



INSTITUT DE HAUTES  
ÉTUDES INTERNATIONALES  
ET DU DÉVELOPPEMENT  
GRADUATE INSTITUTE  
OF INTERNATIONAL AND  
DEVELOPMENT STUDIES



WORLD  
METEOROLOGICAL  
ORGANIZATION

## **Heat Health Warning Systems: Progress, Success Stories and Challenges**

Interdisciplinary Master's in International and Development Studies, Geneva Graduate Institute

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Applied Research Project (ARP 5\_04)

Global Health Track, World Meteorological Organization (WMO)

July 7, 2023

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**Disclaimer:** The findings of the report are those of the authors and do not necessarily reflect those of WMO or its Members. The report is based on available data at the time of writing the report and is not meant to be exhaustive.

## Table of contents

<b>Abstract</b>	<b>p.3</b>
<b>Introduction</b>	<b>p.4</b>
<b>Methodology</b>	<b>p.6</b>
<b>Presentation of Results</b>	<b>p.7</b>
<b>Background Research Findings:Controversy Around Defining Heatwaves</b>	<b>p.7</b>
<b>Chapter 1. Disproportionate effects on the vulnerable</b>	<b>p.10</b>
1.1 Biological and Social Vulnerability	
1.2 Systemic Vulnerability	
<b>Chapter 2. Global Trends</b>	<b>p.16</b>
2.1 Heatwave and Heat Health Warning System	
2.2 Characteristics of a strong Heat Health Warning System	
<b>Chapter 3. Stakeholder Engagement</b>	<b>p.22</b>
3.1 Actors and tools involved	
3.2 EXTREMA Global App	
3.2.1. A successful model of Heatwave Risks Management and Health Protection	
Recommendations	
3.2.2. Building Integrative Networks for Cooler Cities: the <i>story</i> of EXTREMA	
Global	
<b>Conclusion</b>	<b>p.28</b>
<b>References</b>	<b>p.29</b>

*“Every year is warmer than the year before[...] so my life is heatwaves” - Piero Pelizarro*

## Abstract

As climate change continues to shift natural climatic conditions, heatwaves have been and are expected to continue to worsen for the foreseeable future. For a long time, heat was often seen as a climatic condition rather than a destructive event, however following recent catastrophic heatwave events, governments of scale have begun to more broadly invest in heatwave response programs.<sup>1</sup> In seeking to better inform the planning and investment of these response and preparedness efforts, the World Meteorological Organisation (WMO) has partnered with the World Health Organization (WHO) under the banner of the Office of Climate and Health and commissioned a study of the state of global heatwave response systems and an inventory of the characteristics that constitute a strong response system. In pursuance of this mandate, students of Geneva Graduate Institute, Jieun Yoo, Clara Zuccarino and Jack Wesley Ralston have conducted analyses under each of these goals respectively through state survey data on heatwave response system coverage and through interviews with key stakeholders on an innovative approach to heatwave warning services, EXTREMA Global App. We found significant gaps in reporting data and low coverage in African and South-West Pacific regions, particularly in Heat-Health Warning Systems (HHWS), as well as clear stratification of coverage along socioeconomic lines, with small island developing states (SIDS) and least developed countries (LDCs) showing the highest frequency of no reported systems. In our interviews, interviewees made common remarks about how cities are unprepared for the devastating effects of heatwaves and how current response systems do not meet the needs of reaching those endangered, particularly vulnerable communities. The participants also emphasized framing heatwave messaging within parameters of local cultural dialogues. Finally, interviewees reflected on the novel approach of EXTREMA, an app-based approach to heatwave alert dissemination, ‘cool route’ routing, and data collection. They discussed EXTREMA’s values in accessing hard-to-reach communities, but reflected on their requirements for a well-developed ‘digital infrastructure’. Participants also expanded on EXTREMA’s possibilities as a model technology to plan sustainable infrastructure projects and coordinate multi-sectoral responses like never before.

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<sup>1</sup> World Meteorological Organization, “Early Warning Systems Must Protect Everyone within Five Years,” World Meteorological Organization: Weather - Climate - Water, March 21, 2022, <https://public.wmo.int/en/media/press-release/%E2%80%8Bearly-warning-systems-must-protect-everyone-within-five-years>.

## Introduction

The history of heatwaves is one of *continuous reassessment of changing hazards*. Three years stand out in public discourse surrounding heatwaves, constituting a watershed between a “before” and “after” in history. The episodes in question are the 1995 Chicago Heat Wave, which led to the loss of 739 people over the period of five days<sup>2</sup> and represents nowadays a role for heat preparedness; the 2003 Heat Wave in Europe with the highest temperatures in the region for 500 years, causing the death of 20,000 people<sup>3</sup>; the Russian Heat Wave of 2010, killing an estimated 55,000 people.<sup>4</sup>

Why are these events so relevant for us? The report *Heatwaves and Health: Guidance on Warning-System Development*<sup>5</sup> displays that the interest in the development of Heat-Health Warning Systems has been relatively recent, with new systems in Europe only implemented right in the aftermath of the extreme events of 2003. Most importantly, it sheds light on another crucial fact: despite international experience regarding the development of HHWSs since 1995, this information has not been accumulated in a single volume. Indeed, a key characteristic of HHWSs is their constantly evolving sophistication. In order to provide for effective assistance to governments and decision-makers, lessons gained from past experiences of early warning systems should be taken into account.

This applied research project follows the World Meteorological Organisation (WMO)’s need to build a review of heatwave warning systems in the State of Climate Services Report to be included among the materials of the 28th Conference of Parties of the United Nations Framework Convention on Climate Change. The theme of the new report is Climate Services for Health, which reflects an increased attention to the human experience of the climate in light of its effects on health. In 2022, WMO issued a call for case studies to collect stories of how climate services are functioning in communities of scale around the world today. These case studies,

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<sup>2</sup>Cusick D. (2020). *Chicago Learned Climate Lessons from Its Deadly 1995 Heat Wave*, Scientific American. Available at: <https://www.scientificamerican.com/article/chicago-learned-climate-lessons-from-its-deadly-1995-heat-wave1/>

<sup>3</sup>Met Office, *The heatwave of 2003*. Available at: <https://www.metoffice.gov.uk/weather/learn-about/weather/case-studies/heatwave#>

<sup>4</sup>Hoag, H. *Russian summer tops 'universal' heatwave index*. Nature (2014). <https://doi.org/10.1038/nature.2014.16250>

<sup>5</sup>G.R. McGregor, P. Bessemoulin, K. Ebi and B. Menne. (2015). *Heatwaves and Health: Guidance on Warning-System Development*, World Meteorological Organisation - World Health Organisation.

along with surveys conducted by the WMO and WHO on the presence of heatwave warning systems and the integration of meteorological data in those warning systems, comprise our data repository.

Our primary objective is to synthesize these disparate global datasets to create a narrative about how climate services are used to mitigate the risk of heatwaves, especially related to public health and the most vulnerable. The goal is to analyze the available data and derive an inventory of what characterizes a strong heatwave warning system through the extraction of regional, socio-economic and global trends. These observations contribute to answering our primary research question: “What are the key elements of a robust Heat Health Warning System?”. After deriving key conclusions from these analyses, we then incorporate them into our inventory framework to support our previous observations.

After our initial draft, we have continued to develop these observations alongside our WMO partners to identify the core aspects of successful heatwave warning systems. Having disparate datasets facilitates the robustness of our review, which allows us to also formulate answers to our secondary research questions including: “What are the main challenges (that you can control or not) to successfully establish a HHWS (Heat Health Warning System)? What is the world’s situation regarding the HHWS? How many countries have Heat Health Warning Systems? What are some of the success stories? What are the benefits of Heat Health Warning Systems? What are the gaps in Heat Health Warning Systems?”. By incorporating these further considerations into our review process, we aim at ensuring that our conclusions are broad and globally considerate.

