>• National and local policy, plans, and strategies.<br>• National and local statistics and databases |
| **EXPERTISE REQUIRED** | • Thorough knowledge and understanding of local heat risks, socioeconomic factors, and demographics to inform M&E activities.<br>• Appropriate levels of capacity and resources to undertake regular M&E. |
| **OUTCOMES** | • A robust plan to undertake M&E of solution implementation and heat risk reduction against metrics.<br>• Develop clear roles and responsibilities and assign relevant institutions/ personnel to M&E activities.<br>• Undertake regular M&E and prepare assessments updates and plans when appropriate. |

# 3.5.1.

## *Identify the best approach for M&E activities*

It is recommended that the M&E be embedded in your HAP at the creation stage, see Activity 3.2**.** In doing so, any monitoring framework, metric and target can be aligned to the vision, objectives, and solutions set out in the specific plan. This will aid in the evaluation and reporting of these activities and solutions, see Step 3.5.4.

However, your city may not be ready to develop a HAP at this stage. Therefore, when positioning your M&E framework, you should consider the following:

- **Is there another existing plan, strategy, or monitoring system related to heat risk that is already tracking relevant heat metrics and targets,** for example, a CAP or EWS?
- **Does your city have an existing M&E framework** or structure in place that you can leverage?
- **Does your city have a data management and storage system** that includes relevant heat metrics and targets?
- **Is your city reporting relevant metrics and targets, publicly,** preferably in a digital format for easy consumption?

You should identify your point of entry for M&E activities at an early stage in the development of any plan and solution alongside Activity 2.1 to build M&E activities into the plan you create following Activities 3.2 to 3.4.

# 3.5.2.

## *Setting up the right governance mechanisms to ensure effective M&E*

Once you have identified the best way to position your M&E framework, **seek to establish appropriate governance mechanisms which will help to ensure M&E is undertaken effectively and robustly**. In doing so you should consider:

- **Who will take ownership of M&E activities?** Establishing clear roles and responsibilities is key to an effective M&E framework; it could be an individual or team within a specific department in your city which is assigned as a central coordination body.
- **Who are the stakeholders and institutions that will need to be involved in M&E activities?** Communication and cooperation between various government and nongovernment institutions are critical to supporting M&E efforts and ensuring their success, when it comes to urban heat due to the number of actors involved.
- **What resources are needed to undertake effective governance and M&E activities?** Capacity and resources need to be allocated to the M&E activities to ensure they are well established and undertaken regularly.

Heat resilience M&E governance mechanisms should be well integrated across sectors and interlinked with other institutions as well as regional and national structures where appropriate.

You should identify procedures for M&E activities at an early point in the assessment process alongside Activity 2.1, and identify appropriate M&E governance mechanisms for the plan you create following the Activities 3.1 to 3.4.

# 3.5.3.

## *Monitor the implementation process and outcomes of heat resilience solutions*

Monitoring of the implementation process and outcomes of heat resilience solutions should be undertaken once you complete the **activities to Assess Heat Risk and Plan for Heat Resilience** and have been able to identify the best approach as well as set up appropriate governance mechanisms to ensure effective M&E activities.

**The following step should be undertaken no sooner than six months after approval of your HAP and solutions created to build heat resilience in your city.** Thereafter, **you should aim to undertake monitoring at least once a year to ensure consistency**. You may identify that the time to monitor implementation and outcomes of heat resilience solutions is aligned with existing reporting timetables within your city or during periods of local budget spending reviews. This will help you to gather data and establish progress on the implementation of heat-resilient solutions; however, it may not be possible for all metrics and targets.

Undertaking activities and steps in Chapter 2 and Step 3.2.3 will **help you to define the metrics and targets you should monitor to track progress against strategic objectives**. The following should be considered when identifying metrics and targets to be monitored:

- **Inputs** are the direct measures that have fed into implementing the solution, for example, the amount of money, time, or resources contributed to implementing a solution.
- **Outputs** are direct achievements of the solution being implemented, for example, square meter of cool or green roofs installed or kilometer of green corridor implemented.
- **Outcomes** are changes that have occurred because of implementation of the heat resilient solution, for example, reduction in surface temperatures due to a cool roads program.
- **Impact** is the contribution of the solution to larger strategic objectives and metrics, for example, decreasing mortality and morbidity.

Heat resilience M&E governance mechanisms should be well integrated across sectors and interlinked with other institutions as well as regional and national structures where appropriate.

You should identify procedures for M&E activities at an early point in the assessment process alongside Activity 2.1, and identify appropriate M&E governance mechanisms for the plan you create following the Activities 3.1 to 3.4.

**When developing your M&E framework and undertaking monitoring of heat resilience solutions you should consider the following:**

- **What or who is the source of the data you are interested in tracking and how can you easily get access?** relevant sources of data relating to heat resilience include city, regional, and national government departments, utilities and public infrastructure providers, academia, NGOs, and CSOs. In most cases, you may also rely on the data you acquired or developed as part of your **Assessment of Heat Risks** and impact**.**
- **Who will be responsible for collecting the data and how will they be collected?** This will depend on your city's data handling capabilities and data sharing protocols. Moreover, this should be informed by Step 3.5.2.
- **How frequently does the data need to be collected?** Once a year should be the minimum; however, you may wish to collect some metrics and targets on a more frequent basis to build a comprehensive picture of progress and outcomes.
- **Where or to whom will the data be reported and how will it be stored?** This should be informed by Step 3.5.4.

In your efforts to monitor and collect data, you should ensure its quality and reliability by establishing or following already established data quality controls and quality assurance systems. You can review the Climate Data Management framework to support the development of sound data management practices in your city.

# 3.5.4.

## *Evaluate and communicate the results and outcomes*

**Evaluating progress against strategic objectives, metrics, and targets is a critical part of planning for heat resilience and allows for an assessment of the impact of planned/implemented solutions.** Evaluation can also help to identify barriers to implementation, inform adjustments needed to budget and resources, identify lessons learned and develop recommendations that can be applied to future planning activities, and gain a deeper understanding of the successes and challenges to achieving heat resilience. These lessons learned and recommendations should be considered next time you undertake **activities to Assess Heat Risk and Plan for Heat Resilience** to update analyses, plans, and solutions.

The Organisation for Economic Co-operation and Development -Development Assistance Committee network has set out six criteria that have been adapted to the heat risk context, and should be modified to help evaluate the impact and outcomes of heat resilience plans and solutions in your city.

- **Relevance: Was the right solution implemented** (including in the right location and targeting the right vulnerable groups) to achieve desirable outcomes?
- **Effectiveness: Did the plan and implemented solutions achieve their objective of building heat resilience in your city?** For example, has awareness of heat risks and behaviors relating to heat resilience improved?
- **Impact: What difference did the plan and implemented solutions make in building resilient to heat?** For example, did morbidity and mortality rates decline compared to previous heat seasons?
- **Coherence: How well did the plan and solutions for heat resilience fit into existing planning regimes and projects being implemented across your city?** What feedback was received from residents and the media relating to their implementation?
- **Efficiency: Were the resources allocated for planning for heat resilience and implementing solutions used appropriately?** Moreover, do scientific data and health records show tangible improvements because of implemented solutions?
- **Sustainability: Will the implemented solutions provide lasting impact and benefits for your city and its vulnerable communities?**

**Reporting on the progress and impacts of your heat resilience plan and implemented solutions is an important step to building further stakeholder awareness and political buy-in.** It creates accountability for implementation and potentially increases investor and public confidence in your actions (see Activity 3.1). Your reporting should be tailored to the target audience considering its format, purpose, and frequency to ensure the appropriate information is conveyed and reporting fatigue is avoided.

***Resources***

- "Monitoring, Evaluation and Reporting" guidance produced by C40 Cities relating to the production of a Climate Action Plan for further insight on how to undertake effective M&E.
- "Monitor and Evaluate Heat Action" Learning Module as part of the Arsht-Rock Heat Action Platform.

CASE STUDY 12

## Reporting framework for the Kuala Lumpur CAP

The reporting framework for the Kuala Lumpur CAP was developed to highlight achievements in implementing climate action as well as to identify opportunities to adapt and improve the existing approach. The framework assigns responsibility to a low carbon and resilient cities secretariat for updating progress and achievements compared to the baseline year and against goals.

Importantly, the framework identifies a matrix of reporting styles that should be followed to ensure the appropriate stakeholder receives pertinent information through the correct communication method.

The reporting process is intended to provide visibility and opportunities to support transparency and accountability relating to the implementation of CAP.

| | MAYORAL TEAM | KLCH DEPARTMENTS | NON-GOVERNMENTAL STAKEHOLDERS | CITIZENS |
|---|---|---|---|---|
| What do they need? | Progress: Action Development and Effects<br>Outcomes (Quantitative and Qualitative)<br>Cost-Benefit Ratios | Progress: Action Development<br>Outputs (Quantitative and Qualitative)<br>Outcomes (Quantitative and Qualitative)<br>Cost-Benefit Ratios | Outputs<br>Outcomes<br>Impacts<br>Risk Reduction<br>Information | Risk Reduction<br>Information<br>Impacts Indicators<br>Future Scenarios |
| Why do they need to know this? | Accountability<br>Decision-making and Planning<br>Resource Allocation<br>Policy Making for Climate Action | Accountability<br>Progress Reporting<br>Resource Allocation<br>Basis for Partnerships and Synergies | Reporting<br>Basis for Funding Requests<br>Basis for Partnerships and Synergies | Accountability<br>Awareness Building<br>Education<br>Behavioural Change |
| Communication methods | Executive Summaries<br>Graphs/Data Tables<br>Cost-Benefit Ratios<br>KPI Achievement % | Graphs/Data<br>Spatial Distributions/ Mapping<br>Reports and Assessments<br>Scenario and Climate Modelling Summaries | Infographics<br>Scenario and Climate Modeling Summaries<br>Executive Summaries | Social Media Infographics |
| FREQUENCY | **Monthly/ project based** | **Quarterly/ monthly/ project based** | **Quarterly/ Ongoing** | |

**Figure 2-17.** Kuala Lumpur CAP reporting matrix. **Source:** Kuala Lumpur City Hall 2021.

**HOW TO ADAPT THIS ACTIVITY TO YOUR CONTEXT**

The activity and its steps will help you to undertake well-coordinated, effective, and efficient M&E of heat risk and resilience while ensuring the plans and solutions you implement are realistic, effective, context-specific, and achieving the desired outcomes as well as identifying lessons learned for plan creation and stakeholder engagement to build accountability and long-term success.

In undertaking this activity, you should think about the following to adapt the steps to your context:

| | |
|---|---|
| CITY SIZE AND CAPACITY | **Level of effort dedicated to M&E activities**<br>Evaluate the resources and capacity you can allocate to M&E activities; a large city may dedicate more capacity and monitor more frequently.<br>**What methods of M&E should you adopt**<br>A larger city may undertake more sophisticated monitoring of metrics as opposed ot a small one.<br>**Storing and presenting outcomes and findings**<br>You could use an existing digital platform to store and disseminate data, say, a GIS web map, or rely on more traditional methods such as Excel spreadsheets and presentations. |
| CLIMATE | **Impact on the metrics and targets you monitor**<br>The climate of your city may have an impact on the metrics and targets you choose to monitor.<br>**Frequency of monitoring**<br>Some climate-related metrics and targets should be monitored more frequently to build a better picture of how your solutions are impacting urban heat. |
| USER ROLE | **Consider your role and involvement in facilitating M&E**<br>You could coordinate to ensure data is collected at the right time from the right sources, a technical expert could understate data analysis role, whereas an NGO/CSO may help to communicate the findings of M&E activities to the public.<br>**Level of detail and data required from M&E activities**<br>While you may be interested in the high-level impacts and outcomes, a technical expert or academic may look for granular detailed data for further modeling and research, and an NGO/CSO may be interested in impacts on health and communities. |

# 04 Responding to Heatwaves

During the heat season, heatwaves are becoming increasingly intense and frequent due to climate change and urbanization, posing severe risks to urban public health, infrastructure, and essential services, especially in the Global South (UNICEF, 2022; ILO, 2019).

**This chapter provides city authorities with a rapid response framework to manage heatwaves**, including undertaking immediate response actions to mitigate risks and protect vulnerable populations through targeted interventions. By focusing on preparedness measures, protocols, coordination mechanisms, and effective communication of early warning systems in place, this chapter supports you in handling the dynamic and evolving nature of heatwave response. Learnings from each event should inform future preparedness efforts, but this chapter prioritizes direct measures to reduce harm during an active heatwave event

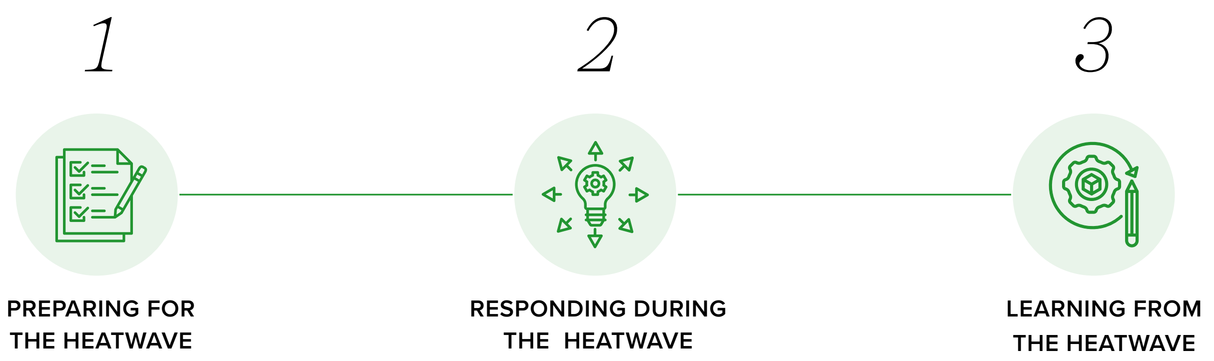



**Figure 2-18.** Activities for responding to heat season

***Resources***

'Heatwave Guide for Cities' by RCCC (2019) for more detailed guidance and background information on heatwave response.

# 4.1
# PREPARING FOR THE HEATWAVE

While long-term preparedness is essential, this activity highlights critical last-minute steps to help ensure that emergency services, communication strategies, and resource distribution plans are in place and ready for deployment. Refer to sections 2 through 5 of the Climate Centre's 'Heatwave Guide for Cities' for further details on this activity.

STEP

*1*

## UNDERSTAND THE SEVERITY AND DURATION OF THE HEATWAVE

Preparation begins with a **clear understanding of the heatwave's potential duration and temperature levels, as well as the geographical areas that might be impacted.** Heat EWS can alert cities to imminent extreme temperatures, enabling proactive planning. You should:

- Utilize heat warnings from the national metrological organization to assess expected conditions and potential danger to health.
- Define temperature thresholds that trigger emergency responses.
- Conduct rapid assessments to identify expected temperature and vulnerable populations.

Refer to section 4 of the Climate Centre's 'Heatwave Guide for Cities' for further details on this step.

STEP

*2*

## DEFINE AND INFORM FOCAL POINTS FOR RESPONSE

**Engaging and identifying decision -makers as focal points ensures a streamlined response.** This should include related national (for example, meteorological agency) and local government authorities, city service providers (like water and electricity utilities), emergency response units, healthcare facilities, and community-based organizations (particularly the Red Cross Red Crescent-national societies). You should:

- Establish clear communication protocols between these focal points and on-the-ground teamsemergency response stakeholders to facilitate rapid mobilization during a heatwave.
- Establish a clear chain of commands to ensure rapid and effective decision-making during critical resource shortages.

STEP

*3*

## ENSURE EFFECTIVE COMMUNICATION AND COORDINATION

**Inclusive and accessible communication is essential to reach diverse populations,** including non-native language speakers and tourists. Public health messages should be simple, actionable, and cover heat protection measures. Coordinate with national health authorities to ensure a coherent messaging for the public to avoid confusion. You should:

- Issue alerts accompanied with health advice when temperatures reach dangerous levels. Mobilize emergency response focal points across agencies.
- Broadcasts messages via television, radio, social media, and SMS messages to disseminate timely information, while printed materials can serve vulnerable populations with limited access to digital media.
- Use data from social media platforms and community outreach programs to provide you with vital insights into population needs and allow rapid response adjustments.
- Tailor messaging for vulnerable groups, including outdoor workers and the elderly.

Refer to section 2 of the Climate Centre's 'Heatwave Guide for Cities' for further details on this step.

STEP

4

STEP UP EFFORTS TO PREPARE HOUSEHOLDS FOR THE HEATWAVES

**While raising awareness about preparing for extreme heat should be a year-round activity, you should increase your awareness raising efforts in the leadup to the heat season.** Highlighting household-level preparation methods that can aid in building individual and household heat resilience is crucial due to the increasing frequency and intensity of heatwaves driven by climate change. Effective preparation can significantly reduce health risks, protect vulnerable populations, and enhance community resilience. You should:

- Inform residents on actions they can take to stay cool, hydrate, and reduce indoor heat, including, drinking plenty of water, wearing loose clothing, staying indoors and/or going to cooling centers, ensuring these messages drive action, not just awareness.
- Provide Guidance on making homes heat-resistant, including using reflective curtains and reducing the use of indoor heat sources (for example, ovens).
- Collaborate with community groups to distribute practical household checklists.

STEP

5

MOBILIZE AND ALLOCATE NECESSARY RESOURCES

**It is critical to assess staff, finances, and available resources,** such as knowledge of the health staff to recognize heat stroke and exhaustion, and the **capacity of health facilities to handle the surge during heatwaves.** The need for relief items, such as umbrellas, water, potential cooling stations, and shade areas, that can aid in heat relief efforts should be assessed and made available. Municipal authorities should coordinate with local organizations to allocate these resources effectively, focusing on neighborhoods with high heat exposure and vulnerable populations (NDMA, n.d.). You should:

- Verify the availability of medical personnel and emergency supplies.
- Distribute cooling resources and check the conditions and operational status of water stations and shade areas.
- Engage community-based "heat champions" to coordinate efforts.

Refer to section 3 of the Climate Centre's 'Heatwave Guide for Cities' for further details on this step.

## COMMUNICATING VISUALLY

Simple illustrations can be a great way of sharing key information about how to keep safe during a heatwave. You can share these on social media platforms or through traditional media outlets like your local newspaper.

Refer to RCCC Heat Communication Guide for the Cities in South Asia for more detailed guidance and examples.

**en et. Al 2022), © 2021, Climate and Development Knowledge Network. T.**

# 4.2
# RESPONDING DURING THE HEATWAVE

This activity forms the core of the response effort. Once a heatwave is underway, you must act swiftly and dynamically to protect lives and infrastructure. The response phase requires real-time decision-making, adjusting strategies based on evolving conditions, and prioritizing resources where they are most needed. Refer to section 6 of the Climate Centre's 'Heatwave Guide for Cities' for further details on this activity.

## STEP 1
### ISSUE A HEATWAVE WARNING

**Issuing a heat warning is a critical first step to effectively respond to a heatwave. You should communicate urgent heat protection measures** as widely as possible, so that city residents are aware of the specific risks from the imminent heatwave and actions they can take to protect themselves. In some cases, individual behavioral change and action can be the most effective way to prevent adverse impacts of heatwaves. You should:

- Disseminate warnings and alerts via television, radio, social media, and SMS in partnership with mobile providers.
- Engage with trusted community leaders to expand outreach efforts and check on vulnerable people.

## STEP 2
### DYNAMICALLY ALLOCATE EMERGENCY RESOURCES

**Monitoring of key data, including meteorological data or hospital admissions, is essential to dynamically allocate resources** and ensure these are funneled to the people who need them most. You should:

- Prioritize electricity and water supply to hospitals, cooling centers, and elder care facilities.
- Adjust medical response capacity based on heat-related illness trends.
- Scale up interventions or redirect resources based on real-time monitoring.

## STEP 3
### PROVIDE DIRECT HEAT RELIEF IN HIGH-RISK AREAS

**Temporary infrastructure and measures to address heat stress among city residents can help provide relief during heatwaves.** Physical structures and shade can help reduce exposure to direct sunlight whereas access to water can help people cool down and stay hydrated. Engage local organizations to assist with coordinating and implementing your emergency response efforts. You should:

- Set up cooling stations, hydration points, and shaded rest areas, and prolong their opening hours.
- Deploy temporary shade and hydration points, for example, freshwater tank trucks for hard-to-reach areas and where supplies could be limited such as in informal settlements to mitigate heat risk.
- Deploy misting systems and mobile cooling units in urban heat hotspots.
- Use your assessment of urban heat, geographic hotspots, and vulnerable groups to determine the best locations for such direct heat relief interventions

STEP

4

### IMPLEMENT EMERGENCY MEASURES WHEN NECESSARY

During particularly severe heatwaves, consider **deploying additional emergency measures to limit exposure to extreme heat**. You should:

- Decide whether exposed public spaces, such as schools or transit hubs, require temporary closure.
- Determine if certain public spaces may be cooler than homes and can be repurposed as heatwave shelters.
- Modify work schedules and introduce heat-adaptive labor practices.
- Restrict high-traffic areas to reduce urban heat accumulation.

