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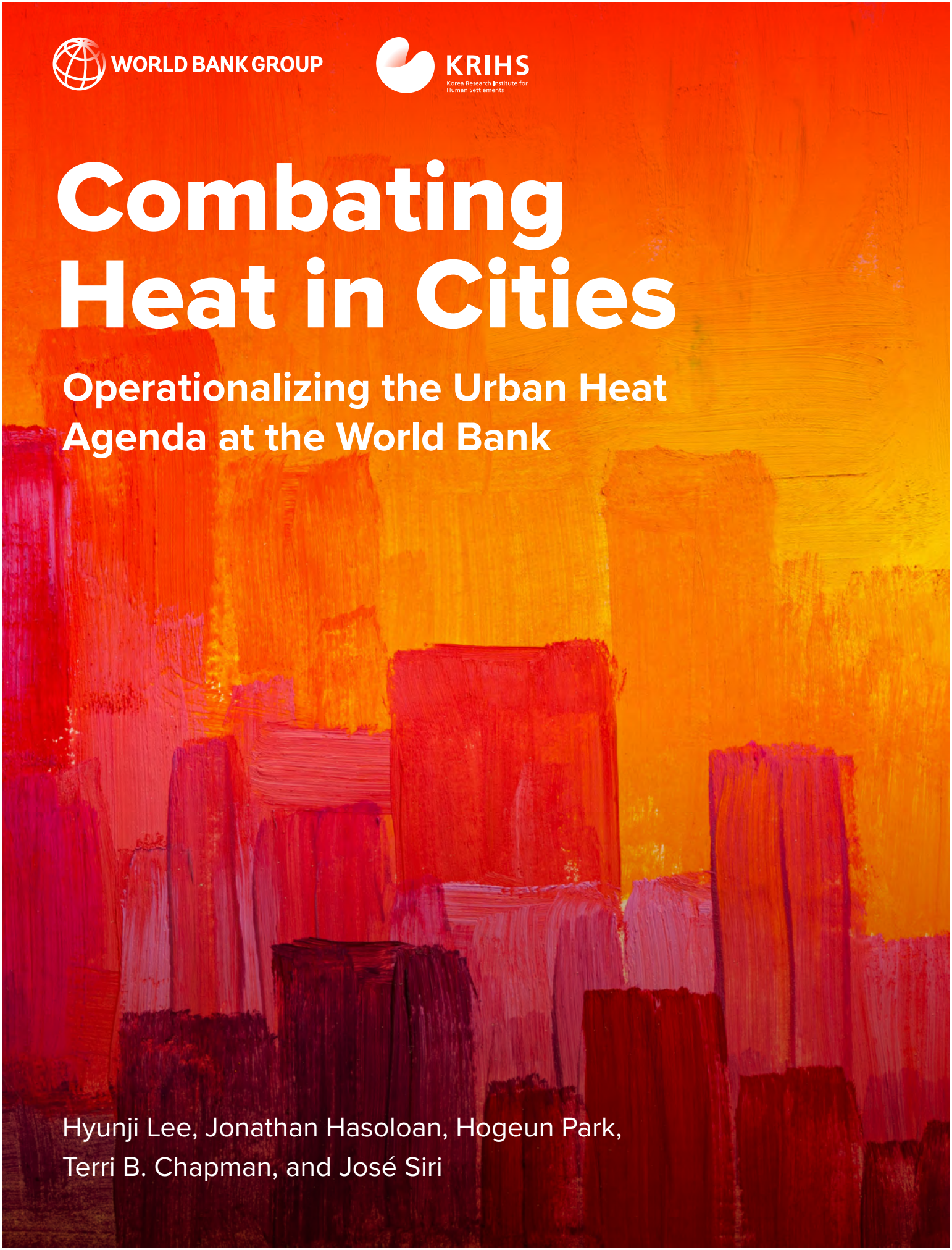
Combating Heat in Cities

Operationalizing the Urban Heat Agenda at the World Bank



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Acknowledgement

"Combating Heat in Cities: Operationalizing the Urban Heat Agenda at the World Bank" is a product of a joint study between the World Bank's Global Practice for Urban, Disaster Risk Management, Resilience and Land (GPURL) and the Korea Research Institute for Human Settlements (KRIHS). The team consists of Hyunji Lee (Urban Development Specialist), Jonathan Hasoloan (Urban Consultant), Hogeun Park (Urban Specialist), Terri Chapman (External Consultant), and Jose Siri (Senior Health Consultant). The team thanks Anas Mohammad (IT Analyst) and Shrutha Sivakumar (Consultant), who provided support in data collection and analysis for the portfolio review.

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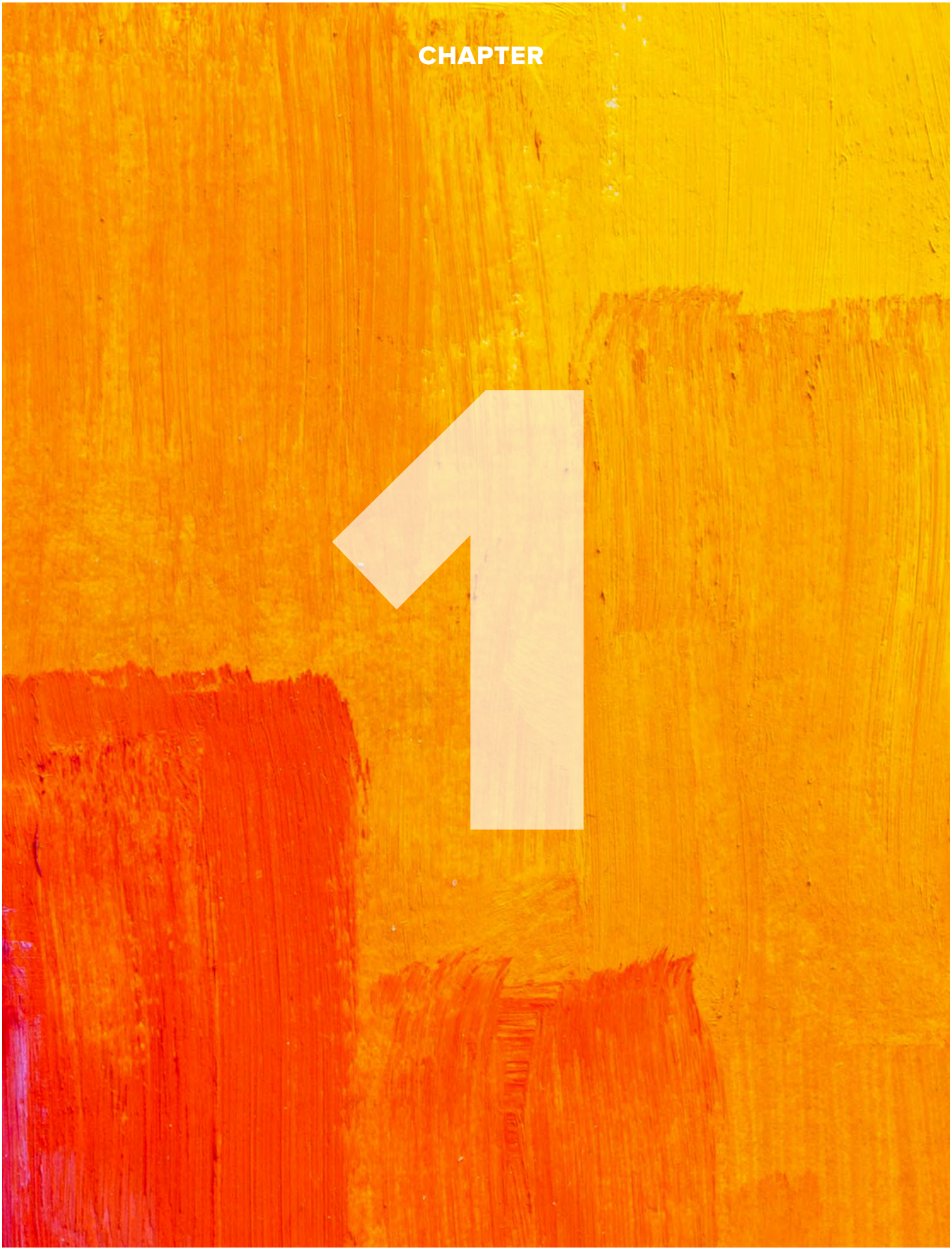
Purpose and Audience

This report stems from growing concern about the threat of extreme heat in urban settings and its adverse impacts on health. The team made use of the TIP—that is, the *targeted*, *integrated*, and *prepared*—framework, introduced in the recent *Healthy Cities* report (Lee et al. 2023), to help World Bank task teams explore pathways toward urban heat investments. This study gathered city responses and investigated existing World Bank initiatives to gain an understanding of what had already been done and the potential for future action. The main part of this report reviews the GPURL portfolio from 2012 to 2022, illustrating a spectrum of relevant heat interventions. Recommendations built on these findings highlight opportunities to operationalize urban heat in World Bank investments.


CHAPTER
1

Why It Matters?

Extreme heat refers to higher temperatures relative to the normal conditions or average for a particular geographical area, while a heatwave—or extreme heat event—refers to a prolonged period of extreme heat. The standards that define extreme temperature levels and the period of a heatwave vary across different environments. The elevated temperatures of heatwaves are exacerbated by elevated humidity, which hinders the human body's ability to cool off by sweating.

The incidence of extreme heat events has increased dramatically as a result of global warming caused by ongoing emissions of greenhouse gases (GHGs) that trap heat and warm the planet (figure 1.1). Already, 30 percent of the global population is exposed to potentially lethal temperatures for 20 days a year; this is estimated to increase to a staggering 48 percent by the close of the century, even assuming substantial efforts are undertaken to curtail greenhouse gas emissions (Mora et al. 2017).

Today, 1.7 billion people are exposed to extreme heat in cities (Tuholske et al. 2021). The urban built environment—characterized by impermeable and nonreflective surfaces, designs that ignore airflow, and, often, a lack of vegetation and water features—creates heat reservoirs, trapping heat and raising local temperatures relative to surrounding areas. This phenomenon, known as the urban heat island (UHI) effect (Roberts et al. 2023), is further exacerbated by the extensive use of air conditioning and motor vehicles, which also raise temperatures (Deuskar 2022). The UHI effect can cause temperatures in cities to be as much as 10°C higher than in nearby areas, significantly amplifying heat-related risks for urban dwellers (Shandas et al. 2019).

