Regional Toolkit for Heatwave Management in Asian Cities

Purpose of the Document

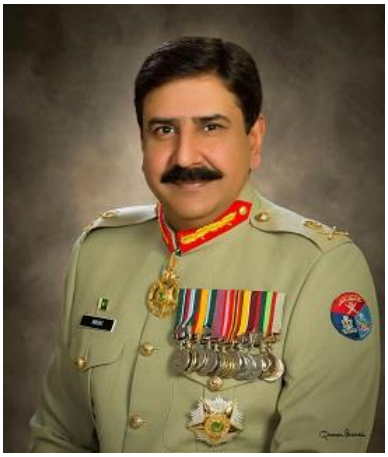
Every city differs in their definition of a heatwave due to its local contexts that affect and the population's ability to acclimatize to extreme temperatures. This Toolkit is intended for use by local authorities and other stakeholders in large Asian cities who are involved in extreme temperature and heatwave mitigation. Keeping a focus on the Asian context, the Toolkit builds on regional and international best practice to offer guidance and resources for the development of heatwave management strategies at the municipal level. The Toolkit has a modular structure and guides the reader through the key steps and considerations needed to develop and implement heatwave management plans. It highlights simple tools and knowledge resources to help move from theory to action.

Contents

List of Figures

List of Boxes

Foreword



The rising intensity and frequency of heatwave events under the influence of climate change presents a major adaptation challenge to urban centres, the engines of growth in modern economy. Being the most rapidly urbanizing region in the world, Asia remains highly vulnerable to extreme heat impacts. The Special Report on Climate Extremes by the Intergovernmental Panel on Climate Change (IPCC) concluded that patterns of temperature extremes for global regions, including South Asia, are shifting. Trends and projected changes point to increased health risks in the future, with the frequency and severity of hot days likely to increase in the decades ahead. The staggering death toll from 2015 heatwave episode in South Asia was a stark reminder of the scale of this challenge. If not managed adequately, heatwaves can significantly retard economic growth and socio-economic disparities in our region.

Managing the increasing risk of excessive heat in urban areas, that will house 70 percent of the world's population by 2050, heat wave management plans have become a prominent feature of the climate change adaptation plans. In face of rising threat from extreme heat events, various promising initiatives for heatwave management have been initiated in the region. LEAD Pakistan, through its Climate & Development Knowledge Network (CDKN) program, has also made commendable contributions in this domain. Starting with the globally recognized Ahmadabad Heat Health Plan, CDKN has scaled out and replicated its interventions, the most recent being in Karachi City. It is heartening to learn that Karachi has developed the first comprehensive heatwave management plan in Pakistan which can serve as an example for other cities. Moreover, there are also other global examples of successful development and implementation of heat wave management plans. Lessons and learnings from such interventions have been synthesized in this document. This Toolkit is intended for use by local authorities and other stakeholders in large Asian cities who are involved in managing heatwave events.

On behalf of NDMA, I congratulate all the persons and institutions who have contributed towards the development of this document. We hope that the various heatwave management initiatives coming up in the region will create synergies through meaningful knowledge exchange. It is also important to highlight that heatwave management planning presents one part of the solution for protecting our cities. It is only effective when coupled with a participatory implementation and evaluation process. The Toolkit will serve as guideline for the disaster managers to formulate effective response plans against heatwave related hazards for South Asian mega cities likely to experience this phenomenon. I am hopeful that this Toolkit will serve as an important contribution in the efforts to make our cities resilient and sustainable.

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About

National Disaster Management Authority (NDMA) is the lead agency at the Federal level to deal with the whole spectrum of Disaster Management activities. It is the executive arm of the National Disaster Management Commission (NDMC) which has been established under the Chairmanship of the Prime Minister as the apex policy making body in the field of Disaster Management.

The Climate and Development Knowledge Network supports decision-makers in designing and delivering climate compatible development. We do this by combining research, advisory services and knowledge management in support of locally owned and managed policy processes. We work in partnership with decision-makers in the public, private and non-governmental sectors nationally, regionally and globally. We hold strongly to the ideals of human development and environmental sustainability. It is managed by an alliance of organisations led by PricewaterhouseCoopers LLP (PwC), and including Fundación Futuro Latinoamericano, LEAD International, LEAD Pakistan, the Overseas Development Institute, and SouthSouthNorth.