STEP

5

### SUPPORT CONTINUITY OF EMERGENCY AND HEALTHCARE SERVICES

**Ensuring your response measures continue through the entire duration of the heatwave is essential to minimize the adverse effects of the heatwaves on people and human health.** You should:

- Effectively manage stockpiles of emergency resources.
- Increase staffing in emergency rooms and heat shelters.
- Provide backup power to hospitals and essential cooling infrastructure. Maintain coordination with healthcare providers to manage increased patient loads.
- Partner with utility companies, local suppliers, and community groups to ensure you have a good network of partners to provide continuous support to vulnerable groups.

### PROTECTING ELDERLY COMMUNITY MEMBERS DURING HEATWAVES IN SINGAPORE

**Red Cross personnel, Singapore. ©Singapore Red Cross (SRC)**

Singapore Red Cross is strengthening community resilience during heatwaves by focusing on protecting the elderly through a range of activities including:

- Volunteers check in on elderly individuals during hot weather to ensure their wellbeing and provide practical cooling strategies.
- Door-to-door transport for seniors commuting for medical appointments offers a cooler and safer travel alternative, especially during extreme heat conditions.
- Centers double as cooling spaces, providing respite from high temperatures, and sites for heat-health engagement activities to educate and support the elderly.

# 4.3

# LEARNING FROM THE HEATWAVE

After a heatwave or at the end of the heat season, evaluating the response and identifying gaps is crucial for improving future preparedness. However, this activity focuses on ongoing learning that can be undertaken during an extreme heat event to improve the response for future heatwaves as well as prepare for later evaluation. Refer to section 7 of the Climate Centre's 'Heatwave Guide for Cities' for further details on this activity.

STEP

*1*

## COLLECT RELEVANT HEAT RISKS DATA

**After the heatwave ends, you should collect relevant heat risk data to build an accurate picture of the heatwave and its outcomes.** This will also help you to understand how your response worked and benefited your population. You should collect data on:

- Temperature thresholds and climate conditions.
- Health records, including hospital admissions because of heat-related illnesses and mortality numbers.
- Socioeconomic indicators and effects of heat on economic activity.
- Infrastructure utilization and requirements, for example, water distribution and electricity interruptions.
- Feedback and experience from community leaders, NGOs and CSOs on response efforts and impacts in your local community.
- Partnering with organizations which have epidemiology expertise for a public health surveillance function or a heat-health observatory.

STEP

*2*

## ASSESS STRENGTHS AND WEAKNESSES OF YOUR RESPONSE

**Using the data you collected, undertake an assessment to understand the strengths and weaknesses of your response.** You should:

- Document immediate challenges and emerging issues which arose during your response to the heatwave.
- Capture best practices you should continue implementing for future heatwave responses.
- Document successful outreach methods that ensured high engagement.
- Identify efficient coordination practices between your agencies and community groups.
- Maintain records of response timelines to refine future emergency protocols.

STEP

*3*

## IDENTIFY WHAT YOU WOULD DO DIFFERENTLY

**Think about how you could improve your response efforts for future heatwaves.** This could include:

- Allocating additional resources for emergency response.
- Collaborating with other community leaders, NGOs and CSOs to strengthen your networks to aid with the emergency response.
- Consider the need for further awareness-raising and dissemination of information.
- Consider the need to implement additional solutions across your city, for example, setting up and expanding the number of cooling stations, hydration points, and shaded rest areas, and prolonging their opening hours when needed.

STEP

4

APPLY YOUR FINDINGS AND BEGIN LONG-TERM HEAT RISK MANAGEMENT

**Use the information you have gathered to begin planning for future heatwaves and begin robust heat risk management in your city.** You should also:

- Consider other cities' efforts to apply any lessons learned to your response.
- Undertaken stakeholder engagement with community leaders, NGOs, CSOs, and government agencies to maintain your network of partners.

## LESSONS LEARNED AT THE NATIONAL DISASTER MANAGEMENT AUTHORITY (NDMA) IN INDIA

NDMA disseminates lessons learned from heat management practices across the country, highlighting how improved inter-agency coordination and granular data collection, including setting an institutional mandate at NDMA for data collection and weekly data sharing with stakeholders, has allowed the government to address heat-related illness and death in Indian cities.

**Source: NDMA, n.d.**

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# Handbook on Urban Heat Management

## in the Global South

*Volume III*
*Solutions Catalog*

WORLD BANK GROUP

UN-HABITAT

UN environment programme

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# Contents

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# *Abbreviations and Acronyms*

| | |
|---|---|
| °C | degree centigrade |
| °F | degree Fahrenheit |
| Arsht-Rock | Atlantic Council's Climate Resilience Center |
| CBO | community-based organization |
| CDKN | Climate and Development Knowledge Network |
| CSO | civil society organization |
| ESMAP | Energy Sector Management Assistance Program |
| EWS | early warning system |
| FGD | focus group discussion |
| GHG | greenhouse gas |
| GIS | Geographic Information System |
| GIZ | German Corporation for International Cooperation |
| HAP | heat action plan |
| IBRD | International Bank for Reconstruction and Development |
| IPCC | Intergovernmental Panel on Climate Change |
| km | kilometer |
| M&E | monitoring and evaluation |
| NbS | nature-based solutions |
| NDMA | National Disaster Management Authority |
| NGO | nongovernmental organization |
| PV | photovoltaic |
| RCCC | Red Cross Red Crescent Climate Centre |
| UHI | urban heat island |
| $UHI_a$ | Urban Heat Island Index |
| UHIE | Urban Heat Island Effect |
| UNDP | United Nations Development Programme |
| UN-Habitat | United Nations Human Settlements Programme |

**The Solutions Catalog forms the third volume of the World Bank's Handbook on Urban Heat Management. This catalog contains a range of solutions to help develop and implement appropriate actions to improve heat resilience. It is not an exhaustive list but serves as a starting point for developing context-specific actions for your city. The solutions in this catalog are organized under three categories corresponding to the guidance in this Handbook:**

## *Assess*

*Solutions showcasing methods to help you establish a baseline of urban heat exposure, risks, and vulnerabilities.*

## *Plan*

*Long-term actions you can implement to mitigate and adapt to urban heat and build a heat-resilient city.*

## *Respond*

*Short-term solutions and approaches to save lives during heatwaves.*

Each solution has been indexed against the criteria shown in Table 3-1 to help you quickly determine whether it could apply to your context.

| | | |
|---|---|---|
| SCALE | **City** Solutions implemented at a large scale across multiple neighborhoods and sites. | |
| | **Neighborhood and community** Solutions implemented at a medium scale focusing on a single neighborhood in your city. | |
| | **Site and household** Solutions implemented at a small scale focusing on a single site, building, or household. | |
| EASE OF IMPLEMENTATION | **Hard** Solutions that require significant resources and are often excessively difficult to implement and/or require a long-term approach, for example, a new transit-orientated development. | |
| | **Medium** Solutions that require substantial resources and can be difficult to implement and require time to plan, for example, an early warning system (EWS). | |
| | **Easy** Solutions that require few resources and are easy to implement relatively quickly, for example, an awareness-raising campaign. | |
| BENEFITS | **People (health and equality)** Solutions that can have a beneficial impact on your city's residents, visitors, and employees. | |
| | **Economy (productivity and livelihoods)** Solutions that can have a beneficial impact on your city's economy. | |
| | **Infrastructure** Solutions that can have a beneficial impact on improving your city's infrastructure networks and provision. | |
| | **Environment** Outlines how implementing the solution can have a beneficial impact on your city's natural systems and environment. | |
| TYPE OF SOLUTION | **Governance, policy, and plans** Solutions focusing on your city's regulatory environment. | |
| | **Capacity development and behavior change** Solutions focusing on developing capacity and influencing people to act differently. | |
| | **Data and technology** Solutions that use digital and smart solutions. | |
| | **Infrastructure (gray, green, blue)** Solutions focusing on infrastructure investment (gray relates to human-made structures, green relates to natural structures and interventions, and blue relates to water-related interventions). | |
| LEVEL OF EVIDENCE | **Pilots** Promising and innovative solutions that, while supported by limited or moderate scientific evidence, have shown early success and adaptability across diverse contexts—demonstrating potential for scaling up. | |
| | **Established practices** Widely tested and well-established solutions with strong scientific evidence. | |

**Table 3-1.** Solutions Indexed to City-specific Criteria

Where possible, each of the solutions in this catalog is accompanied by a case study demonstrating a similar project or program implemented in a city in the Global South. In addition, links to further reading, examples, and resources are provided to encourage you to undertake your own research, learn more about solutions, and identify whether they are appropriate for implementation in your city.


**Figure 3-1.** Catalog of 25 solutions for urban heat resilience

SECTION 1

# Assess Heat Risk

01

# *Establishing an Early Warning System*

### SCALE

City

### TYPE OF ACTION

Data and technology

### EASE OF IMPLEMENTATION

Medium

### LEVEL OF EVIDENCE

Established practices

### SUITABILITY

#### City Context

Urban environments with dense infrastructure, a high percentage of vulnerable populations (e.g., elderly, low-income, homeless), and significant air pollution. Cities that might be facing an increase in heat-related mortality and morbidity due to climate change and urbanization.

#### Climate Context

Cities located in regions with higher-than-average temperatures and more frequent and intense heatwaves.

#### User Context

- Vulnerable residents (the elderly, low-income communities, children, people with pre-existing health conditions) and the public.
- Implemented by local governments.
- Used by health organizations, emergency services, and urban planners to inform service provision.

## DESCRIPTION

EWS for heat risk in urban settings are data-driven systems designed to predict, monitor, and provide warnings of high heat risks, particularly during heatwaves or extreme temperature events.

The system should combine meteorological data, satellite imagery, and data from local environmental sensors to assess heat intensity and predict potential heat stress events. The system and the warnings it produces can be used to alert vulnerable populations and public health services of immediate heat risk and danger. This can enable timely action, such as opening cooling centers, disseminating heat safety tips, and issuing advisories.

## IMPLEMENTATION STEPS

1. **Assess current heat-related risks:** and historical data to identify vulnerable areas, and establish local temperature warning threshold levels (e.g., yellow, orange, red) based on daily mortality data from the local vital records agency.
2. **Install environmental monitoring:** sensors across the city (temperature, humidity, air quality). *[optional, otherwise, use national data]*
3. **Develop algorithms and models:** to predict heat risks based on meteorological data and urban characteristics. *[optional, otherwise, use national data]*
4. **Build a central system:** for real-time monitoring and alerts, integrating local weather data, satellite imagery, and public health data.
5. **Create user-friendly interfaces:** for the public, emergency services, and health organizations to receive timely alerts.
6. **Collaborate with local governments, nongovernmental organizations (NGOs) and civil society organizations (CSOs):** to ensure effective communication and outreach.
7. **Establish clear response protocols:** that are activated based on the established thresholds, including setting up cooling centers, distributing hydration kits, and activating emergency health responses. *[refer to response solutions]*
8. **Conduct regular simulations:** and testing to ensure the system functions effectively, protocols are clear, and stakeholders know their roles during heatwaves.
9. **Continuously refine the system:** based on feedback and evolving climate models.

## BENEFITS

| | |
|---|---|
| **PEOPLE (HEALTH AND EQUITY)** | • Improved public health because of early alerts that can reduce heat-related illnesses and deaths.<br>• Enhanced access to cooling centers and heat mitigation resources for vulnerable populations.<br>• Increased public awareness and preparedness for heat risks. |
| **ECONOMY (PRODUCTIVITY AND LIVELIHOODS)** | • Reduced healthcare costs by minimizing heat-related emergency hospital visits and long-term health consequences.<br>• Increased productivity by reducing heat-induced work disruptions and absenteeism.<br>• Enhanced resilience of the workforce, particularly in sectors vulnerable to heat impacts. |
| **INFRASTRUCTURE** | • Reduced strain on emergency services by using predictive tools to manage heat-related demands.<br>• Improved urban planning and infrastructure development, focusing on green spaces, water bodies, and cooling technologies.<br>• Better integration of climate resilience in urban development projects. |
| **ENVIRONMENT** | • Promotion of greener urban spaces that reduce the UHIE (e.g., green roofs, urban forests, and cool pavements).<br>• Increased public engagement with environmental sustainability through awareness campaigns.<br>• Long-term reduction in urban heat through mitigation strategies (e.g., tree planting and energy-efficient building designs). |

CASE STUDY

## EWS in Dar es Salaam, Tanzania

Dar es Salaam, Tanzania, is increasingly affected by heatwaves and the UHIE, which poses risks to public health and productivity. In response, the city in partnership with the communities implemented an EWS to address heat-related risks, collaborating with the Tanzania Meteorological Agency to track weather patterns and temperature forecasts. The system uses mobile alerts, radio, and community networks to warn residents of high heat risks, especially in informal settlements. Cooling centers were set up in critical areas, and public health campaigns helped raise awareness about heat stress. The system has successfully reduced the number of heat-related illnesses and deaths by allowing vulnerable populations to take precautionary measures before heat events occur (UNDRR. 2025).

### *Resources*

- National Oceanic and Atmospheric Administration for weather data and prediction models.
- Local government and health agencies for coordination and public outreach.
- NGOs for community-based engagement and support.
- Meteorological data providers and satellite imaging companies.
- Urban infrastructure experts for planning cooling interventions.
- Funding from climate adaptation and resilience programs, such as those provided by international development organizations.

02

# *Data-driven assessment of urban heat risks*

## SCALE

City

## TYPE OF ACTION

Data and technology

## EASE OF IMPLEMENTATION

Hard

## LEVEL OF EVIDENCE

Pilot project

## SUITABILITY

### City Context

Urban areas with comprehensive data infrastructure, including weather stations, satellite data, and urban planning data. Cities with dense, heterogeneous infrastructure consisting of both high-rise buildings and informal settlements, may experience significant differences in heat exposure. There may be existing concerns regarding health risks associated with extreme heat, particularly in poorer neighborhoods lacking green spaces or cooling infrastructure.

### Climate Context

Cities experiencing increasingly frequent and intense heatwaves, exacerbated by the UHIE. Temperature trends indicate rising average temperatures, particularly in urban centers, with the potential for prolonged periods of heat stress during the summer months.

### User Context

Local governments, urban planners, environmental agencies, public health organizations, emergency services, and climate adaptation specialists.

## DESCRIPTION

Heat risk assessments can be standalone solutions or form part of the development of an EWS (Solution 1). Depending on available resources and context, you may choose to follow a qualitative assessment method, a data-driven method (this solution), or ideally a combination of the two.

A data-driven heat risk assessment leverages geospatial methods and advanced analytics to assess heat exposure and vulnerability in an urban setting. This approach uses satellite imagery, Geographic Information System (GIS), and other environmental data to create heat vulnerability maps. These maps help identify areas of extreme heat exposure, UHI, and vulnerable populations.

The process should also integrate socioeconomic data, infrastructure conditions, and demographic information to assess both physical and social vulnerability. The results from this data-driven analysis can inform heat action plans (HAPs), guide urban development, and improve emergency response strategies.

## IMPLEMENTATION STEPS

1. **Collect and compile relevant geospatial data:** including satellite derived , meteorological and air quality data, and population demographics.
2. **Integrate high-resolution satellite imagery:** (e.g., from MODIS or Landsat) to map temperature variations across the city and identify UHI hotspots.
3. **Overlay socioeconomic data:** (e.g., income levels, age distribution, health vulnerability) to identify vulnerable populations and communities.
4. **Use GIS tools:** to analyze the spatial relationship between heat exposure and vulnerability factors, such as access to green spaces, housing quality, and urban infrastructure.
5. **Develop heat risk maps:** that visualize areas with high heat exposure, high vulnerability, and inadequate coping capacity.
6. **Apply predictive models:** (e.g., climate simulation models) to forecast future heat risks based on projected climate trends, population growth, and urban development patterns.
7. **Collaborate with local authorities:** to interpret the results and develop targeted HAPs, including the establishment of cooling centers, tree planting initiatives, and infrastructure improvements.
8. **Disseminate findings:** to decision-makers, community organizations, and the public to inform policy and guide interventions.
9. **Regularly update the heat risk assessment:** with new data and adjust strategies as climate conditions and urban landscapes evolve.

## BENEFITS

**PEOPLE (HEALTH AND EQUITY)**

- Improved identification of heat risks allows for better preparedness and resource allocation, reducing heat-related illnesses and deaths, especially among vulnerable groups (e.g., the elderly, children, and low-income populations).
- Community members can be informed about the risks of extreme heat and receive guidance on how to protect themselves (e.g., cooling centers, hydration).
- Better identification of vulnerable neighborhoods enables targeted health interventions, such as the installation of cooling infrastructure or the provision of relief resources.

**ECONOMY (PRODUCTIVITY AND LIVELIHOODS)**

- By identifying high-risk areas and promoting preventive measures, heat-related health issues can be minimized, reducing the economic burden on public healthcare systems.
- By addressing extreme heat in the workplace and public spaces, workers' health and productivity can be maintained, especially in heat-sensitive industries.
- Data-driven insights can inform more sustainable urban planning and development, leading to long-term cost savings by reducing the impact of heat on infrastructure and resources.

**INFRASTRUCTURE**

- The heat risk maps can guide future city planning, promoting the development of cooling green spaces, energy-efficient buildings, and climate-resilient infrastructure.
- By understanding which areas are most heat-exposed, resources (e.g., cooling centers, water stations) can be distributed more effectively during heat events.
- Data-driven assessments can inform retrofitting of existing buildings and public spaces with green roofs, cool pavements, and shaded areas to mitigate the UHIE.

**ENVIRONMENT**

- Insights from heat risk maps can guide initiatives to plant trees, create parks, and implement green roofs, which help cool the city and absorb heat.
- Data helps to identify and target UHI hotspots, enabling specific interventions to reduce heat absorption through reflective surfaces and urban greening projects.
- The integration of climate data into urban planning ensures that future development is aligned with long-term environmental sustainability goals, reducing the overall urban heat burden.

CASE STUDY

### Satellite imagery and local temperature data used in Cape Town, South Africa

Cape Town has increasingly faced extreme heat events, exacerbated by the UHIE. In response, a heat risk assessment was conducted using satellite imagery and local temperature data to identify heat hotspots in both informal settlements and more affluent areas. By integrating this heat data with socioeconomic factors, the city identified areas with high vulnerability, including informal settlements where access to cooling infrastructure is limited. The findings were presented in an ArcGIS storyboard – a web-based report with interactive maps – making findings accessible to a broad (including non-technical) audience. The results led to the installation of urban greening projects, creation of cooling zones, and development of HAPs, including public awareness campaigns on heat risks. The assessment also provided key data to inform future climate resilience strategies, with a focus on adapting to increasing temperatures.

Refer to the web-based report of Cape Town's Heat Risk Assessment to explore how findings are communicated in interactive maps: Heat Watch Cape Town.

### *Resources*

- Data Providers: NASA (MODIS, Landsat), European Space Agency (Sentinel), local weather stations, and national meteorological agencies.
- Software and Tools: GIS platforms (ArcGIS, QGIS), remote sensing tools, heat mapping tools (e.g., Heat Mapping Tool by Environmental Protection Agency), and predictive modeling software.
- Local Stakeholders: City government departments (urban planning, public health, emergency services), NGOs focused on climate resilience and health, and academic institutions with expertise in urban climate research.
- Funding Sources: Climate adaptation funds, government climate resilience programs, and international development organizations (e.g., the United Nations Development Programme (UNDP), World Bank).

03

# *Participatory assessment of urban heat risks*

## SCALE

Neighbourhood and community

## TYPE OF ACTION

Data and technology

## EASE OF IMPLEMENTATION

Medium

## LEVEL OF EVIDENCE

Pilot project

## SUITABILITY

### City Context

Small cities and towns or neighborhoods of large urban areas, and urban areas with informal settlements, limited access to advanced meteorological data, and pockets of poverty and inequality. The community has limited access to cooling infrastructure and often lacks sufficient green spaces. Residents may not have widespread access to public health information or resources.

### Climate Context

Cities facing rising temperatures, exacerbated by the UHIE, with frequent heatwaves and long periods of high heat. These extreme conditions disproportionately affect the poorest and most marginalized communities, with health risks such as heat stroke, dehydration, and respiratory problems.

### User Context

Residents of informal settlements and vulnerable neighborhoods, local government, health organizations, urban planners, NGOs, and community organizations.