Additionally, with the help of the results drawn from our data, we dedicate particular attention to the biological and socio-economic vulnerabilities that are further exacerbated by heatwaves. Our second primary objective of the research is to select a case study that represents unique perspectives on climate services for health to be featured as a more stakeholder-user oriented storytelling feature of the report. We have facilitated interviews with the stakeholders featured in our key case study to tell the individual stories of heatwave warning systems through their experience using EXTREMA Global App. These participants include Chief Heat Officers, Senior Advisors for Resilience and Sustainability and Head of Sustainability and Industry Affairs, individual recipients of heatwave information involved in the structure of the systems. The contribution we aim at providing and our ultimate goal is to facilitate the discussion of

climate services and the global improvement thereof through robust HHWS analysis and discussion into countries that lack such systems to promote public well-being and health especially related to heat-related illness.

## **Methodology**

The data collection for the report comprises one primary dataset. This consists of two surveys conducted by the WMO and WHO, respectively, asking about the existence of a Heatwave Warning System (HWS) and a Heat-Health Warning System (HHWS). We did not participate in the collection of data, but rather synthesized the sets into one master set. From the consolidated dataset, we worked with the WMO team to derive indicators of a country's heatwave system status based on whether it responded "Yes" to having an HWS or a HHWS. We derived 5 indicators, divided as follows: 1) countries that responded "Yes" to having both a HWS and a HHWS; 2) "Yes" to having a Heatwave Warning System (HWS), but not a Heat-Health Warning System (HHWS); 3) "Yes" to having a Heat-Health Warning System, but not a Heatwave Warning System; 4) "No" to both, and 5) "No data". We mapped these trends globally from these datasets, both individually from each survey and together to derive synthesized trends. We then conducted direct analyses based on the distributions of these indicators, as well as their spatial and socio-economic character, using their respective regional and socio-economic WMO designations as measures of these features. Reflecting the reporting of survey-related systems along geographical and socio-economic indicators allowed us to extrapolate conclusions and trends using stacked bar graphs and a global map. By using the WMO's Member States, regional and socio-economic categorization as the full representative reference sample, the main limitation was that, despite the attempt to bring WHO's relevant data into perspective, the conclusions inevitably reflect more the WMO.

First, the robustness of the relevant information we have gathered from the data has allowed us to directly address some of the fundamental questions: "What is the world's situation regarding the HHWS? How many countries have Heat Health Warning Systems? What are the gaps in Heat Health Warning Systems?". After that, the collected facts formed the basis for answering the remaining queries "What are the main challenges to successfully establish a HHWS? What are some of the success stories? What are the benefits of Heat Health Warning

Systems?”), the answers to which were facilitated by the information gathered through interviews with some of the key stakeholders who featured in our case study to tell their individual stories of heat-health warning systems.

## **Presentation of Results**

### **Background Research Findings: Controversy Around Defining Heatwaves**

Heat has been considered as a vital health risk and is expected to pose a significant danger to public health with the exacerbating climate crisis. However, low awareness on health risks triggered by heat still persists and thousands of deaths which could have been preventable occur annually.<sup>6</sup> Much of this stems from the fact that climate variability and change is seen mainly as an environmental issue, as opposed to a health one over the twentieth century by the international community. The concept of climate services has emerged in response to this development gap, which recognizes a need for provisioning public and governance support for increasingly risky climatic conditions. However, “Climate service related health projects continue to be developed in isolation and are typically ‘supply-driven’ by the interests and projects of meteorological agencies and health institutions rather than ‘demand driven’ by the decision-support needs of health actors in developing countries.”<sup>7</sup>

The keystone resolution from the World Health Assembly (WHA) in 2008 on Health Protection from Climate Change (WHA61.19) signaled a broader shift to incorporating climate considerations into health. In recognizing this gap in provision, the Third World Climate Conference in 2009 and the World Meteorological Conference in 2011 mandated the Global Framework for Climate Services, which identifies health as a priority alongside disaster risk reduction, agriculture and water resources. Another resolution in 2011 focused on strengthening national health emergency and disaster management capacities for managing the risk of meteorological or other extreme events (WHA64.10). This increasing recognition of health as an essential aspect of a changing climate has allowed for more formal and comprehensive

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<sup>6</sup> World Health Organisation(WHO), and Word Meteorological Organisation(WMO). “Atlas of Health and Climate.” World Health Organization, October 24, 2012. <https://www.who.int/publications/i/item/9789241564526>

<sup>7</sup> World Health Organisation(WHO), and Word Meteorological Organisation(WMO). “Atlas of Health and Climate.” World Health Organization, October 24, 2012. <https://www.who.int/publications/i/item/9789241564526>



cooperation between health and climate agencies. Greater formal integration between the sectors has followed this shift, as the Joint Office for Climate and Health was established and seeks to strengthen, harmonize and leverage resources and opportunities to empower and support Member States and partners through interagency cooperation.<sup>8</sup> This partnership is what the State of Climate Services Report and consequently our project were created through.

In moving to unify approaches to climate-related health threats at a local level, many National Hydrological and Meteorological Services (NHMS) have recently been actively participating in coordinated efforts to come up with Heat Action Plans (HAPs) with different stakeholders and agencies that could provide extreme heat warnings to save people's lives. However, such collaborative measures are yet to be implemented widely across the regions. There is still a need for more cooperation between agencies to define heat as an important meteorological threat and efficiently implement relevant actions to protect the health and well-being of people.<sup>9</sup>

As heat has been highlighted as a major hazard to public health, there has been an increase in a demand for naming and defining heatwaves. Nevertheless, there are several contexts that prevent the incidents of naming extreme weather phenomena from being equally applied across the countries in the world. Currently, there is no common international system, regional or national protocol or framework to name and coordinate the appropriate naming of events related to heatwaves. Agreed protocol and naming for heatwaves would be required to guarantee effectiveness and avoid misnaming. Moreover, during such process of naming, each nations' National Hydrological and Meteorological Services (NHMS), which possess the national duty of forecasting and warning extreme weather and relevant hazardous influence, must be involved in the process of developing a heatwave naming system that aligns with current warning provision services. Without involvement of NMHS in naming heatwaves, if a third party names a weather event using different criteria without examining a national context and publicly announces the event, such consequence would weaken the authority of the weather-related

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<sup>8</sup> World Meteorological Organization (WMO), and World Health Organization (WHO). "WHO - WMO Joint Climate and Health Programme." ClimaHealth. Accessed June 23, 2023. <https://climahealth.info/who-wmo-joint-programme/>

<sup>9</sup> WMO. "CONSIDERATIONS REGARDING THE NAMING OF HEATWAVES." *Technical Brief*, SERCOM 2 - INF 5.10 (1a) (Oct 2022): 1. [https://library.wmo.int/index.php?lvl=notice\\_display&id=22190](https://library.wmo.int/index.php?lvl=notice_display&id=22190)

organizations, trigger confusion among the public and provoke unnecessary debates regarding the naming and could lead to public distrusts in relevant authorities.<sup>10</sup>

Recently, a civil society from the United States has proposed to name and rank heatwaves and started to pilot such an approach in several countries. The World Meteorological Organization (WMO) has assessed the advantages and disadvantages of naming extreme weather events, especially related to heat, and has stated that it needs to be cautious when promoting or adopting such practice. First of all, for the public, deciding on the definition of heatwaves would increase awareness of heat-related impacts on society, while conflicts in the naming would result in confusion with other early warning systems (EWSs) and false sense of security concerning heatwaves. Second, regarding insurance, categorization of heatwaves according to health impacts could create a market for heat insurance. However, a singular naming system would not suit all the different insurance types ranging from energy to transport. Third, in regard to NMHS, appropriate naming of heatwaves would raise awareness of its hazard but non-official naming would lead to tensions among relevant bodies such as private weather forecast providers by undermining authoritative decision and local level warning systems. Fourth, labeling heatwaves globally would make it easier for the media to create relevant stories due to the fact that they can be very varied in intensity and impact across a region or city and can therefore complicate communications regarding heat-related risks. Lastly, for public health and emergency governmental organizations, such naming procedures could increase awareness on heatwaves. However, there might be only specific attention given to heatwaves situations, and not equally distributed to hazardous chronic heat.<sup>11</sup>