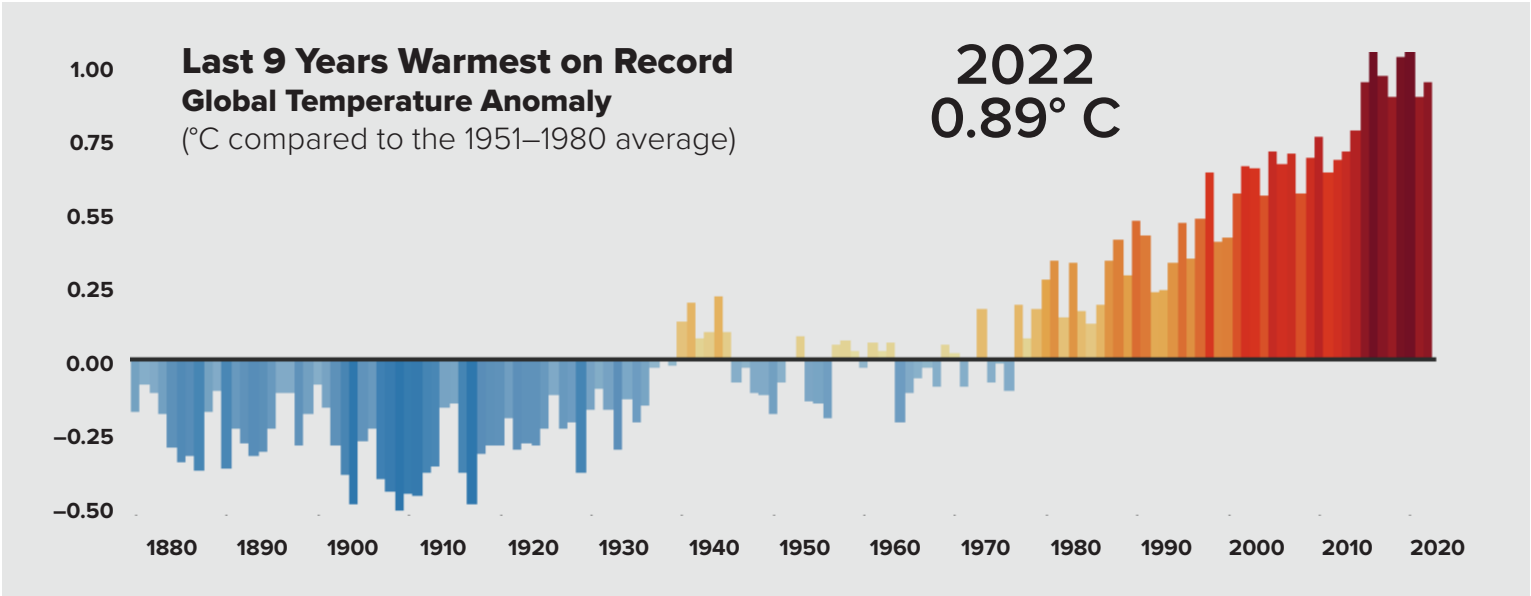
Exposure to extreme heat presents a wide range of challenges for public health, labor productivity, economic growth, and other vital societal priorities. Extreme heat is associated with increased rates of hospitalization and emergency room visits, accidents (Park, Pankratz, and Behrer 2021; Wu, Zaitchik, and Gohlke 2018), violence, risk of cardiorespiratory and other diseases, mental health challenges (Burke et al. 2018), and health care costs. Between 2000 and 2019, heat was responsible for approximately 489,000 excess deaths each year globally (Zhao et al. 2021)—an estimate that may be too low because of contextual differences in reporting standards, definitions, and impacts that complicate the estimation of overall mortality and morbidity from extreme heat. Additionally, studies show that extreme heat hurts the economy. By 2050, UHI effects could cause cities to lose an average of 1.4–1.7 percent and as much as 10 percent of their gross domestic

products (Estrada, Botzen, and Tol 2017).[1] One mechanism through which such losses occur is declines in productivity. The International Labor Organization estimates that extreme heat will lead work hours to diminish by 2 percent between 2019 and 2026 (ILO 2019b).

In many places, extreme urban heat perpetuates inequality. Variation in the characteristics of the built environment within cities, often corresponding with socioeconomic divisions, leaves some areas (for example, informal settlements) more exposed to the effects of rising temperatures than others (Roberts et al. 2023). Moreover, poor and vulnerable groups tend to have fewer resources and less capacity to adapt, leading to disproportionate impacts in these populations.

Overall, extreme heat makes cities less livable, inclusive, and competitive (Roberts et al. 2023). And, while rising temperatures caused by climate change are a global issue that requires interventions across governments and sectors, their local causes and effects in cities can be addressed, in part, by the cities themselves (Roberts et al. 2023). This brief report will explore how the World Bank can strengthen its existing initiatives and provide further support to cities battling the effects of extreme urban heat.

Figure 1.1. Global Near-Ground Atmospheric Temperature since 1880



Source: NASA Earth Observatory 2022.

1 The sample for this study comprises 1,692 of the largest cities in the world for the period 1950–2015.

Elen Marlen / Shutterstock


CHAPTER
2

City Responses

Cities are increasingly aware of the threat of extreme heat and are well positioned to respond and adapt to heatwaves, including by mitigating the UHI effect. The World Bank's recent *Healthy Cities* report (Lee et al. 2023) offers a practical framework for understanding and approaching the problem of urban heat, focusing on *targeted*, *integrated*, and *prepared* (TIP) actions. In addition, the recent *Unlivable* report (Roberts et al. 2023) outlines a framework for organizing levels of urban heat interventions, including *people*, *places*, and *institutions*. Drawing on these two frameworks, we define an investment menu for addressing urban heat:

- ***Targeted*** *measures:* These interventions and investments are targeted to vulnerable communities. They include, for example, procuring cooling equipment for heat-exposed workers and establishing cooling shelters for the elderly, those with health conditions, and others most at risk from the heat.
- ***Integrated*** *actions:* This group of interventions consists of *place*-based efforts to cool cities, which typically are part of wider urban investments with other development co-benefits. They include heat-sensitive urban planning, construction of energy-efficient buildings, and urban greening projects.
- ***Prepared*** *systems and institutions:* These interventions seek to enhance city preparedness for extreme events. They include raising awareness, strengthening institutional coordination, establishing early warning systems, collecting and assessing data, enhancing monitoring capacity, and establishing response procedures.

The rest of this chapter elaborates on the interventions that cities are currently undertaking in these three areas.

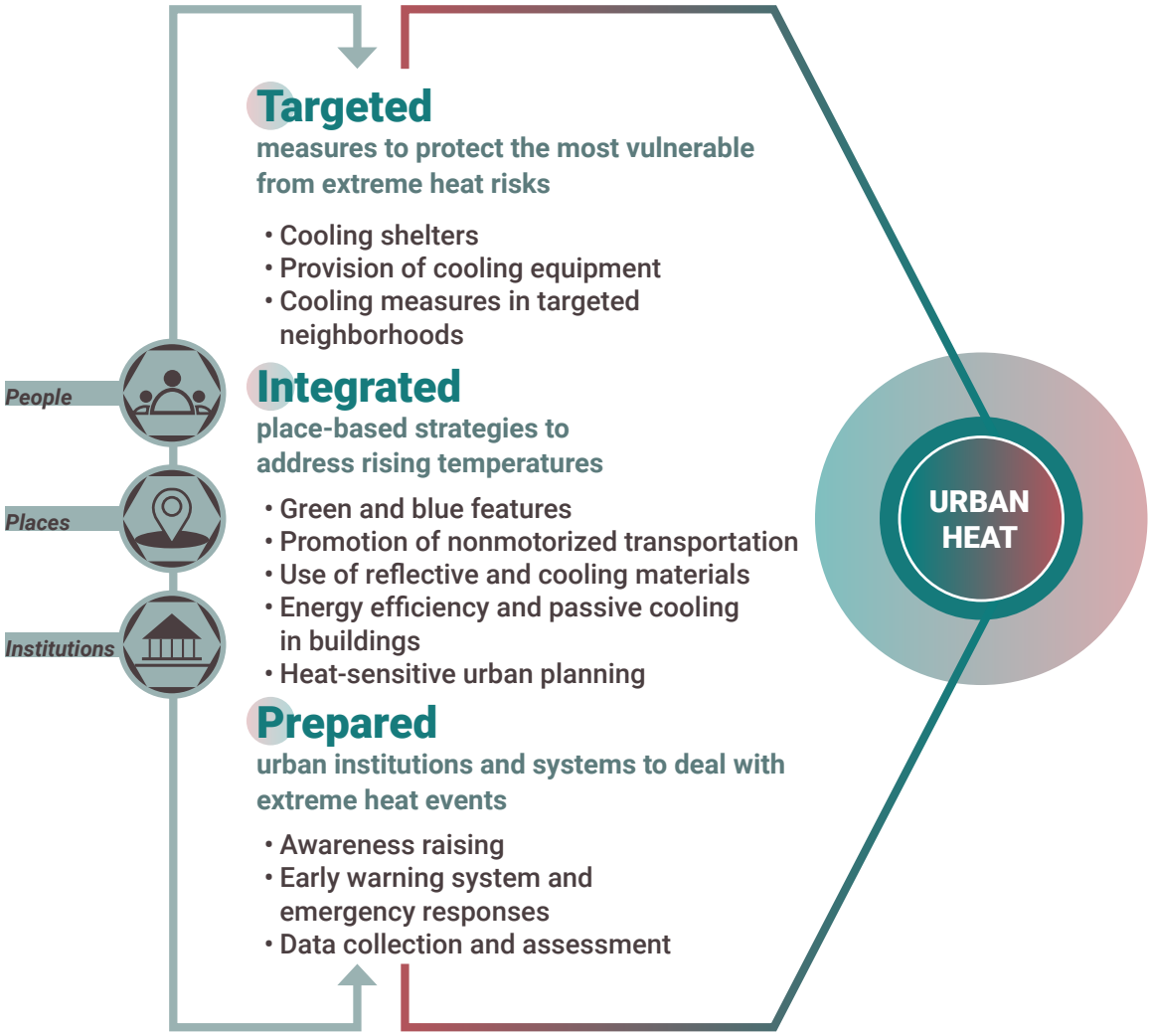
2.1. Targeted Actions

Some people, including outdoor workers, the elderly, people with existing health conditions, and children, among others, are particularly vulnerable to extreme heat. Many cities are, therefore, taking special measures to protect such groups. Among the most common are programs providing free public cooling shelters—for example, Barcelona's Climate Shelters,[2] Paris's Oasis,[3] and London's Cool

2 https://www.barcelona.cat/barcelona-pel-clima/en/barcelona-responds/specific-actions/climate-shelters-network.

3 https://www.paris.fr/pages/les-cours-oasis-7389.

Figure 2.1. A List of Relevant Investment Activities for Addressing Urban Heat



Source: Authors, building upon the frameworks introduced in various World Bank reports, including *Healthy Cities* (Lee et al. 2023), *Primer for Cool Cities* (ESMAP 2020), and *Unlivable* (Roberts et al. 2023).

Spaces.[4] Each offers a network of climate shelters in public buildings, such as schools, libraries, and community centers, reducing risks and enhancing climate resilience (Mavrogianni et al. 2021; Baró et al. 2022).

To protect workers, many cities are also implementing new regulations that minimize occupational exposure to heat and hot environments. Qatar, for instance, has established a midday work ban from mid-June through mid-August

4 https://www.london.gov.uk/programmes-strategies/environment-and-climate-change/climate-change/climate-adaptation/cool-spaces.

to protect outdoor workers from exposure to extreme summer temperatures (ILO 2019a). Several other countries have implemented similar regulations. People's Republic of China, for one, requires employers to pay high-temperature subsidies to their workers if workplace temperatures exceed 35°C outdoors or 33°C indoors (NRDC 2021).

Other measures increasingly deployed to protect people from extreme temperatures include heat-related social assistance and insurance programs. Under Bangladesh's new Early Action Protocol (EAP) for extreme heat, targeted individuals—including outdoor workers and members of other vulnerable populations—will receive multi-purpose cash transfers they can use to mitigate the effects of the heat (IFRC 2023). In Gujarat, India, one of the first social insurance schemes for extreme heat has been taken up by more than 20,000 self-employed female workers and is co-run by a nonprofit organization, a micro-insurance firm, and a trade union, with small insurance payouts triggered automatically when a temperature threshold is met for three consecutive days (Dickie, Jessop, and Patel 2023).