## DESCRIPTION

Heat risk assessments can be standalone solutions or form part of the development of an EWS (Solution 1). Depending on your available resources and context you may choose to follow a qualitative assessment method (this Solution), a data-driven method (Solution 3), or ideally a combination of the two.

Heat risk assessment in an urban setting with a participatory approach emphasizes qualitative data collection and community-driven knowledge, especially in data-poor or underserved environments. This approach integrates local perceptions and lived-experiences of heat risks and vulnerability into the assessment, helping to identify areas with high exposure to heat, health risks, and gaps in infrastructure and services.

The process involves community engagement through participatory mapping, focus group discussions (FGDs), and interviews to capture nuanced information on heat exposure and adaptive capacity. Methods that can be used include the vehicle traverse approach (i.e., sensors attached to a fleet of vehicles driven by volunteers), citizen science through sensors outdoors or in homes, or handheld thermal imagery cameras. It also considers local knowledge and informal strategies used by residents to cope with heat. This participatory model can complement scarce quantitative data, offering a more complete picture of heat risks and enhancing community resilience.

## IMPLEMENTATION STEPS

1. **Identify the target communities and key stakeholders** (community leaders, local NGOs, public health workers) to engage in the process.
2. **Design a participatory methodology for data collection** (e.g., FGDs, interviews, community mapping, walking surveys).
3. **Conduct participatory mapping:** with community members to identify areas of heat exposure and vulnerability (e.g., locations of hot spots, lack of green space, poorly ventilated buildings). This could be done using a printed map or a spatial data collection app such as Community Maps or Kobo Toolbox.
4. **Facilitate FGDs and semi-structured interviews:** to capture local knowledge on heat impacts, coping strategies, and concerns about heat risks.
5. **Use qualitative data:** to map heat exposure, health risks, and resource gaps. Combine community insights, reports, or newspaper articles with available basic climate data (e.g., temperature records, local weather data).
6. **Analyze the collected data:** to identify heat-vulnerable areas and populations, pay attention to patterns of inequality in heat exposure and adaptive capacity.

7. **Collaborate with local authorities and community representatives:** to co-create interventions based on the findings (e.g., cooling spaces, tree planting initiatives, or awareness programs).
8. **Create a report or visual representation:** (e.g., heat vulnerability map) to communicate findings to decision-makers and community members.
9. **Build local capacity:** to continuously monitor heat risks and engage the community in ongoing climate resilience planning.

## BENEFITS

| | |
|---|---|
| **PEOPLE (HEALTH AND EQUITY)** | • Increased awareness of heat risks and strategies to reduce exposure.<br>• Empowerment of community members to actively participate in identifying solutions.<br>• Improved adaptive capacity, particularly for vulnerable populations, through localized knowledge and action.<br>• Strengthened community ties through collective action for heat resilience. |
| **ECONOMY (PRODUCTIVITY AND LIVELIHOODS)** | • Reduced costs associated with heat-related healthcare (e.g., heatstroke, dehydration) by identifying and addressing high-risk areas.<br>• Enhanced productivity and reduced heat-related work stoppages by improving public awareness and promoting cooling strategies.<br>• Creation of local jobs and economic opportunities related to climate adaptation efforts, such as creating shaded areas or promoting local cooling solutions. |
| **INFRASTRUCTURE** | • Improved urban planning and resource allocation based on community-driven data.<br>• Identification of critical infrastructure gaps, such as insufficient cooling facilities or green spaces.<br>• Enhanced resilience of existing infrastructure, including energy systems, by integrating climate-sensitive design (e.g., green roofs, cool pavements). |
| **ENVIRONMENT** | • Promotion of green spaces, tree planting, and other cooling strategies that mitigate the UHIE.<br>• Increased community engagement with sustainable environmental practices, such as rainwater harvesting or planting native plants for heat mitigation.<br>• Long-term environmental benefits from reduced urban heat, leading to improved air quality and biodiversity. |

CASE STUDY

### Heat risk assessment as part of Ahmedabad HAP, India

In 2018, Ahmedabad implemented a participatory heat risk assessment as part of its HAP. Community members, particularly from informal settlements, were involved in mapping their local environments and discussing heat exposure and health impacts. This process revealed several areas of high vulnerability, including neighborhoods with poor access to cooling spaces and limited water access. The insights gathered were used to develop targeted interventions, such as providing water distribution points and establishing cooling centers. The participatory approach helped ensure that the solutions were context-specific and community-driven (NRDC 2019).

***Resources***

- Local government departments (urban planning, public health, disaster management).
- CBOs and NGOs with local knowledge and access to vulnerable populations.
- Academic institutions and researchers with expertise in climate change, public health, and participatory research methods.
- Mobile technology and platforms for data collection and community engagement (e.g., survey apps, online mapping tools).
- Funding from climate adaptation and resilience programs (e.g., UNDP, Green Climate Fund).

04

# Heat risk awareness campaign

## SCALE

City

## TYPE OF ACTION

Capacity development and behavior change

Data and technology

## EASE OF IMPLEMENTATION

Easy

## LEVEL OF EVIDENCE

Established practices

## SUITABILITY

### City Context

- Densely populated urban areas where extreme heat poses a significant health risk and awareness of climate-related risks may be low.
- Informal settlements and low-income neighborhoods where access to cooling infrastructure is limited and individual action is more impactful.

### Climate Context

- Most effective in regions with frequent heatwaves and where heat-related illnesses and mortality are high.
- Think about how you can use the climate of your city to provide inputs into the type of awareness raising you undertake and when.

### User Context

- Often led by city governments and integrated into wider heat management and resilience plans.
- Employers, particularly in industries focusing on outdoor labor, can implement workplace awareness and heat safety-raising campaigns.
- NGOs, CSOs, and public health organizations could play a key role in helping to identify target communities and stakeholders as well as disseminate and undertake any awareness-raising activities.

## DESCRIPTION

Heat awareness campaigns can be a standalone solution or integrated within an EWS (Solution 1). These are best undertaken ahead of the hot season to help mitigate urban heat by educating communities about the dangers of extreme heat, promoting heat-resilient behaviors, and encouraging the adoption of cooling measures. These campaigns empower individuals with knowledge of hydration, shade, and energy-efficient cooling practices, reducing health risks and easing the strain on urban infrastructure during heatwaves. By fostering a culture of preparedness, they enhance community resilience and support sustainable urban living.

## IMPLEMENTATION STEPS

1. **Assess your city's demographic and socioeconomic context:** This is critical to ensure that awareness raising is tailored to your city's context and maximizes the number of stakeholders and people who hear and engage with your messages. You may want to interact with NGOs and CSOs to help you identify a target audience for your campaign.
2. **Determine the intended key messages:** Use your understanding and assessment of heat risks in your city to determine the key messages you want to disseminate to stakeholders and the public. This could be about what heat risks exist in your city, who is most affected and, how/what is being done to limit the negative impacts.
3. **Identify the best awareness-raising approach:** Based on your understanding of the demographics and socioeconomic composition of your city and your key messages, identify the best medium and approach to undertaking awareness-raising, this could include in-person workshops, social media campaigns, or traditional media and billboards. Try to align your approach to existing awareness-raising methods in your city to capitalize on tried and tested methods.
4. **Develop material and media content:** Take all your learning from the previous steps and apply it to the development of awareness-raising material and media content. This could be in the form of posters, infographics, short or long-form videos, etc.
5. **Disseminate material and undertake awareness-raising activities:** Once you have developed the material, begin to disseminate to your previously identified target population and undertake planned awareness activities. Use what you have learned about your city's demographics, climate, and environment to your advantage; for example, by holding events on hot days to highlight the issue, holding seminars at schools, or speaking with elderly people in retirement homes.

## BENEFITS

| | |
|---|---|
| **PEOPLE (HEALTH AND EQUITY)** | • Helps educate stakeholders and the public regarding heat risks in your city and how these relate to their circumstances.<br>• Helps people to identify how they can respond to acute heat and adapt to chronic heat by limiting the effects of extreme heat on their lives. |
| **ECONOMY (PRODUCTIVITY AND LIVELIHOODS)** | • Highlighting heat risks, for example, for outdoor workers, could help to educate employers and employees to better mitigate and adapt to extreme heat and therefore help to protect employment and livelihoods. |
| **INFRASTRUCTURE** | • Highlights the risks to infrastructure assets and provisions associated with urban heat and helps better prepare for such events. |
| **ENVIRONMENT** | • Highlights the effects of heat on the urban environment and helps to advocate for context-specific solutions, for example, planting drought-tolerant and native plant species in dry climate conditions. |

***Resources***

- "Heat Communication Guide for the Cities in South Asia" developed by the Red Cross Red Crescent Climate Centre to understand how to design a heat communication plan.
- Resources developed as part of the #HeatSeason campaign by Arsht-Rock as a toolkit of posters to raise heat risk awareness.
- Examples of awareness-raising posters developed for the Ahmedabad Heat Action Plan.

CASE STUDY

### Heatwave awareness raising in Delhi, India

Volunteers from the Indian Red Cross Society performing a flash mob in Delhi.
**Source:** © Aditi Kapoor / Climate Centre 2017.

Urban heat is a major risk in Delhi. Its Mungeshpur area recorded a temperature of 52.3 degree centigrade (oC), making it the highest temperature recorded in the city during the 2024 heat season (The Times of India, 2024). In recognition of the major issue, the Delhi Disaster Management Authority developed the "HAP 2024-25" aimed at providing stakeholders with insight into heat-related illnesses and the necessary mitigation and response actions to be undertaken (Delhi.gov, 2024). The HAP identified public awareness and community outreach as key components for mitigating heat risk. In doing so, the city government, along with NGOs and CSOs, has undertaken numerous awareness-raising campaigns, including, for example:

- **Organizing workshops for parents and school kids** to raise awareness and co-create possible solutions to beat the heat. Three workshops were run by the Transportation Research and Injury Prevention Centre, Indian Institute of Technology-Delhi, and HumanQind and reached 43 parents and 55 children (Skill Outlook, 2024). Workshops were designed to help parents and children explore the challenges they face while walking to school and present various strategies to reduce heat exposure.
- **Holding flash mobs in crowded places**, including markets, parks, and airports, to inform and spread awareness on solutions that can be implemented by individuals to reduce heat exposure. A total of eight flash mobs across four days were organized by the Indian Red Cross Society (Climate Centre, 2017).

SECTION 2

# Plan for Heat Resilience

05

# *Urban ventilation corridors*

## SCALE

City

## TYPE OF ACTION

Governance, policy and plans

Infrastructure (gray)

## EASE OF IMPLEMENTATION

Medium

## LEVEL OF EVIDENCE

Pilot project

## SUITABILITY

### City Context

- Dense urban areas where heat retention and poor air circulation exacerbate the UHIE.
- Rapidly expanding cities to integrate cooling strategies into urban planning.
- Areas with significant industrial or vehicular emissions, improving air quality alongside cooling.

### Climate Context

- Regions with high temperatures and limited natural ventilation.
- Cities with seasonal heatwaves, helping to channel cooler air into overheated areas.
- Flood-prone regions where ventilation corridors can also assist in stormwater drainage by following green corridors and incorporating nature-based solutions.

### User Context

- Ventilation corridors are designated by city governments during the development of spatial and master plans.
- Any guidelines and regulations developed need to be followed by architects and developers.
- Community-based organizations (CBOs) and stakeholders should be consulted and provide feedback on proposed ventilation corridors.

## DESCRIPTION

Urban ventilation corridors are a powerful tool for mitigating urban heat by harnessing natural wind flows to channel fresh air through densely built environments, dispersing heat, and improving urban microclimates. Such corridors are strategically planned using natural and man-made features to guide air movement, reduce temperature buildup, and combat the UHIE. By aligning city design with the natural dynamics of wind and airflow, ventilation corridors promote thermal comfort, energy efficiency, and overall urban resilience to rising temperatures. Key features of urban ventilation corridors include:

- **Natural topography and features:** Corridors often leverage existing lakes, mountains, or plains that generate wind patterns by influencing pressure systems. These natural elements act as anchors for airflow, guiding cooler breezes into urban areas. The designation of ventilation corridors should consider the prevailing wind direction in your city.
- **Rivers and transport routes:** Linear features such as rivers and transport corridors are ideal for designating ventilation corridors. By restricting development along these routes, cities can preserve unobstructed air channels that facilitate continuous airflow.
- **Connected green spaces:** Linking existing green spaces into a network within the ventilation corridor enhances their cooling capacity. Vegetation provides shade and facilitates evapotranspiration, reducing surface and air temperatures while improving air quality.

To maximize the effectiveness of these corridors, development along them is carefully regulated to ensure that airflow is not obstructed. Restrictions may include limitations on building heights, implementation of minimum setbacks, and discouragement of large podiums or structures that face prevailing wind directions. These measures prevent wind blockages and ensure smooth air circulation, allowing corridors to function as intended.

A visual representation of an urban ventilation corridor.
**Source:** Gabriel Ramos

In addition, to designating such ventilation corridors and implementing planning regulations, accompanying design guidelines should be developed. Architects and developers can use them to become informed about specific requirements for building within these zones, such as orienting structures to align with wind flows or using materials that minimize heat absorption. When integrated into urban planning, ventilation corridors not only reduce urban heat but also create more comfortable, healthy, and sustainable cities that are better equipped to face the challenges of climate change.

## IMPLEMENTATION STEPS

1. **Assess existing urban and climate context:** Undertake a study to identify the best location for the urban ventilation corridors in your city; this includes understanding your geography, microclimate, and prevailing wind direction, as well as urban context in terms of land use planning.
2. **Develop, or embed, urban ventilation corridor regulation:** Once you have a good understanding of where your ventilation corridors should be located, include these in any development and spatial plans and develop regulations to control construction around these.
3. **Develop accompanying design guidelines:** Aim to develop accompanying design guidelines to inform architects and developers on the types of buildings that are allowable in the area around the ventilation corridor, their permitted height, massing, and design.
4. **Obtain council or mayoral approval:** Once you have developed the necessary regulation, seek council approval to write your ventilation corridors into law, ensuring they are protected from inappropriate development.
5. **Enforce urban ventilation corridor regulation:** Begin to enforce the regulation you have developed by assessing any construction and development plans and permits against the regulation to ensure compliance.

***Resources***

- "Guidelines on Integrating Nature-Based Passive Cooling Options into Urban Planning and Design" developed by the World Bank and Energy Sector Management Assistance Program (ESMAP) to learn more about how urban ventilation corridors and other nature-based solutions (NbS) can help cool your city.
- "Cooling the City with "natural wind": construction strategy of urban ventilation corridors in China," a scientific paper by Bing Dang et al. for further insights into urban ventilation corridor practices in Chinese cities.

## BENEFITS

| | |
|---|---|
| **PEOPLE (HEALTH AND EQUITY)** | • Urban ventilation corridors can help to reduce heat by improving thermal comfort as well as reduce air pollution by removing pollutants from urban areas and therefore have a positive impact on public health. |
| **ECONOMY (PRODUCTIVITY AND LIVELIHOODS)** | • The positive impacts on health because of urban ventilation corridors can help to reduce employee downtime and therefore increase economic activity.<br>• The change in planning regulations to enforce urban ventilation corridors has the potential to stimulate appropriate design development along the corridor or in other areas of the city that do not have similar restrictions. |
| **INFRASTRUCTURE** | • Provides opportunities to develop climate resilient infrastructure, by incorporating green infrastructure, for instance, daylighting or improving the conditions of existing rivers which could be designated as ventilation corridors. |
| **ENVIRONMENT** | • Provides opportunities to incorporate green infrastructure along designated ventilation corridors and capitalize on their ecosystem benefits to help reduce urban heat. |

CASE STUDY

### Sarajevo Canton Urban Ventilation Corridor study, Sarajevo, Bosnia and Herzegovina

As part of the Sarajevo Green City Action Plan, an Urban Ventilation Corridor study was carried out which identified two main urban ventilation corridors: one running along the Miljacka River and the other along the main Zmaja od Bosne transport corridor running through the center of the city. Although the main aim of the ventilation corridor was to improve air quality in the city, it would also lead to co-benefits including mitigation of urban heat. A 3D computer model was used to identify the optimal wind flow through the city and its interactions with the existing built form and urban plans. This study and model also fed into suggested regulatory and planning changes that would restrict certain development and their heights along these corridors to ensure unobstructed airflow through the city.

06

# *Urban heat design guidelines and regulations*

## SCALE

City

## TYPE OF ACTION

Governance, policy and plans

## EASE OF IMPLEMENTATION

Medium

## LEVEL OF EVIDENCE

Established practices

## SUITABILITY

### City Context

- Densely populated urban areas which can contribute to and are adversely affected by the UHIE.
- Cities and areas undergoing rapid urban growth or undertaking regeneration of informal settlements to ensure heat resilience are integrated into plans.

### Climate Context

- Cities and urban areas with prolonged high temperatures and expected increase in temperatures because of climate change.
- Cities in arid climates can benefit from incorporating guidance on green and blue infrastructure to encourage water efficiency and evaporative cooling.

### User Context

- Developed by city governments and integrated into existing policy and planning frameworks.
- Used by developers, urban planners, and architects to design buildings and urban spaces that mitigate and adapt to heat risk.

## DESCRIPTION

Urban heat design guidelines and regulations are critical tools for mitigating urban heat by embedding heat-resilient strategies into planning, construction, and development processes. These frameworks establish clear standards for urban layouts, building designs, and material choices (discussed in further detail in subsequent solutions as part of this catalog), ensuring that cities are designed and constructed with heat mitigation as a priority. Promoting and mandating the use of solutions such as reflective and permeable materials, as well as vegetation integration, urban heat design guidelines and regulation can help to reduce heat absorption and enhance cooling through natural processes like evapotranspiration.

Additionally, such guidelines often include incentives for further climate adaptation and mitigation, such as energy-efficient designs and renewable energy integration, reducing waste heat emissions from buildings and infrastructure, or incorporation of green infrastructure. You should explore and identify any indigenous and local practices for combatting heat risk that could be included in your guidelines showcasing effective and locally tailored practices. Some examples of design guidelines developed with mitigating urban heat in mind include:

*Sun Shading Catalogue*

**UN Habitat**




*Thermal Comfort Guidelines*

**City of London**

*Building Code Checklist for Green Buildings*

World Bank


© Davide Fiammenghi

By standardizing heat mitigation practices, design regulations ensure widespread and consistent application, amplifying their impact across neighborhoods and entire cities. Moreover, they encourage innovation by fostering collaboration between urban planners, architects, and engineers, driving the development of sustainable and heat-resilient urban environments that can adapt to rising temperatures and climate change.

## IMPLEMENTATION STEPS

1. **Assessment of existing policy and planning framework:** To understand where the urban heat guidelines will sit within your city's policy and planning framework, these could be embedded into urban development strategies, master plans, or sit as standalone supporting documents to guide the design of buildings and urban spaces in your city.
2. **Assessment of urban and heat context:** To understand what your guidelines need to include to tackle challenges as well as identify any existing design solutions that have a positive impact on reducing heat in your city that should be replicated.
3. **Community and stakeholder engagement:** Understanding stakeholder and community options and suggestions regarding design guidelines can help you to develop context-specific guidelines that can be followed in your city given any resource and capacity constraints.
4. **Development of guidelines:** Once you have undertaken the above steps, ensure guidance at appropriate levels, especially to address any resource and capacity constraints.
5. **Council or mayoral approval:** Once you have developed the urban heat design guidelines or regulations, seek approval so that you can begin to enforce the guidelines.
6. **Enforcement of guidelines:** Ensure you make any guidelines and regulations publicly available and encourage new developments to review and apply these to their designs. You can make this a criterion for developers to gain construction permits and assess their implementation when undertaking any building controls.

## BENEFITS

| | |
|---|---|
| PEOPLE (HEALTH AND EQUITY) | • Increased thermal comfort of buildings and urban spaces resulting in a positive impact on health.<br>• Opportunity to integrate traditional methods of construction highlighting cultural identity. |
| ECONOMY (PRODUCTIVITY AND LIVELIHOODS) | • Increased health outcomes because of increased thermal comfort can improve work conditions and therefore stimulate the economy.<br>• Potential to reduce maintenance costs. |
| INFRASTRUCTURE | • Buildings that provide inhabitants and users with improved thermal comfort.<br>• Potential to increase sustainable and locally sourced building material use.<br>• Reduced energy and resource demands, for example, for air conditioner cooling, through improved design. |
| ENVIRONMENT | • Potential to integrate further climate adaptation and mitigation solutions providing opportunities to build resilience and reduce greenhouse gas (GHG) emissions. |

***Resources***

- "Creating a Design Code" guidance developed by the UK Government's Ministry of Housing, Communities, and Local Government to see how you can develop similar guidance targeting urban heat.
- New York City "Climate Resiliency Design Guidelines" developed by the Mayor's Office of Climate and Environmental Justice for inspiration in addition to the examples above.