Based on the current situations concerning the definition, there has been a demand in services from health agencies since the impacts from severe and extreme hot weather has broadly affected society. The importance of defining heatwaves has been reflected in the particular interests in heatwave forecast systems. Health agencies expect to differentiate the impacts on a regional level so that they will not over-warn the public and rather provide warning services according to regionally appropriate strategies.<sup>12</sup>

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<sup>10</sup> WMO. "CONSIDERATIONS REGARDING THE NAMING OF HEATWAVES." *Technical Brief*, SERCOM 2 - INF 5.10 (1a) (Oct 2022): 2. [https://library.wmo.int/index.php?lvl=notice\\_display&id=22190](https://library.wmo.int/index.php?lvl=notice_display&id=22190)

<sup>11</sup> WMO. "CONSIDERATIONS REGARDING THE NAMING OF HEATWAVES." *Technical Brief*, SERCOM 2 - INF 5.10 (1a) (Oct 2022) : 3. [https://library.wmo.int/index.php?lvl=notice\\_display&id=22190](https://library.wmo.int/index.php?lvl=notice_display&id=22190)

<sup>12</sup> The Centre for Australian Weather and Climate Research. "Defining heatwaves : heatwave defined as a heat-impact event servicing all community and business sectors in Australia " *CAWCR Technical Report*, No.060 (Mar 2013) : 66. [https://www.cawcr.gov.au/technical-reports/CTR\\_060.pdf](https://www.cawcr.gov.au/technical-reports/CTR_060.pdf)

## Chapter 1. Disproportionate effects on the vulnerable

### 1.1 Biological and Social Vulnerability

Heatwaves, like many climate change challenges, act as a magnifier of both existing biological and socioeconomic vulnerabilities. This gives heatwaves a particularly wicked sensibility that demands more attention and planning toward risk mitigation. The effects of heatwaves can include cramps, fainting, heat exhaustion, heatstroke, dehydration, disease exacerbations.<sup>13</sup> Biologically, those with preexisting morbidities, such as heart disease, obesity, and high blood pressure are more likely to be in serious danger during extreme weather, as it challenges our bodies' homeostatic regulation mechanisms. This is particularly concerning given that increasing prevalence of chronic disease infers increasing population risk of death during a heatwave.

As our advisor and Senior Advisor of extreme heat, John Nairn noted, the most insidious features of heatwaves are not the temperature highs, but rather the increased lows at night. This coincides with a wealth of academic development of heat threshold impacts through Australia's advanced management of heatwaves, which has found that mortality rates are higher in vulnerable populations when the average minimum temperature exceeds a threshold.<sup>14</sup> Rather than what we deem 'extreme heat', that being the periods of acutely high temperature, that is most of concern, Nairn notes how important, but underappreciated the danger of 'severe heat' is. Severe heat lasts longer and leads to greater retention of heat at ground level overnight, which puts homeostatic regulation and processes that are essential for health, such as sleep, in extreme risk. The period of the heatwave is also of extreme importance when considering biological vulnerability. While this extreme weather event that scorches for a few days may draw greater media attention and boast more alarming figures at face-value, it is the unrelenting, but lower temperature heatwaves that deeply cripple society.

In interviews conducted on WMO's behalf to assess the characteristics of comprehensive heatwave response systems, former Chief Heat Officer for the City of Athens Eleni Myrivili noted how vulnerability is often assessed by city officials through biological markers. Not only

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<sup>13</sup> Julio Diaz, Cristina Linares, and Tobias Aurelio, "Critical Comment on Heat Wave Response Plans | European Journal of Public Health | Oxford Academic," September 13, 2006, <https://academic.oup.com/eurpub/article/16/6/600/587702>.

<sup>14</sup> Neville Nicholls et al., "A Simple Heat Alert System for Melbourne, Australia," *International Journal of Biometeorology* 52, no. 5 (May 1, 2008): 375–84, <https://doi.org/10.1007/s00484-007-0132-5>.

are people with morbidities at increased risk during severe heat, but the biologically predisposed, such as the very old and the very young can face the most serious harm. Whereas older people tend to spend more time sedentary, and may often not be able to move in the case of heat danger, young children tend to spend more time outside and in contact with the ground, which can cause them to face stronger heats.

Furthermore, the immune and circulatory systems of the elderly tend to be more fragile and at risk to the disruptions caused by heatwaves and older people tend to be on medications, often which may conflict with elevated heat conditions. The isolation of older people also predisposes them to inadequate social and health support, acting to layer their vulnerability.<sup>15</sup> Due to these conditions, the reporting of heat-related deaths is often unclear, with many deaths being conflated with other conditions, causing part of the widespread trend of true rates of heat-related mortality being much higher than reported.<sup>16</sup> In the case of children, their development requires that they process more nutrients, predisposing them to dehydration and wasting, which could manifest as irreversible heat-induced damage, causing lifelong morbidities. However, by and large, heat-related consequences of morbidity are far less explored in research than mortality, obscuring our understanding of how dangerous heatwaves can be. Those with biological vulnerabilities usually cannot do anything to reduce their exposure, creating challenges toward mitigation.

Apart from physiological susceptibility, heatwaves also act as a threat multiplier for poor and marginalized peoples, particularly in cities, as one of the largely-attributed factors of heatwave-related morbidity and mortality is urbanization.<sup>17</sup> These impacts not only threaten socioeconomically disadvantaged people, but worsen inequalities. As Dr. Eleni Myrivili put it during our interview, “Climate change [is] really creating the rift between the haves and the have-nots and making the rift bigger - climate change as an indicator of this - as opposed to other indicators, with heat, it’s clear.” As she continued, in comparing heat to something like flooding,

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<sup>15</sup> Daniel Oudin Åström, Forsberg Bertil, and Rocklöv Joacim, “Heat Wave Impact on Morbidity and Mortality in the Elderly Population: A Review of Recent Studies,” *Maturitas* 69, no. 2 (June 1, 2011): 99–105, <https://doi.org/10.1016/j.maturitas.2011.03.008>.

<sup>16</sup> Daniel Oudin Åström, Forsberg Bertil, and Rocklöv Joacim, “Heat Wave Impact on Morbidity and Mortality in the Elderly Population: A Review of Recent Studies,” *Maturitas* 69, no. 2 (June 1, 2011): 99–105, <https://doi.org/10.1016/j.maturitas.2011.03.008>.

<sup>17</sup> Diana D’Ippoliti et al., “The Impact of Heat Waves on Mortality in 9 European Cities: Results from the EuroHEAT Project | Environmental Health | Full Text,” 2010, <https://ehjournal.biomedcentral.com/articles/10.1186/1476-069x-9-37>.

there are a number of diversified reasons that explain disproportionate impacts on some people and not others, such as building houses in deltas or underground infrastructure.

