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# NEW CHALLENGES FOR XXI CENTURY CITIES

Global warming, ageing of population, reduction of energy consumption, immigration flows, optimization of land use, technological innovation


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TeMA Journal was established with the primary objective of fostering and strengthening the integration between urban transformation studies and those focused on mobility governance, in all their aspects, with a view to environmental sustainability. The three issues of the 2024 volume of TeMA Journal propose articles that deal the effects of global warming, the ageing of population, the reduction of energy consumption from fossil fuels, the immigration flows from disadvantaged regions, the technological innovation and the optimization of land use.

TeMA is the Journal of Land Use, Mobility and Environment and offers papers with a unified approach to planning, mobility and environmental sustainability. With ANVUR resolution of April 2020, TeMA journal and the articles published from 2016 are included in the A category of scientific journals. The articles are included in main scientific database as Scopus (from 2023), Web of Science (from 2015) and the Directory of Open Access Journals (DOAJ). It is included in Sparc Europe Seal of Open Access Journals, and the Directory of Open Access Journals.

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The cover image shows railway street in Hanoi, Vietnam (Source: TeMA Journal Editorial Staff).

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## Contents

REVIEW NOTES

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**REVIEW NOTES – Urban Practices**

# Global warming or global warning? A review of urban practices for adaptation to extreme heat

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**Abstract**
Starting from the relationship between urban planning and mobility management, TeMA has gradually expanded the view of the covered topics, always remaining in the groove of rigorous scientific in-depth analysis. This section of the Journal, Review Notes, is the expression of continuously updating emerging topics concerning relationships between urban planning, mobility and environment, through a collection of short scientific papers written by young researchers. The Review Notes are made of four parts. Each section examines a specific aspect of the broader information storage within the main interests of TeMA Journal. In particular, the Urban Practices section aims at presenting recent advancements on relevant topics that underline the challenges that the cities have to face. This note provides an overview of the challenges that global warming poses and the risks in terms of climate change that it generates for territories and cities, with a specific focus on the extreme heat phenomenon. The challenges that adaptation to extreme heat events commonly faces are outlined, and a brief review of international case studies is carried out. Finally, the results of the review are discussed highlighting some key threads of extreme heat events adaptation practices and three significant examples of adaptation in urban areas are reported, within a perspective of integration and sharing of know-how on the topic.

**Keywords**
Climate change; Adaptation; Urban practices; Case studies; Extreme heat.

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# 1. Introduction

With each passing month, in line with the IPCC predictions, global temperatures continue to rise, setting new and increasingly critical records. According to the Copernicus Climate Change Service bulletin, January 2024 was the hottest January ever recorded. The analyses carried out by the European monitoring service on global surface air and sea temperatures, sea ice cover and hydrological variables confirm the continuing upward trend, keeping global warming at the top of the list of threats to the stability of communities, ecosystems and global balances also for 2024 (Copernicus Climate Change Service, 2024). As set out in the previous review note of this series, in fact, temperature increases are determining factors in altering the climate, interfering with natural weather cycles, and in doing so exacerbating pre-existing conditions of vulnerability and inequality at a global level, leading to a real political and social crisis: the climate crisis (European Environment Agency, 2024).

The extreme climatic hazards triggered by climate change are multiple, different in nature and in the effects they produce. Each of these requires specific independent assessments, evaluations of their mutual correlation, and consequent adaptation strategies that are targeted, effective, and capable of being integrated into existing urban planning practices and adaptation to other pressing climate hazards. Building resilience to contain the risks for inhabitants, businesses and infrastructures deriving from the impact of climate change represents a challenge for local planners and public decision-makers (Palermo et al., 2024).

In the previous note of this series, a review of several European climate change adaptation case studies was conducted, the analysis of which, although limited and not exhaustive, allowed the identification of some prevailing threads of action on the basis of the climate impacts or the sector concerned. Five categories were identified: extreme temperatures, extreme rainfall and flooding, drought and alteration of ecosystems due to extreme heat, physical and psychological human health and the spread of dangerous viruses and invasive species, and finally governance measures (Pennino, 2024). In their conciseness, these five categories constitute a useful framework for schematising and unifying the analysis of adaptation strategies to complex climatic phenomena, bringing their study back to the monitoring of two naturally variable causes: water sources and temperature variations, and their respective effects on three sectors: ecosystems and biodiversity, human beings, and the governance of the aforementioned systems.