07

# Upgrading water supply networks

### SCALE

Neighbourhood and community

### TYPE OF ACTION

Infrastructure (gray)

### EASE OF IMPLEMENTATION

Hard

### LEVEL OF EVIDENCE

Pilot project

### SUITABILITY

#### City Context

- Cities with aging infrastructure to rehabilitate networks and improve potable water provision.
- Cities undergoing rapid growth or urban renewal where water networks can be extended to underserviced areas such as informal settlements.

#### Climate Context

- Regions with high temperatures and limited rainfall, where improved water distribution ensures cooling solutions, such as public water features, remain effective, and people have access to potable water.
- Cities facing extreme seasonal variations in precipitation, helping to manage water availability during dry and wet periods.

#### User Context

- Led by city governments and utility providers, integrating water security into climate resilience and infrastructure policies.
- Private sector involvement through public-private partnerships can improve efficiency and expand access to sustainable water solutions.
- Community organizations and local initiatives can support decentralized water management, such as rainwater harvesting and neighborhood-scale improvements, as well as useful feedback when such projects undergo stakeholder engagement.

## DESCRIPTION

Refurbishment of water supply networks can significantly contribute to mitigating urban heat as well as improving public health and sanitation. This is particularly important in the Global South where access to clean water is still often a challenge for vulnerable and marginalized groups of people.

Upgrades to the water supply network could include:

- Expansion of the network to underserviced areas or rehabilitation of aging infrastructure;
- Increase in the number of connections to the network;
- Implementation of sensors and equipment to reduce leakage and high loss of water;
- Sustainably tapping into new water sources;
- Development of water treatment plants to increase the quantity of potable water, and
- Implementation of infrastructure to store water and ensure its supply during heatwaves and other disasters.

Effective water supply networks ensure water is available for cooling down during heatwaves. However, they also support the development of public water features, such as drinking water fountains or misting systems, and green infrastructure. Upgrades to the network could also include infrastructure to increase rainwater harvesting, and gray and stormwater reuse, which can be used for irrigating green infrastructure and reduce the pressure on potable water use.

Any upgrades to the water network need to undergo comprehensive planning and stakeholder consultation, which will help to identify issues in the current network and opportunities for upgrades and expansions. Moreover, you should seek to align water supply network upgrade plans with other infrastructure interventions, such as road upgrade programs to reduce duplication of construction work and streamline the use of your city's resources.

## IMPLEMENTATION STEPS

1. **Assessment and planning:** Undertake a comprehensive assessment of the current water supply network to identify issues and potential opportunities. Begin to plan out your activities to upgrade the water supply network.
2. **Community and stakeholder engagement:** Engage with your local community and stakeholders to gain a deeper understanding of their needs and challenges; this could further highlight opportunities for upgrades as well as garner buy-in for the implementation of the solution.

3. **Design and development:** Once you have a comprehensive understanding of the issues, needs, and opportunities, engage with technical experts to design the necessary interventions. Moreover, begin to engage in discussions with potential implementation partners as well as finance institutions to establish the essential resources for the implementation of your solution.
4. **Implementation:** Begin implementation of your solution.
5. **Monitoring and evaluation (M&E):** Upon completion of the implementation of your solution to upgrade the water supply network, undertake M&E to understand what worked and what didn't.
6. **Adaptation and scale-up:** The M&E you undertake should inform any adaptation to ongoing work programs or future upgrade schemes. You should also build upon your successes by scaling up implementation to ensure 100 percent coverage of water supply networks across your city.

CASE STUDY

## Société Nationale d'Exploitation et de Distribution des Eaux expansion of water network, Tunisia

In Tunisia, the water company Société Nationale d'Exploitation et de Distribution des Eaux, signed a €19 million loan agreement with the International Bank for Reconstruction and Development (IBRD), which allowed it to expand its supply and distribution network to around 70,000 new connections (allAfrica, 2015) by offering customers a connection loan scheme. Customers can pay the cost of the connection every quarter over five years. New customers, who opted for a connection through this loan scheme, receive a bill each quarter that includes the tariff for consumption during the previous quarter, and a loan repayment installment.

## BENEFITS

| | |
|---|---|
| **PEOPLE (HEALTH AND EQUITY)** | • Upgrades to the water supply network can result in major benefits for public health and sanitation as people have access to safe drinking water sources which they can use for cooling down during heatwaves. |
| **ECONOMY (PRODUCTIVITY AND LIVELIHOODS)** | • Increasing the number of connections to the water network and enhancing the revenue streams for water supply and distribution companies, providing them with resources to continue expansion and rehabilitation of the network. |
| **INFRASTRUCTURE** | • Often aging networks or those made of poor-quality material can lead to pollution as well as degradation, leakage, and high loss of water. Such upgrades modernize the supply network and result in greater efficiency.<br>• Upgraded water networks are capable of better withstanding increased temperatures. |
| **ENVIRONMENT** | • Upgrading the water supply network presents opportunities to incorporate green infrastructure, such as sustainable drainage systems as well as water harvesting and alternative water use, which can reduce the pressure on other water sources across your city, like springs, lakes, and groundwater reservoirs. |

08

# *Blue Infrastructure*

## SCALE

Neighbourhood and community

## TYPE OF ACTION

Infrastructure (gray)

## EASE OF IMPLEMENTATION

Hard

## LEVEL OF EVIDENCE

Established practices

## SUITABILITY

### City Context

- Densely populated areas where green spaces are limited.
- Areas undergoing urban renewal, to integrate large-scale sustainable practices.
- Enhances the aesthetic and functional value of urban waterfronts.

### Climate Context

- Regions with high temperatures and limited rainfall.
- Areas where seasonal variations in temperature and precipitation need management.
- Regions susceptible to flooding, through absorbing and managing excess rainwater.

### User Context

- Led by local governments at a city-wide scale, integrating into plans and policies.
- Community organizations and the private sector can incorporate and implement smaller-scale projects, such as local water management initiatives or as part of commercial and residential projects.

## DESCRIPTION

Blue infrastructure, such as water retention systems, ponds, and rivers, offers a sustainable solution for urban heat management. The surface temperature of the water is typically several degrees cooler than the surrounding built environment, contributing to ambient cooling through convective processes. Water-based urban landscapes, including lakes, rivers, and wetlands, create “urban cooling islands” that can decrease city temperatures by 1–2°C. Man-made water features like fountains, swimming pools, and misting stations also provide passive cooling benefits and can be repurposed as cooling stations during acute heat episodes events. Additionally, active water components such as evaporative wind towers and sprinklers enhance cooling in public spaces. These water features not only mitigate urban heat but also offer aesthetic and recreational value, making them a multifaceted solution for enhancing urban resilience and liveability. However, maintaining water quality and combining water features with shade to reduce evaporation are essential considerations for effective implementation (Campbell, 2021; ESMAP, 2020).

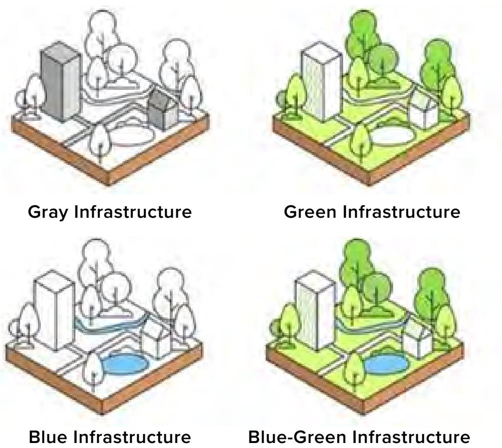



**Figure 3-2.** Interaction between gray, green and blue infrastructure.
**Source:** © Pochodyła, E., Glińska-Lewczuk, K. and Jaszczak, A. 2021

## IMPLEMENTATION STEPS

1. **Assessment and planning:** Comprehensively assess the current state of water bodies, green spaces, and UHIs. Identify areas most affected by heat and those suitable for blue infrastructure.
2. **Community and stakeholder engagement:** Raise awareness through workshops and informational sessions. Engage with local stakeholders to gather input and build support.
3. **Design and development:** Create a master plan that integrates blue infrastructure with urban development goals. Choose suitable solutions like restored streams, wetlands, and artificial lakes depending on city context.
4. **Implementation:** Restore and re-naturalize streams and rivers in combination with green infrastructure

elements such as green roofs, permeable pavements, and rain gardens.

5. **Monitoring and maintenance:** Regularly monitor environmental indicators like temperature and water quality. Develop maintenance plans to ensure long-term functionality.
6. **Evaluation and adaptation:** Assess the effectiveness of blue infrastructure projects. Gather community feedback and adjust strategies based on monitoring data to improve outcomes.

## BENEFITS

| | |
|---|---|
| PEOPLE (HEALTH AND EQUITY) | • Reduces pollutants and enhances respiratory health.<br>• Lowers urban temperatures, reducing heat-related illnesses.<br>• Provides green and blue spaces accessible to all community members, promoting social equity and improving mental well-being |
| ECONOMY (PRODUCTIVITY AND LIVELIHOODS) | • Projects create jobs in construction, maintenance, and environmental management.<br>• Attractive green and blue spaces draw tourists, boosting local businesses.<br>• Proximity to well-maintained blue infrastructure can increase property values. |
| INFRASTRUCTURE | • Reduces flood risk by absorbing and managing rainwater.<br>• Decreases the need for air conditioning, lowering energy consumption and costs.<br>• Presents opportunities to improve drainage infrastructure through implementation of sustainable urban drainage. |
| ENVIRONMENT | • Supports diverse plant and animal species, enhancing urban ecosystems.<br>• Improves water quality by filtering pollutants and managing runoff.<br>• Restores and improves natural habitats, contributing to ecological balance. |

***Resources***

- The “Primer for Cooling Cities: Reducing Excessive Urban Heat” developed by IBRD and The World Bank provides further context for this solution.
- The “Beating the Heat” Handbook developed by the Cool Coalition introduces more details and provides relevant diagrams for this solution.

CASE STUDY

### Ehlanzeni District Municipality Wetlands, South Africa

Wetlands offer essential ecosystem services but, in Ehlanzeni District Municipality, their value has historically been overlooked, leading to degradation and loss. This has compromised water quality and increased vulnerability to climate change.

To address this, Ehlanzeni joined the Local Governments for Sustainability-led Local Action for Biodiversity: Wetlands South Africa project in 2015. Key actions included:

- Awareness Workshops: Educating stakeholders and the community about the importance of wetlands;
- Stakeholder Networking: Collaborating with various stakeholders to enhance wetland conservation; and
- Wetland Report: Compiling all available wetland information to identify and address gaps in management.

Located in Mpumalanga Province, the municipality covers ca. 30,000 square kilometer (km) and includes diverse biomes with several wetlands, including a Ramsar site. The project aims to integrate wetland and biodiversity considerations into local planning, building capacity for effective management, and urban heat mitigation (ICLEI, 2023).

CASE STUDY

### Cheonggyecheon Stream Restoration Project, Seoul, South Korea

Cheonggyecheon flows through the heart of Seoul, South Korea, spanning 13 neighborhoods across four districts. Historically, the stream served various roles until it was covered by an elevated highway in the 1970s, hiding it for over 30 years. In 2003, the Seoul city government initiated a project to restore and reintegrate this urban waterway, aiming to boost the local economy and revive the area’s cultural heritage. Led by Mikyoung Kim Design, the project was completed in 2005.

The project effectively contributed to the mitigation of the UHIE, reducing temperatures along the stream 3.3°C to 5.9°C cooler than on a parallel road four to seven blocks away. This is a combination of effects from the removal of the paved expressway, the cooling effect of the stream, increased vegetation, reduction in auto trips, and a 2.2-7.8 percent increase in wind speeds moving through the natural ventilation corridor (Carrasco, 2024).

09

# Public water features

## SCALE

Neighbourhood and community

## TYPE OF ACTION

Infrastructure (gray and blue)

## EASE OF IMPLEMENTATION

Medium

## LEVEL OF EVIDENCE

Pilot project

## SUITABILITY

### City Context

- Dense urban areas where green infrastructure may be limited and the UHIE is high to introduce evaporative cooling.
- Cities undergoing growth or redevelopment of informal settlements to introduce water features and enhance resilience.
- Waterfront cities, such as those along coasts or riverbanks to maximize the benefits of being close to water.

### Climate Context

- Regions with high temperatures and frequent heatwaves, where evaporative cooling can reduce urban heat.
- Areas experiencing seasonal temperature fluctuations, providing adaptable cooling benefits throughout the year.
- Cities with high rainfall variability, where water features can help manage stormwater while offering cooling effects.

### User Context

- Led by city governments as part of broader urban climate adaptation and public space improvement strategies.
- Private developers and businesses can incorporate water elements in commercial and residential projects to enhance cooling and aesthetics.
- Community organizations can advocate for and maintain smaller-scale water features, such as drinking fountains and public splash areas, to improve local heat resilience.

## DESCRIPTION

Public water features play a vital role in mitigating urban heat by providing localized cooling, enhancing thermal comfort, and promoting community well-being.

## EXAMPLES OF PUBLIC WATER FEATURES

**Source:** Szymon Shields

**MAGICAL WATER CIRCUIT IN LIMA, PERU**

Ornamental fountains and waterfalls create evaporative cooling effects, reducing ambient temperatures by releasing fine mist and increasing localized humidity, especially in hot and dry climates.

**Source:** © Nanda Ramesh 2009

**BASAVANAGUDI AQUATIC CENTRE IN BENGALURU, INDIA**

Open-air swimming pools and lidos provide large water surfaces that absorb and dissipate heat, while also offering direct cooling for users, fostering a sense of refreshment during high-temperature periods.

Source: Getty Images

**DRINKING WATER FOUNTAINS IN CAPE TOWN, SOUTH AFRICA.**

Drinking water fountains not only provide essential hydration in heat-stressed environments but also contribute to psychological cooling by promoting accessibility to water and alleviating discomfort. These could be temporary arrangements or mobile freshwater trucks to provide water in hard-to-reach areas or of where supplies can be limited, such as informal settlements.

Strategically placed water features enhance microclimates, reduce the UHIE, and improve the aesthetic value of public spaces, attracting foot traffic and supporting economic activities. Additionally, they encourage sustainable urban design by integrating natural elements into dense cityscapes, creating multifunctional spaces that simultaneously address heat mitigation, recreation, and community health. When combined with vegetation and shading, water features amplify their cooling impact, making urban areas more resilient to rising temperatures and climate extremes.

## IMPLEMENTATION STEPS

1. **Assessment and planning:** Undertake a heat risks assessment of your city to identify hotspots and potential areas for implementing public water features. Review national and local planning policies to understand any constraints and opportunities in implementing water features into public spaces.
2. **Community and stakeholder engagement:** Reach out to the local community and involve stakeholders, such as city departments in charge of public spaces, NGOs, and CSOs to understand their needs and the possibility of establishing partnerships to aid with implementation.
3. **Site, intervention selection, and design:** Once you have developed a thorough understanding of opportunities and constraints in implementing water features in public spaces, you should undertake an exercise to select sites and the type of water feature to be implemented. Engage with landscape architects to develop coherent designs for embedding water features into public spaces.
4. **Implementation:** Upon the completion of design work and receipt of necessary agreements between stakeholders, approvals, and construction permits, begin to gather and mobilize resources to implement the water features in question.
5. **Scale up:** Based on the success of pilot projects, scale up the implementation of water features to other public spaces across the city. Document and share best practices and lessons learned to encourage wider adoption.

## BENEFITS

| | |
|---|---|
| PEOPLE (HEALTH AND EQUITY) | • Evaporative cooling of water features helps to decrease air temperatures and so increases the thermal comfort of public spaces. |
| ECONOMY (PRODUCTIVITY AND LIVELIHOODS) | • Increases the aesthetic appeal of public spaces and their use by residents and tourists, boosting local businesses.<br>• Proximity to well-maintained blue infrastructure can increase property values. |
| INFRASTRUCTURE | • Potential to increase water provision through, for example, incorporating drinking water fountains. |
| ENVIRONMENT | • The design of the water feature could provide opportunities to enhance urban biodiversity through the provision of aquatic habitat.<br>• Potential to regulate and filter surface water runoff during rainfall events reducing the risk of flooding and increasing water quality. |

***Resources***

The "Urban Blue Space, Planning and Design for Water, Health and Well-being" book explores an evidence-based approach to landscape planning and design for urban blue spaces that maximizes the benefits to human health and well-being.

10

# Green space and tree planting

## SCALE

Neighbourhood and community

## TYPE OF ACTION

Infrastructure (green)

## EASE OF IMPLEMENTATION

Easy

## LEVEL OF EVIDENCE

Established practices

## SUITABILITY

### City Context

- Densely populated areas in cities where concrete and asphalt dominate.
- Areas with high pedestrian traffic and limited open spaces.

### Climate Context

- Hot and temperate climates.
- Reduces ambient temperatures.
- Drought-resistant species and efficient irrigation systems are crucial in arid climates.

### User Context

- High density neighbourhoods or urban cores.
- Communities with high population density and limited access to natural environments.

## DESCRIPTION

Expansion of the urban tree canopy and green spaces is a highly effective strategy for urban heat management. Trees and vegetation provide cooling through evapotranspiration and shading, significantly reducing temperatures in dense urban areas. Strategic placement around buildings and high-traffic areas maximizes these benefits. Furthermore, green spaces improve air quality, reduce stormwater runoff, and enhance mental and physical health, resulting in a multifaceted solution for sustainable urban living.

Green spaces and trees are appropriate where adequate water is available and when species choice reflects local natives and those that will thrive in expected future local climate conditions. The proposed measure includes the development of small pilot green spaces, and tree planting using native species of plants that are adapted to the environment and biodiversity in the region. Trees can be planted along the roadside within public spaces to provide shade and cooling to the local community. Green spaces can include shrubs, flowers, and small tree areas that support biodiversity in the urban setting (Kim, E., Henry, G. and Jain, M., 2023; Campbell, 2021; ESMAP, 2020).

**Figure 3-3.** An illustration of Green Corridors in Eldoret, Kenya
**Source:** © AtkinsRéalis, 2021.

## IMPLEMENTATION STEPS

1. **Assessment and planning:** Conduct a baseline assessment of the current provision of green spaces across the city and identify priority areas for tree planting and green space development based on heat maps and population densities.
2. **Planning and strategy:** Develop a comprehensive urban greening strategy from the baseline analysis, inclusive of goals, timelines, and budget. Expert stakeholders and local communities should be engaged in this step.

3. **Detailed design stage:** Appropriate tree species and vegetation that are climate resilient, noninvasive, and suitable to the local context should be selected, with plans and design for a mix of green space use – including parks, street trees, green roofs, and urban forests.
4. **Site preparation:** The soil of identified sites should be prepared to ensure it is suitable for planting, and any required infrastructure adjustments should be addressed at this stage, such as the irrigation and drainage systems.
5. **Planting and installation:** The trees and vegetation should be planted in the identified strategic locations, focusing on areas with high pedestrian traffic and between buildings. Proper spacing and planting techniques should be deployed to maximize the growth and health of vegetation.
6. **Maintenance and monitoring:** Establish a maintenance plan for trees and vegetation and monitor the health and growth of trees and vegetation regularly.

## BENEFITS

| | |
|---|---|
| **PEOPLE (HEALTH AND EQUITY)** | • Improves air quality which has adverse health impacts on people, e.g., asthma.<br>• Provides for social activities such as exercise, relaxing, and socializing. |
| **ECONOMY (PRODUCTIVITY AND LIVELIHOODS)** | • Expands economic opportunity to street-front shops and markets.<br>• Attracts tourism.<br>• Employs workers to maintain green space and biodiversity |
| **INFRASTRUCTURE** | • Supports key drainage infrastructure.<br>• Reduces the risk of flooding and landslides.<br>• Presents opportunities to upgrade critical water, energy, and transport infrastructure to withstand high temperatures and build resilience. |
| **ENVIRONMENT** | • Supports local biodiversity and the growth of native species.<br>• Sustainable urban drainage systems reduces the risk of flooding from heavy rainfall. |

CASE STUDY

## The 'greener Medellín for you' program, Medellín, Colombia

Since 2016, Medellín has developed 30 interconnected 'Green Corridors' across the city, enhancing urban greenery, reducing the UHI effect, and sequestering carbon dioxide. This US$16.3 million initiative, part of the "Greener Medellín for You" program, involved training 75 citizens from disadvantaged backgrounds to become planting technicians, leading to the planting of 8,800 trees and 90,000 smaller plants over 65 hectares. The corridors reduce city temperatures by 2°C, improve air quality by capturing pollutants, and boost biodiversity by creating habitats for wildlife. This award-winning project highlights the transformative potential of NbS in sustainable urban design (C40 Cities Climate Leadership Group and Nordic Sustainability, 2019).