The Republic of Korea has also implemented a comprehensive heat-response package for vulnerable people. Its National Climate Change Adaptation Plan (NCCAP) incorporates a policy mandate to protect health that has translated into strong heat-targeted measures, such as a door-to-door counseling program. More specifically, Korea introduced a comprehensive heatwave response plan in 2005, which is updated annually and has evolved into an interministerial effort led by the Ministry of the Interior and Safety. The 2023 version of the plan minimizes casualties through intensive management of the three most heat-vulnerable groups—outdoor construction workers, elderly single-person households, and farm workers. Measures include weekly calls and personal visits to elderly persons living alone during the heatwave season, and two new measures protect outdoor workers: the temporary suspension of construction activities during severe-heat alerts and the provision of a self-diagnosis checklist for outdoor construction workers to monitor heat-related illness and symptoms. The Ministry of the Interior and Safety also installs temporary cooling solutions, such as cooling fog systems and smart shade canopies, in targeted neighborhoods. Finally, the interministerial collaboration has laid out a list of actions to protect workers at different levels of risk (table 1.1).

In sum, targeted, people-centered interventions, like those highlighted in table 1.1, can reduce exposure to extreme heat, mitigate its effects, and help people cope with and respond to extreme heat events. Such interventions are central to broader urban heat strategies and to safeguarding people's health and welfare against the reality of rising urban temperatures.

Table 1.1. Worker Protection by Risk Level under Korea's Comprehensive Heatwave Response Plan

LEVEL OF RISK	WORKER PROTECTION MEASURES
Caution Perceived temperature 31°C and above	• Pay attention to cleanliness management at workplaces to prevent diseases (food poisoning, typhoid, etc.). • Prepare cool and clean water for sufficient hydration. • Provide shade where workers can rest. • Identify in advance individuals sensitive to heat-related illnesses, such as heatstroke.
Warning Perceived temperature 33°C and above, or heatwave advisory	• Provide an ample supply of cool and clean water. • Provide shade where workers can rest. • Allow a 10-minute break in the shade every hour. • Shorten outdoor work or adjust work hours during the hottest time of day (2:00–5:00 p.m.). • Encourage the use of cooling devices, such as ice vests or ice packs, when engaging in outdoor work. • Allocate additional rest time for individuals sensitive to heat-related illnesses.
Alert Perceived temperature 35°C and above, or heatwave warning	• Provide an ample supply of cool and clean water. • Provide shade where workers can rest. • Allow a 15-minute break in the shade every hour. • Suspend outdoor work during the hottest period (with sufficient rest time if the work is unavoidable). • Encourage the use of cooling devices when engaging in outdoor work. • Restrict outdoor work for individuals sensitive to heat-related illnesses.
Danger Perceived temperature 38°C and above	• Provide an ample supply of cool and clean water. • Provide shade where workers can rest. • Allow breaks of 15 minutes or more in the shade every hour. • Refrain from outdoor work. • Suspend outdoor work during the hottest period, except for emergency and safety management tasks (even in emergencies, provide sufficient rest time). • Encourage the use of cooling devices when engaging in outdoor work. • Restrict outdoor work for individuals sensitive to heat-related illnesses.

Source: NDMI 2021.
Note: Perceived temperature (also known as "feels-like") considers the measured temperature, humidity, and windspeed.

2.2. Integrated Actions

Many cities around the world are already experimenting with integrated, place-based strategies to address rising temperatures. Such measures incorporate heat considerations into urban planning and design and address urban heat at scales ranging from the entire city to neighborhoods, blocks, and individual buildings.

Hong Kong's urban design guidelines, for instance, include strategies to enhance ventilation and shape the wind environment (Hong Kong Planning Department 2015). One study has found that urban morphology significantly affects the flow of air through cities (Ng et al. 2011). At the district level, therefore, the guidelines require consideration of breezeways, street orientation, building height profile, and greening. At the site level, they seek to ensure buildings are designed to respond to the prevailing wind as a function of their form, landscaping, and materials. The city enforces these guidelines by including ventilation assessments in the development permitting process.

Other cities emphasize the benefits of shade in public spaces. Freetown, Sierra Leone, for instance, built awnings over public marketplaces to reduce direct sun exposure, while Singapore built an extensive network of covered walkways to provide shade for pedestrians (Roberts et al. 2023). As discussed below, cities are also planting trees and taking other greening measures to provide natural shade.

Some municipalities focus on building-level changes. In India, for instance, "Cool Roof" programs in Hyderabad and Ahmedabad are painting residential and public roofs with lime-based whitewash or are adding tarp-like coverings or white ceramic tiles to reduce roof surface—and, thus, indoor— temperatures (NRDC 2019). Similarly, the Cool Roofs Indonesia program helps reduce indoor building temperatures by as much as 10°C by installing reflective roof materials (Clean Cooling Collaborative 2022).

Yet other cities have been working to increase green cover. Medellin, Colombia, for example, formed a network of greenery across the city called *corredores verdes* (green corridors) to connect existing green spaces, promote biodiversity, encourage outdoor physical and social activities, reduce UHI effects, filter air pollution, and sequester carbon (C40 Knowledge 2019). In parallel, the Botanical Garden of Medellin trained urban residents to become city gardeners and planting technicians. These residents then helped plant 8,800 trees and palms along thirty corridors covering 65 hectares of the city (ibid.). The green corridors have helped reduce average city temperatures by 2°C and improved air quality, and they serve as natural habitats for wildlife. The city expects the initiative to decrease average temperatures by an additional 4°C to 5°C over the next 28 years, despite climate change–related temperature increases (ibid.).

The Korean government deploys similar integrated measures at both national and subnational levels. The national government through various ministries supports investments in green features, energy efficiency, and building improvements. In Busan, one of Korea's largest cities, the local government established a comprehensive framework for action by enacting an ordinance for the prevention of heatwave damage and mitigation of the UHI phenomenon. Busan's integrated measures include the Cool Roof Project, the Cool Pavement Project, and the Urban Wind Path Forest Project. The last is a W20 billion (approximately US$1.5 million) investment supporting 39 kilometers of wind corridors that bring clean, cool air into the city across twenty-two districts. Each year, Busan has expanded this project to create new green areas. The most recent intervention under the framework introduces five types of green infrastructure suitable for urban spaces: green shelters (point spaces), street tree planting (linear spaces), green surfaces, and underpass and rooftop greening (structures). Notably, Busan has complemented this expansive green investment with a post-planting management system by establishing an ordinance on the creation and management of urban forests.[5]

To summarize, as all of these examples show, cities increasingly are combating urban heat using integrated, place-based approaches. These include, among others, urban planning guidelines to increase green cover and optimize wind corridors, increasing shade cover in public spaces like markets and walkways, implementing building-level initiatives like cool roofs, and increasing greenery and interconnected green spaces.

2.3. Prepared Systems and Institutions

The preparation of institutions and urban systems for extreme heat events will be crucial to limiting their adverse impacts. Several promising activities in Korea, Canada, and elsewhere that foster such preparedness—from forecasting to the creation of action plans to the appointment of heat officers—offer templates for other cities to follow.

Effective institutional arrangements are essential for carrying out heat action plans and responding effectively to extreme heat events. The formation of the governing structures usually aligns with climate change responses and generally cascades from national to local governments. A critical first step in many cases is to recognize extreme heat as a natural disaster, thus triggering institutionalized response mechanisms and policies across various levels of government. The Korean government legally designated extreme heat as a natural disaster in 2018,

5 Busan Metropolitan City Ordinance no. 7188.

ushering in significant heat adaptation policies and measures at national and subnational levels. A time series analysis that investigated heat-related mortality in Korea from 2012 to 2022 (Kim et al. forthcoming) found nationwide heat-related mortality had been reduced by 72 percent compared to the counterfactual (that is, what it would have been without the 2018 designation and subsequent relevant policies). The study also corroborated the greater benefits of the policy for vulnerable groups, such as older adults (above age 60) and blue-collar workers.

Korea also established the National Comprehensive Heatwave Response Plan (NCHRP) in 2005, which has evolved over time. The 2023 NCHRP encompasses four implementation strategies: strengthening monitoring and management of the three most vulnerable population groups; establishing a government-wide heatwave response system; promoting heatwave measures with the public; and laying the foundation for reducing the damage from heatwaves.

To support local implementation of the response plan, the national government developed a web-based vulnerability assessment tool. Called VESTAP, the tool is used to assess 57 indicators across seven categories (health, disaster, agriculture, forest, marine/fishery, water, and ecology) and helps local governments make informed decisions about climate change adaptation. By measuring health vulnerability to heatwaves, VESTAP can also inform actions to protect people at risk.

Despite these efforts, nationally led action often suffers from coordination issues. Although prepared jointly with relevant ministries, implementation of the Korean NCHRP has led to the fragmentation of efforts across them and an emphasis on short-term interventions. The Korean experience in Busan and Daegu shows that stronger involvement from local governments could support better integration in managing heat policies and, thus, greater effectiveness. These cities enacted heat-focused ordinances, built institutional capacity for heatwave management, and developed systems to monitor and respond to heat risks.

Another good example of local-level preparedness is Toronto's 2023 Heat Relief Strategy (City of Toronto 2023), which defines the roles and responsibilities of various stakeholders in responding to heat emergencies. Heat warnings and notifications of other heat-related special weather events are issued by Environment and Climate Change Canada, a national agency. At the city level, the Office of Emergency Management coordinates heat response with a range of institutions, including Toronto Public Health; Strategic Public and Employee Communications; 311 Toronto;[6] Corporate Real Estate Management; Park, Forestry and Recreation; the Shelter, Support and Housing Administration; and

6 311 provides easy access to nonemergency city services, programs, and information twenty-four hours a day, seven days a week.

the Housing Secretariat, among others (City of Toronto 2023). The city also works with community partners, such as Streets to Home and the Toronto Drop-In Network, to support heat relief efforts.

Two fundamental components of preparedness are forecasting capacity and reliable warning systems. Many countries have developed and deployed sophisticated weather forecasting systems, increasingly complemented by warning systems that relay information about potential hazards to officials, relevant institutions, and the public.

Many cities have also developed heat action plans (HAPs) that are automatically activated under certain conditions, such as when forecasted temperatures reach a certain threshold. HAPs often include emergency hotlines, home visits to vulnerable groups, the provision of shelter and water, and increased coordination between government agencies and health service providers (Casanueva et al. 2019). Ahmedabad, India, was among the first in South Asia to develop and implement a HAP (Knowlton et al. 2014). The city also published a "how-to" guide and has worked with the federal government, states, and other cities to support their efforts to develop HAPs (Gujarat Institute of Disaster Management 2022).

Korean cities also make use of digital platforms and smart systems to enhance preparedness measures. Busan has developed an integrated heatwave monitoring system supported by 55 sensors to collect data and predict heatwaves. Information from this system is displayed on Busan's public website and includes the highest temperature forecast for the next day and its time of occurrence, along with information on high-risk areas and heat warnings. Additionally, the Busan Life Map provides the locations of heatwave shelters and sunshade canopies so people can quickly find protection during extreme events.

Recently, a number of cities across various countries[7] have appointed chief heat officers. CHOs deploy awareness-raising initiatives, enhance response capacity, and introduce cooling solutions in their cities. They help cities focus on heat-related investments and provide a clear channel for navigating politics, community engagement, and financing for implementing these efforts (Keith et al. 2021).

Because the UHI effect is strongly influenced by the characteristics of the built environment, urban planning and design agencies and departments are also among those with important roles to play in mainstreaming heat resilience in cities. Instilling awareness and knowledge about urban heat within these bodies is essential.

7 These include Dhaka, Bangladesh; Melbourne, Canada; Santiago, Chile; Athens, Greece; Monterrey, Mexico; Freetown, Sierra Leone; and Los Angeles, California, Phoenix, Arizona, and Miami, Florida, in the United States.

Source: Kernel Nguyen / Shutterstock


CHAPTER
3

The World Bank's Responses

Climate resilience has been a development priority across various sectors at the World Bank, and urban heat is emerging as a major concern of client countries and cities. Already, GPURL provides clients with technical assistance (TA) and Advisory Services and Analytics (ASA) to help them better understand urban heat as a threat and develop solutions. The following comprises an overview of relevant TA cases and a portfolio review of urban heat–related investment projects carried out by the World Bank, with case examples of relevant investment projects.