Leadership for Environment and Development (LEAD) Pakistan, is a leading international think tank, inspiring sustainable development across diverse sectors, with a focus on environment, climate change and development issues, since 1995. Our programmes, comprise Climate Action Programme, Water Programme, Environmental Management, Special Initiatives, Leadership Development Programme, and Social Capital Development.

ESSA Technologies Ltd is an innovative consulting company specializing in environmental and social sciences and decision support. Established in 1979, with the mission is to bring together people, science and analytical tools to sustain healthy ecosystems and human communities.

Executive Summary

Asian cities and extreme heat

The risk of exposure to extreme heat is increasing with climate change. Because of the toll on people's health, the prospect of more and / or longer and more severe summer heatwaves is alarming for densely-populated, built-up cities that keep the environment hotter through the "urban heat island effect". Densely populated and rapidly growing Asian cities are especially at risk, given the urbanization trends (i.e., widespread use of heat-absorbing asphalt and concrete, pollution from transportation and industrial processes, etc.) and climate patterns in the region.

The International Disaster Database of the Centre for Research on the Epidemiology of Disasters documents 59 heatwaves in China, India, Japan, Nepal, Pakistan and South Korea between 1953 and 2015, resulting in 15,878 deaths. The deadly heatwave that occurred in Karachi in June 2015 is a recent example that raised heat health to the agenda of Karachi's city government.

The health impacts of heatwaves are largely preventable through targeted measures. However, for measures to be effective, plans need to be in place before heatwaves occur. Confronted with this major public health risk, Asian cities are at different stages in preparing for and responding to heatwaves. A salient example is the Heatwave Action Plan for the Indian city of Ahmedabad which was developed in 2013 and has served as a framework for heatwave management initiatives in other cities in South Asia.

Purpose, structure, and intended use of the Toolkit

Every city differs in their definition of a heatwave due to its local contexts that affect and the population's ability to acclimatize to extreme temperatures. Keeping a focus on the Asian context, this Toolkit (intended for use by local authorities and other local stakeholders in large Asian cities who are involved in extreme temperature and heatwave mitigation) builds on regional and international best practice to offer guidance and resources for the development of heatwave management strategies at the municipal level.

The Toolkit has a modular structure and guides the reader through the main steps (Figure 1) and considerations needed to develop and implement heatwave management plans. It highlights simple tools and knowledge resources to help move from theory to action. At the end of each section of the Toolkit, a summary box presents key messages and ideas.

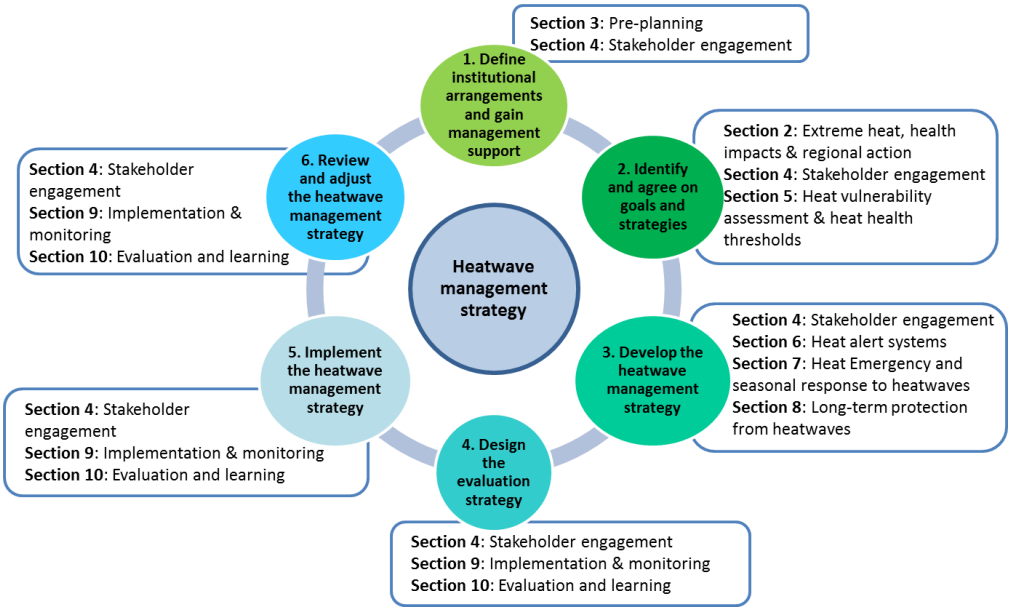


Figure 1: Structure of the Toolkit and relation of the different sections with the steps to develop a heatwave management strategy

Defining institutional arrangements and gaining management support

Heat health is a shared responsibility, often involving stakeholders across levels of government and sectors, and coordination is extremely important. Section 3 discusses these institutional arrangements and points to the need for a **lead agency** which sets the overall direction of the initiative.