***Resources***

- The "Urban Heat in South Asia" report developed by the World Bank provides more detail about this solution in the South Asia context.
- The "Primer for Cooling Cities: Reducing Excessive Urban Heat" developed by IBRD and The World Bank provides further context for this solution.
- The "Beating the Heat" Handbook developed by the Cool Coalition introduces more details and provides relevant diagrams for this solution.

11

# *Cool roads and pavements*

## SCALE

Neighbourhood and Community

## TYPE OF ACTION

Infrastructure intervention
(gray, green, or blue)

## EASE OF IMPLEMENTATION

Medium

## LEVEL OF EVIDENCE

Pilot project

## SUITABILITY

### City Context

- Low-density areas with low pedestrian and vehicular traffic.

### Climate Context

- High albedo paint is suitable in most climate conditions.
- Permeable pavement is suitable in areas with high rainfall.

### User Context

- Implemented by the city/local government as a public asset, either directly or by including suitable specifications in tenders for road and pavement construction.

## DESCRIPTION

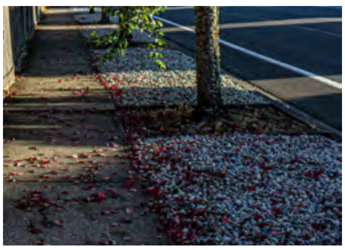
Cool roads and pavements have emerged as a possible solution to mitigate urban heat. As opposed to traditional concrete and asphalt materials on roads, this solution focuses on implementing heat-reducing and reflective materials and designs for roads and pavements.
Cool roads and pavements can be established using the following methods (Global Cool Cities Alliance and R20 Regions of Climate Action, 2012; ESMAP, 2020):

- **Using high albedo paint or reflective surfaces** to increase the amount of solar radiation reflected into the atmosphere; or
- **Using permeable materials** to allow water to seep through roads and pavements which aids evaporative cooling; this could include grass pavers, porous asphalt, or pervious concrete.

The application of such interventions can also go beyond roads and pavements and be applied, for example, in unshaded car parks, pedestrian routes, play areas, sports courts in parks, and plazas and city squares (see the following examples). Since reflective pavements can sometimes increase heat stress for pedestrians by reflecting radiation back into their bodies and faces, the use of advanced paints and surfaces is recommended.

EXAMPLES OF USE CASES OF COOL ROADS AND PAVEMENTS

**White reflective material on roads**



**Permeable paving stones**

**Reflective materials in play areas**

**Source:** Unsplash

## IMPLEMENTATION STEPS

1. **Assessment and planning:** Understand urban heat conditions and vulnerable areas of the city as well as possible locations for the implementation of cool roads and pavements. This can be undertaken as part of Assessing Heat Risk and Planning for Heat Resilience.
2. **Material selection:** Research and select appropriate cool pavement materials, considering factors like reflectivity, permeability, durability, climate, and location of the intervention in your city.
3. **Design and engineering:** Collaborate with urban planners and engineers to design road and pavement layouts that optimize cooling effects. As far as possible, incorporate other solutions such as trees, green spaces, and shading to maximize temperature reduction potential and co-benefits (for example, improve air quality).
4. **Community and stakeholder engagement:** Engage with local communities, businesses, and government agencies to garner support and gather input on program implementation. Foster partnerships to ensure widespread adoption and long-term sustainability.
5. **Pilot projects:** Implement small-scale pilot projects to test the effectiveness of selected materials and designs. Gather data on temperature reduction, surface reflectivity, and public feedback.
6. **Implementation and monitoring:** Based on the finding of the pilot project, undertake necessary changes to the designs and begin implementing the project on a larger scale, ensuring targeted urban areas and prioritizing high-heat zones and vulnerable communities. Establish monitoring mechanisms to track progress and evaluate performance over time.
7. **Evaluation and adaptation:** Regularly evaluate the impact of the project on urban heat reduction and community well-being. Adjust strategies and interventions as needed, based on feedback and evolving environmental conditions.

***Resources***

- The "Practical Guide to Cool Roofs and Cool Pavements" developed by the Global Cool Cities Alliance and R20 Regions of Climate Action provides a deeper dive into the solution.
- The "Mitigating Urban Heat Island Effects, Cool Pavement Interventions" resource developed by Bloomberg Associates showcases further case studies.
- The "Primer for Cooling Cities: Reducing Excessive Urban Heat" developed by IBRD and The World Bank provides further context for this solution.

## BENEFITS

| | |
|---|---|
| **PEOPLE (HEALTH AND EQUITY)** | • Improves thermal comfort of street space, reducing heat stress on elderly and children.<br>• Reduces health risks for outdoor workers, for example, street vendors or rickshaw drivers.<br>• Encourages active travel (walking and cycling) and associated health benefits. |
| **ECONOMY (PRODUCTIVITY AND LIVELIHOODS)** | • Contributes to lower costs for cooling in buildings.<br>• Stimulates pedestrian activity and increases footfall for businesses along the street. |
| **INFRASTRUCTURE** | • Reduces damage and deterioration of roads and improves its service life and durability.<br>• Materials with high reflective index, such as white paint, help with nighttime illumination and improve safety for vulnerable groups.<br>• Permeable pavements help with noise reduction. |
| **ENVIRONMENT** | • Permeable surfaces help with absorbing stormwater.<br>• Reduce heat through increased evapotranspiration. |

CASE STUDY

### Cool pavements program in Tokyo, Japan

Tokyo set a goal of implementing more than 130 km of cool pavement across the city by 2020 and, as of 2017, the program has supported the delivery of 96 km of pavement with reflective coating and 20 km of permeable pavement. The program was linked with wider road maintenance programs as well as the Tokyo 2020 Olympics. The Tokyo Metropolitan Government offered subsidies to wards and municipal governments that installed the pavements around competition venues; this incentivized adoption and reduced the burden of making a business case for cool pavements andeasing implementation.

**Source:** Implementation (Bloomberg Associated, 2019)

12

# *Providing shade in public spaces*

**SCALE**

Neighbourhood and community

**TYPE OF ACTION**

Infrastructure intervention (gray, green, or blue)

**EASE OF IMPLEMENTATION**

Medium

**LEVEL OF EVIDENCE**

Established practices

**SUITABILITY**

### City Context

- Urban environments with sparce tree canopy.
- Heavy-traffic zones with high pedestrian activity, as well as within informal settlements.

### Climate Context

- Adaptable to various climate conditions.
- Reduces temperatures and provides relief from intense sunlight.
- Adjustable shading devices can balance sun exposure and shade.

### User Context

- Improves comfort and safety.
- Reduces the risk of heat stress for pedestrians, particularly those engaged in manual labor and outdoor activities.
- Enhances the usability and attractiveness of public spaces.

## DESCRIPTION

Provision of shade in public spaces offers a sustainable, passive cooling approach to managing urban heat, crucial for mitigating the economic and health risks posed by rising temperatures and humidity, particularly in regions like South Asia. Rising heat and humidity levels pose a significant economic risk to South Asia, where a sizable portion of the workforce is vulnerable to heat stress. The impacts of occupational heat exposure extend beyond individual health, affecting the macroeconomic scale. Sectors that rely heavily on manual labor and outdoor work, such as construction, are particularly at risk, with projections indicating a loss of over 8 percent of shaded working hours (International Labor Organization, 2019). Without intervention, these lost labor hours will not only have substantial economic repercussions but also severely impact the health and well-being of workers.

Effective shade can prevent overheating, reduce the UHIE, and enhance thermal comfort. It is essential to balance shade and sun. While shade prevents overheating, some sun exposure supports indoor daylighting and passive heating in colder weather. Shade solutions include fabric, metal, or wood canopies, solar canopies, and vertical panels, which can improve comfort in public spaces like sidewalks, parks, and bus stops. Look to indigenous and local practices in shading streets and public spaces that can help to develop effective and tailor-made solutions in combatting the effects of urban heat in your city. Solar photovoltaic (PV) panels are also a viable solution for providing shade while generating electricity, with applications ranging from parking lots to bus shelters (Kim, E., Henry, G. and Jain, M., 2023; Campbell, 2021; ESMAP, 2020).

### EXAMPLES OF PROVISION OF SHADE IN PUBLIC SPACES

**Fabric shading, Madrid, Spain.**

**Green infrastructure shading, Darwin, Australia.**

**Steel shading, Bragado, Spain.**

**Source:** netzerocities 2025.

## IMPLEMENTATION STEPS

1. **Assessment and planning:** Conduct a heat vulnerability assessment to pinpoint areas most at risk. Engage with local communities to understand their needs and preferences, and where shade may be most needed.
2. **Design and selection:** Design structures that provide a balance between shade and sun exposure. Choose materials that are durable, cost-effective, and suitable for the local climate. Consider integrating solar PV panels to offer both shade and electricity generation.
3. **Installation:** Implement the project in phases, starting with the most critical areas. Monitor the installation process to ensure it meets quality and design specifications.
4. **Maintenance and monitoring:** Develop a maintenance plan to ensure the longevity of the shading structures. Regularly inspect and repair damage. Monitor the effectiveness of the shade in reducing temperatures and improving comfort.
5. **Community and stakeholder engagement and education:** Educate the public about the benefits of shade and how to use shaded areas effectively. Encourage community involvement in the maintenance and upkeep of the shading structures.
6. **Evaluation and adaptation:** Evaluate the impact of the shade on heat reduction and public comfort. Collect feedback from users and stakeholders. Adapt and improve the shading solutions based on the evaluation results and feedback.

### *Resources*

- The "Urban Heat in South Asia" report developed by the World Bank provides more detail about this solution in the South Asia context.
- The "Primer for Cooling Cities: Reducing Excessive Urban Heat" developed by IBRD and The World Bank provides further context for this solution.
- The "Beating the Heat" handbook developed by the Cool Coalition introduces more details and provides relevant diagrams for this solution.

## BENEFITS

| | |
|---|---|
| **PEOPLE (HEALTH AND EQUITY)** | • Lowers the risk of heat-related illnesses, protecting vulnerable populations such as the elderly and children.<br>• Encourages outdoor activities, boosting physical and mental well-being.<br>• Provides equitable access to shaded areas to ensures benefits for all. |
| **ECONOMY (PRODUCTIVITY AND LIVELIHOODS)** | • Protects outdoor workers from acute heat episodes, reducing lost labor hours.<br>• Minimizes heat stress for sectors like construction and agriculture.<br>• Attracts visitors and customers, benefiting local businesses. |
| **INFRASTRUCTURE** | • Protects urban infrastructure from thermal damage, maintaining roads and buildings.<br>• Solar PV panels in shading structures provide renewable energy, easing grid strain. |
| **ENVIRONMENT** | • Lowers ambient temperatures and tackles the UHI effect,<br>• Reduces the need for air conditioning. |

CASE STUDY

### Freetown Market Cover Shade Project, Freetown, Sierra Leone

Freetown faces severe heat challenges that particularly impact outdoor and informal workers, predominantly women. To address this, Chief Heat Officer Eugenia Kargbo, in collaboration with Arsht-Rock and as part of the Extreme Heat Resilience Alliance, launched the Market Cover Shade Project. This initiative installs low-cost, sustainable shade covers with solar panels, offering heat protection and nighttime lighting, thus extending safe shopping hours and supporting vendors' livelihoods. With 669 square meters of shade and 40 solar lights across three markets, the project has directly benefited over 2,300 women and indirectly reached 11,500 people, while raising awareness of heat resilience (Owen-Burge, C., 2023).

13

# Resource efficiency measures

## SCALE

Site and household

## TYPE OF ACTION

Data and technology

Infrastructure (gray)

## EASE OF IMPLEMENTATION

Medium

## LEVEL OF EVIDENCE

Pilot project

## SUITABILITY

### City Context

- High-density urban areas where energy-intensive cooling exacerbates heat buildup.
- Cities or individual buildings undergoing redevelopment, integrating energy-efficient design into new infrastructure.
- Regions with strained power grids, reducing energy demand during peak heat periods.

### Climate Context

- Hot climates where excessive energy use for cooling contributes to the UHIE.
- Areas with frequent heatwaves to lower indoor temperatures sustainably.
- Regions with water scarcity, where efficient cooling systems can reduce water consumption.

### User Context

- Typically led by city governments through building codes, incentives, and urban policies.
- Private developers and businesses can implement energy-efficient measures to cool their buildings and indoor spaces.
- Households and communities can adopt energy-efficient measures to cool their buildings and indoor spaces.

## DESCRIPTION

Resource efficiency measures, in particular energy efficiency, can play a crucial role in mitigating urban heat in buildings by reducing the internal and external heat loads. By optimizing energy use, buildings generate less waste heat, which contributes to lower ambient temperatures.

Energy efficiency measures, such as reflective roofs, high-performance insulation, and energy-efficient windows, reduce heat absorption and heat transfer, keeping interiors cooler and less reliant on air conditioning. This, in turn, lowers electricity demand, particularly during peak periods, easing pressure on power grids and reducing heat emissions from power plants, some of which can potentially be located near urban areas. Moreover, energy-efficient heating, ventilation, and air conditioning systems and lighting produce less heat compared to conventional systems, contributing to a cooler indoor environment and reducing the spillover of waste heat into outdoor spaces.

When integrated with passive cooling measures, discussed as part of other solutions in this catalog, the cumulative effect of enhanced resource efficiency not only improves the energy performance of individual buildings but also contributes to broader urban cooling, enhancing resilience to rising temperatures and creating more comfortable, liveable cities.

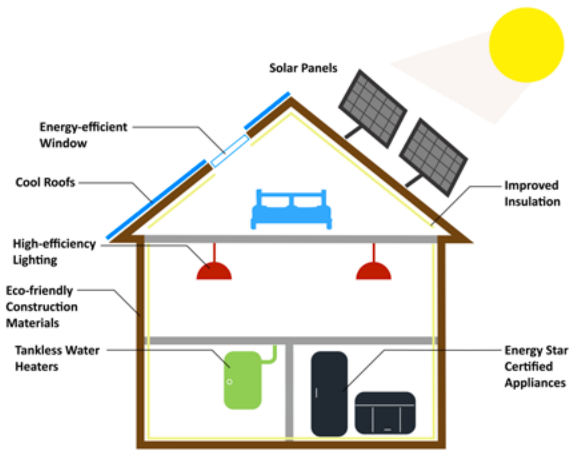



**Figure 3-4.** Features of an energy-efficient home.
**Source:** © AtkinsRéalis, 2025

## IMPLEMENTATION STEPS

1. **Regulatory understanding:** Research local and national building regulations to gain an understanding of the types of resource efficiency measures that could be implemented. You may find that local laws and regulations restrict or promote the use of some measures over others.

2. **Building survey:** Survey the building where resource efficiency measures will be implemented to understand its structural integrity and utility infrastructure, especially electricity installation.
3. **Selection of resource efficiency measure:** Based on the building survey results determine the most appropriate resource efficiency measure to be implemented.
4. **Implementation:** Gather the required funds and resources to implement the identified resource efficiency measures.
5. **Scale up:** If you are a city government intending to implement resource efficiency measures in multiple buildings, use the above steps to pilot the initiative. Thereafter, assess the outcomes and benefits of the implemented measure and look to scale up the initiative to improve the resource efficiency of other buildings across your city.

## BENEFITS

| | |
|---|---|
| PEOPLE (HEALTH AND EQUITY) | • Increases thermal comfort of buildings. |
| ECONOMY (PRODUCTIVITY AND LIVELIHOODS) | • Potential to reduce energy bills (electricity and heating) through reduced energy consumption. |
| INFRASTRUCTURE | • Increases energy efficiency and reduces energy consumption.<br>• Promotes the use of new technologies.<br>• Potential to strengthen critical infrastructure, including water and energy, at the household level to improve resilient to high temperatures. |
| ENVIRONMENT | • Potential to implement rainwater harvesting to reduce runoff.<br>• Solutions implemented to improve energy efficiency will lower household GHG emissions associated with energy use |

CASE STUDY

## Kuyasa low-income energy efficiency housing project, Cape Town, South Africa

The Kuyasa Low-income Energy Efficiency Housing Project in Cape Town, South Africa, is a pioneering initiative aimed at improving the living conditions of low-income residents while addressing urban heat and energy efficiency. The project involved retrofitting 2,309 houses with solar water heaters, ceiling insulation, and compact fluorescent lamps.

The retrofits included the installation of 25-millimeter IsoBoard thermal insulation, which significantly improved the thermal performance of the houses. This intervention helped maintain indoor temperatures at comfortable levels, reducing the need for paraffin heaters and thus mitigating urban heat effects.

The project also had significant socioeconomic benefits. It created local job opportunities, provided technical training to residents, and enhanced community engagement. The reduction in energy costs and improved indoor environmental quality led to better health outcomes and increased household income. The project demonstrated how energy efficiency measures could be effectively implemented in low-income communities, resulting in multiple benefits, including the mitigation of urban heat (ESMAP, 2012).

*Resources*

- The "Energy Sector Management Assistance Program" website provides more information about energy efficiency, as well as resources, case studies, and technical assistance in developing energy-related projects.
- The "Building Code Checklist for Green Buildings" developed by The World Bank can be used as a checklist to identify resource efficiency measures and green building interventions.

14

# High-performance building envelopes

## SCALE

Site and household

## TYPE OF ACTION

Infrastructure (green)

## EASE OF IMPLEMENTATION

Medium

## LEVEL OF EVIDENCE

Pilot project

## SUITABILITY

### City Context

- Densely populated urban areas with significant heat retention issues.
- Mitigates UHIE by reflecting and reducing heat absorption.
- Enhances urban livability by lowering indoor temperatures.

### Climate Context

- All climates.
- Regions with high heat retention from traditional building materials.

### User Context

Households seeking to lower energy costs and indoor temperature.

## DESCRIPTION

High-performance building envelopes can play a crucial role in managing heat in buildings, especially in regions where the use of heat-trapping materials is prevalent. In regions such as South Asia, buildings are often constructed with materials that retain heat, such as tin, asbestos, and polyvinyl chloride. These materials contribute to higher indoor temperatures, particularly in non-engineered, temporary, or self-built structures. Studies have shown that buildings with tin roofs can have indoor temperatures that exceed outdoor temperatures by up to 4°C at night, impacting sleep quality and overall health (Kim et al. 2023; Campbell 2021; ESMAP 2020).

High-performance building envelopes, such as cool walls and roofs, offer a solution by reflecting more solar energy and reducing heat absorption. Cool walls, for example, are light-colored and maintain their reflectivity over time, helping to lower indoor temperatures and improve thermal comfort. These materials are applicable in various climates and can significantly reduce energy costs by lowering the need for air conditioning.

The widespread use of cement bricks and poured cement in building construction is GHG intensive, presenting an opportunity for emissions reductions. Concrete, with its high thermal mass, retains cooler temperatures and requires less energy for heating and cooling. However, using sustainable concrete and alternative building materials like clay bricks and sustainably sourced wood can further enhance resilience to increasing temperatures. These materials naturally support energy cost reduction from air conditioning units and improve overall health.

Using high-albedo materials and passive cooling techniques, such as shade and ventilation, can further enhance the effectiveness of building envelopes. These strategies not only improve indoor comfort but also contribute to broader urban cooling efforts, making cities more liveable and resilient to heat stress. Encouraging the use of these materials through building codes and incentives can drive widespread adoption and help mitigate the adverse effects of urban heat (Roberts, et al. 2023; Kim et al., 2023; Campbell, 2021; ESMAP, 2020).

## IMPLEMENTATION STEPS

1. **Assessment and planning:** Conduct a comprehensive assessment of existing building materials

and their impact on indoor temperatures. Identify areas and neighborhoods with the highest need for intervention, particularly focusing on nonengineered, temporary, or self-built structures that use heat-trapping materials like tin and asbestos.

2. **Policy development:** Develop and implement policies that promote the use of high-performance building envelopes, such as updating building codes.
3. **Incentive programs:** Create financial incentives such as grants, tax rebates, or low-interest loans to encourage property owners to upgrade to high-performance building envelopes, helping to offset the initial costs of materials and installation.
4. **Pilot projects:** Engage with specialists and implementing pilot projects in key areas identified from step 1 to demonstrate the effectiveness of high-performance building envelopes. Focus on public buildings, schools, and low-income housing and gather data on performance and cost savings.
5. **Collaboration with industry:** Establish partnerships with manufacturers and suppliers of sustainable building materials to ensure a steady supply of high-quality products.
6. **M&E:** Establish a system for M&E of the performance of high-performance building envelopes. Collect data on temperature reductions, energy savings, and occupant comfort to assess the effectiveness of the interventions and make necessary adjustments.