3.1. Summary of Heat-Related Work

Heat-related work by GPURL encompasses fundamental elements of urban heat knowledge, covering the provision of overarching frameworks; data collection to facilitate the design of investments; and the development of heat-response mechanisms. Below are several examples representative of the richness of existing TA projects and ASA related to urban heat.

The *Unlivable* report (Roberts et al. 2023) and the *Primer for Cool Cities* (ESMAP 2020) provide an overarching framework for urban heat approaches, with a strong emphasis on the urgency of these issues. Backed by research, they conclude with recommendations for action:

- The **Unlivable** report evaluates the impact of UHI effects on cities in East Asia. An analysis of satellite data for 100 cities reveals they are, on average, 1.6°C and 2°C warmer than rural areas within 2 kilometers and 10 kilometers, respectively. Temperature differences also occur within cities, as shown by new research in Bandung, Indonesia, where air temperature between neighborhoods can differ by as much as 7°C (Roberts et al. 2023). Moreover, the UHI effect is often stronger in poorer neighborhoods. This report highlights how UHI effects, and urban heat more broadly, damage city competitiveness, health, and overall livability. A "places, people, institutions" policy framework is developed to guide city leaders in cooling cities and mainstreaming heat resilience.
- The **Primer for Cool Cities** (ESMAP 2020) provides practical, actionable guidance and examples for policymakers and planners tasked with mitigating the effects of urban heat. The report serves as a compendium of actions to cool cities, encompassing a range of solutions that can be deployed at the building, community, and city levels. It also elaborates on the economics of different interventions and provides a framework for a synergistic and inclusive approach to urban cooling. Moreover, the report underscores the need for

cities to determine the best mixture of interventions, according to their own circumstances and priorities.

Several TA projects center on data collection (for example, heat mapping), which raises awareness and provides a basis for action. The initiatives in South African and Balkan cities below, for instance, help draw attention to the disproportionate impacts of urban heat on the poor and vulnerable through participatory mapping and identification of prevailing inequalities:

- **Extreme Heat in South African Cities** is identifying thermal inequalities caused by the differing built-environment characteristics and adaptation capacities of various communities. This project includes a citizen-based heat-mapping exercise for Johannesburg and Ekurhuleni (Souverijns et al. 2022), cities that together comprise an economic powerhouse region responsible for 35 percent of South Africa's gross domestic product. The legacies of apartheid-era practices in spatial planning define the landscape of these cities, resulting in differential heat exposure. While UHI effects raise urban temperatures overall 3°C to 4°C higher than in the nearby countryside, the differential reaches 6°C in the hottest neighborhoods, which are generally in areas with dense buildings, little vegetation, and a majority of black residents. The project predicts that inequality will increase as global carbon emissions continue to rise and interact with the UHI effect, affecting the hottest neighborhoods yet more severely. It also takes note of the substantially higher temperatures inside wood-frame, corrugated iron homes compared to nearby modern brick or concrete homes, highlighting the importance of housing construction as a significant determinant of heat exposure indoors. In short, this TA project is producing strong evidence that urgent actions are needed to address heat impacts in South African cities.
- **Heat Watch** in cities in Albania[8] and Bosnia and Herzegovina[9] is another participatory heat mapping activity supported by the GFDRR. Its main objectives are to develop high-resolution models to describe air temperature, heat index, and air quality and to build relationships and awareness among relevant stakeholders by engaging with local communities. The activity finds significant disparities in heat exposure and risk to health impacts across cities, influenced by elements of the built environment, such as impervious surfaces and tree coverage. In collaboration with volunteers, this activity also undertakes a photo-mapping exercise at various locations within cities and generates community-based ideas for equitable cooling solutions.

8 https://storymaps.arcgis.com/stories/0acc8804f35e4ca9b907bb93e0f1d11c.

9 https://storymaps.arcgis.com/stories/0acc8804f35e4ca9b907bb93e0f1d11c.

Sudarshan Jha / Shutterstock

Other TA projects have enabled follow-up on temperature measurement and the building of response mechanisms, as in Ahmedabad and other cities in India:

- **Prioritizing Heat Mitigation Actions in Indian Cities** provides a cost-benefit analysis for a number of heat mitigation measures under different climate change scenarios. UHI effects are currently causing Indian cities to experience nighttime temperatures at least 5°C higher than in surrounding rural areas. Analysis of three cities (Chennai, Lucknow, and Surat) has forecasted 30–50 percent more heatwave days and hot nights per year by 2050, which will reduce economic productivity and cause excess mortality. The study (Jones, Tiwardi, and Takacs 2023) first assesses the impact of extreme heat on these cities under a no-intervention scenario and then identifies a feasible package of heat mitigation interventions. Among the range of interventions considered, the study has found significantly positive benefit-cost ratios (larger than 1) for urban greening, cool roofs, and early warning system (EWS) interventions. Tree planting yields a benefit-cost ratio of 1:1 (break-even) or higher considering its heat mitigation potential alone, with additional benefits for health and disaster mitigation, such as flood reduction. Cool roofs and heat-health EWSs have particularly high ratios of benefits to costs (50:1 or higher).

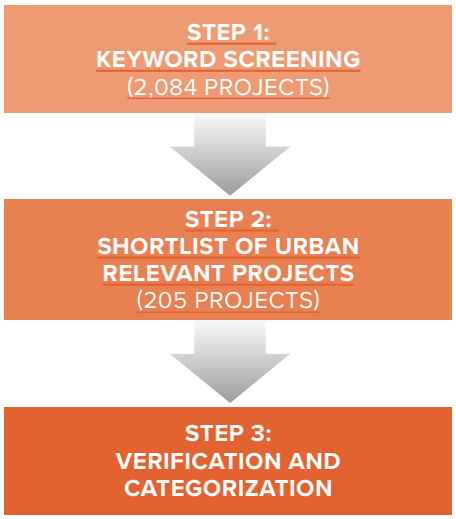
3.2. A Portfolio Review of World Bank Investments

This section presents key findings from a systematic review of urban heat–related investment projects financed by the World Bank between FY2012 and FY2023 (excluding ASA and pipeline projects).

3.2.1. OBJECTIVE AND METHODOLOGY

The process undertaken for the review consisted of three steps (see figure 3.1):

Figure 3.1. Portfolio Review Process



STEP 1. Keyword screening. A long list of projects with potential links to the extreme heat agenda was identified from across all relevant sectors at the World Bank, including Urban, Disaster Risk Management, Resilience and Land (URL); Environment, Natural Resources and Blue Economy (ENB), Health, Nutrition and Populations (HNP); Transport (ITR), and Water (WTR), using a specialized taxonomy of terms and phrases representing heat-related problems and solutions. The keyword screening identified a total of 2,084 potentially relevant projects.

STEP 2. A shortlist of urban-relevant projects. The initial list was narrowed down to projects with investments and activities relevant to urban contexts. Projects addressing heat in non-urban contexts were excluded. Step 2 produced a shortlist of 205 projects.

STEP 3. Verification and categorization of the shortlisted projects. This step had two parts:

First, the shortlisted projects were stratified by regions, and 120 were randomly selected. Then the key documents associated with these projects (project appraisal documents, project papers, and so on) were reviewed in greater detail against the following criteria:

i Whether the project documents included urban heat (or extreme heat) in the development objective and/or respective indicator(s) in the results framework

ii Whether the project documents introduced relevant components that fit into the urban heat investment menu (see figure 2.1)

iii Whether the project documents stated an explicit linkage between investment activities and urban heat and/or included extreme heat among the key challenges to address

Second, the projects were categorized into four groups, as listed in table 3.1: heat-focused, heat-relevant, heat-potential, and unidentified.

Table 3.1. Categorization of Projects

CATEGORY	CRITERION 1	CRITERION 2	CRITERION 3
Heat-focused	Yes	Yes	Yes
Heat-relevant	No	Yes	Yes
Heat-potential	No	Yes	No
Unidentified	No	No	No

An integrated urban upgrading project, for example, that included green spaces or park rehabilitation would be grouped as *heat-relevant* if it listed an explicit link to heat mitigation as one of its impacts. If no explicit linkage were made to the extreme heat agenda, it would be classified under *heat-potential*. The review emphasized explicit linkages to identify whether and how heat had been recognized in the project design and how the relevant component(s), small or large, contributed intentionally to the solution. Further, the review classified as *unidentified* non-urban interventions and/or projects that had some level of discussion of urban heat but did not include relevant investments.

It should be noted that since this categorization relied entirely on the review of appraisal documents, which reflected the project design, it might have overlooked aspects of implementation that determined the realization of project components into more elaborate outputs and potentially produced heat-relevant benefits. Hence, *heat-potential* and *unidentified* projects might include significant heat investments in addition to those captured by the review process.

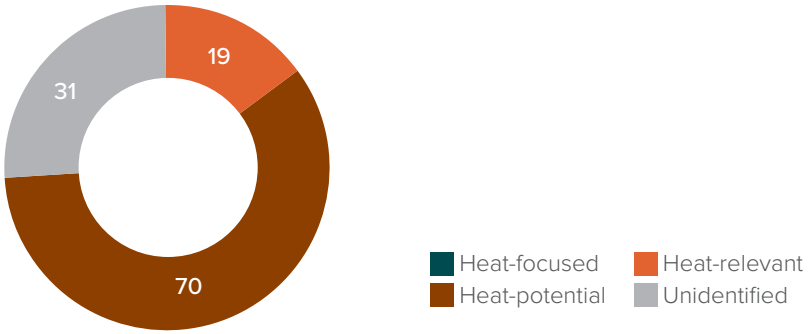
3.2.2. KEY FINDINGS FROM THE PORTFOLIO REVIEW

The portfolio review yielded three key findings: the demand is growing for projects to address urban heat; interventions related to the urban heat agenda include a wide range of investment activities; and the large majority of *heat-relevant* projects have explicit links to the urban heat agenda.

Growing demand for projects to address urban heat

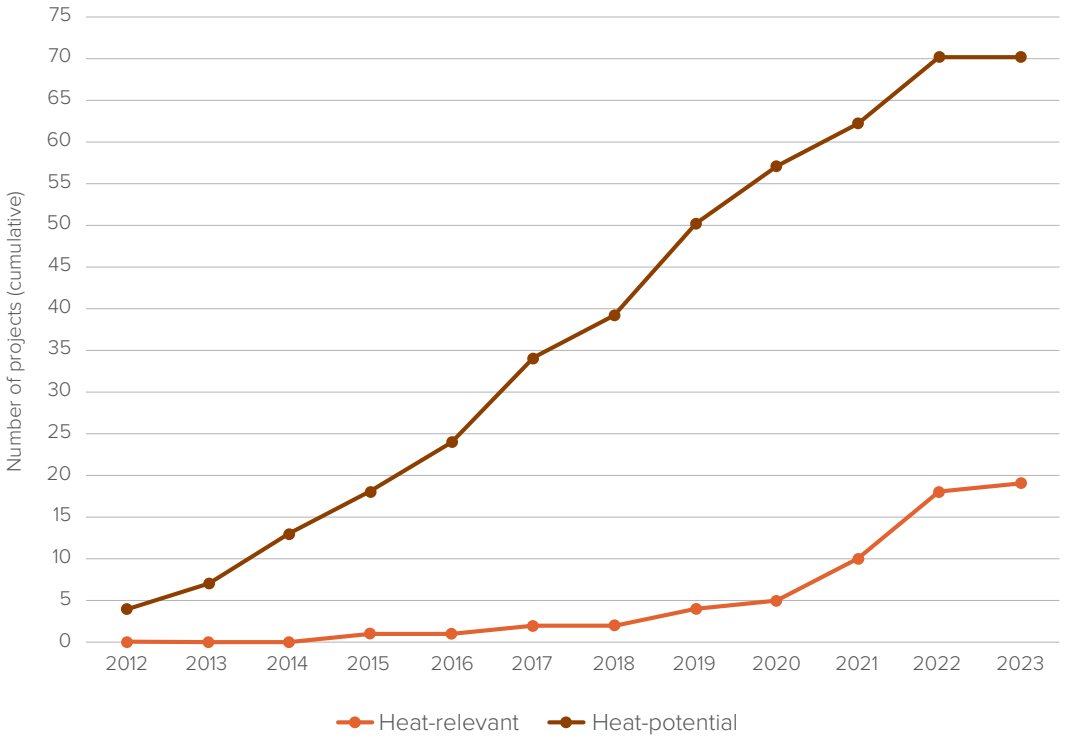
The majority of the reviewed projects fall into the *heat-potential* category. In other words, they include investment activities that are related to urban heat but don't have an explicit link to the urban heat agenda. A total of 19 (16 percent) and 70 (58 percent) of the projects were identified as *heat-relevant* or *heat-potential*, respectively, while none had attained the level of *heat-focused* at the time of the review (figure 3.2).