As a prosecution of this analysis, this review note aims to deepen the investigation of case studies of urban practices of adaptation to climate change, focusing however on examples related to extreme temperatures and their impacts on the different subsystems mentioned. Adaptation to climate change and the need to deal with its impacts pose in evidence how important it is to identify and implement new planning practices that integrate these profiles into land-use policymaking (Isola et al., 2024).

# 2. Adaptation to extreme heat

Extreme heat events or so-called "heat waves" when they persist more than two following days can be defined as periods that are much hotter than usual for the time of year and the area where they take place (Eltahir & Krol, 2022), and are characterised by stagnant warm air masses and consecutive nights with high minimum temperatures (Luber & McGeehin, 2008). Climate change models and statistics developed so far show a correlation between climate change and the frequency and intensity of extreme heat events, increasing the risk associated with the phenomenon and making the measures to be taken in this regard more urgent (U.S. Environmental Protection Agency, 2016). Indeed, these phenomena constitute a major risk to human health, being the first cause of weather-related deaths in the United States (NOAA's National Weather Service, 2023) and a prevalent cause in many other countries. In addition to this, extreme heat also poses a threat to infrastructures such as roads and power lines (Cybersecurity & Infrastructure Security Agency, n.d.), constitutes a risk factor for energy security, as increased energy consumption for air-conditioning causes an increase in demand and also affects production costs (Center for Climate Change and Health, 2016), can

damage or kill crops and livestock, and contributes to natural disasters such as droughts and wildfires (European Commission, n.d.).

Due to some compounding factors, extreme heat is a prominent risk in urban environments. There are in fact two factors that exacerbate the phenomenon in these areas:

- The first is the urbanization rate; this in fact has an impact on the so-called "urban heat island" phenomenon, a state that increases the perceived temperature and, depending on the morphology of cities, prevents the dissipation of the hot air masses that characterise periods of extreme heat.
- The second is the ageing of the population; this demographic trend, combined with the concentration of the population in urban areas, implies a greater concentration of people vulnerable to these phenomena precisely in urban areas, requiring even more effective and targeted strategies in these areas.

Urbanization has a great effect on the change in land cover and urban planning is the most relevant decision-making process affecting urban land covers (Dinç & Gül, 2021). Moreover, the multidisciplinary nature of the issue highlights how reducing the phenomenon of urban heat islands also leads to an improvement in the energy efficiency of urban settlements (Gaglione & Ania, 2021).

The less visibly evident nature of this type of climatic phenomena sometimes causes little public recognition and even underreporting of their effects, making them a silent killer (Luber & McGeehin, 2008). In recent years, however, interest in this type of phenomena has increased significantly, and several cities around the world have put in place adaptation measures such as increasing urban greenery, increasing the albedo of urban roofing and pavement surfaces, financial support programmes for low-income people, public health strategies, monitoring tools, communication campaigns, public cooling shelters, and in the most virtuous cases a combination of these strategies through the drafting of actual Heat Response Plans. A research group of the University of Oxford published in 2021 a systematic heat-specific review of implemented actions, reporting on the state of the art of implemented extreme heat adaptation actions. From their results, they found that in the more developed high-income countries extreme heat is mainly treated as a health issue and with particular reference to urban areas, while in low- and middle-income countries adaptation strategies focus more on agriculture and livelihood impacts, often including related phenomena such as drought (Turek-Hankins et al., 2021).

Strategies for adapting to extreme heat are therefore diverse and differentiated according to geographical region and national income, and there is currently a substantial body of literature on the subject and collections of case studies. From a comparative study of review papers on the topic, and of various repositories of case studies, it was possible to identify leading threads of extreme heat adaptation, and the organisations and fields that support and guide each of these.

## 3. A review of case studies

Climate change is a global issue, affecting all regions of the world but impacting each one in different ways, depending on pre-existing conditions. As such, at the global level, UN-sponsored organisations and programmes are at the forefront in funding and implementing adaptation strategies and actions. Through a complex bureaucracy of bodies, organisations, conventions and frameworks, the United Nations is engaged in producing reports and guidelines that can guide countries to implement locally targeted adaptation actions. In addition, they directly promote the actions carried out in lower-income countries, thus having organisations that operationally follow up on the design and implementation of adaptation actions worldwide.