However, with heat, the pressure is more equally applied across cities, allowing for a much more clear view of who suffers because of heat. For example, as Dr. Myrivili noted, low-paid workers tend to be much more vulnerable in part due to their often outdoor working conditions, doing challenging and sometimes dangerous work. They often work long hours and face increased stress and a need to focus on the health of their family over themselves as a result of financial hardship, while living in areas more likely to face the ‘heat island’ effect due to crowded infrastructure and lack of insulating vegetation vis-à-vis green space.<sup>18</sup> Furthermore, low-paid workers often lack insurance necessary to deal with the consequences of heat-related health impacts, acting as a barrier to personal resiliency. Women also face disproportionate burdens during heatwave events, wherein social expectations call on women to ‘fill the gap’ when infrastructures serving communities fail, resulting in poorer health outcomes for care-providing women.<sup>19</sup>

A person’s self-perceived health status has been shown to imply significant influence over whether or not they change their behavior during climate danger,<sup>20</sup> and a general lack of self-perception of health vulnerability observed in populations in comparison to public health officials creates a class of people ‘suffering in silence’ from the dangers of heat related illness and unacknowledged risk,<sup>21</sup> prompting a particular impetus to escalate messaging efforts. These disparities function geospatially as well, as equatorial, particularly Mediterranean cities face some of the worst increases, of up to 9.4% higher than their Northern continental counterparts.<sup>22</sup> As a symbol of inequity through heat, several of our participants noted their disdain for air conditioners, with one even describing it as an ‘egotistical appliance’. The reasoning for this is

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<sup>18</sup> Grégoire Rey et al., “Heat Exposure and Socio-Economic Vulnerability as Synergistic Factors in Heat-Wave-Related Mortality,” *European Journal of Epidemiology* 24, no. 9 (September 1, 2009): 495–502, <https://doi.org/10.1007/s10654-009-9374-3>.

<sup>19</sup> Lena Dominelli, “Mind the Gap: Built Infrastructures, Sustainable Caring Relations, and Resilient Communities in Extreme Weather Events,” *Australian Social Work* 66, no. 2 (June 1, 2013): 204–17, <https://doi.org/10.1080/0312407X.2012.708764>.

<sup>20</sup> Duncan Shaw, Judy Scully, and Tom Hart, “The Paradox of Social Resilience: How Cognitive Strategies and Coping Mechanisms Attenuate and Accentuate Resilience,” *Global Environmental Change* 25 (March 1, 2014): 194–203, <https://doi.org/10.1016/j.gloenvcha.2014.01.006>.

<sup>21</sup> Yuhong Tian et al., “Strengths and Gaps of Climate Change Perceptions in the Beijing Metropolis,” *Climate Services* 30 (April 1, 2023): 100350, <https://doi.org/10.1016/j.cliser.2023.100350>.

<sup>22</sup> Diana D’Ippoliti et al., “The Impact of Heat Waves on Mortality in 9 European Cities: Results from the EuroHEAT Project | Environmental Health | Full Text,” 2010, <https://ehjournal.biomedcentral.com/articles/10.1186/1476-069x-9-37>.

that those with wealth can afford to keep cool and push out all of the hot air into the public space, causing those outside more often to suffer. However, after nights of struggling to sleep and feeling a need to protect her family, Dr. Myrivili finally broke down and bought an air conditioner during the Athens heat wave of 2021, emphasizing just how uncomfortable the situation had become.

These particular vulnerabilities are often factored into heatwave responses as an essential consideration, as noted by several of our interviewees. As doctor Myrivili reflected on, these include short-term strategies for protecting vulnerable people, including emergency phone lines, public safety messaging, and rapid categorization of heatwaves. These solutions act as a temporary ‘stop-gap’ in promoting resiliency, but do not enact the level of revolutionary civil restructuring that is required to meaningfully adapt cities to the heatwaves crisis. In seeking more impactful sustainable urban solutions, the Arsht-Rock Resilience Center was founded in 2019, with whom several of our participants collaborated to innovate new urban heat resilience strategies. Broader strategies included cross-sectoral collaboration with, for example, The Red Cross, to look after the needs of refugee groups during heat waves. Such interventions demonstrate how multi-stakeholder engagement is often needed to reach those living on the fringes of society.

Due to their widespread impacts and tendency to ‘widen the gap’, efficiently tailoring responses to heatwaves to the needs of citizens, particularly the most vulnerable, is essential. Highlighting this, Dr. Myrivili emphasized, “One of the first things a city should do is map in relation to heat.” As several of our participants emphasized, having a view of where the hottest places are in the city can be essential to restructure city infrastructure through ‘blue green and gray’ infrastructure projects, and systemic and direct interventions. Heat-oriented views of the cityscape allow planning committees benefits in targeting areas that have been exceptionally susceptible to heat, and in combination with other demographic maps, heat maps can provide a clear geographic risk assessment. The level at which this can be implemented is largely contingent on what former Chief Resilience Officer to the City of Milan, Piero Pelizzaro, calls a city’s ‘digital infrastructure’. These include digital data including integration of digital systems that can be sourced for information and used to disseminate alerts, such as mobile phones, weather monitoring, and satellite coverage. Such accessibility platforms allow pathways for city decision makers and sustainability advocates to access those oft-marginalized vulnerable

populations through broad system coverage. This accentuates the divide in heatwave response capabilities between developing and developed cities.

## 1.2. Systemic Vulnerability

The crux of gaps in heatwave management lies in the widespread historical lack of consideration of heat as a health issue in comparison to its more violent and visibly catastrophic extreme weather event counterparts. Globally, this has manifested as a startling lack of integration of health into heatwaves monitoring systems - known as ‘heat health warning systems’. In response to this lack, the WHO Regional Office for Europe published guidance on heat health action plans (HHAPs) in 2008, which has ‘served as a blueprint for countries in designing their own heat-related prevention efforts.’<sup>23</sup> While many countries may monitor heat through their meteorological bureaus, public health authorities are often not included in response systems, which leaves health promotion advocates uninformed and unprepared for heatwave risk. This is a common situation even in highly developed regions, as in the WHO Europe region, 33 of 55 member states did not demonstrate heat health action plans.<sup>24</sup> These gaps were predominantly observed in intersectorial long-term measures, surveillance, and plan evaluation.

Various widely-integrative heatwave response capacity building approaches have been explored since, but are often under evaluated as a result of challenges in measuring areas such as urban planning and indoor heat exposure due to their representation in various sectors’ policies.<sup>25</sup> This leaves a blindspot in sustainable policy promotion, and as previously mentioned, the lack of multistakeholder sustainable planning strategies leaves cities with inefficient and ineffective ‘band-aid’ responses to heatwaves that fail to confront the underlying issues hampering civic resiliency. While the establishment and maintenance of real-time surveillance systems that enable monitoring of the health impacts of heatwaves at high temporal and geospatial resolution

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<sup>23</sup> Rajashree Kotharkar and Aveek Ghosh, “Progress in Extreme Heat Management and Warning Systems: A Systematic Review of Heat-Health Action Plans (1995-2020),” *Sustainable Cities and Society* 76 (January 1, 2022): 103487, <https://doi.org/10.1016/j.scs.2021.103487>.

<sup>24</sup> Martin-Immanuel Bittner et al., “Are European Countries Prepared for the next Big Heat-Wave?,” *European Journal of Public Health* 24, no. 4 (August 1, 2014): 615–19, <https://doi.org/10.1093/eurpub/ckt121>.

<sup>25</sup> Martin-Immanuel Bittner et al., “Are European Countries Prepared for the next Big Heat-Wave?,” *European Journal of Public Health* 24, no. 4 (August 1, 2014): 615–19, <https://doi.org/10.1093/eurpub/ckt121>.

is among the primary responsibilities of the health sector, they were also found to be lacking in many of these HHAPs reviewed.<sup>26</sup>

Another key gap is a lack of public health and safety awareness distribution. The key to this aspect of response are heatwave early warning systems (HEWS), which involve forecasting the event, predicting potential health outcomes, triggering efficient and effective responses toward vulnerable groups, notification of heatwave events, and communication regarding prevention responses and the evaluation and revision of response systems.<sup>27</sup> The WMO has been championing the importance of this aspect of the resiliency supply chain with their Early Warnings for All initiative, which seeks to provide minimum levels of early warning systems across the world by rationalizing that even, “24 hours' notice of an impending hazardous event can reduce damage by 30 percent.”<sup>28</sup>

The triggering of these warnings function along various different thresholds and definitions of heat - particularly what constitutes a heatwave. As John Nairn points out, the lack of agreed upon definition of a heatwave by the international community acts as an immense barrier toward the standardization of HEWS and the development of a ‘common language’. Consequently, these are critical sites of disjuncture between the city governance, meteorology, and health communities, which we experienced through the distinct vocabulary, recommendation practices, and indices used by the WHO and WMO, which ended up causing significant confusion in our work. One could only imagine how these dialectic dissimilarities would function during a heatwave crisis event. This constitutes one of the key objectives of the Early Warnings for All program, in that by seeking to implement a baseline coverage of warning systems in states of various approaches to climate-related risk, WMO hopes to establish and promote universally-replicable common practices about informing populations of risk.