Understanding a city's institutional context surrounding heat health is key to define the most appropriate institutional arrangement. Cities can apply simple frameworks, such as the Strengths-Weaknesses-Opportunities-Threats analysis to characterize the institutional framework. Explicit recognition and integration of heatwave management issues into existing policies and practices is part of a robust response to heatwaves.

Identifying and agreeing on goals and strategies

There is no standard definition for what we commonly refer to as heatwaves. The local context (e.g., population's sensitivity and ability to cope, local weather patterns in terms of humidity and wind speed) of the cities matters greatly in defining thresholds for magnitude and duration of a heatwave event.

Health outcomes are also shaped by community and individual factors although there groups who are generally at a higher risk (e.g., older population, infants and young children, outdoor workers, people affected by previous illnesses, socially-disadvantaged and itinerant population, etc.).

Understanding of **vulnerable groups** and places is at the core of heatwave planning. Conducting heat vulnerability assessments (Section 5) can help cities achieving this understanding. There are various vulnerability frameworks that can be used for this type of analysis. Data, resource and time constraints will dictate the scope and level of detail of the approach for heat vulnerability assessment.

Heat **vulnerability indices** combine several types of information related to exposure, sensitivity and response capacity into one aggregate measure at a given spatial unit. These indicators and methods of aggregation can be tailored to the particularities of each city. Section 5.2 presents some examples of heat vulnerability indices and associated vulnerability maps, which can be helpful inputs for city planning.

Another key element in understanding a city's vulnerability to extreme temperature is to establish **heat-health thresholds**. These thresholds are usually developed based on local evidence and represent the relationship (often defined in quantitative terms) between weather parameters and human health outcomes. Heat-health thresholds are the basis for heat alert systems (Section 6).

Involving locally-based stakeholders (Section 0) is essential for identifying the goals of the heatwave management strategy. They will be aware of local effects of hot weather, have a vested interest in mitigating heat events and can be readily available for seasonal planning and during an event.

Developing the heatwave management strategy

There are some key components required for the development of a successful heatwave management strategy. One of these components is the **heat alert protocol**. Section 6 presents an overview of best practice and illustrative examples of heat alert protocols. These protocols involve identifying heat alert **triggers** (Section 6.1) based on heat-health thresholds. These thresholds are numerical values derived from one or more weather parameters (e.g., temperature, humidity) – see examples developed for different locations in Section 6.1 - that are forecasted to last for one or more days. When these values are exceeded, an alert is issued. Alert systems will often use more than one level of warning to communicate the severity of the event.

Heat triggers will activate warning levels and activation/deactivation protocols (Section 6.2). The purpose of alerts and warnings is to effect behaviour change during heatwave events. It is important to consider how warnings are communicated and what the implications might be of different approaches (e.g., staged or hierarchical warnings, terminology and visuals for communication).

An essential aspect of alert protocols is how they are communicated (Section 6.3). Lessons emerging from international practice suggest that effective **warning communication** needs to be targeted and tailored to the audience, especially to vulnerable groups. It is also important to maintain a transparent system throughout the heat risk communication process to build trust among stakeholders. Awareness campaigns should occur year round to ensure the public is prepared during heat season.

The mitigation actions in a heatwave management strategy can be categorized into response measures (Section 7) and longer-term protection actions (Section 8). **Response measures** or interventions, aimed at individuals or organizations, follow up on heat alerts and help prepare for the heat season. Educating and informing stakeholders and the public about dangerous weather conditions and protective actions to take during an extreme heat event is one of the critical response measures that needs to be included in any heat management plan. Cities should establish cool centres for the public to go to, especially if they do not have access to air-conditioning. High-risk areas of the city should be identified so that more centres can be established in those areas. At the individual level, there are many steps and actions that people can take during heat to minimize their exposure to extreme temperatures.

A lack of climate resilience planning and prevention strategies will lead to a city that is merely coping with heatwaves, rather than adapting and progressing. Section 8 offers an overview of these preventive, **longer-term actions** that need to be included as part of the heatwave management strategy. Actions

related to education and information-sharing, urban planning and city resilience and the urban heat island (UHI) effect are discussed. Priorities should be set to reduce the likelihood of mal-adaption.