Among the many outcomes of this UN-coordinated work is the Adaptation Knowledge Portal of the United Nations Framework Convention on Climate Change, an online resource of the UNFCCC Knowledge-to-Action Hub for Climate Adaptation and Resilience (also called as the Nairobi work programme (NWP)). This repository collects and makes available numerous knowledge resources on climate change adaptation such as tools, documents, methodologies and an extensive collection of case studies. This portal brings together many of

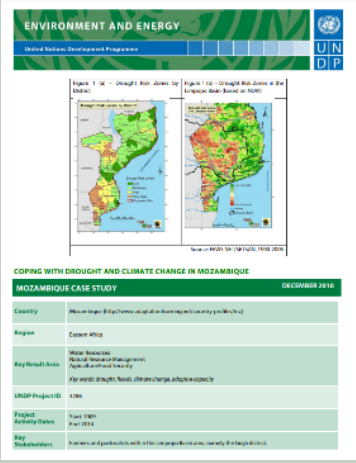
the projects carried out by large organisations (Wetlands International, International Union for Conservation of Nature, etc.), NGOs (WWF, Conservation International, etc.) and international organisations (UNDP, UNESCO, etc.). In terms of adaptation to extreme heat, in accordance with the results of the review by Turek-Hankins et al. (2021), this platform brings together most of the adaptation actions carried out in low-income countries. Thus, these case studies focus on adaptation in terms of agriculture and cultivation, and the maintenance of local livelihoods and livability for the inhabitants of global areas that are heavily impacted by rising temperatures and that previously showed higher levels of vulnerability.

At the opposite end of the spectrum, numerous international networks have sprung up to collect and connect the experiences of higher-income areas, focusing especially on cities that, due to their concentration of activities and people, are particularly relevant to the climate change issue, both on the side of causes and mitigation, and on the side of consequences and adaptation. One of the most famous and influential networks is C40, which brings together the experiences of the world's largest cities engaged in climate action. In 2021, C40 published a report on Urban Heat & Equity, reporting on the experiences of the 12 cities in the C40 Cool Cities Network. This report brings together case studies of cities with very different social and geographic characteristics and stands out because it links the issue of adaptation to extreme heat with that of spatial justice or climate justice. In fact, the case studies in this report are a remarkable resource for analysing the relationship between the socio-demographic characteristics of a city and its geographical and ecosystemic characteristics, for the development of plans and strategies for adapting to extreme heat that are integrated, multifaceted, just and inclusive.

A third specialist source of case studies, halfway between the two previous examples, is the repository of Case Studies and Heat Action Plans of the Global Heat Health Information Network, an independent international forum of scientists, practitioners and policy makers focused on improving the capacity to protect populations from the avoidable health risks of extreme heat in the context of climate change. This network of practitioners, funded by the WHO and WMO among other institutions, has a clearly defined strategy of action organised in 5 pillars, ranging from capacity building to monitoring services up to communication and outreach. In fact, the case studies reported by this organisation stand out for the integrated approach they present, being characterised as multi-focus interventions that integrate principles and good practices of climate change adaptation, comprehensively improving the health of the people they address.

In order to provide a multi-faceted overview of case studies, one has been extrapolated from each of the cited repositories.

### 2.1 Coping with drought and climate change (CwDCC) in Mozambique



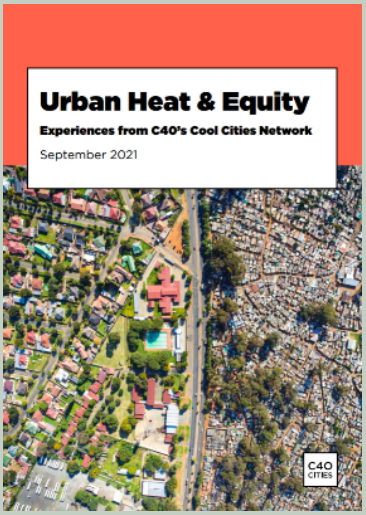

Mozambique is one of the poorest countries in the world and it is also frequently affected by natural disasters. Recent natural disasters have included droughts over consecutive years, alternated with severe flooding. The current coping strategies the communities use during the droughts are not adapted to the environmental changes, but often lead to further environmental degradation. To address vulnerability in the agriculture sector, the project is developing and piloting a range of coping mechanisms to enhance food security and the capacity to adapt to climate change in agricultural and pastoral systems. The aim of the project is to reduce vulnerability to drought in farming and pastoral communities by diversifying agricultural production to cope with changed climatic conditions. More specifically, the Mozambique CwDCC project will reduce drought vulnerability in farming and pastoral communities by guaranteeing water supply and through training the local communities to grow drought-resistant crops, like sweet potato, cassava or sorghum. The project will also help improve the communication lines to make weather forecast and climate information available to communities. Moreover, the project will address water supply issues through construction of water harvesting cisterns.