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<sup>26</sup> Martin-Immanuel Bittner et al., “Are European Countries Prepared for the next Big Heat-Wave?,” *European Journal of Public Health* 24, no. 4 (August 1, 2014): 615–19, <https://doi.org/10.1093/eurpub/ckt121>.

<sup>27</sup> Dianne Lowe, Kristie L. Ebi, and Bertil Forsberg, “Heatwave Early Warning Systems and Adaptation Advice to Reduce Human Health Consequences of Heatwaves,” *International Journal of Environmental Research and Public Health* 8, no. 12 (December 2011): 4623–48, <https://doi.org/10.3390/ijerph8124623>.

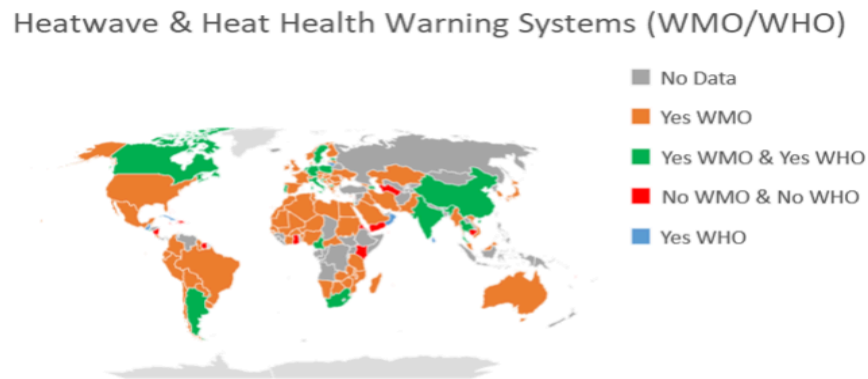
<sup>28</sup> World Meteorological Organization, “Early Warnings for All,” Governance, WMO.int, September 16, 2022, <https://public.wmo.int/en/earlywarningsforall>.



## Chapter 2. Global Trends

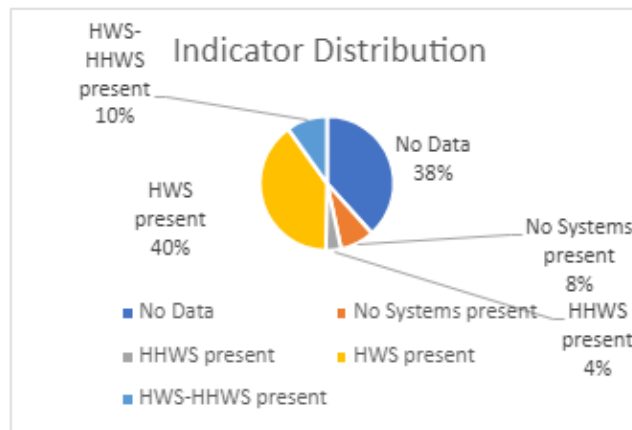
### 2.1. Heatwave and Heat Health Warning systems

**Figure 1. Global Map. Worldwide coverage of HWSs and HHWSs.**



Source: authors' construction based on WHO and WMO database

**Figure 2. Global Indicator Distribution in Percentages**



Source: authors' construction based on WHO and WMO database

Heatwaves are increasingly pressuring the global community, threatening healthcare systems, civic policies, and exacerbating socioeconomic inequalities.<sup>29</sup> However, while health based approaches have recently been identified as key focuses in heatwave response systems, the global community lags behind. Surveys conducted by the World Health Organization (WHO)

<sup>29</sup> World Health Organisation. "Heat and Health". 1 June 2018. Available at: <https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health>

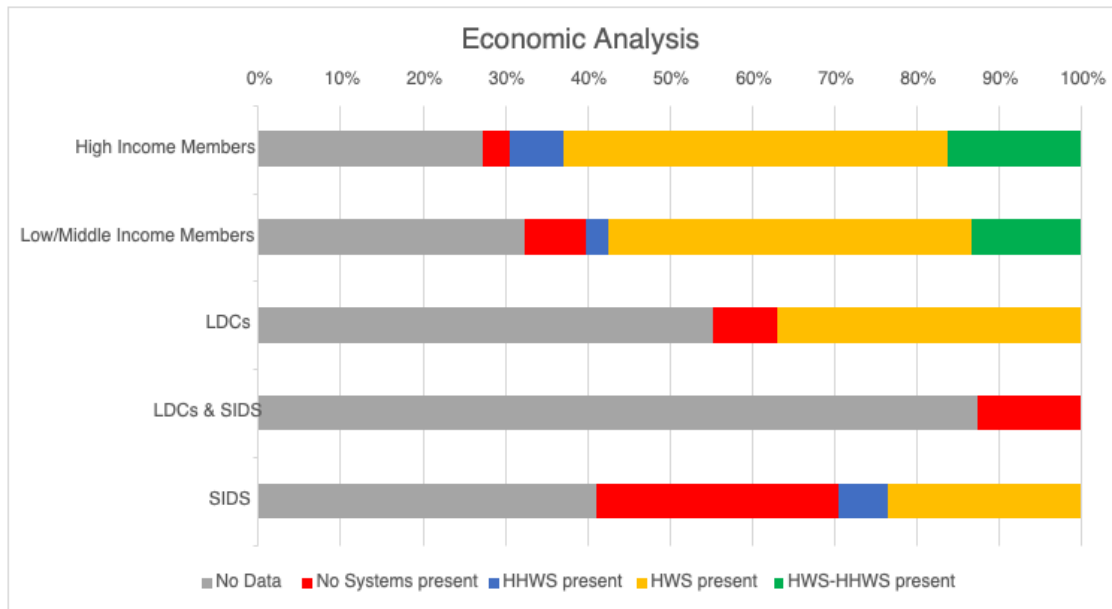
and the World Meteorological Organization (WMO) in 2021 and 2022 respectively reveal that the global state of Heat Health Warning Systems (HHWS) and Heatwave Warning Systems (HWS) demonstrate little health integration. WHO and WMO have been jointly gathering information about countries or their meteorological services conducting any heatwave warning systems or heat health warning systems and our team was able to take responsible of analyzing data and drawing notable conclusions. The analyzed findings are as follows. Much fewer, only 26 (23.95%), of 193 WMO member state countries have indicated the presence of an HHWS than the 96 (42.0%) of WMO member state countries that reported an HWS. Broad regional and socioeconomic disparities underpin this integrative focus on heat health, with Europe reporting the highest percentage of HHWS at 24%, with Africa and South America reporting the least, at 3.8% and 4.5% respectively. Moreover, highly developed countries reflect this coverage, with high income countries and low/middle income countries reporting 22.6% and 16.2% coverage respectively.

While an integrative approach to health has been shown to be essential in promoting effective responses to heatwaves, basic coverage of Heatwave Warning Systems is highly fragmented. South America, being geographically one of the most affected heatwave regions, boasts a highly developed HWS coverage, at 96 countries (75%), but regions with less attention have suffered from extreme lacks in coverage, such as Africa and the South-West Pacific at 3.8% and 4.5% respectively. However, socioeconomically, high income, and lower and middle income countries report relatively similar coverage, at 62.9% and 57.4% respectively, indicating heatwave response development in countries with pre-existing systems to support implementation.