## BENEFITS

| | |
|---|---|
| PEOPLE (HEALTH AND EQUITY) | • Improved family and community health due to the reduction in temperature inside homes. |
| ECONOMY (PRODUCTIVITY AND LIVELIHOODS) | • Reduced health costs for families from heat-related illnesses.<br>• Reduced energy costs from air conditioning.<br>• Reduced consumer and construction costs from reduced cement requirement. |
| INFRASTRUCTURE | • Improved building design for natural cooling using clay as it is. |
| ENVIRONMENT | • Reduced GHG emissions from the reduced production of cement.<br>• Reduced GHG emissions from energy demand for cooling. |

CASE STUDY

### Burkina Institute of Technology, Koudougou, Burkina Faso

Kéré Architecture's design and construction of the Burkina Institute of Technology in Burkina Faso exemplifies the use of high-performance building envelopes. The university, part of the Lycée Schorge Secondary School campus, features walls made from locally sourced clay combined with concrete, enhancing thermal mass and cooling the interiors naturally. The use of clay bricks over cement bricks was chosen because of the availability of locally sourced clay and its cooling benefits as it dissipates heat unlike cement blocks that heat up due to solar radiation.

The building's design includes staggered modules to facilitate airflow, shaded corridors, and eucalyptus wood screens, which together improve ventilation and reduce heat accumulation. This approach not only leverages local materials but also integrates sustainable design principles to create a comfortable and environmentally friendly educational facility (Crook 2021).

***Resources***

- The "Urban Heat in South Asia" report developed by the World Bank provides more detail about this solution in the South Asia context.
- The "Primer for Cooling Cities: Reducing Excessive Urban Heat" developed by IBRD and The World Bank provides further context for this solution.
- The "Beating the Heat" Handbook developed by the Cool Coalition introduces more details and provides relevant diagrams for this solution.

15

# *Indoor cooling measures*

## SCALE

Site and household

## TYPE OF ACTION

Data and technology

Infrastructure (gray)

## EASE OF IMPLEMENTATION

Easy

## LEVEL OF EVIDENCE

Pilot project

## SUITABILITY

### City Context

- Suitable for urban areas with high-density living and limited green spaces.
- Reduce the UHIE by minimizing heat retention in buildings.
- Active cooling systems, when energy-efficient, can provide necessary relief in densely populated areas.
- Reduce health risks and heat stress on the elderly and children.

### Climate Context

- Active cooling systems are essential in regions with acute heat episodes.
- Ensure balance with energy efficiency to avoid exacerbating outdoor temperatures.
- Suitable for hot climates, and regions experiencing high temperatures.

### User Context

- Requires stable and affordable energy sources, which can be a challenge in informal settlements.
- Suitable for households to implement with minimal technical capacity.
- Local governments can provide financial support towards implementation, particularly for low-income communities.

## DESCRIPTION

Indoor cooling measures are essential for managing urban heat in cities. These measures can be broadly categorized into passive and active cooling strategies, each offering unique benefits and challenges.

- **Passive cooling** involves building designs and measures that provide thermal comfort without relying on mechanical systems such as optimized building orientation, use of insulation, enhancement of natural ventilation, incorporation of reflective surfaces, and addition of shading elements – refer to Solution No. 6 for more details regarding passive cooling solutions.
- **Active cooling** involves the use of mechanical systems, such as electric fans and air conditioning units, to reduce indoor temperatures and humidity. While these systems effectively provide relief from heat, they also require a stable and affordable energy source to operate. Additionally, they produce exhaust heat that can elevate nearby outdoor temperatures, contributing to the UHIE. Improving the energy efficiency of air conditioning units and promoting district cooling systems can help mitigate the heat added to urban environments. District cooling, which delivers chilled water to buildings from a central plant, offers a more efficient and climate-friendly alternative to individual room air conditioning units (ESMAP, 2020)

## IMPLEMENTATION STEPS

1. **Assessment and planning:** Conduct a comprehensive assessment of the current cooling infrastructure and identify areas with the highest need for active cooling solutions.
2. **Policy development:** Develop and implement policies that promote the use of energy-efficient air conditioning units and district cooling systems. Establish standards and regulations to ensure new installations meet high energy efficiency criteria.
3. **Incentive programs:** Create financial incentives such as grants, tax rebates, or low-interest loans to encourage the adoption of energy-efficient cooling systems. Offer subsidies for upgrading old, inefficient units to newer, more efficient models.
4. **Public awareness campaigns:** Launch public awareness campaigns to educate residents and businesses about the benefits of energy-efficient cooling systems.
5. **Collaboration with utility provider:** Partner with local utility companies to promote energy-efficient cooling solutions. Develop programs that offer rebates or discounts on energy bills for customers who install high-efficiency air conditioning units.

## BENEFITS

| | |
|---|---|
| **PEOPLE (HEALTH AND EQUITY)** | • Reduces the risk of heat-related illnesses, such as heat exhaustion and heatstroke.<br>• Effective cooling solutions provide more comfortable living for all, including low-income and informal settlements. |
| **ECONOMY (PRODUCTIVITY AND LIVELIHOODS)** | • Improves productivity by reducing heat-induced fatigue and discomfort. |
| **INFRASTRUCTURE** | • Energy-efficient cooling systems can decrease overall energy demand. |
| **ENVIRONMENT** | • Reduces heat emitted by buildings. |

***Resources***

The "Improving Building-Level Thermal Comfort and Indoor Air Quality in South Asia" report developed by The World Bank to gain further insight into the types of indoor cooling measures and their application.

16

# Natural ventilation in buildings

## SCALE

Site and household

## TYPE OF ACTION

Infrastructure (green)

## EASE OF IMPLEMENTATION

Easy

## LEVEL OF EVIDENCE

Established practices

## SUITABILITY

### City Context

- Dense urban areas reliant on mechanical cooling systems.
- Enhance airflow in high-rise buildings.

### Climate Context

Regions with high temperatures.

### User Context

Improves indoor air quality and reduces temperature in residential and commercial buildings.

## DESCRIPTION

Natural ventilation is a cost-efficient and sustainable solution for managing urban heat. By incorporating design elements that enhance airflow and reduce heat retention, buildings can maintain comfortable indoor temperatures, reduce energy consumption, and mitigate the adverse effects of urban heat. Natural ventilation leverages natural forces to supply outdoor air into indoor spaces, using pressure differences, buoyancy (stack effect), or a combination of both. As a passive cooling strategy, natural ventilation disperses heat and enhances thermal comfort without relying on mechanical systems that are often energy-intensive, produce exhaust heat, and are high in cost. The main types of natural ventilation within buildings are listed here (Ahmed, et al, 2021; Stouhi, 2021; Ali et al. 2023):

- **Single-sided ventilation:** Utilizes openings on one side of a building to naturally ventilate spaces. This method is particularly useful in projects with limited area or where cross ventilation is not feasible. However, it provides the least air circulation among natural ventilation systems.
- **Cross ventilation:** Involves openings on opposite or adjacent walls, allowing air to flow through the building, creating constant air renewal to reduce internal temperatures. This method is especially effective in high-temperature climatic zones.
- **Stack ventilation:** Introduces cooler air at a low level, which warms up as it rises and exits through higher openings. This system is effective in tall buildings with central atriums and can be useful where cross ventilation is inadequate. It relies on the indoor temperature being higher than the outdoor temperature.
- **Chimney effect:** Common in vertical buildings, this method uses the pressure difference created by cold air pushing warm air upwards. Open areas in the building's center or towers allow air to circulate and exit through the roof or other high openings.

Enhancement of natural ventilation can be achieved through design features such as atriums, windcatchers, solar chimneys, and specific window types. An exploration of indigenous and local practices in ventilation of building can help to develop effective and tailor-made solutions in combatting the effects of urban heat and improving thermal comfort. In multistory buildings, sky courts—vertical extensions of traditional courtyards—are often used as a design to create natural ventilation within buildings, providing direct airflow, increasing thermal comfort, and significantly reducing energy consumption.

## IMPLEMENTATION STEPS

1. **Assessment and planning:** Assess the current ventilation systems in selected buildings and identify areas where natural ventilation can be integrated or improved. Conduct further research on features appropriate for relevant building typologies within the city.
2. **Policy and regulation:** Develop and distribute guidelines for architects and developers on best practices for incorporating natural ventilation in the city's context.
3. **Pilot projects:** In collaboration with the private sector and architects, implement pilot projects by integrating natural ventilation systems in the design of new buildings. Optimize the building layout to maximize airflow, using techniques like single-sided ventilation for smaller spaces and cross ventilation for larger areas.
4. **Scaling up:** Based on the success of pilot projects, scale up the implementation of natural ventilation systems in new buildings across the city. Document and share best practices and lessons learned to encourage wider adoption of natural ventilation in other regions.

## BENEFITS

| | |
|---|---|
| PEOPLE (HEALTH AND EQUITY) | • Enhances indoor air quality by reducing pollutants and providing fresh air.<br>• Prevents respiratory issues and heat-related illnesses through enhanced air quality, beneficial for the elderly population.<br>• Reduces reliance on energy-intensive cooling, with comfortable living conditions accessible to low-income households. |
| ECONOMY (PRODUCTIVITY AND LIVELIHOODS) | • Enhances comfort and productivity, reducing heat-related fatigue.<br>• Lowers energy costs for businesses and households. |
| INFRASTRUCTURE | • Decreases reliance on mechanical cooling systems.<br>• Reduces the strain on the electrical grid and lower energy consumption.<br>• Reduces indoor temperatures and humidity levels.<br>• Prevents damage caused by heat and moisture. |
| ENVIRONMENT | • Reduces heat emitted by buildings, lowering urban temperatures.<br>• Lowers energy consumption for cooling, reducing GHG emissions. |

CASE STUDY

### Laayoune Technology School, Morrocco

The Laayoune Technology School in Morocco includes various teaching and administrative buildings strategically fragmented to maximize natural ventilation and lighting. They are interconnected by external paths, squares, covered areas, and mineral gardens to enhance urbanity. The architecture features solid, geometric forms with contrasting exterior and interior lighting. Various sun protection devices, such as sun breakers and overhangs, double layer cladding, and protected walkways, are employed. Materials are minimized to ensure abstraction, coherence, sustainability, and easy maintenance (Castro, F. 2021).

***Resources***

The "Back to Basics" article on natural ventilation by ArchDaily provides an overview of the types of natural ventilation in buildings and a diverse list of examples of natural ventilation in buildings of different uses.

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# *Façade screening and external shading elements*

## SCALE

Site and household

## TYPE OF ACTION

Infrastructure (green)

## EASE OF IMPLEMENTATION

Medium

## LEVEL OF EVIDENCE

Pilot project

## SUITABILITY

### City Context

- Buildings where direct solar exposure intensifies indoor heat.
- Cities promoting energy-efficient and climate-responsive architecture.
- In both new developments and when retrofitting existing buildings to improve thermal comfort.

### Climate Context

- Hot and arid regions where solar radiation significantly increases cooling demand.
- Tropical and humid climates to reduce heat gain while allowing ventilation.
- Areas with frequent heatwaves, providing passive cooling without extra energy consumption.

### User Context

- Led by architects and developers integrating shading elements into building designs.
- Supported by city governments through building codes and sustainability policies.
- Adopted by businesses and homeowners to reduce cooling costs and improve indoor comfort.

## DESCRIPTION

Façade screening and external shading elements are highly effective strategies for mitigating urban heat in buildings with benefits such as reduced solar heat gain and enhanced thermal comfort. These measures act as physical barriers between the building's exterior and direct sunlight, preventing surfaces from absorbing excessive heat and transmitting it indoors. By intercepting solar radiation before it reaches walls or windows, façade screens, such as perforated panels or green facades, significantly reduce the surface temperature of building envelopes (see Figure 3-5).

External shading elements, including overhangs, louvers, and brise-soleil, are designed to block high-angle summer sun while allowing natural daylight and ventilation, to create a cooler indoor environment without compromising energy efficiency or occupant comfort. These elements also contribute to reduced reliance on air conditioning, lowering energy consumption and decreasing waste heat emissions, which further alleviates the UHIE.

In addition to their functional benefits, façade screening and shading structures can be designed with aesthetic appeal, integrating seamlessly into urban landscapes while supporting sustainability goals. When used strategically, these features not only improve building performance but also enhance the overall urban microclimate by mitigating localized heat build-up and creating cooler, more comfortable public spaces. Explore indigenous and local practices to identify screening and external shading elements that can help to develop effective and tailor-made solutions in combating the effects of urban heat in your city.

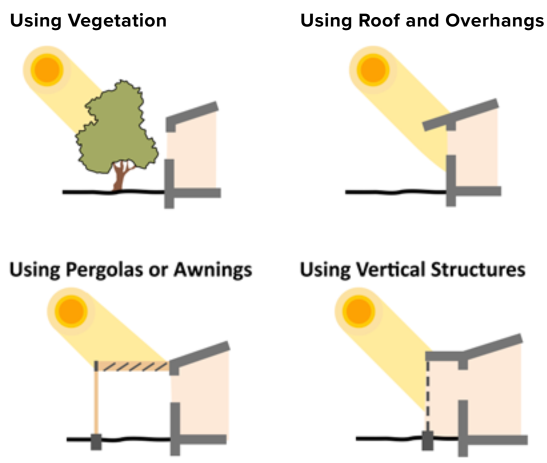


**Figure 3-5.** Examples of façade screening and external shading.
**Source:** © AtkinsRéalis, 2025

## IMPLEMENTATION STEPS

1. **Assessment and planning:** Assess the current façade of selected buildings and identify areas where shading elements such as those discussed above can be integrated or improved. Conduct further research on features appropriate for relevant building typologies within the city.
2. **Policy and regulation:** Develop and distribute guidelines for architects and developers on best practices for incorporating façade screening and external shading elements in the city's context.
3. **Pilot projects:** In collaboration with the private sector and architects, implement pilot projects by integrating façade screening and external shading elements in the design of new buildings. Optimize the design of façades and external elevations to include such shading elements, in particular, near windows and open structural elements with direct sunlight.
4. **Scaling up:** Based on the success of pilot projects, scale up the implementation of such shading elements in new buildings across the city. Document and share best practices and lessons learned to encourage wider adoption.

## BENEFITS

| | |
|---|---|
| PEOPLE (HEALTH AND EQUITY) | • Increased thermal comfort of internal spaces results in higher health and well-being benefits as exposure to high internal temperatures is limited. |
| ECONOMY (PRODUCTIVITY AND LIVELIHOODS) | • The impacts of reduced absorption of solar radiation because of shading elements can increase the thermal comfort of internal spaces and lead to potential increases in employee productivity. |
| INFRASTRUCTURE | • Such shading elements help to reduce the absorption of solar radiation by external façades and internal spaces. |
| ENVIRONMENT | • Using green infrastructure, such as trees and green walls, for such shading elements can also provide other co-benefits, for example, improved air quality or biodiversity. |

CASE STUDY

### IPHIKO "Wing" Classrooms, South Africa

The IPHIKO "Wing" Classrooms is the first phase of the implementation of two classrooms in South Africa. The main aim is to create a sustainable building that ensures thermal comfort indoors and does not require heating or air conditioning. Moreover, the design incorporates a wide roof structure with a large overhang over the outdoor space to ensure shade from the sun during the summer. This allows for the space outside the classrooms to be used for education and play even during summer days when the sun is beating down on the spaces (Divisare 2025).

***Resources***

"Sun Shade Catalogue – Adequate shading: Sizing overhands and fins" developed by UN-Habitat to gain a deeper understanding of façade screening and external shading elements alongside further case studies.

18

# Cool roofs

## SCALE

Site and household

## TYPE OF ACTION

Infrastructure (green)

## EASE OF IMPLEMENTATION

Medium

## LEVEL OF EVIDENCE

Pilot project

## SUITABILITY

### City Context

- Urban areas with extensive roof surfaces.
- Potential for an initial investment within informal settlements.
- Reduces the UHIE and lowers ambient temperatures.
- Integrates well into building codes and urban planning policies.
- Enhances sustainability and resilience against heat.

### Climate Context

- Most effective in warm and temperate climates.
- Significant energy savings during hot months.
- Less suitable for extremely cold climates but still offers benefits.
- Adaptable to a wide range of climatic conditions with improving technology.

### User Context

- Benefits low-income housing, commercial properties, and municipal buildings.
- Provides cost savings, improved thermal comfort, and extended roof life.
- Short payback period and long-term advantages.
- Enhances quality of life by mitigating heat stress and improving overall comfort.

## DESCRIPTION

Cool roofs can be a highly effective solution for managing urban heat in cities. These roofs are designed with high solar reflectance, meaning they reflect more sunlight and absorb less heat compared to traditional dark roofs. This reduces the amount of heat transferred to buildings and the surrounding air, leading to cooler indoor temperatures and a decrease in the UHIE. Cool roofs can be made by applying reflective coatings to existing roofs or by installing new reflective materials. Studies have shown that cool roofs can reduce roof surface temperatures by up to 15°C and indoor air temperatures by 2-3°C, enhancing thermal comfort and reducing the need for air conditioning (ESMAP 2020). The benefits of cool roofs extend beyond temperature reduction. They offer energy savings, lower energy bills, and improved roof and equipment life. The payback period for cool roofs is relatively short, ranging from zero to eight years based on energy cost savings alone. Therefore, they are a cost-effective solution, with materials for low-slope roofs being more reflective and cheaper per square meter than those for steep-slope roofs.

Cool roofs are suitable for nearly all building types and climates, except the coldest regions where increased winter heating demand may offset some benefits. However, even in these areas, the overall energy savings during warmer months typically outweigh the winter heating penalty. Additionally, cool roofs can be combined with rooftop solar PV technology to further enhance their benefits. Inexpensive cool roofs, such as those created by coating corrugated metal with lime wash, are particularly applicable in informal settlements and areas where building codes are not strictly enforced. Pilots in low-income housing in India and South Africa have shown increased indoor thermal comfort and resident satisfaction (Kim et al. 2023; Campbell 2021; ESMAP 2020; Kats et al. 2021).

## IMPLEMENTATION STEPS

1. **Assessment and planning:** Identify buildings and neighborhoods that would benefit most from cool roofs, focusing on areas with high heat exposure and vulnerable populations.

2. **Design and material selection:** Select high solar reflectance materials suitable for different roof types. Consider integrating rooftop solar PV technology to enhance energy savings and provide additional benefits.
3. **Pilot projects:** Implement pilot projects in selected areas, such as low-income housing or public buildings, to demonstrate the effectiveness of cool roofs. Monitor and evaluate the performance of these projects, measuring temperature reductions and energy savings.
4. **Regulatory support:** Local governments should work to include requirements or incentives for cool roofs in building codes and streamline the permitting process for installing cool roofs.
5. **Installation:** Roll out the project in phases, starting with high-priority areas and expanding based on the success of initial installations.
6. **Maintenance and monitoring:** Establish routines for inspecting and maintaining cool roofs to ensure their longevity and effectiveness. Monitor the performance of cool roofs, collecting data on temperature reductions and energy savings.

## BENEFITS

| | |
|---|---|
| **PEOPLE (HEALTH AND EQUITY)** | • Improves indoor thermal comfort, reducing heat stress and related health issues.<br>• Enhances living conditions in low-income housing and informal settlements.<br>• Increases resident satisfaction and well-being. |
| **ECONOMY (PRODUCTIVITY AND LIVELIHOODS)** | • Lowers energy bills, providing cost savings for households and businesses.<br>• Reduces cooling energy demand, leading to lower operational costs.<br>• Short payback period, making them a cost-effective investment. |
| **INFRASTRUCTURE** | • Extends the lifespan of roofing materials and equipment.<br>• Improves roof and building performance, reducing maintenance costs.<br>• Compatible with other technologies like solar PV, enhancing overall building efficiency. |
| **ENVIRONMENT** | • Mitigates the UHI effect, lowering ambient temperatures.<br>• Reduces GHG emissions by decreasing energy consumption.<br>• Improves air quality and contributes to global cooling efforts. |

CASE STUDY

### Mahila Housing Trust's empowerment of women to improve household resilience to heat stress, India

The Mahila Housing Trust in India is a grassroots development organization empowering woman to become changer makers for more sustainable and gender-inclusive cities. It is working to improve household resilience to heat stress by supporting the installation of sustainable cooling technologies. To date, over 27,000 households in more than 1,000 informal settlements have benefited from modular roofs with solar reflective white paint. This initiative is part of a broader effort to empower women and promote sustainable, gender-inclusive urban development.

The One Million Cool Roofs Challenge aims to scale up solar reflective roofs in developing countries. In Bangladesh, this initiative led to the painting of roofs on two factories and 105 other buildings in Dhaka, resulting in a significant reduction in indoor air temperatures by more than 7°C. These efforts highlight the effectiveness of cool roofs in mitigating heat stress and improving living conditions in vulnerable communities (Ashden 2022).