Organization: UNDP – United Nations Development Programme

Source: UNDP Climate Change Adaptation Portal, UNFCCC Adaptation Knowledge Portal; 2024

Retrieved from: https://www4.unfccc.int/sites/NWPStaging/Pages/item.aspx?ListItemId=23200&ListUrl=/sites/NWPStaging/Lists/MainDB&SearchId=86801ab1-b396-d2f8-2c74-f76687b61550, https://www.adaptation-undp.org/projects/coping-drought-and-climate-change-cwdcc-mozambique

### 2.2 How does your city integrate inclusivity and equity in planning and delivering heat actions? The Mexico City case study




The Government of Mexico City has developed the "Green Infrastructure Master Plan" whose goal is to reconnect the Conservation Land and Natural Protected Areas, with the urban land; to provide the city and its inhabitants with green spaces for multiple environmental, social and cultural purposes, and to contribute to the mitigation and adaptation to climate change. This plan includes four main programmes:
1) Designing of Parks;
2) Socio-Environmental Restoration of Conservation Areas;
3) River Sanitation;
4) Green Challenge.
Its aim is to protect, conserve, and build new green areas around the city, focusing on the city's marginalised zones.
Designing of parks is an effort between SEDEMA, the Water System (SACMEX, in Spanish) and the Public Works and Services Ministry (SOBSE, in Spanish). Its aim is to protect, conserve, and build new green areas around the city, focusing in the city's marginalised zones.
To select those areas a regionalisation (mapping) of Mexico City was done. The criteria to do it were the type of climate, type of soil, type of vegetation, land use, habitability index. The habitability index measures the population's access to health, transportation, job, education, services. Areas with a less habitability index are those where it is needed to pay more attention to provide services. Then these criteria were crossed with geological, hydro-meteorological, and chemical-technological risks. The final criterion crossed was the accessibility to green areas. With this information the areas to build green areas were selected, taking into account free space to do it.
The goals of the programme included:

- Expanding and improving green areas per citizen;
- Revegetation of the city;
- Building green spaces for recreation and enjoyment of citizens;

The selection of vegetation to be used in each park was made considering its potential and contribution to environmental services such as soil conservation and improvement, humidity regulation, heat island mitigation, rainwater infiltration, carbon capture, pollinator attraction, biodiversity, among other aspects, which also considers comfort parameters and the application of new technologies to improve the environment. Until now, the city has rehabilitated 11 parks of 16 for example Xochimilco Ecological Park, National Canal Linear Park or Grand Canal Linear Park.

The local community is involved to be part of those changes in their area in order to appropriate, enjoy and take care of the green spaces.

Organization: The Government of Mexico through its Ministry of Environment (SEDEMA) with the Water System (SACMEX) and the Public Works and Services Ministry (SOBSE)

Source: Urban Heat & Equity, Experiences from C40's Cool Cities Network; September 2021

Retrieved from: https://www.c40knowledgehub.org/s/article/Urban-Heat-and-Equity-Experiences-from-C40s-Cool-Cities-Network?language=en_US

**2.3 AI for Resilient Cities: bringing together technology and community outreach for heat-health interventions in India**

This intervention deals with using AI to provide early warning of heatwaves and developing and disseminating early warnings to vulnerable populations. In India, most vulnerable communities do not have access to either information about the occurrence of these events, or the understanding of risk from current warnings. This lack of useful information inhibits pre-emptive and potentially life-saving action.

SEEDS, in partnership with Microsoft, has developed the AI for Resilient Cities model. The AI for Good Lab research program has been funded primarily by Microsoft. The model leverages weather datasets (e.g., temperature patterns, built-up roof type classification, vegetation cover, water bodies) and high-resolution satellite imagery to identify areas at high risk of heatwaves. SEEDS uses the AI generated maps to find high risk homes, prioritize outreach for early warning and preparation, and demonstrate the significance of heat risks to locals (since many residents underestimate the danger that they face). Furthermore, early heatwave warning allows healthcare providers to take proactive measures to protect public health, reducing the overall burden of heatwaves on the healthcare system and leading to more climate-resilient cities. Evidence based outreach also allows SEEDS to implement long term heat mitigation interventions such as: monitoring temperature and humidity through Automatic Weather Stations (AWS), infrastructure interventions such as cool roofing strategies and water supply point repair, heatwave preparedness and response, including the establishment of cooling centers and the distribution of heat-health advisories.