As we can see from Figure 3 representing the data analysis based on the economic status, High Income Members and Low and Middle Income Members are the ones that have both HWS and HHWS, at 10 of 62 (16.1%) and 9 of 68 (13.1%) respectively, while there are no countries which reported both HWS-HHWS present among LDCs, LDCs&SIDs and SIDs. Concerning HWS, While High Income (39 out of 62-63%), Low/Middle Income (39 out of 68-57.4%), LDCs (14 out of 38 - 36.8%) and SIDs (4 out of 17 - 23.5%) had member states with HWS present, only LDCs&SIDs did not have HWS present. Only LDCs and SIDs reported a lack of HHWS, while a lack of both systems was exclusively present in LDCs & SIDs. Therefore, there is a

significant disparity in the HWS and HHWS presence based on socioeconomic member state status.

**Figure 3. HWS and HHWS presence based on the economic status of countries.**

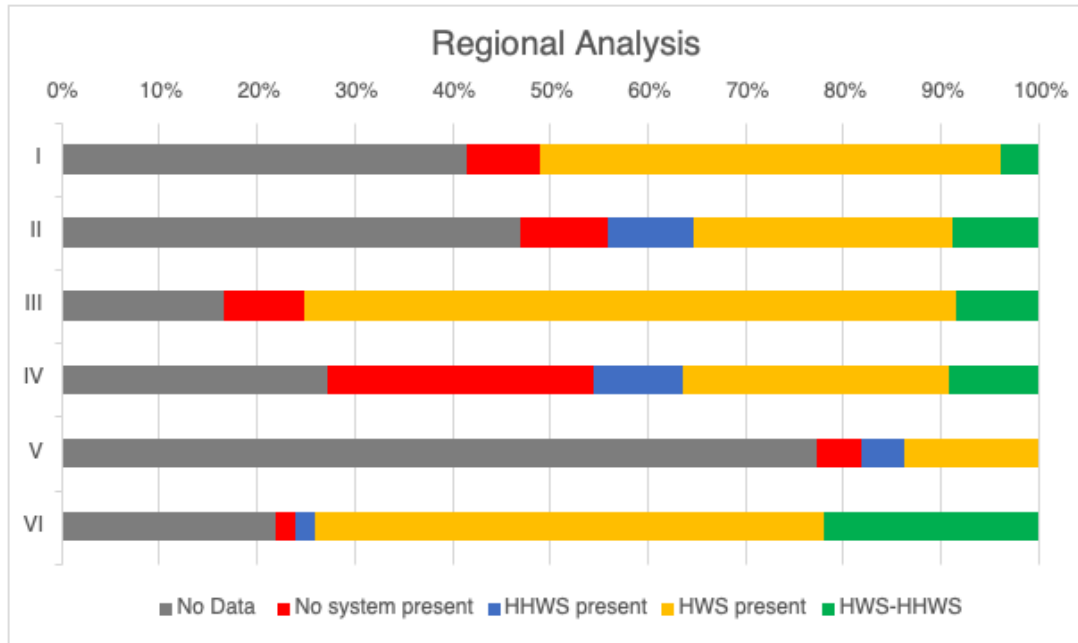


Source : authors' construction based on the WHO and WMO database

As we can see from Figure 4 of stacked bar graphs representing that data analysis based on the WMO member states' regions, South-West Pacific was the only region that does not have member states who possess both HWS and HHWS, while Africa (2 out of 53, 3.8%), Asia (3 out of 34, 8.8%), South America (1 out of 12, 8.3%) North America, Central America, Caribbean (2 out of 22, 9.1%) and Europe (1 out of 50, 22%) have reported both systems. When it comes to HWS, there was HWS presence for member states from all the regions (Africa: 25 out of 53, 51%; Asia : 12 out of 34, 35.3%; South America : 9 out of 12, 75% ; North America, Central America, Caribbean : 8 out of 22, 36.4%; South-West Pacific : 3 out of 22, 13.6%; Europe : 37 out of 50, 74%). Europe was the region with the most member states with HWS present while the South-West Pacific especially had the lowest presence for HWS compared to other regions. In addition to that, North America, Central America, Caribbean was the region with the highest number of member states that had no warning systems present, accounting for 6 out of 22, approximately 27%. Based on such facts, there are significant findings that regions that include

SIDs such as Caribbean, South-West Pacific tend to have low HWS and HHWS presence compared to regions such as Europe.

**Figure 4. HWS and HHWS presence based on the regions of countries.**



Source : authors' construction based on the WHO and WMO database

## 2.2. Characteristics of a strong heat health warning system

As aforementioned, while there are a lot of disparities and lacks in the systems of heatwave warning systems related to public health, there have been some cases from various parts of the governments and stakeholders in the international community to provide accurate and appropriate climate health-related information to the public. What are the worldwide efforts to protect people from increasing threats of heatwaves? What has been done so far and what could be done to promote such successful steps towards promoting heatwave and heat health warning systems? Throughout the process of the applied research project, we were able to access preliminary data analyzed by the WMO on the successful cases of generating strong heat health warning systems around the world, from which we selected the examples of Nanjing and Hong Kong.

In Nanjing, China, in the year of 1988 the number of people suffering from heatstroke reached 4,500. The total number of severe cases reached 411. Ten years later, comparing the meteorological data of 1998 and 1988, the high temperature degree and time were similar, but the number of severe heat stroke was far from the same, and in 1998, there were only 232 people with severe heat stroke and 24 deaths. Since 1998, the Nanjing Municipal Health Bureau and the Meteorological Bureau have jointly introduced the meteorological heatstroke index. The index forecast first combined the medical pathological mechanism of heat stroke symptoms and pathogenesis with the analysis and prediction methods of meteorology on heat stroke related meteorological factors, this made heatstroke, a major disease in the south in summer, predictable and preventable.

Studies in this field became a practical technology that helps people prevent heatstroke. The heatstroke index forecast enables the medical department to scientifically prepare for treatment in advance (preparation of corresponding medicines, preparation of wards, scheduling of medical and nursing personnel, etc.); enables enterprises to reasonably arrange their works and do a good job in heatstroke prevention, and avoid the loss of personnel and property to the greatest extent; enables the public to get clear weather forecast information on heat stroke prevention, which is different from conventional daily weather forecasting, and arrange their daily life for their families, especially for infants, the elderly and the sick to avoid heatstroke.

This case has proven that as the timeliness and accuracy of weather forecasts increases, the forecastable period is continuously rising, the potential of using these kinds of forecast information for early warning will increase. Moreover, by analyzing the incidence of some common and frequently-occurring diseases under certain meteorological conditions, the forecast of future atmospheric environmental conditions that could bring such diseases and pathogenic-tendencies to people could be made. These kinds of forecasts will warn the medical department to take preparatory measures in advance; remind the public to prevent the occurrence of diseases by dressing or adjusting the artificial environment microclimate, so as to stay healthy and improve the quality of life.

On the other hand, in Hong Kong, since 2000, Hong Kong Observatory (HKO) has been issuing the Very Hot Weather Warning (VHWW) to alert the public to the risk of heat stroke and

sunburn in very hot weather, and to advise the public on relevant precautionary measures.<sup>30</sup> Over the years, the VHWW and related advisory services have in general gained wide public acceptance and understanding in Hong Kong. The warning also alerts relevant government departments to consider the need to take actions, such as the opening of temporary air-conditioned shelters to accommodate citizens in need.