Figure 3.2. Overview of Project Types



Note: The review found no heat-focused projects.

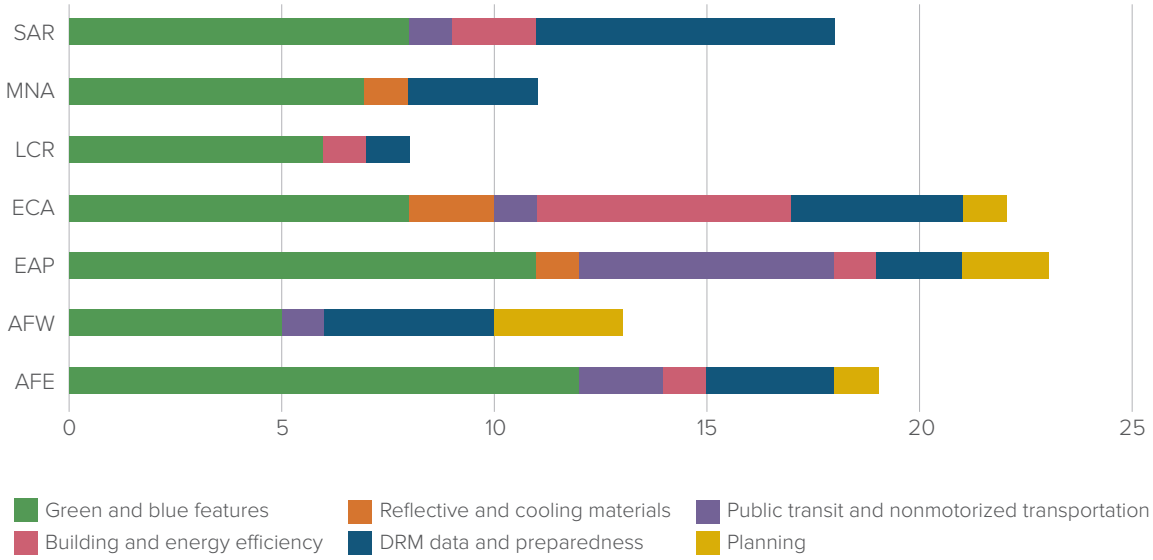
Figure 3.3. Trends in Heat-Relevant and Heat-Potential Projects



Urban heat project components covering a broad range of issues—such as extreme heat, heatwaves, and UHI, among others—are becoming more prevalent in the portfolio over time. Almost all identified *heat-relevant* projects were approved after 2018. This increase has been driven by the World Bank's commitment to climate change, including the Climate Change Action Plans for 2016–2020 and 2021–2025.

The overall urban portfolio at the World Bank is concentrated mostly in the Africa and South Asia region. The greatest number of relevant projects, however, are in Europe and Central Asia and East Asia and the Pacific. The portfolio review also revealed that regions have different appetites for investment activities related to urban heat. Europe and Central Asia, for example, have focused more on building performance and energy efficiency measures than other regions, while the East Asia and the Pacific and Eastern and Southern Africa regions have emphasized green measures more broadly.

Figure 3.4. Number of Identified Projects by Type and Region



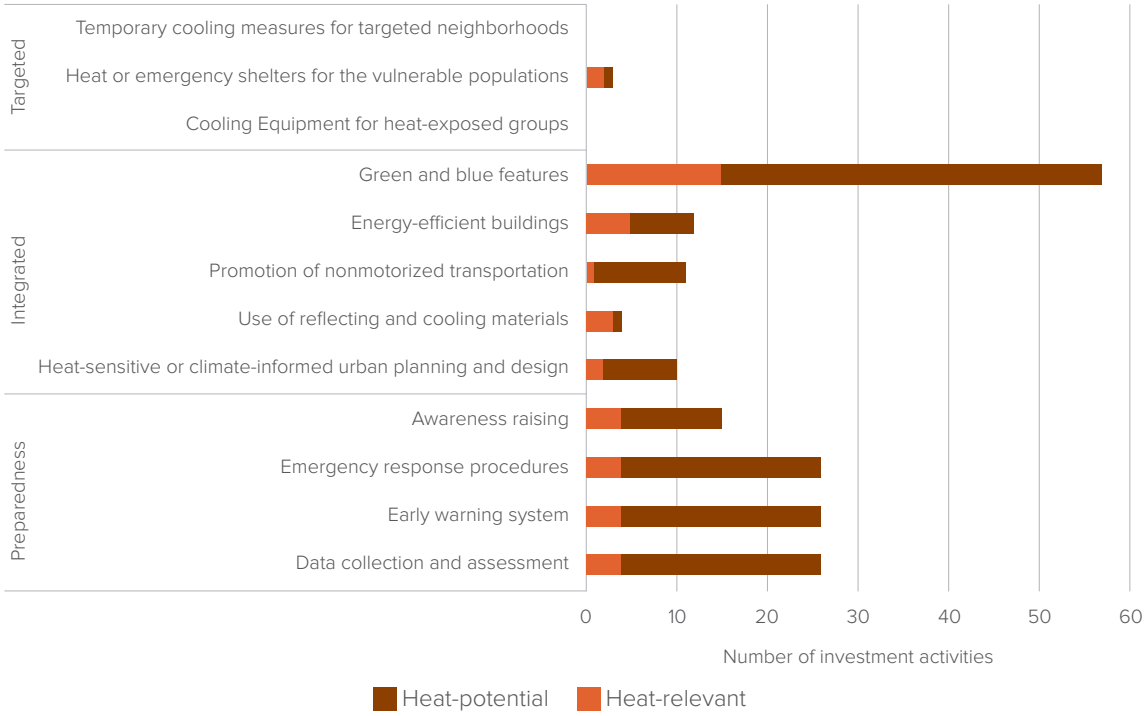
Note: Names of regions are abbreviated in the figure as follows: SAR = South Asia; MNA = Middle East and North Africa; LCR = Latin America and the Caribbean; ECA = Europe and Central Asia; EAP = East Asia and Pacific; AFW = Western and Central Africa; AFE = Eastern and Southern Africa.

Interventions related to the urban heat agenda

The *heat-relevant* and *heat-potential* projects in the World Bank portfolio include a wide range of different investment activities. Figure 3.5 shows the distribution of relevant interventions within the *targeted*, *integrated*, and *prepared* (TIP) framework.[10]

10 The TIP framework is meant to emphasize three critical dimensions of strategic action for urban health. Individual actions can and do fulfill multiple functions. The allocation here is, thus, indicative.

Figure 3.5. Investment Activities in Heat-Relevant and Heat-Potential Projects under the TIP Framework



A wide range of *integrated* investments was identified in the portfolio, despite only about 20 percent of the reviewed activities presenting an explicit link to the urban heat agenda:

- Investments in green features, such as public parks, green spaces, and tree planting, and in nature-based solutions are the most common interventions, accounting for 57 projects (48 percent). Of these, 15 explicitly indicate a linkage to the heat agenda.
- Five projects (4 percent) consider the use of construction materials, such as permeable-surface and light-colored materials for roofs and pavements, to mitigate heat. Although these interventions contribute directly to heat mitigation, their application in projects is still rare.
- Eleven projects (9 percent) address public transit planning and nonmotorized transportation, such as walking and cycling. In some rare cases, projects—for example, the Ningbo Sustainable Urbanization Project in China (P149485)—also invest in electric buses.
- Twelve projects (10 percent) involve increasing the energy efficiency of utilities and buildings. These interventions occur in reconstruction and housing projects and support policy reforms to promote green and sustainable development, such as green buildings. Incorporating energy efficiency measures in building retrofits

and construction is among integrated actions that improve building resilience and performance and reduce emissions, energy consumption, and heat production.

- Ten projects (8 percent) provide technical assistance for enhancing urban planning and design, through, for example, open space allocation, transit planning, and wetland management, which could have indirect impacts on urban heat. Only two projects—Sustainable Cities in Türkiye (P128605) and the Republic of the Marshall Islands Urban Resilience Project (P177124)—articulate strong linkages to heat and climate risk mitigation.

Investments in *preparedness* are also prevalent within the portfolio. The 26 projects in this category include raising awareness, gathering data, enhancing monitoring capacity, and establishing early warning systems and response procedures. At present, only about 15 percent of these investments are clearly linked to the urban heat agenda, while the rest are designed to address other types of disasters. A good example of the former is the Niger Integrated Urban Development and Multi-Sectoral Resilience Project (P175857), which supports cities in developing integrated planning instruments, conducting risk assessment, and enhancing preparedness capacity in response to floods, droughts, and heat. The Resilient Urban Sierra Leone Project (P168608), on the other hand, invests in a hydromet EWS that warns only of flood risk. Such *heat-potential* investments can unlock their unmet "potential" by including extreme heat among targeted disaster types and assessing impacts of investments on urban heat mitigation and adaptation.

Furthermore, the Contingency Emergency Response Component (CERC) included in many projects is inherently a preparedness measure. The CERC allows projects to reallocate uncommitted funds to responding to natural and manmade crises, which may include extreme heat events. Of the reviewed projects, 28 (23 percent) have a CERC component. Client governments that have established heat as a defined crisis can take advantage of the CERC to support immediate measures during a heatwave or extreme heat event.

Targeted UHI measures are still rare in GPURL projects. The review identified three that articulate a targeted measure: the Resilient Infrastructure for Adaptation and Vulnerability Reduction Project in Bangladesh (P173312), the Niger Integrated Urban Development and Multi-Sectoral Resilience Project (P175857), and the Lushan Earthquake Reconstruction and Risk Reduction Project (P153548). These invest in emergency shelters (or climate-resilient flood shelters) that could also serve as heat shelters for the vulnerable.