***Resources***

- The "Urban Heat in South Asia" report developed by the World Bank provides more detail about this solution in the South Asia context.
- The "Primer for Cooling Cities: Reducing Excessive Urban Heat" developed by IBRD and The World Bank provides further context for this solution, whilst discussing the cost-effectiveness of solutions with costs outlined.
- The "Beating the Heat" Handbook developed by the Cool Coalition introduces more details and provides relevant diagrams for this solution.
- The "Cooling Cities, Slowing Climate Change and Enhancing Equity" report developed by the Abell Foundation discusses further implications of this solution.

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# Urban agriculture

## SCALE

Site and household

## TYPE OF ACTION

Capacity development and behavior change

Infrastructure (green)

## EASE OF IMPLEMENTATION

Medium

## LEVEL OF EVIDENCE

Pilot project

## SUITABILITY

### City Context

- Ideal for densely populated cities where green spaces are limited.
- Significantly reduces the UHIE.
- Provides local food sources through community gardens and vertical farming, beneficial for low-income neighborhoods.

### Climate Context

- Hot and arid regions through its cooling effects.
- Flood-prone areas by using permeable surfaces to absorb excess water.

### User Context

- Government-led large-scale initiatives at the city scale, allocating public land, providing funding, and creating supportive policies.
- Residents can implement and create community gardens at the neighborhood and household level.

## DESCRIPTION

Urban agriculture, including community gardens, and vertical and rooftop farming, offers a multifaceted solution for managing urban heat. These gardens transform urban spaces from gray to green, improving air and soil quality and regulating water runoff. By increasing evapotranspiration, urban agriculture can help to create cooling spaces, mitigate the UHI effect, providing areas where people and wildlife can escape the heat. In some cases, soil-less hydroponic systems could be used. Unlike traditional cultures, hydroponic systems is a method of growing plants without soil and in a nutrient rich water solution which provides the plant with the substances it needs for its biological development. Moreover, such systems also require less maintenance. Urban gardens also promote social cohesion and civic engagement, as seen in Kibera, Nairobi, where vertical sack gardens provide nutritious food and enhance incomes. In Jakarta, vertical and organic household gardens have increased access to nutritious food and reduced waste. These initiatives not only improve food security and nutrition but also strengthen community bonds and resilience against climate impacts. Urban agriculture is a sustainable and inclusive approach to enhancing urban environments and combating heat stress.


Vertical sack gardens in Kibera, Nairobi.
**Source:** The Guardian, 2015.

Urban agriculture can be led by families in their own homes or by communities in public spaces. The local government can promote urban agriculture on the city scale by implementing the following project components:

- **Land:** Integrate urban agriculture considerations into land use planning, for example, in local development plans, and identify land plots suitable for farming practices, such as sections of public parks or school yards.
- **Skills:** Provide capacity building on climate-resilient urban farming techniques, for example, educate residents on how to grow food and drought-tolerant crops in an urban environment through targeted training, information campaigns, or setting up information centers.
- **Finance:** Support small-scale financing opportunities for households or CBOs to enable investment into seeds or fertilizer. Financing opportunities could include micro-credits or community saving groups.
- **Machinery and equipment:** Purchase machinery and tools to be shared/rented by the community members.
- **Marketing:** Support small-scale urban farmers to access markets by pooling products to reduce transport and time costs.

## IMPLEMENTATION STEPS

1. **Assessment and planning:** Integrate urban agriculture into land use policies and master plans, identifying suitable plots for farming, such as sections of public parks or school yards. Assess and select plants that are most appropriate for the local climate and soil conditions, focusing on drought-tolerant and heat-resistant varieties.
2. **Skills development:** Provide training in climate-resilient urban farming techniques for residents and CBOs. Educate residents on growing food and drought-tolerant crops through workshops, information campaigns, or setting up information centers.
3. **Financial support:** Support small-scale financing opportunities for households or CBOs. Offer micro-credits or community-saving groups to invest in seeds and fertilizers.
4. **Rainwater harvesting:** Implement rainwater harvesting systems alongside urban agriculture projects to ensure a sustainable water supply for the gardens.
5. **Evaluation and adaptation:** Regularly evaluate the uptake of urban agriculture in communities and neighborhoods. Monitor participation rates and the extent of community engagement. Gather feedback from participants to understand barriers and successes. Adapt and improve the projects based on evaluation results and feedback to ensure ongoing effectiveness and sustainability.

## BENEFITS

**PEOPLE (HEALTH AND EQUITY)**

- Decreases the risk of food insecurity.
- Reduces temperatures in the area and reduces the risk of heat stress.
- Accessible green spaces ensure that all community members, especially those in low-income areas, benefit from reduced heat stress and improved living conditions.
- Community gardens foster social interactions and civic engagement, strengthening community bonds and resilience.

**ECONOMY (PRODUCTIVITY AND LIVELIHOODS)**

- Creates job opportunities and supports local economies by providing fresh produce and reducing food costs.
- Improves food security for urban populations by increasing access to nutritious food.

**INFRASTRUCTURE**

- Reduces the UHIE, lowering temperatures and protecting infrastructure from heat-related damage.
- Regulates water runoff, reducing the risk of flooding and enhancing urban resilience.

**ENVIRONMENT**

- Supports and strengthens urban biodiversity.
- Increases green cover in built-up areas
- Reduces the need for transportation and lowers GHG emissions.

CASE STUDY

### Fruit tree planting at local schools, Accra, Ghana

Accra, facing increasingly higher temperatures, started a program to plant fruit trees at local schools to increase greenery and shade as well as awareness amongst students. The Department of Agriculture at the Accra Metropolitan Assembly, under the Planting for Export and Rural Development program, collaborated with the Resilience and Sustainability unit of the Assembly in carrying out the project by supplying and monitoring fruit tree crops (coconut seedlings). Monitoring was done by the department to ascertain the level of growth of the seedlings supplied while also identifying other schools that can also benefit from the fruit tree crops during the monitoring. Between 2018 and the end of 2019, about 200 coconut seedlings had been distributed to about 15 schools. The department intends to extend this program to other schools and houses in 2020 (FSS Project).

CASE STUDY

### Hydroponic Roof Farming Program in Cairo, Egypt

In 2014, a rooftop farming project was initiated in the Ezbet El-Nasr, informal settlements of the Greater Cairo Region, to address climate change challenges and empower the local community. The project was initiated by the Federal Ministry for Economic Cooperation and Development of Egypt and supported by the German Corporation for International Cooperation (GIZ). As part of the project, low-income families received training and loans to cover the costs which were repaid by monthly crop sales within a year.

The project aimed to reduce ambient temperatures in a densely populated area through implementing box planters on rooftops and reduce the impacts of the UHIE and heat risk. The implementation was a multi-stakeholder effort, including local NGOs, private sectors companies and development partners (Ezbet El-Nasr 1).

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# *Integration of green infrastructure into buildings*

**SCALE**

Site and household

**TYPE OF ACTION**

Infrastructure intervention (green)

**EASE OF IMPLEMENTATION**

Hard

**LEVEL OF EVIDENCE**

Pilot project

**SUITABILITY**

**City Context**

- Dense urban areas with high-rise buildings and limited green spaces.
- Public buildings where pilot projects can be used to promote public awareness.

**Climate Context**

Cities in hot climates, such as those in South Asia, to reduce the UHIE.

**User Context**

- The private sector should aim to integrate solutions into new and existing buildings.
- Create more attractive environments for residents, businesses, and communities.

## DESCRIPTION

Integrating green infrastructure, such as green walls and green roofs, into buildings is an effective solution for managing urban heat. Green roofs, which can be intensive (including small trees and shrubs) or extensive (covered by a thin layer of vegetation), significantly reduce surface temperatures through evapotranspiration. This process cools the air by using heat to evaporate water from plants and soil. Green roofs can lower surface temperatures by 17–22°C compared to conventional roofs and reduce city-wide ambient temperatures by up to 3°C when implemented at scale. For example, a demonstration in Chicago showed that green roof surface temperatures ranged from 33–48°C, while a conventional roof reached 76°C (ESMAP, 2020).

Additionally, green roofs improve stormwater management, extend roof life, support biodiversity, and enhance property values. Despite higher initial costs, the long-term benefits, including energy savings and reduced GHG emissions, make green roofs a valuable investment for urban cooling and sustainability (Kim et al. 2023; Campbell, 2021; ESMAP, 2020).

### INDICATIVE PROPERTIES OF TYPES OF GREEN ROOFS

**EXTENSIVE**

**Maintenance**
Low

**Plant communities**
Moss-sedum-herbs and grasses

**Costs**
Low

**SEMI-INTENSIVE**

**Maintenance**
Periodically

**Plant communities**
Grasses, herbs and shrubs

**Costs**
Middle

**INTENSIVE**

**Maintenance**
High

**Plant communities**
Lawns or perennials, shrubs, and trees

**Costs**
High

**Source:** Unsplash

Another method of effective integration of green infrastructure within buildings is green walls, also known as living walls or bio-walls, consisting of plants grown in supported vertical systems attached to internal or external walls. These walls can be direct green façades, where plants like vines attach directly to the building surface, or indirect façades, which use a vertical structure to support climbing plants. Living walls utilize complex planter boxes and pre-vegetated structures to facilitate plant growth. Green walls cool the surrounding air through evapotranspiration and provide additional benefits such as reducing air pollution and noise (Kats et al. 2021).

## IMPLEMENTATION STEPS

1. **Assessment and planning:** Evaluate the relevant building's structure and climate conditions to determine suitability for green roofs or walls.
2. **Design and selection:** Decide between extensive, semi-intensive, or intensive green roofs depending on need and budget, and select appropriate plant species accordingly. For green walls, decide on direct façades or living walls. Consider adding rainwater harvesting and solar panels.
3. **Installation:** Implement the project in phases, starting with high-priority areas, and monitor the process for quality.
4. **Maintenance and monitoring:** Establish a maintenance routine for watering, pruning, and inspections. Regularly assess the health of the plants and their cooling effectiveness.
5. **Evaluation and adaptation:** Assess the impact of the green infrastructure on cooling and gather feedback from users. Adjust based on results to improve performance and sustainability.

## BENEFITS

| | |
|---|---|
| PEOPLE (HEALTH AND EQUITY) | • Reduces surface and ambient temperatures.<br>• Lowers risk of heat-related illnesses.<br>• Enhances mental well-being and encourages outdoor activities. |
| ECONOMY (PRODUCTIVITY AND LIVELIHOODS) | • Creates job opportunities in installation, maintenance, and urban farming.<br>• Improves the attractiveness of cities and buildings, increasing property value. |
| INFRASTRUCTURE | • Extends the lifespan of roofing materials by protecting them from extreme temperatures and ultraviolet radiation.<br>• Mitigates flood risk by absorbing rainwater and reducing runoff. |
| ENVIRONMENT | • Reduces the UHIE.<br>• Enhances biodiversity through the provision of habitats for plant and animal species. |

CASE STUDY

### Green Building Initiative in Quezon City, Philippines

Quezon City has implemented a green building Initiative to combat the UHIE. This initiative encourages the use of green walls and rooftops to reduce heat accumulation caused by urban canyons, building materials, and lack of evaporation surfaces. Ordinance No. 2399, signed by Mayor Herbert Bautista, introduced a rating system with tax incentives for sustainable building practices. This system applies to most municipal and commercial buildings, promoting construction waste management, material reuse, and energy and water efficiency. Depending on the points achieved in the rating system, buildings can receive up to a 25 percent reduction in real property taxes, further incentivizing green construction and maintenance practices (INQUIRER.NET, 2015).

***Resources***

- The "Urban Heat in South Asia" report developed by the World Bank provides more detail about this solution in the South Asia context.
- The "Primer for Cooling Cities: Reducing Excessive Urban Heat" developed by IBRD and The World Bank provides further context for this solution, whilst discussing the cost-effectiveness of solutions with costs outlined.
- The "Beating the Heat" Handbook developed by the Cool Coalition introduces more details and provides relevant diagrams for this solution.
- The "Cooling Cities, Slowing Climate Change and Enhancing Equity" report developed by the Abell Foundation discusses further implications of this solution.

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# *Integration of water features within buildings*

## SCALE

Site and household

## TYPE OF ACTION

Infrastructure intervention (gray and blue)

## EASE OF IMPLEMENTATION

Medium

## LEVEL OF EVIDENCE

Pilot project

## SUITABILITY

### City Context

- Buildings in high-density urban areas where outdoor cooling spaces are limited.
- Commercial, residential, and mixed-use developments to enhance thermal comfort.

### Climate Context

- Hot and arid regions where evaporative cooling can reduce indoor temperatures.
- Humid climates where strategically placed water features improve air circulation. However, their design should limit still water to avoid environments for mosquito breeding.
- Areas with seasonal heatwaves, providing passive cooling without high energy use.

### User Context

- Led by architects and developers incorporating water-efficient cooling designs.
- Supported by city governments through green building incentives and regulations. In addition, city governments can incorporate such water features into the buildings they own or operate.
- Adopted by businesses and homeowners to enhance indoor comfort and sustainability.

## DESCRIPTION

Incorporating water features into buildings can significantly mitigate urban heat by leveraging the evaporative cooling effects of water. Features, such as indoor or rooftop ponds, cascading waterfalls, fountains, and misting systems create localized cooling through evaporation. As water evaporates, it absorbs heat from the surrounding air, lowering ambient temperatures within and around the building. This effect not only improves thermal comfort for occupants but also reduces reliance on energy-intensive cooling systems like air conditioning, contributing to energy efficiency and lower GHG emissions.

Water features also enhance the microclimate of buildings by increasing humidity levels and reducing heat buildup on hard surfaces. When strategically placed, such as near entrances, courtyards, or rooftops, they help cool down areas exposed to direct sunlight. Features like reflective pools or shaded water bodies can reduce heat absorption on building surfaces, especially in hot climates. These cooling benefits are particularly valuable in densely populated urban areas, where heat islands exacerbate the effects of rising temperatures.

In addition to their cooling properties, water features in buildings provide aesthetic and psychological benefits that contribute to overall wellbeing. They create soothing environments, reduce stress, and improve air quality by trapping dust and pollutants. In climates prone to extreme heat, especially in the Global South, incorporating water features into building designs offers an effective and sustainable solution for mitigating urban heat while enhancing the quality of the space for residents and visitors.

An indoor water feature like a pool/pond
**Source:** Tills 2025, and archdaily 2025.

## IMPLEMENTATION STEPS

1. **Assessment and planning:** Identify buildings that would benefit most from integrating water features, focusing on areas with high heat exposure and vulnerable populations. The solution could target public and government buildings or look to influence the design of private buildings, such as houses and commercial buildings.
2. **Solution design:** Once you have identified the buildings that are most appropriate for integrating water features, undertake a study to understand if this would be technically possible, for example, ensuring the building has a connection to the piped water network or a system of water reuse in place. If there is a lack of these elements, be sure to include them in the design of the water feature.
3. **Pilot projects:** Implement pilot projects in selected areas, such as low-income housing or public buildings, to demonstrate the effectiveness of water features in cooling down the urban space around them. Monitor and evaluate the performance of these projects, measuring temperature reductions and co-benefits.
4. **Regulatory support:** You should also review your local planning and design regulations to evaluate if there are ways in which you can incentivize the incorporation of water features into buildings; this may include mandating them or providing financial incentives.
5. **Monitoring and scale-up:** Establish routine maintenance and monitoring of the benefits of the incorporated water features. Based on the results, look to adapt the solution or scale up the initiative to target more buildings across your city.

## BENEFITS

| | |
|---|---|
| **PEOPLE (HEALTH AND EQUITY)** | • Water features can provide cooling effects through evaporative cooling and therefore can lead to improved thermal comfort in and around buildings.<br>• The presence of water close to buildings can also play a role in improving mental health. |
| **ECONOMY (PRODUCTIVITY AND LIVELIHOODS)** | • Incorporation of water features in buildings could have a positive effect in drawing in crowds and revenue if commercial activities exist as part of the building. |
| **INFRASTRUCTURE** | • Addition of water features in buildings could be tied to a wider program to upgrade or rehabilitate the building's piped water infrastructure. |
| **ENVIRONMENT** | • Depending on the design of the water feature, there may be opportunities to improve biodiversity. |

SECTION 3

# Respond to Heatwaves

22

# Protective interventions during heatwaves

## SCALE

City

## TYPE OF ACTION

Governance, policy and plans

Capacity development and behavior change

## EASE OF IMPLEMENTATION

Medium

## LEVEL OF EVIDENCE

Established practices

## SUITABILITY

### City Context

- Areas with high population density, especially where vulnerable groups reside.
- Cities with a history of recurring heatwaves, focusing on mitigation strategies.
- Informal settlements with limited infrastructure and resources to adapt.

### Climate Context

- Regions experiencing prolonged extreme heat events, especially with rising temperatures due to climate change.
- Areas prone to UHIE, where built-up areas exacerbate temperatures.
- Areas that lack adequate natural cooling elements (vegetation, water bodies).

### User Context

- Best implemented at the city level, with enforcement through local policies and ordinances.
- Collaboration between city governments, local communities, and businesses to ensure effective monitoring and compliance.
- Encourages adaptive behavior through public awareness campaigns and community-driven HAPs.

## DESCRIPTION

Implementation of protective interventions during heatwaves can effectively mitigate the adverse impacts of urban heat on public health and productivity. For example, by limiting outdoor work during the hottest parts of the day, particularly for labor-intensive sectors such as construction, agriculture, and delivery services, these measures reduce the risk of heat-related illnesses, including heat exhaustion and heatstroke. Shifting work to cooler hours, such as early mornings or late evenings, not only protects workers but also minimizes strain on healthcare systems during extreme heat events. Other examples of such measures could include limiting school hours to cooler periods of the day, complete closure of schools and/or protecting children from exposure to direct sunlight during breaks, encouraging people to stay indoors and in cool places, or altering transport network timetables to limit damage to infrastructure and vehicles.

These interventions also indirectly contribute to mitigating urban heat by reducing energy demand during peak hours. For example, limiting activity during high temperatures periods can decrease reliance on cooling systems, reducing the overall energy load on urban infrastructure. Additionally, decreased vehicle and machinery usage during heatwaves lowers waste heat emissions, a significant contributor to the UHIE, thereby helping to lower ambient temperatures in densely populated areas.

Furthermore, such policies encourage broader societal adaptation to extreme heat by fostering awareness of heat risks and promoting behavioral changes. Integration of protective interventions into public education campaigns can ensure communities understand the importance of heat preparedness, including hydration, wearing appropriate clothing, and recognizing heat stress symptoms. These coordinated efforts make cities more resilient to rising temperatures, particularly in the Global South, where vulnerable populations are often disproportionately affected by heatwaves due to high exposure and limited capacity and resources.

## IMPLEMENTATION STEPS

1. **Review existing policy and regulation:** Undertake a review of your national and local policy and regulations to understand if any such interventions have already been used or ways in which you can develop regulations

to support such measures. This could include reviewing your workers' rights policies and any existing heatwave guidance and regulation.

2. **Community and stakeholder engagement:** Undertake comprehensive engagement with the community and stakeholders, in particular, local businesses and public organizations, to understand the challenges they face during heatwaves and determine if heatwave interventions would be beneficial. This can also be used as an opportunity to build relationships and highlight the benefits of acting against heatwaves.
3. **Develop heatwave restrictions:** Once you have determined the best approach and received stakeholder support, develop your heatwave interventions.
4. **Run a pilot or test scenario:** Use the heatwave interventions to run a test scenario before the heatwave season. In doing so, you can ascertain if the interventions will be beneficial and if any alternations are needed before an actual heatwave occurs in your city.
5. **Adopt and scale up:** Upon successful trial runs, adopt the new heatwave interventions and, as a heatwave approaches your city, communicate these to businesses and residents to raise awareness.

## BENEFITS

| | |
|---|---|
| **PEOPLE (HEALTH AND EQUITY)** | • Reduces people's exposure to urban heat during heatwaves and therefore has the potential to improve health outcomes. |
| **ECONOMY (PRODUCTIVITY AND LIVELIHOODS)** | • Potential to increase productivity because of working during cooler periods. However, there is a need to balance the number of limited working hours so as not to impact economic output. |
| **INFRASTRUCTURE** | • Potential to reduce strain on infrastructure, in particular, energy as well as transport, during heatwaves. |

CASE STUDY

### Paid afternoon break for construction laborers in Delhi, India

In Delhi, India, the government instructed laborers at construction sites to receive a paid break from 12 noon to 3 pm when temperatures reach around 50°C in some areas of the city. The measures were implemented by the Delhi Development Authority and continued until temperatures dropped below 40°C.

Among other measures, the Delhi Development Authority was instructed to ensure construction workers had access to adequate hydration facilities and arrangements were made to provide workers with water and coconut water to prevent dehydration. Moreover, earthen pots of drinking water were placed at bus shelters to enhance evaporative cooling, and treated water was sprayed on roads and around high-rise buildings (Livemint, 2024).