HKO has been partnering with the academia to investigate the impacts of heat stress on public health in Hong Kong. Through these collaborations, a series of research studies related to extreme high temperatures and heat stress in the region has been conducted, including spatiotemporal assessment of extreme heat risk, impact of extremely hot weather events on mortality, and projection on future temperature-related mortality. Moreover, a research study also indicated that the introduction of VHWW might help reduce the elderly mortality in Hong Kong.<sup>31</sup> HKO has also been collaborating closely with a key stakeholder in elderly services in the region such as the Senior Citizen Home Safety Association (SCHSA), not only on health data impact study but also on developing new precautionary measures tailored for senior members of the public. The scientific findings of these studies help advance the knowledge of the impacts of extreme high temperatures on public health and provide an underpinning scientific basis for the enhancement of heat stress information services and promoting public awareness on heat health risk in the country.

## **Chapter 3. Stakeholder Engagement**

### **3.1. Actors and tools involved**

While the climate constituent of HHWSs falls under the control of the National Meteorological and Hydrological Services (NMHSs)<sup>32</sup> and the World Meteorological Organisation, the management regarding the societal element lies within health and social

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<sup>30</sup> Hong Kong Observatory(HKO). "Cold and Very Hot Weather Warnings." | Hong Kong Observatory(HKO) | Our Services. Accessed June 23, 2023.  
<https://www.hko.gov.hk/en/wservice/warning/coldhot.htm>

<sup>31</sup> Chau, P. H., K. C. Chan, and Jean Woo. "Hot Weather Warning Might Help to Reduce Elderly Mortality in Hong Kong." *International Journal of Biometeorology* 53, no. 5 (2009): 461–68.  
<https://doi.org/10.1007/s00484-009-0232-5>

<sup>32</sup> NMHSs observe and monitor the atmosphere, ocean, inland waters; makes inquiries in order to model and predict their related processes; provide forecasts and warnings to the community at large. Source: [https://elibrary.worldbank.org/doi/10.1596/9781464800269\\_Ch03](https://elibrary.worldbank.org/doi/10.1596/9781464800269_Ch03)

services sectors. To ensure that the health sector is not alone in facing the challenges posed by extreme events, all levels of government, NGOs, business and the public can be involved and provide for quicker and more effective coordination.

In order to facilitate the system and make it more accessible to the public, various platforms, including websites and mobile applications, have been experimented. Among others, a Heat Action Plan<sup>33</sup> has been developed in India in order to include a dissemination of public messages via orientation materials (pamphlets, advertisements on heat stress prevention, emails, text messages) and social media outlets. Meanwhile, a new centralized online portal was launched last year in Germany to provide information on heat warnings and different forecasts where the public can also receive notifications by email, newsletters or apps: warnings are automatically generated by daily weather forecasts and are further adjusted by a biometeorological forecaster. Similarly, Lund University in Sweden has developed the mobile tool of ClimApp<sup>34</sup>, providing personalized heat and cold stress warning advice to users in Sweden, Denmark, and the Netherlands. Likewise, EXTREMA Global app<sup>35</sup> has been used since 2016 first in Athens then in some cities across Greece, Italy, the Netherlands, France, United Kingdom and the United States to let the users know about the announcements from city authorities, make them informed on the current heat risk in their location, provide recommendations for health protection, and suggest the nearest drinking spots and cooling places. These cases show how local governments and society's efforts move towards a more coherent identification of the objectives and the information to be disseminated. They constitute an integral part of a successful communication strategy whose benefits can be seen in metrics such as reduced mortality and hospital admissions.

The purpose of the present research is therefore an attempt to engage with the central figures to create a “story” based on a testimony, a point of view of one of the beneficiaries of this system by taking EXTREMA Global App as a case study.

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<sup>33</sup>Pillai V. Adita, “The gaps in India’s ‘heat action plans’”, *Carbon Brief*. (March 28, 2023). <https://www.carbonbrief.org/guest-post-the-gaps-in-indias-heat-action-plans/>

<sup>34</sup>LTH Faculty of Engineering. “Climapp.” Lund University. Accessed April 2, 2023. <https://www.lth.se/climapp/>.

<sup>35</sup> “Emergency Notification System.” Extrema. National Observatory of Athens, 2018. <https://extrema.space/>.

## 3.2. EXTREMA Global App

### 3.2.1 A successful model of Heatwave Risks Management and Health Protection Recommendations

By making use of services based on open Earth Observation data, climate and atmosphere models and local data, EXTREMA Global App stands out as a successful tool to lessen the impacts of heatwaves on public health, while making cities more heat-resilient. Indeed, its uniqueness lies in the ability to provide health recommendations depending on the current heat risk at the location of the ground users - be it citizens or tourists - while guiding them to the closest cooling places, drinking water spots and suggesting the briefest, freshest, “cool routes” where people can walk around safely. The city of Athens, precursor of the App since 2016, as part of its #CoolAthens campaign<sup>36</sup> has adopted a highly successful operation aimed at making citizens and tourists aware about EXTREMA through a dedicated advertisement carried out at Athens International Airport, which led to up to 1,000 downloads in Athens in 2022 and made it the top utility app in Google Play the month it was launched. Similarly, the city of Milan has been promoting the App in the local press which resulted in days of peak usage, reaching up to 6,324 requests for service. Milan is making use of these digital services also in view of decreasing the use of plastic bottles and calculating the freshest routes for bicycles. Additionally, with its ability to support multiple profiles and the opportunity to customize the temperature to be set as an “alert”, users are able to check on family members (in particular, the vulnerable and the elderly) in various locations.

Given that it is updated daily by each city, another core advantage of EXTREMA is the dynamic information it provides, allowing its algorithm to calculate the adjusted cool routes based on the changes made. Besides providing a user-friendly, direct and immediately accessible tool for people, the App also stands as an example of improved communication among different stakeholders and departments of the municipality in a shared effort to exchange know-how and data. Indeed, while cities have access to satellite-derived maps of surface temperature distribution to identify hot spots and areas that need intervention (for example through the

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<sup>36</sup> Developed as part of the Athens Resilience Strategy’s climate action plan. Governance Strategies for cooling cities: the cases of Athens and Istanbul. Available at: [https://gef.eu/wp-content/uploads/2020/02/GEF\\_Oikos\\_Article\\_Istanbul.pdf](https://gef.eu/wp-content/uploads/2020/02/GEF_Oikos_Article_Istanbul.pdf) [accessed June 21, 2023]

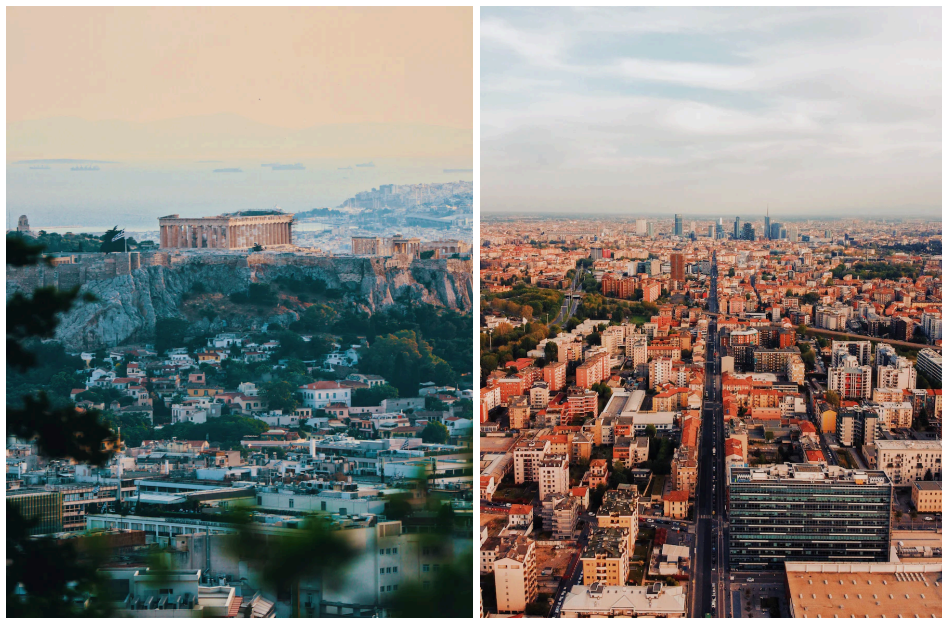


planning, and management of urban infrastructures), through a dashboard, city authorities can access alerts to help users manage their resources and reduce heat exposure.