Explicit links to the urban heat agenda

The large majority (17 of 19) of *heat-relevant* projects highlight UHI or extreme heat as one among several climate and disaster risks, alongside exposure to floods,

earthquakes, and droughts. These projects identify increasing temperatures or more frequent heatwaves as a threat to various development sectors and industries. Examples include the following:

- **The Resilient Urban Sierra Leone Project (P168608)** provides a comprehensive discussion of the threat of extreme heat, which translates into the project components. It states that "*the combination of such higher average temperatures and humidity leads to high heat index values, which can have a detrimental impact on some areas of the economy such as the energy sector and has the potential to bring additional health risks. Among them are a higher prevalence of diarrheal diseases; an increase in toxic algae blooms, leading to seafood poisoning; and an expansion in breeding locations and seasons for mosquitoes that are malaria and dengue carriers.*"
- **The Seismic Resilience and Energy Efficiency in Public Buildings Project (P175895)** states that "*beyond seismic risk, public buildings in Türkiye and their occupants are at risk from floods, storms (wind and snow loading), landslides, extreme heat and cold, and water scarcity.*" Furthermore, the project elaborates on the connection between rising temperatures and the increased need to cool buildings, which generates exhaust heat and perpetuates the heat island effect in cities. This project also highlights that incorporating energy efficiency measures into building retrofits and new construction will help mitigate climate change: "*In the context of climate change, incorporating energy efficiency measures such as thermal insulation into retrofitting of existing buildings or construction of new buildings will be important for reducing pressure on power grids, reducing the urban heat island effect, reducing emissions, and enhancing human health and resilience, including resilience to climate change related heat and cold shocks. Similarly, with more extreme temperatures on the rise, thermal insulation is critical for ensuring comfort of building occupants without a commensurate increase in energy consumption.*"

In other cases, the relevance of urban heat is found in individual project components. They invest in urban interventions that potentially address or respond to the urban heat agenda. Among them are the following:

- **The Tamil Nadu Housing and Habitat Development Project (P168590)** seeks to build climate resilience through investments in affordable housing. In its implementation, the project component provides TA for undertaking climate and disaster screening, including for "*plantation of trees to reduce heat island effect.*"

- **The Yemen Integrated Urban Services Emergency Project II (P175791)** rehabilitates "*local parks and green spaces to better manage storm water runoff and help reduce the urban heat island effect.*"
- **The Djibouti Integrated Slum Upgrading Project—Additional Financing (P172979)** emphasizes as part of its urban upgrading component the benefit of tree planting in public spaces "*to help reduce the incidence of heat waves in the neighborhood.*"
- **The Seismic Resilience and Energy Efficiency in Public Buildings Project (P175894)** in Türkiye includes in its retrofitting and renovation component the promotion of "cool" buildings for managing extreme heat events. The project seeks to improve energy efficiency in government buildings, an objective that also supports "*increased functionality and comfort for the buildings' occupants during extreme heat and cold events—which are expected to increase with climate change.*"

Boxes 3.1, 3.2, and 3.3 provide more details about the design of some *heat-relevant* projects.

Box 3.1. Türkiye Earthquake, Floods and Wildfires Emergency Reconstruction Project (P176608)

- **Approval year:** 2022
- **Commitment amount:** US$449 million
- **Project type:** Investment Project Financing (IPF)
- **Project development objective:** "*To support green and resilience disaster reconstruction in municipalities affected by earthquake, floods, or wildfires; to strengthen municipal capacity for disaster resilience; and to respond promptly and effectively in the event of an eligible crisis or emergency.*"

The Türkiye Earthquake, Floods and Wildfires Emergency Reconstruction Project identifies extreme heat as a major climate risk to Türkiye's cities and invests in measures to reduce the UHI effect and promote sustainable cooling. All investments will integrate improvements in energy efficiency and the harnessing of renewable energy.

The project has two main components: one is green and resilient rehabilitation, reconstruction, and construction of municipal infrastructure and actions to strengthen municipal resilience, and the other is technical assistance to support green, resilient, and inclusive cities. The first prioritizes subprojects that adopt innovative approaches to increasing resilience, such as combined green and grey measures to reduce urban flooding and urban heat.

The reconstruction and rehabilitation of urban infrastructure provide multiple entry points for urban heat mitigation. The project is committed to a "one intervention, many benefits" approach. Complementary nature-based solutions, for example, hold a high potential for maximizing the impact of investments by reducing floods, extreme heat, and water scarcity while at the same time increasing air quality and improving city amenities.

HASAN AKBAS / Shutterstock

Box 3.2. GEF7: Green and Carbon Neutral Cities (P173316)

- **Approval year:** 2022
- **Commitment amount:** US$26 million
- **Project type:** Investment Project Financing (IPF)
- **Project development objective:** "*To integrate biodiversity conservation in the participating cities' urban development and establish their pathway to carbon neutrality.*"

GEF7 enhances the government's planning capacity for green and carbon-neutral cities through two main components: strengthening the government's high-quality development framework by promoting ecological and biodiversity conservation and carbon neutrality; and supporting integrated solutions to biodiversity and climate change, by planning for and investing in nature and carbon neutrality.

Under the second component, the project maps urban natural assets and ecosystem services and assesses their economic value and co-benefits for biodiversity and climate resilience. This activity will include identifying urban cooling effects provided by green and blue spaces.

The second component also includes investing in urban regeneration to promote integrated solutions for building carbon-neutral communities. The development of the demonstration sites integrates urban biodiversity and nature-based solutions to make communities walkable, promote transit-oriented development, and mitigate UHI.

Three cities (Chengdu, Chongqing, and Ningbo) are participating in the project, with direct beneficiaries numbering 3.4 million residents. The residents will benefit from TA in developing neighborhood public spaces, ecological parks, pedestrian walkways, and green infrastructure, which will mitigate climate impacts, including excessive urban heat.

The project also benefits from an ASA product, **Support Sustainable Cooling Strategy in Guangzhou (P173306)**, by applying the knowledge it generates to its implementation.

Heat mitigation appears to be one of GEF7's main appraisal values. The economic analysis recognizes the value of integrating green growth and low-carbon strategies into urban planning, including their capacity to provide effective urban temperature regulation and lower the incidence of health-related issues. The project also assesses the state of UHI and its impacts (for example, fatalities) in the participating cities.

In its results framework, the project includes several indicators related to the planning instruments, capacity building, and physical investments. It measures the number of implemented nature-based solutions and carbon-neutral design options in selected sites. Enhancement of planning instruments becomes one of the project's main avenues to measure results in cities; this includes the development of ecological conservation and carbon-neutral development indicators, biodiversity strategies, an inventory of natural assets and ecosystem services, and a carbon neutrality roadmap. Additionally, to ensure sufficient local capacity to carry out sustainable development in Chinese cities, the project determines how many knowledge exchange activities and trainings on urban sustainability are being undertaken.

Box 3.3. Strengthening Climate Resilience in Burkina Faso (P164078)

- **Approval year:** 2018
- **Commitment amount:** US$31 million
- **Project type:** Investment Project Financing (IPF)
- **Project development objective:** "*To improve the country's hydro-meteorological, climate and early warning services, and improve access to such services by targeted sectors and communities.*"

Strengthening Climate Resilience in Burkina Faso is an example of a comprehensive investment in enhancing climate resilience and preparedness that is urban heat–relevant. The overall objective is to enhance the country's preparedness to respond to climate hazards by investing in disaster risk management (DRM).

The first component of the project undertakes capacity building and institutional development to ensure the necessary legal and regulatory framework, standard operating procedures, and staff capacity are in place to deliver and operate the second component—improvement of hydromet services and early warning systems.

This component encompasses the attainment of comprehensive climate information that is relevant to urban heat—albeit not mentioned explicitly in the project document. It also strengthens technical systems for performing meteorological, hydrological, and climate modeling and forecasting that will enable the responsible agencies to monitor and respond to hazards, including extreme heat. Another component of the project serves to enhance service delivery and warnings to communities, including the communication of weather, water, and climate information to the public through multiple platforms, which also pertains to heat events.

Overall, the project pays special attention to flooding and food security but not to UHI or extreme heat events. One of the project indicators, however, refers to improvement in capacity for weather forecasting (with respect to mean temperature and precipitation), a meteorological observation network, and the establishment of an emergency operations center, a communication system to deliver timely and adequate decision-making services, and a digital platform for data sharing. All of these are fundamental elements for responding to extreme heat events.

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CHAPTER

4

Going Forward: Recommendations

The escalating frequency and intensity of extreme heat events poses serious challenges for cities, causing preventable morbidity and excess mortality that are further compounded by the UHI effect. Such trends have led to increased political pressure and urgency to act on heat-related issues.[11]

As a response, cities across the globe are scaling up efforts to address urban heat. As chapter 2 has shown, many cities, such as Ahmedabad and Busan, have developed heat action plans to respond to extreme heat events, complemented by increased capacity in forecasting and improved early warning systems. Cities like Hyderabad are also implementing cooling measures using green corridors and lightly painted roofs, while Freetown, Hong Kong, Singapore, and cities in Korea are implementing heat-sensitive urban design, among other interventions.

The World Bank is well-positioned to help cities improve their investments and policies related to the urban heat agenda. Piloting and scaling up urban heat interventions is a promising pathway to serve the Bank's mandate to increase climate co-benefits and align all its operations with the Paris Agreement.

4.1. A Catalogue of Potential Investments

The urban projects financed by the World Bank can carve out a niche for operationalizing the urban heat agenda. This review indicates that the Bank's efforts have been largely confined to supporting *integrated* measures (such as urban cooling), while *targeted* interventions and *preparedness* have received less attention. The review suggests several more detailed takeaways:

- ***Targeted** investments:* Currently, *targeted* investments are limited, but they are likely to become more common. Investments in broader DRM response (for

11 The Cerberus Heatwave, for example, brought record high temperatures across European countries in June 2023—over 40°C in southern Europe, rising as high as 48.8°C in Italy. France's director general for health resigned amid the deaths of 5,000 French citizens during the heatwave, as the French public and journalists underscored failed policy programs and the government's negligence in protecting the vulnerable (see https://www.nytimes.com/2003/08/22/opinion/IHT-the-politics-of-heat-waves-victims-of-a-hot-climate-and-a-cold.html). Similarly, the death tolls sparked political contention in Uttar Pradesh, India, with opposition leaders blaming the government for not warning people about the heatwave. More broadly, the impacts of heatwaves on energy, food security, transboundary water sharing, and migration will cause destabilization in addition to health issues (see https://www.usip.org/publications/2023/06/how-heat-waves-are-destabilizing-asia).

IndustryAndTravel / Shutterstock

example, flood response) offer an opportunity to address urban heat, and they include many targeted measures to protect vulnerable groups, accompanied by specific indicators (for example, the number of people and the vulnerable groups protected from floods). Extreme heat events that significantly affect vulnerable groups could receive similar treatment when designated and understood as priority climate and health risks. Projects pertaining to slum upgrading, climate resilience, health, and social protection all offer avenues for promoting targeted heat measures.

- ***Integrated*** *investments:* To maximize the impacts of existing *integrated* investments in urban heat mitigation and adaptation, two key aspects should be strengthened: technical design of the investments and measurement of results. Investments in green and blue features, for instance, such as waterfronts, parks, and tree plantings, have proved effective in supporting urban cooling, especially if designed and planned to address heat from the outset—that is, at the appraisal stage of a project, proposed investments should include key indicators of "heat-sensitive" designs, such as the ratio of green coverage and shade, cooling material selection, and types of vegetation, which is not typically the case within the existing portfolio. Mainstreaming the extreme heat agenda into long-term urban planning documents is another avenue for further exploration and investment. Such efforts then also need to be better incorporated into the objectives and results frameworks of the projects.
- ***Preparedness*** *investments:* The World Bank's urban projects can more broadly incorporate measures for protection from heatwaves or extreme heat events, especially within urban resilience projects. EWS and multi-hazard preparedness projects, for example, support the development of capacity to monitor, forecast, and respond to various climate conditions; this can be effectively leveraged for responding to extreme heat events.

The portfolio review also revealed many missed opportunities for optimizing the impacts of World Bank investments on the urban heat agenda. This highlights the need for a clearer theory of change (ToC), specific indicators, and explicit links to the urban heat agenda for future investments. Table 4.1 provides a catalogue of possible investment activities and respective indicators.