Once the AI tool has identified the households at risk, SEEDS begins outreach to prepare for the upcoming heatwave and implement solutions. Approximately 2,500 volunteers from the local community have been engaged by SEEDS thus far. The outreach program has included the following activities: mobilizing some 40 women as community leaders to lead door to door awareness campaigns, training frontline workers, including 13 traffic police officers, 247 civil defense officers, 154 Anganwadi workers, and 32 ASHA workers, training of some 60 community volunteers in communication skills to effectively educate and engage the community, educating over 6,100 students about climate change and heatwaves, creating posters for the beat the heat campaign to ensure widespread awareness of heatwave risks and precautions. Besides the community, SEEDS partnerships also extend to government organizations and agencies who focus on climate resilience, heat and health.

The existing framework for the AI for Resilient Cities program exhibits high scalability potential because of its community centric design, so the program can easily be tailored to suit diverse cultural, social, and geographical contexts. By combining data driven modelling with community engagement and low cost, sustainable interventions, it offers a holistic approach to climate adaptation.

Organization: Sustainable Environment and Ecological Development Society (SEEDS)

Source: Global Heat Health Information Network; 2023

Retrieved from: https://ghhin.org/resources/ai-for-resilient-cities-bringing-together-technology-and-community-outreach-for-heat-health-interventions-in-india/, https://climahealth.info/resource-library/ai-for-resilient-cities-bringing-together-technology-and-community-outreach-for-heat-health-interventions-in-india/

## 4. Considerations from case studies

Extreme heat is an inevitable climatic hazard that will occur more and more frequently and intensely due to climate change. The assessment of the intensity of the occurrence though, and the development of the coping

strategies, are not easy due to the complexity of the phenomenon. It is indeed strictly tied to the level of urbanization of the area, to the locally pre-existing conditions of vulnerability, and among this occurrence the socio-demographic situation of the specific community affected.

A wide range of targeted measures are now well established as effective solutions to extreme heat assessment, prevention or coping mechanisms like monitoring systems, increase of urban surfaces albedo or urban greening, and heat wave support procedures for the elderly. Due to the intrinsic complexity of climate change itself though, single specific and targeted actions can sometimes risk to not effectively integrate in the broader pre-existing context, lowering the level of success of the whole strategy.

The three case studies reported from the different repositories have been specifically selected for the broader vision that characterises them.

The first case study integrates a strategy aimed at reducing the vulnerability of the agri-pastoral system of the region together with reducing the vulnerability of the community affected by the natural threat and having to actively deal with it. This example offers a good practice of capacity building, and it manages to jointly deal with the environmental and the social aspect of the phenomenon, and by doing so it also strengthens the economic system both on the side of the products and of the producers. This intervention is also an example of ecosystem-based adaptation. In order to be effective and long-lasting, adaptation interventions must be developed accordingly to the natural, social and historical characteristics of the target area, in order to well integrate into it, last during time, and obtain the maximum possible outcome in terms of ecosystem services provided. Ecosystem Services are crucial elements for human well-being, and despite their inclusion in urban plans, there are still issues to address requiring innovative research approaches and trajectories to explore for planning the ecological and digital transition of cities (Moraci et al., 2024).

The second case study integrates planning of parks and greenery with the provision of services to the population. It particularly stresses on two key concepts of effective adaptation: to be local-based, in fact it is accurately designed on the technical side to take advantage of the particular characteristics of the soil and the area identified; and to engage the community, developing a sense of attachment and cure which will also encourage further preservation of the area. This second example also represents a sustainable intervention, as it is designed to concurrently cope with environmental and social needs, also optimizing the use of economic resources while dealing with extreme heat and other extreme climate events at the same time.

The third case study is a comprehensive good practice. It involves the use of the most recent technologies, therefore implementing the now well-established extreme heat monitoring systems with AI, with the community engagement and capacity building. This practice stresses the great helpfulness, but insufficiency, of technologies and ICT systems, that must always be integrated with appropriated training of the operators, engagement and sensibilisation of the citizens, all with a great care towards inclusivity and the empowerment of less regarded social categories, in this case women.

This brief overview on the state of the art of adaptation to extreme heat and the presentation of three different case studies collects the main actual trends and underlines some key concepts that will be central in the effective implementation of climate change adaptation interventions. Raising awareness in the civil population is a first common need to increase effectiveness, sharing, and support given to the implemented action. The targeted training of all the operators involved, the volunteers, the community leaders is also a key factor as it increases the positive outcomes of the actions implemented and becomes a key element of the capacity building, strengthening the skills of the locals and reducing their vulnerability to the climatic threat. Pertinent communication is also a clue element, it is needed to inform the citizens, to further raise awareness, and it needs to be differentiated depending on the population target of the communication. Finally, a strong reliance on the characteristics of the single area, both in terms of environment, culture, people and economy is always the base for an effective climate change adaptation intervention.

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## Author's profile

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