As the Chief Heat Officer of the City of Athens, Elissavet Bargianni, noted during her interview with Geneva Graduate Institute, the App has the potential to become a “lifestyle app” at some point in the future, meaning that its functionality might eventually become so essential to the users that it will be incorporated into their everyday life.

The story we have drafted around EXTREMA Global with the help of the testimony of Eleni Myrivili, Anna Vasila, Elissavet Bargianni and Piero Pelizzaro is proposed as an attempt to visualize how this tool has proven to be effective while essentially engaging with its beneficiaries at the times of extreme heat.

### 3.2.2. Building Integrative Networks for Cooler Cities: the *story* of EXTREMA Global



**Athens** (Copyright: Nomadic Julien)      **Milan** (Copyright : Andrea Ferrario)

*“It was almost like a war and we had to wear masks because of the air... even when we were inside the house.” - Dr. Eleni Myrivili*

The year is 2021, and Athens, Greece is in the midst of a scorching summer. The Greek citizens seek refuge from the sweltering heat by flocking to the beaches, while even the tourists endure the rising temperatures with propped umbrellas or by seeking intermittent shade. As the mercury soars, the air becomes stifling, and the city becomes a battleground against a relentless heatwave.

In this setting, Dr. Eleni Myrvili takes on the role of Athens' Chief Heat Officer. Just two weeks into the job, Athens is engulfed by a cataclysmic heat wave, reaching temperature highs of 43.9 °C. The heat wave seemed never-ending. “It seemed like it would never stop,” she recalls, “And then at the end of July, we had a heat wave that lasted three and a half weeks.”

As the city baked under the scorching sun, massive fires ravaged the land north of Athens, turning the once-blue sky into an ominous blend of red and brown. As the city emptied out, with residents seeking shelter inside, the air, “would burn your lungs as you breathed in.” Scenes like these were becoming increasingly common in a world ravaged by climate-induced heatwaves.

Dr. Myrivili reflected on the situation with a sense of urgency. "Cities are not prepared," she lamented. Despite decades of discussions on global warming, the realization that global warming equates to intense heat has not fully taken hold. The result was a crisis where heat waves crippled civic infrastructure and posed a severe threat to the vulnerable. The situation left cities like Athens with no alternative but to take charge and tackle the issue head-on.

*“Heat is very horizontal. Heat affects everyone and everything: the systems, the people’s health, ecosystems, the design of the city, energy, transportation. - Elissavet Bagianni*

Amidst the challenges posed by heatwaves, one thing becomes abundantly clear: awareness and preparedness are essential to safeguarding citizens. Elissavet Bargianni, Chief Heat Officer for the city of Athens, emphasizes the significance of understanding vulnerability beyond its conventional boundaries. Factors such as age, socio-economic status, and health conditions play pivotal roles in defining vulnerability to extreme heat. However, obtaining specific personal data remains a challenge.

Bargianni suggests a two-pronged approach. First, by making comprehensive information easily accessible to the public through an English-translated website, Athens can showcase its

capacity to address heat-related issues, raising awareness and empowering individuals to seek assistance. Second, Bargianni emphasizes the significance of eco-friendly city design, aiming to provide 70% of the population with access to green spaces. These areas not only provide relief from the heat but also bring valuable ecosystem benefits.

*“EXTREMA is an emergency tool, a monitoring tool, and a planning tool” - Piero Pelizzaro*

The EXTREMA Global App serves as a beacon of hope, coordinating awareness and empowering cities worldwide. With its free, multi-language capabilities, constant updates, and expansion from Athens to cities like Milan, Paris, and Rotterdam, EXTREMA has the potential to become a global tool for managing heatwaves. By utilizing satellite data and creating user-friendly maps, policymakers can plan sustainable infrastructure and identify vulnerable areas within cities. Even during heatwaves, the app guides users to safe routes, considering the distribution of trees along the way.

*“I call it initiative because I think it is something larger than just an app.” - Anna Vasila*

Heatwaves present significant challenges that extend beyond their direct impact on the local tourism industry, as highlighted by Anna Vasila, Head of Sustainability and Industry Affairs at Athens International Airport. The scorching heat acts as a game changer, prompting tourists to explore alternative seasons rather than traditional summer visits. This shift in preferences not only affects the tourism seasonality but also has far-reaching implications for various aspects, including the city's preparedness to provide adequate infrastructure throughout the year. Furthermore, it impacts the broader network of Greek destinations connected to the capital. However, the EXTREMA Global App strives to restore Athens as a year-round destination, demonstrating resilience in the face of climate change's influence.

*“The app can guide you through selected destinations of the center of Athens, while protecting you from extreme heat [...].It's part of our continuous attempt to enhance the customer experience to show them how they could potentially experience better routes while visiting the renowned sites of Athens.” - Anna Vasila*

At Athens International Airport, the promotion of EXTREMA Global throughout its terminals demonstrates a concrete commitment to prioritize the health and safety of tourists. By enabling visitors to independently experience the city and its attractions in a sustainable manner, the airport fosters resilience and showcases the city's dedication to providing a year-round destination despite the challenges posed by climate change.

*“In my country climate change is something that they think is very far away and it affects other people in other climates and not Greece.” - Dr. Eleni Myrvili*

Understanding and addressing the needs of cities is crucial in finding effective solutions. Instead of solely focusing on scientific perspectives, it is important to engage with local communities. In Milan and Athens, climate change discussions often remain distant from everyday concerns, hindering community involvement in innovative initiatives like EXTREMA. “Smart communities are the key to building smart cities,” emphasizes Former Chief Resilience Officer Piero Pelizarro. To overcome this barrier, Dr. Myrvili suggests reframing the discourse on climate change to highlight its tangible impact on vulnerable individuals. This approach allows programs like EXTREMA to be tailored to community needs and foster empowerment through meaningful engagement.

*“In an idyllic world every city would have an EXTREMA app that has solutions that the city promotes for dealing with heat.” - Dr. Eleni Myrvili*

Dr. Myrvili highlights the urgency of dispelling the misconception that climate change is a distant issue, urging a profound awareness of how heat profoundly affects the most vulnerable. “It’s important to make it easy for people to see that you have to live with the changing climate,” she emphasizes. By reshaping the conversation and embracing EXTREMA as a foundational tool, cities like Athens can tailor solutions that address their unique needs, fostering active engagement and empowerment. With a resolute focus on smart communities building smart cities, EXTREMA becomes the catalyst that ignites transformative change.

## **Conclusion**

As we contend with increasing climate-induced heat risk, the message of urgency and adaptation becomes clear. Normalizing climate change discussions, recognizing vulnerability, and implementing innovative tools like EXTREMA are essential to promoting heat-health in diverse communities of scale. By linking heat and health into innovative civic networks, practitioners are increasingly finding new ways to integrate climate concerns into daily life. While the path ahead may require years of innovation, coordination, and negotiation, the transformative power of tools like EXTREMA offers a beacon of hope in our efforts to mitigate the consequences of anthropogenic climate change. Our ultimate aim has been to facilitate the discussion of climate services and their global improvement through attentive Heat-Health Warning Systems analysis and discussion in countries lacking such systems to promote public welfare and health, particularly in relation to heat-related illness. In conclusion, we believe it is important to underpin the signs of hope by presenting the characteristics of a strong system and highlighting some of the tools at our disposal. As the increasing heat impacts of climate change require collaboration between different disciplines, there are greater opportunities to unite around a common vision of a resilient future.

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