Table 4.1. Catalogue of Possible Investment Activities

PROBLEMS	INVESTMENT MENU		DESCRIPTION
• Prolonged exposure to extreme heat poses health risk. • Urban built environment induces urban heat island effect. • Building design and utilities produce excessive heat. • Indoor environment does not protect against heat condition. • Increased use of motorized vehicles creates more heat and pollution. • Awareness of extreme heat and accompanying risks is low. • Preparedness to address extreme heat events is lacking.	**Targeted** measures for *people*	Cooling shelters for the vulnerable	Rehabilitation of existing or underused community spaces as cooling shelters in highly affected neighborhoods
		Provision of cooling equipment	Provision of personal protective equipment (PPE) to heat-exposed groups
		Temperature cooling measures for targeted neighborhoods	Provision of temporary cooling measures (e.g., wetting of pavements during heatwaves) in targeted neighborhoods
	Integrated measures in *places*	Green and blue features	Rehabilitation of waterfronts and green spaces with heat-sensitive design considerations
		Promotion of nonmotorized transportation	Improvement of pedestrian networks with heat-sensitive design considerations
		Use of reflective and cooling materials in construction and infrastructure	Replacement of dilapidated paving and building materials (in public and municipal-owned buildings) with cooling materials
		Energy efficiency and passive cooling in buildings	Improvement of efficiency of building utilities and appliances (e.g., modern appliances, materials, insulation) and promotion of passive cooling design (e.g., cross ventilation, natural light) to reduce energy consumption, especially for air conditioning
		Heat-sensitive urban planning	Integration of the urban heat agenda in urban planning documents
	Prepared *systems and institutions*	Awareness raising	Community-level awareness-raising activities Appointment of city-level chief heat officer (CHO)
		Early warning systems	Inclusion of extreme heat in the list of disasters for early warning Operationalization of heat-included early warning system (EWS)
		Data collection and assessment	Heat vulnerability assessment Community-led data collection as part of climate adaptation activities

Note: The World Bank Group's corporate scorecard is organized around 15 outcome areas: (1) protection for the poorest; (2) no learning poverty; (3) healthier lives; (4) effective macroeconomic and fiscal management; (5) green and blue planet and resilient populations; (6) inclusive and equitable water and sanitation services; (7) sustainable food systems; (8) connected communities; (9) affordable, reliable, and

EXAMPLE INDICATORS
• Number of heat (or climate) shelters constructed or rehabilitated • Number of people served
• Number of people who received PPE
• Number of people benefited from temporary cooling measures in poor neighborhoods
• Hectares of heat-sensitive (or climate-resilient) public spaces rehabilitated • Average temperature within and around the rehabilitated spaces
• Kilometers of heat-sensitive pedestrian networks • Number of shaded markets/public parks
• Square meters of paving replaced with cooling materials • Number of buildings rehabilitated or constructed with cooling materials
• Number of buildings with energy efficiency measures implemented • Number of buildings designed with passive cooling
• Inclusion of climate and heat considerations in long-term urban planning documents
• Number of awareness-raising activities conducted • Number of people reached by campaigns • CHO appointed by the city government (Y/N)
• Extreme heat included in the list of disasters for early warning (Y/N) • Number of heat-included EWS beneficiaries
• City-level heat vulnerability assessment conducted (Y/N) • Community-level data collection activities conducted (Y/N)

sustainable energy for all; (10) digital connectivity; (11) digital services; (12) gender equality; (13) better lives for people in fragile and conflict-affected situations; (14) more and better jobs; and (15) more private investment. For further information, see the World Bank Group Scorecard at https://scorecard.worldbank.org/en/scorecard/home.

4.2. Avenues for Operationalizing the Urban Heat Agenda

Drawing upon the results of the portfolio review, this section explores ways to strengthen the design of future investments for the agenda.

A NEW STANDALONE "HEAT-FOCUSED" PROJECT?

As discussed earlier (section 3.1), **a *heat-focused*** project would have three main elements:

1. It would include extreme urban heat in the project's development objective (PDO) and/or one or more heat-related indicators in its results framework.
2. It would introduce components that fit into the relevant investment menu.
3. It would state an explicit link between investment activities and urban heat and/or include extreme heat in key challenges to address.

This *heat-focused* approach may be appealing to a country where the urban heat agenda is one of the most urgent policy priorities. The possibility of forming such a standalone *heat-focused* project is likely to be low, however, given the following design and implementation challenges:

- *First*, the lack of an agreed-upon definition of extreme heat may challenge the identification of targeted populations and geographical scope. Extreme heat is highly contextual (for instance, regional thermal risks vary), and, unlike floods and droughts, which have salient and visible impacts, the impacts of heat are often overlooked.
- *Second*, the definition and technical scope of "heat-sensitive" design for urban infrastructure needs further discussion to refine assessments of its feasibility, applicability, and sustainability. While it has commonalities with design for climate-resilient or low-carbon urban investments, it also has unique features for extreme heat mitigation that require more study.
- *Third*, adequately capturing the multi-layered impacts of a project may be difficult. Results could mainly be measured on the basis of output indicators, because some expected outcomes, such as reduced temperature and a reduction in heat-related diseases, are not fully accountable to implementation of a project and are difficult to measure within the implementation period. Therefore, the inclusion of PDO-level indicators focusing on the heat agenda would be challenging.

That said, as demand continues to grow, further exploration of the points mentioned above is due through a series of in-depth studies in the coming years.

A recent policy brief on the integrated urban heat policy in Korea (Lee et al. 2024) provides valuable food for thought by introducing how the country incorporated extreme heat into its national disaster agenda, along with city-level investments in heat-sensitive urban assets and development of a results monitoring system.

STEP-BY-STEP APPROACH FOR URBAN PROJECTS

Meanwhile, most existing urban projects financed by the World Bank, including the *unidentified* group in the review, can become ***heat-relevant*** projects. Below are five key ways in which existing and future urban interventions financed by the Bank can better contribute to addressing the urban heat issue:

1. **Identify and highlight the potential impacts of planned interventions on the urban heat agenda.** Urban projects often have a broad development objective, such as "*enhance disaster and climate resilience in selected urban areas*," in the case of an urban resilience program. An intervention under such a project often creates multiple benefits, including, in some cases, effective urban heat treatment, which has often remained unaddressed. Acknowledging the linkage between interventions and the urban heat agenda in project design can increase the impact of each dollar spent and lead to better alignment with corporate climate initiatives. Some examples are provided in section 3.2 and the annex of this report.

2. **Assess heat conditions in cities.** In countries where the extreme heat agenda is not yet considered a policy priority but awareness is increasing, data collection and analysis offer a useful starting point for gaining a better understanding of local heat conditions and heat vulnerability and defining potential high-impact interventions. Through its City Resilience Program and Digital Earth Partnership, the Global Facility for Disaster Reduction and Recovery (GFDRR) offers a variety of technical assistance. This includes advanced urban heat modeling, community-driven urban heat measurement and mapping campaigns, knowledge exchanges, and capacity-building workshops.[12]

3. **Integrate the urban heat agenda in the urban and DRM systems.** As shown for some cases in Korea (Lee et al. 2024), inclusion of extreme heat in the national DRM system can effectively increase the associated budget for cities, raise awareness, and bolster relevant investments at the local level, leading to considerable environmental, economic, and health benefits. The Bank's various financing instruments, such as Program-for-Results Financing, Development Policy Financing, and Investment Project Financing with Performance Based

12 To date, GFDRR has supported technical assistance to 47 cities through World Bank engagements. See https://www.gfdrr.org/en/crp and https://www.gfdrr.org/en/digitalearthpartnership for more details.

Contracting, have suitable mechanisms to support governments in taking such action. That is, governments can receive financial incentives upon achieving the agreed-upon targets related to the integration of extreme heat in their national urban and DRM systems.

4. **Refine the technical design of capital investments in urban infrastructure and amenities.** Although further investigation is needed, studies in India and Korea suggest that heat-sensitive design for urban infrastructure and amenities, covering roads, public buildings, and open spaces, can yield high benefit-cost ratios. The Korean government, for instance, allocated US$61 million (US$120,000 per 100,000 population) for extreme heat adaptation policies under its second national climate change adaptation budget. This generated a reduction of approximately US$173 million in the total annual economic burden of heat-related diseases[13] (US$335,500 per 100,000 population), amounting to a nearly threefold return on the investment (Kim, Park, and Hong, forthcoming). Heat-sensitive design features include increased coverage of green and shaded areas and the use of cooling and/or reflective materials and passive cooling, among others. Ongoing investments in various urban assets can benefit from such "extra" efforts to reap the benefits of heat mitigation in cities.

5. **Focus more on protecting vulnerable groups from heat-related risks.** The vulnerable, especially the elderly, are exposed to a variety of heat-related risks, including overheating in informal settlements, working outdoors during heatwaves, and walking in areas without shade. Based on results of a heat vulnerability assessment, a relevant project (associated with, for example, slum upgrading, affordable housing, urban resilience, health, or social protection) can design and implement special measures to protect vulnerable groups from heat-related health risks. The Korean experience also corroborates the efficacy of targeted heat measures in providing benefits for those at higher risk, thus promoting health equity (ibid.).

4.3. Concluding Remarks

This report stems from a growing concern over a narrowing window of opportunity for cities to take adequate actions to ameliorate the extreme heat threat in urban settings and lessen its adverse impacts on health. It lays out possible pathways for maximizing contributions from the World Bank in addressing urban heat issues by enhancing heat interventions in Urban, Disaster Risk Management, Resilience and Land projects. Working within the Healthy Cities' TIP (*targeted, integrated,* and *prepared*) framework (Lee et al. 2023), the report serves as a reference for

13 "Economic burden of disease" refers to the direct and indirect costs related to medical care.

Bank task teams to explore what has been and could be done. The portfolio review then showcases the spectrum of relevant heat interventions and identifies opportunities for quick wins: existing projects can consider adjusting relevant activities at the implementation stage (with regard to, for instance, material selection, design features, green coverage, and heat emergency response), while future ones have wider openings to incorporate relevant components, technical requirements, and results frameworks from the outset. The combination of these efforts will ensure the World Bank's urban investment portfolio is well prepared to respond to the growing threat of urban heat.