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# *Issuing heat warnings*

## SCALE

City

## TYPE OF ACTION

Capacity development and behavior change

## EASE OF IMPLEMENTATION

Easy

## LEVEL OF EVIDENCE

Pilot project

## SUITABILITY

### City Context

- Can be undertaken by any city, provided there is access to good weather services.
- Uses various available communication channels such as television, radio, and SMS as well as internet-based websites and apps
- Targets the most vulnerable populations such as outdoor workers, people in informal settlements, and children, as well as health service providers
- Requires city authorities to collaborate with weather information services and emergency services.

### Climate Context

- Effective in both warm and temperate climates.
- Highly dependent on the effectiveness and quality of weather services.

### User Context

- Requires a well-established network of weather stations to obtain accurate warnings.
- False alarms reduce the trust and usage of heat warning information.
- Users of heat warnings should be educated about acting on probabilities so that they are not surprised in case a forecast warning does not happen.
- Needs functional radios and television sets and an internet network.
- Telecommunication companies and technology can be leveraged to achieve wider reach.

## DESCRIPTION

Heat warnings are a critical part of protecting cities against extreme heat. Warnings provide information that enables decision-makers and communities to take preventative actions to avoid adverse impacts of heat on the most vulnerable people and services. Heat warnings are often part of comprehensive EWS established at the national or city level (see Solution 1 EWS for further details) led by meteorological or disaster management agencies. This solution also provides more detail on effective communication before the onset of the heatwave.

Dissemination of warnings is part of a multi-stakeholder process with an elaborate coordination mechanism. The warnings are issued by the weather services when the temperature reaches a predefined threshold which is deemed dangerous. These warnings are issued in simple, clear language and passed down through communication channels most accessible to those at risk of heat. The mode of communication for heat warnings varies from traditional SMS, television, and radio to social media, websites, and apps. A good warning will provide a concise description of the hazard including where it will affect, who it will affect, the possible extent of impact, how soon, and what people can do to protect themselves. It is recommended that the cities incorporate the Common Alerting Protocol, which is broadly recognized internationally as the key standard for societies to achieve all-hazards, all-media public alerting for emergencies.

In addition to direct-to-public alerts, heat EWS must trigger institutional actions to protect the most vulnerable. This second component of the warning system relies on pre-agreed protocols across key sectors, including health, education, social protection, and urban services, to activate heat response plans. For example, frontline health workers, municipal staff, or NGO outreach teams may be instructed to increase visits to at-risk populations, open cooling centers, or adjust work schedules and school hours. These sector-specific triggers ensure that protective actions reach those who may not access or act on public alerts alone, such as the elderly, people with disabilities, and the unhoused. Together, these coordinated responses reinforce the effectiveness of the EWS by combining public awareness with proactive institutional engagement.

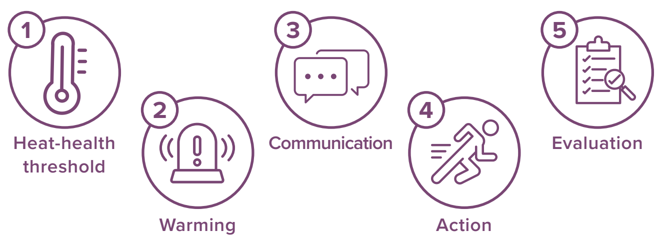


**Figure 3-6.** Key steps in issuing heat warnings
**Source:** Climate Centre, 2019.

## IMPLEMENTATION STEPS

1. **Stakeholders mapping and coordination:** Heat warnings require multiple stakeholders and thus the first step is to identify key stakeholders and get buy-in from the respective local government or municipality representatives. Where necessary, the local authority has a formal agreement with weather services to receive regular heat alerts. Establish an effective coordination mechanism with relevant stakeholders including emergency services.
2. **Assessment and planning:** Identify available heat/temperature forecasts for your city. Understand how often the forecasts are issued. Understand the level of accuracy of the forecasts and the effectiveness of the dissemination channels used to reach the most vulnerable.
3. **Determine the heat threshold:** The threshold helps to understand 'when to act'. It should be defined based on an understanding of local weather and its impact on health. Stakeholders can choose to use color codes, such as yellow, orange, and red alerts (see EWS/Solution 1) which correspond to moderate, high, and extreme heat, to communicate the danger levels.
4. **Identify heat hotspots:** Agree on the most vulnerable populations and most vulnerable areas that should be given extra attention when sending warnings.
5. **Collaborate:** Work together with the national weather services to understand the accuracy and coverage of heat warnings issued. Pay special attention to the possibility of underestimating heat in informal settlements. The emergency services are also important and often responsible for announcing extreme heat if it becomes a disaster. Using the input of medical professionals, develop and share sample public health advisory messages that can be disseminated when certain thresholds are crossed.
6. **Improve dissemination:** Ensure that heat warnings are distributed through channels that are accessible to the most vulnerable people and acceptable in the local cultural context. Use multiple communication channels and multiple formats (audio-visuals) where literacy levels differ a lot.
7. **Evaluation and learning:** Work with national weather services to obtain feedback from users about the effectiveness of the warnings following the end of the heating season.

## BENEFITS

| | |
|---|---|
| PEOPLE (HEALTH AND EQUITY) | • Lowers risk of heat-related illnesses among the most vulnerable.<br>• Encourages collaboration among heat warning providers, NGOs, and community groups.<br>• Better preparedness and response to extreme heat.<br>• Reduces mortality and morbidity. |
| ECONOMY (PRODUCTIVITY AND LIVELIHOODS) | • Saves on hospital bills.<br>• Communicates with employers and communities to adjust working hours to facilitate better productivity. |
| INFRASTRUCTURE | Potential to implement mitigation measures relating to infrastructure, e.g., changing timetables on transport networks to reduce vehicle and equipment exposure to heat. |
| ENVIRONMENT | Delivers time to provide animals with appropriate shelter and resources to cope with heat. |

CASE STUDY

### Heatwave alert portal, Bangladesh

The Heatwave Warning Portal in Bangladesh, launched by Regional Integrated Multi-Hazard Early Warning System and Save the Children in 2024, addresses the growing threat of heatwaves exacerbated by climate change. This portal provides advanced heatwave forecasts up to five days in advance, enabling the Bangladesh Meteorological Department and Dhaka North City Corporation to issue timely alerts. By offering detailed forecasts down to the ward and upazila levels, the portal empowers public to take necessary precautions and emphasizes the need for a city-specific HAP. The initiative also includes awareness campaigns and resource distribution, such as cooling shelters and umbrellas, to enhance community resilience. The impact of the Heatwave Warning Portal has been significant, improving Bangladesh Meteorological Department's ability to issue timely alerts and equipping communities with the knowledge and tools to better withstand heatwaves. Collaboration among government bodies, NGOs, and international organizations highlights the importance of joint efforts in addressing climate-related challenges. This initiative not only safeguards public health and productivity but also represents a proactive approach to mitigating adverse effects of climate change in Bangladesh (RIMES. 2024).

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# *Setting up heat relief/ cooling centers*

**SCALE**

Neighbourhood and community

**TYPE OF ACTION**

Response and health risk reduction

**EASE OF IMPLEMENTATION**

Medium

**LEVEL OF EVIDENCE**

Established practices

**SUITABILITY**

**City Context**

This type of program is best suited to densely populated areas of the city where daytime pedestrian traffic is high and where the availability of air conditioning is limited in low-income neighborhoods.

**Climate Context**

Consider the climate of your city when designating and creating cooling centers. For example, this could include ensuring air-tight windows and doors to reduce entry of high moisture and humidity.

**User Context**

Such programs can be developed by the city/ local government in partnership with local NGOs and CBOs in a variety of public buildings and institutions.

## DESCRIPTION

At the individual level, air conditioning provides the most obvious protection against the adverse health impacts of extreme heat, but access to air-conditioned spaces is limited particularly in low- and middle-income countries and countries in the northern latitudes.

In recent years, heat relief/cooling centers have been increasingly used in response to heatwaves affecting cities. They provide safe, air-conditioned spaces for vulnerable populations, including outdoor workers, people without shelter, the elderly, low-income families, and those with pre-existing health conditions. Cooling centers reduce the burden on medical facilities and staff who face a surge of patients experiencing heat exhaustion or stroke. Cities can incorporate water supply and public education programs about heat safety and other wellbeing measures into the cooling centers programs which can strengthen community resilience against future heat events. By offering a chance to cool down and gather energy, cooling centers help maintain the productivity of workers during extreme heat events.

## IMPLEMENTATION STEPS

1. **Assessment and planning:** Identify heat hotspots in the city through analysis of meteorological data and conduct heat impact and risk perception studies to understand the exposure and vulnerabilities of individuals and communities.
2. **Material selection:** Choose building materials with high insulation and reflectivity to help keep indoor temperatures low and reduce electricity usage for air conditioning.
3. **Design and engineering:** Strategically map the locations where the cooling centers should be located to maximize usage. Rearrange public transportation routes to increase accessibility.
4. **Pilot projects:** Implemented in pilot locations to learn from and improve before scaling up across the city.
5. **Stakeholder engagement:** Engage with local communities, businesses, and government agencies to encourage the opening of their facilities for public usage during heatwaves.
6. **Implementation and monitoring:** Roll out the operation of centers in multiple locations. Establish monitoring mechanisms to track progress and evaluate performance over time.

7. **Evaluation and adaptation:** Regularly evaluate the program's impact on the health and productivity of individuals. Adjust strategies and interventions as needed based on feedback and evolving environmental conditions.

## BENEFITS

| | |
|---|---|
| **PEOPLE (HEALTH AND EQUITY)** | • Mitigates adverse health impacts of heat by cooling down body temperatures. |
| **ECONOMY (PRODUCTIVITY AND LIVELIHOODS)** | • Helps maintain the productivity of workers during extreme heat events. |
| **INFRASTRUCTURE** | • Reduces the demand for electricity by sharing air-conditioned spaces. |

CASE STUDY

## Cooling centers in Phoenix, Arizona, USA

Phoenix, Arizona, known for its scorching summers, is among the cities in the United States most affected by extreme heat.  The City of Phoenix Heat Response Plan defines May through September as operational season for heat response. However, in October 2024, the city recorded it's first 110 degree Fahrenheit (°F), which resulted in addition of October data to support planning. The year 2024 also recorded new all-time highs of around 70 days reaching 110°F and 113 days reaching 100°F, making heat a significant public health concern. Recognizing the need for a robust response to mitigate the impacts of extreme heat, the City of Phoenix implemented a network of cooling centers during heatwaves along with hydration stations where free bottled water is available. The primary objectives of establishing the cooling centers were to:

1. **Reduce heat-related illnesses:** Provide safe, air-conditioned spaces for vulnerable populations, including the elderly, outdoor workers, low-income families, and those with pre-existing health conditions.
2. **Increase community awareness:** Educate residents about heat safety and the availability of cooling resources.
3. **Enhance emergency response:** Strengthen the city's infrastructure to respond to extreme heat events effectively.

Phoenix identified key locations for cooling centers, like community centers, libraries, schools, and recreation facilities. These sites were strategically chosen based on their accessibility, existing air conditioning systems, and proximity to neighborhoods with high rates of heat-related hospitalizations. The cooling centers recorded over 15,000 visits during heat events in 2021, indicating a strong demand for these services.

***Resources***

- The City of Phoenix case study website here.
- "The role of cooling centers in protecting vulnerable individuals from extreme heat" for further information on heat relief/cooling centers.

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# Distribution of drinking water

## SCALE

Neighbourhood and community

## TYPE OF ACTION

Capacity development and behavior change

## EASE OF IMPLEMENTATION

Easy

## LEVEL OF EVIDENCE

Pilot project

## SUITABILITY

### City Context

- This low-cost action can be implemented in a wide area of the city but should target hotspots and areas lacking accessibility to potable water networks.
- Water distribution points are temporary but help to provide hydration for those most in need including outdoor workers, vendors, and people in informal settlements.

### Climate Context

Any climate context.

### User Context

- It is mostly critical in low-income settings where most residents depend on daily wages for survival and thus can easily do without water because they cannot afford it.
- Caution should be taken to ensure that the water distributed is free from contamination to prevent unintended negative impacts on health.
- Foster a sense of collective responsibility by involving local groups.

## DESCRIPTION

Staying hydrated saves lives during heatwaves. Distribution of drinking water is especially important in low-income communities whose homes and livelihoods disproportionately expose them to heat impacts.

Setting up temporary water distribution points in public areas with high footfall such as markets, bus stops, and informal settlements provides quick access to the most vulnerable population. Choose a distribution site guided by high density and proximity to those that are highly exposed and vulnerable to extreme heat. Religious premises, schools, and public spaces provide ample space for temporal water distribution points. The distribution points should have an adequate supply of clean and safe water. Mobile freshwater tank trucks could be used to provide water in hard-to-reach areas or where supplies could be limited, such as informal settlements. You can work with private companies, local shops, and community groups to offer bottled water as part of social good. In other cases, NGOs and local governments provide water tanks. In case water tanks are used, undertake quality checks to ensure the water distributed is safe for human consumption.

For wider reach, water distribution should be accompanied by an awareness campaign informing the public about the location of water distribution points.

## IMPLEMENTATION STEPS

1. **Identify and assign responsibilities:** Set up a team with the shared interest of reducing the impact of heat on the lives and livelihoods.
2. **Agree on the mode of operation:** Choose from among portable water or tank water, stationary or mobile water distribution. Implement an awareness campaign so that people know where to go to access water.
3. **Undertake a site selection exercise:** Locate the place with greater exposure and vulnerability to extreme heat. Secure permission to use the place temporarily for water distribution.
4. **Identify available suppliers:** of portable water or water tracking services. Analyze the water quality for human consumption.
5. **Collaborate:** Establish a memorandum of understanding with preselected suppliers.

6. **Distribution:** Work with volunteers and local government officials to implement distribution. Local government officials will help to keep order especially if there is panic due to the severity of the event or low supplies of potable water.

## BENEFITS

| | |
|---|---|
| **PEOPLE (HEALTH AND EQUITY)** | • Improve access to hydration for most vulnerable populations. |
| **ECONOMY (PRODUCTIVITY AND LIVELIHOODS)** | • Outdoor workers can continue undertaking productive work and stay hydrated. |
| **INFRASTRUCTURE** | • Offers an opportunity to identify opportunities to improve the piped water network to underserviced areas. |

CASE STUDY

### Public drinking water stations in Ahmedabad, India

The city of Ahmedabad developed its HAP in 2013 as a step forward towards building heat resilience. One of the identified actions was the establishment of water distribution points to ensure the most vulnerable remained hydrated.

The Ahmedabad Municipal Corporation set up public drinking water stations locally known as "Piyau" in high-traffic areas such as bus stops, markets, and informal settlements. Here, the public had access to free water during periods of extreme heat. In addition, mobile water tankers were deployed to make water accessible to those in slums who would be constrained by distance and movement in the scorching sun.

Distribution of water is conducted in collaboration with religious leaders and local organizations who help with mobilization and creating awareness as well as providing spaces for water distribution. The Ahmedabad experience shows the practicality and viability of distributing drinking water to reduce the impact of extreme heat on the most vulnerable populations.

**Source: NRDC, 2019.**

# *Glossary of Terms*

A glossary of key terms used through this report and references material relating to heat risk and resilience is provided.

| KEY TERM | DEFINITION |
|---|---|
| **Adaptive capacity** | "The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (IPCC SRCCL 2019). |
| **Albedo** | Solar reflectance, or albedo, is the percentage of solar energy reflected by a surface. Solar reflectance is correlated with a material's color. Darker surfaces tend to have lower solar reflectance values than lighter surfaces. |
| **Anthropogenic heat** | "Heat released to the atmosphere as a result of human activities, often involving combustion of fuels. Sources include industrial plants, space heating and cooling, human metabolism, and vehicle exhausts" (Glossary of Meteorology, AMS). |
| **Chronic heat exposure** | The prolonged or repeated experience of increased temperatures over an extended period. |
| **Climate Change** | "The change of climate due directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods" (PAS 2022). |
| **Early Warning System** | "The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare to act promptly and appropriately to reduce the possibility of harm or loss" (IPCC AR5 WGII 2014, UNISDR 2009). |
| **Extreme heat** | "Temperatures that are much hotter and/or more humid than average for a particular time and place" (PAS 2022). |

| KEY TERM | DEFINITION |
|---|---|
| **Extreme heat event** | "A series of days that are hotter and/or more humid than average for a particular time and place. Also referred to as heatwaves" (PAS 2022). |
| **Heat equality** | "The development of practices and policies to mitigate and manage heat with a focus on reducing the inequitable distribution of risk across different groups within the same community" (PAS 2022). |
| **Heat flux** | The amount of heat transferred per unit area per unit time to or from a surface. |
| **Heat index** | "A measure of how hot the air feels to the human body. The index is mainly based on surface air temperature and relative humidity and thus reflects the combined effect of high temperature and humidity on human physiology and provides a relative indication of potential health risks" (IPCC WGII 2022). |
| **Heat management** | "Preparation and response strategies for extreme heat events, often within the domain of emergency management or public health" (PAS 2022). |
| **Heat mitigation** | "Design and planning strategies to reduce the contribution of the built environment to urban heat" (PAS 2022). |
| **Heat resilience** | "Proactively managing and mitigating urban heat across the many systems and sectors it affects" (PAS 2022). |
| **Heat risk** | The potential for harm or adverse effects on people, infrastructure, the economy, and the environment from heat exposure. |
| **Heat stress** | "A range of conditions in, for example, terrestrial or aquatic organisms when the body absorbs excess heat during overexposure to high air or water temperatures or thermal radiation. In aquatic water-breathing animals, hypoxia and acidification can exacerbate vulnerability to heat. Heat stress in mammals (including humans) and birds, both in air, is exacerbated by a detrimental combination of ambient heat, high humidity, and low wind speed, causing the regulation of body temperature to fail" (IPCC WGII 2022). |

| KEY TERM | DEFINITION |
|---|---|
| **Heat Vulnerability** | "Heat vulnerability is the degree to which the system and its components are likely to suffer harm due to exposure to heat hazards" (Turner 2003). |
| **Heat-related illness** | "Heat-related illnesses include heat stroke, heat exhaustion, rhabdomyolysis, heat syncope, heat cramps, and heat rash" (CDC) |
| **Heatwave** | "A period of abnormally hot weather, often defined with reference to a relative temperature threshold, lasting from two days to months. Heatwaves and warm spells have various and, in some cases, overlapping definitions" (IPCC WGII 2022). |
| **Heatwaves** | "A period of abnormally hot weather, heatwaves and warm spells have various and, in some cases, overlapping definitions" (IPCC SRCCL 2019). |
| **Informal settlement** | "A term given to settlement or residential areas that by at least one criterion fall outside official rules and regulations." (IPCC AR5 WGII 2014). |
| **Intersectional vulnerability** | The impact of heat on people varies according to their physical and socioeconomic characteristics. The combination of these exacerbates vulnerability and is referred to as intersectional vulnerability. |
| **Microclimate** | "Local climate at or near the Earth's surface" (IPCC AR5 WGII 2014). |
| **Nature-based solutions** | "Nature-based solutions 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 2016). |
| **Passive cooling** | "Passive cooling refers to a set of design principles and techniques that utilize natural processes to help maintain comfortable indoor temperatures without the need for active, energy consuming, mechanical systems, such as electrically powered air conditioning units, thereby reducing environmental impacts and economic costs." (Clean Cooling Network). |

| KEY TERM | DEFINITION |
|---|---|
| **Relative humidity** | "The relative humidity specifies the ratio of actual water vapor pressure to that at saturation with respect to liquid water or ice at the same temperature" (IPCC AR5 WGI 2013). |
| **Remote sensing** | "The process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance (typically from satellite or aircraft)" (USGS). |
| **Thermal comfort** | "How heat is perceived and experienced by the human body. Thermal comfort is influenced by ambient air temperature, air speed, humidity, radiant temperature, clothing insulation, and the body's metabolic rate" (PAS 2022). |
| **Thermal inequality** | "An unequal distribution of heat in urban areas or neighborhoods within them, which causes disproportionate impacts to people living in those communities. Unequal threat of heat stress in urban environments is often correlated with differences in demographics, including racial and ethnic background, income, education level, and age" (Chen Peng 2024). |
| **Urban heat** | "Hotter conditions in urban areas caused by a combination of the climate, characteristics of the built environment, and waste heat" (PAS 2022). |
| **Urban heat island** | "The temperature differences between an urban area, which is typically hotter due to the built environment and waste heat, and surrounding rural and natural areas. Temperatures can also vary substantially within the same community" (PAS 2022). |
| **Wet-bulb temperature** | An index of heat stress measure that indicates the human cooling capacity through sweating. |

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