Annex: Heat-Relevant Projects in the Portfolio Review

P-CODE	PROJECT	APPROVAL YEAR	COUNTRY	REGION	TYPE	COMMITMENT AMOUNT (US$M)
P175857	Niger Integrated Urban Development and Multi-Sectoral Resilience Project	2022	Niger	AFW	IPF	250
P176608	Türkiye Earthquake, Floods and Wildfires Emergency Reconstruction Project	2022	Turkiye	ECA	IPF	449
P177124	Republic of the Marshall Islands Urban Resilience Project	2022	Marshall Islands	EAP	IPF	30
P175894	Seismic Resilience and Energy Efficiency in Public Buildings Project	2021	Turkiye	ECA	IPF	265.75
P178270	Additional Financing – Integrated Urban Services Emergency Project II	2022	Yemen	MNA	IPF	120
P177765	Peru: Enabling a Green and Resilient Development DPF	2022	Peru	LCR	DPL	500
P146059	Cities and Climate Change PPCR AF	2015	Mozambique	AFE	IPF	15.75
P175830	Stormwater Management and Climate Change Adaptation Project 2	2021	Senegal	AFW	IPF	155
P178141	Casablanca Municipal Support Program—Additional Financing	2022	Morocco	MNA	PforR	100

PROJECT DEVELOPMENT OBJECTIVE	ASSESSMENT
To increase resilience to floods and improve urban management and access to basic services in selected municipalities in Niger.	Through one of its subcomponents, the project invested in green open spaces to mitigate UHI—a linkage mentioned explicitly in the project document. Throughout its components, the project involves relevant heat interventions, such as the use of permeable and light-colored pavement, climate-sensitive design standards, passive cooling in building design, and energy-efficient technology. It also invests in shelters for flood-affected populations and crisis response centers with fire stations; risk assessment for and training in emergency preparedness and response to floods, droughts, and heat; and awareness raising.
To support green and resilient disaster reconstruction in municipalities affected by earthquake, floods, or wildfires; to strengthen municipal capacity for disaster resilience; and to respond promptly and effectively in the event of an eligible crisis or emergency.	The project recognized urban heat as a risk and addressed it in its investments, which include taking green and grey measures to reduce urban flooding and UHI, increasing permeable surfaces, increasing energy efficiency, and reducing the use of cars.
To strengthen the resilience of selected urban areas in the Republic of the Marshall Islands to the impacts of natural hazards and climate change	The project recognized urban heat as a risk and addressed it through its investments, generally for climate resilience but specifically through the use of light-colored material for roof and pavement construction and the building of open spaces. More broadly, the project invests in a climate- and hazard-informed urban design study and guidelines for new development, as well as in raising awareness of (unspecified) climate risks, which may include heat.
To improve the disaster resilience and reduce energy use in selected Central Government Buildings, and to strengthen the policy framework and institutional capacity to develop, finance and implement resilient and sustainable public buildings in Türkiye.	The project recognized the risk of extreme heat and invested in improving energy efficiency through the retrofitting of building envelopes and utility systems and the provision of shelter during extreme heat events.
To restore access to critical urban services and strengthen resilience to shocks in selected cities within the Republic of Yemen.	The project recognized the risk of extreme heat and UHI and included heat-relevant components, such as investment in stone paving and open space to reduce the UHI effect; this is explicitly mentioned in the project document.
To support Government policies to: (i) strengthen the foundations for a green economic recovery, (ii) build resilience and enhance climate change adaptation and (iii) support the transition towards a greener economy in selected sectors	Among the priority actions for this DPF is to develop a law for sustainable urban development that guides the management of public spaces to provide healthier and sustainable urban areas. It promotes the role of green public spaces in improving local climate by reducing UHI and enhancing localized cooling.
To strengthen institutional capacity for local revenue enhancement and land use management in targeted municipalities, and to enhance climate resilience in the coastal cities of Beira and Maputo.	The AF enhanced investments in green infrastructure while acknowledging its benefit in abating UHI. Additional project indicators include coping with effects of climate change, although these are not specific to heat, presumably because the project originally focused on flood protection.
To reduce flood risks in peri-urban areas of Dakar and improve capacity for integrated urban flood risks planning and management for selected cities in Senegal.	The project recognized the risk of UHI and invested in NBS and green features for the mitigation of floods and heatwaves.
To increase the investment capacity of the Municipality of Casablanca, improve the busine ss environment in the city, strengthen the city's resilience to climate change and enhance access to basic services in the Program Area.	The project recognized the risk of extreme heat in Casablanca, and one of its disbursement-linked indicators (DLI) is to strengthen the city's climate action by supporting the upgrading or creation of green spaces with DLR to mitigate UHI. The parent project (P149995), approved in FY2018, included green space investments (for urban attractiveness and mobility) but without a UHI angle. The shift shows an evolving awareness of the heat issue.

P-CODE	PROJECT	APPROVAL YEAR	COUNTRY	REGION	TYPE	COMMITMENT AMOUNT (US$M)
P173312	Resilient Infrastructure for Adaptation and Vulnerability Reduction	2023	Bangladesh	SAR	IPF	500
P168608	Resilient Urban Sierra Leone Project	2021	Sierra Leone	AFW	IPF	56.73
P173316	GEF7: Green and Carbon Neutral Cities	2022	People's Republic of China	EAP	IPF	26.91
P178887	Somalia Urban Resilience Project Phase II Additional Financing	2022	Somalia	AFE	IPF	20
P128605	Sustainable Cities	2017	Turkiye	ECA	IPF	155.24
P172979	Djibouti Integrated Slum Upgrading Project—Additional Financing	2021	Djibouti	MNA	IPF	30
P162901	Djibouti Integrated Slum Upgrading Project	2019	Djibouti	MNA	IPF	50
P175791	Integrated Urban Services Emergency Project II	2021	Yemen	MNA	IPF	170
P168590	Tamil Nadu Housing and Habitat Development Project	2020	India	SAR	IPF	50
P164078	Strengthening Climate Resilience in Burkina Faso	2019	Burkina Faso	AFW	IPF	31

PROJECT DEVELOPMENT OBJECTIVE	ASSESSMENT
To reduce the vulnerability of people in targeted communities to riverine and flash floods and improve the country's capacity in disaster preparedness and response.	A component of the project invested in the construction of flood shelters designed with heat shelter parameters because the project recognized the growing exposure to heatwaves. The project also invested in preparedness measures for extreme events (not specific to heat) by gathering disaster risk management data and supporting emergency preparedness capacity, response, and evacuation procedures.
The Project development objective is to improve integrated urban management, service delivery, and disaster emergency management in Western Area and secondary cities of Sierra Leone.	The project recognized heat as a climate risk and linked it with the investments in NBS, which include urban greening, large-scale tree planting, and rehabilitation of public spaces. The project also invested in early warning, preparedness, and response systems (especially hydromet).
To integrate biodiversity conservation in participating cities' urban development and establish their pathway to carbon neutrality.	The project focused on urban biodiversity and made use of green and blue assets to address UHI and reduce greenhouse gas emissions— a lesson learned from another ASA in Guangzhou (P173306). The project invested in green infrastructure and NBS to mitigate the UHI effect. It also recognized the benefit of investments in mitigating climate impacts, such as excessive urban heat, and in lowering the incidence of heat-related health issues and the energy needs for active cooling.
To strengthen public service delivery capacity of local governments, increase access to climate-resilient urban infrastructure and services, and to provide immediate and effective response to an eligible crisis or emergency in selected areas.	The project invested in climate resilience urban infrastructure, such as greening corridors, trees, public parks, and pedestrian walkways, all of which can help absorb urban heat and support drainage, as well as energy-efficient streetlighting. The project recognized the potential of climate co-benefits but did not assess them in detail. The parent project (P170922, approved in FY2020) did not mention any climate aspect, including heat, in the PAD. This shows an evolving awareness of the urban heat issue.
To improve the planning capacity of and access to targeted municipal services in participating municipalities and utilities.	The project leveraged the sustainable city framework, which integrates planned cities, healthy cities, and smart cities frameworks. In the sustainable city framework, efficient use of urban land to prevent heat islands is among the environment sustainability principles. The project supported sustainable city planning and management, which includes green open space and other heat-relevant investments. The indicator included a specific measurement of pollution, which contributes to UHI effects.
To (i) improve the living conditions of host communities and refugees in selected areas, and (ii) enhance the social and economic integration of host communities and refugees.	This is the additional financing for Project P162901 (refer to the next row).
To (i) improve the living conditions of host communities and refugees in selected areas, and (ii) enhance the social and economic integration of host communities and refugees.	The project recognized heatwaves as a risk and invested in tree planting activities to mitigate them.
To restore access to critical urban services and strengthen resilience to shocks in selected cities within the Republic of Yemen.	The project recognized heat as a growing risk and invested in the rehabilitation of local parks and green spaces to improve management of stormwater runoff and reduce UHI.
To strengthen the housing sector institutions of Tamil Nadu for increased and sustainable access to affordable housing.	The project recognized UHI as a climate risk and invested in green certified housing development, green-building/climate-responsive architecture, and tree planting to reduce UHI.
The Project Development Objective is to improve the country's hydro-meteorological, climate and early warning services, and improve access to such services by targeted sectors and communities.	The project invested in early warning and climate information systems and in enhancing forecasting capacity to measure mean temperature and precipitation— the basic indicators needed to measure heat or calculate the heat index.

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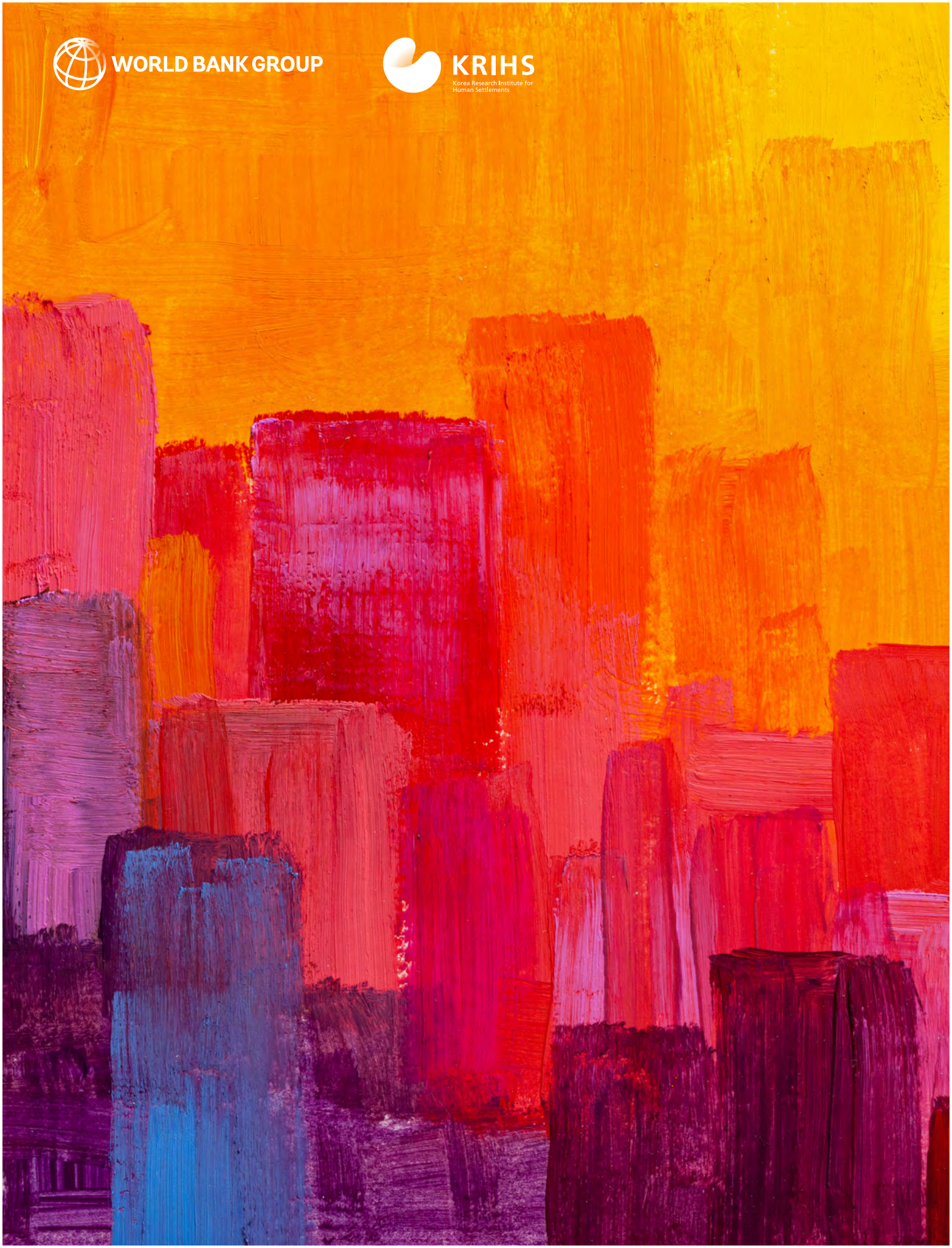
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