Designing the evaluation strategy

Evaluations help validate the effectiveness of heatwave management plans and interventions and provide information to improve heat alert protocols and responses to ensure the most effective use of resources. An evaluation plan, comprised of **process evaluation** (i.e., implementation performance) as well as **outcome evaluation** (i.e., impact of the plan on health outcomes), is integral to iterative heat planning cycles in order to maximize learning and capture long-term changes, such as the effect of prevention strategies and behavioural change.

Section 9 summarizes approaches, methods and resources to maximize learning from heatwave management implementation. The evaluation strategy should incorporate effectiveness and efficiency criteria, tailor data collection and analysis methods to the evaluation objectives, clarity in terms of who will use the evaluation results and how this information will be used and disseminated.

Implementing the heatwave management strategy

Successful implementation of heatwave management plans at the city level relies on strong **leadership** from local governments, support from city leadership and **coordinated action** of all key stakeholders. **Data collection** and monitoring activities during heat events are often included, as "real-time" learning can guide course corrections. Section 9 of the Toolkit summarizes good practice on heatwave management implementation and presents templates for data collection use by cities.

Based on lessons learned from international heat plans, there seems to be a number of enablers that can critically contribute to the success of a heatwave management strategy, including: agreement on a lead agency or body; alert protocols and communication and response plan; attention to vulnerable population; preparedness of health and social services; long-term mitigation measures and systems to collect real-time data during heat events.

Reviewing and adjusting the heatwave management strategy

It is good practice to conduct, at the end of the hot season, an **end of season evaluation** (Section 10) the city or state must assess the efficacy of its heat action plan, including the processes, outcomes, and impacts. Stakeholders should then identify changes and improvements for the next heat season. It is important that the result of any evaluation is disseminated to the participants in the implementation of the heatwave management plan.

Evaluation of the effectiveness and efficiency of the **alert protocol** is also important for continuous improvement and good use of public resources. Evaluating the heat alert protocol in terms of outcomes in the formal public-health sense is challenging and will need to be tailored to the local context and characteristics of the heat response system.

1 Introduction to the Toolkit

Heatwaves are a current public health risk regionally and around the world. In 2015, heatwaves were four of the ten deadliest natural disasters globally.[1] The link between heatwaves and excess deaths and cases of illness is widely recognized[2], although what constitutes a heatwave is locally variable. In general, we understand heatwaves to be a period of abnormally hot and/or unusually humid weather, lasting two or more days.[3] Everyone is vulnerable to extreme heat, but some are more vulnerable than others. In South Asia, vulnerable groups include older adults, the chronically ill, outdoor workers, infants and young children, the homeless, and people living in poverty.

As climate change intensifies, so too will exposure to hot days. The Special Report on Climate Extremes by the Intergovernmental Panel on Climate Change (IPCC) concluded that patterns of temperature extremes for global regions, including South Asia, are shifting.[4] Trends and projected changes point to increased health risks in the future, with the frequency and severity of hot days likely to increase in the decades ahead (*high confidence*).[5]

The health impacts of heatwaves are largely preventable through targeted measures. However, for measures to be effective, plans need to be in place before heatwaves occur. Climate change adds to the urgency of taking concerted action to protect vulnerable groups and enhance the liveability of cities as temperatures rise.

This Toolkit is intended for use by local authorities and other local stakeholders in large Asian cities[6] who already play important roles in public health, emergency management and service provision to vulnerable groups. It is designed as a how-to guide or manual for those involved in reducing the health impacts of heatwaves at the city level and for potential partners in these efforts. The Toolkit guides the reader through steps and considerations needed to develop and implement heatwave management plans. It captures regional and global practice and lessons and highlights simple tools and knowledge resources to help move from theory to action.

The Toolkit provides:

- an overview of regional responses to managing the health impacts of heatwaves, with an emphasis on activities in India and Pakistan, supported by the Climate and Development Knowledge Network (CDKN)
- guidance to develop and implement a heatwave management plan
- mini case studies highlighting cities' experiences and lessons in preparing for and responding to heatwaves
- template materials for local authorities, such as checklists and sample communications material

The Toolkit follows the structure in Figure 2. Section 2 is an overview of the relationship between extreme heat and health as well as regional action on the issue. Sections 3 to 10 expand on six core steps integral to heatwave planning.[7]

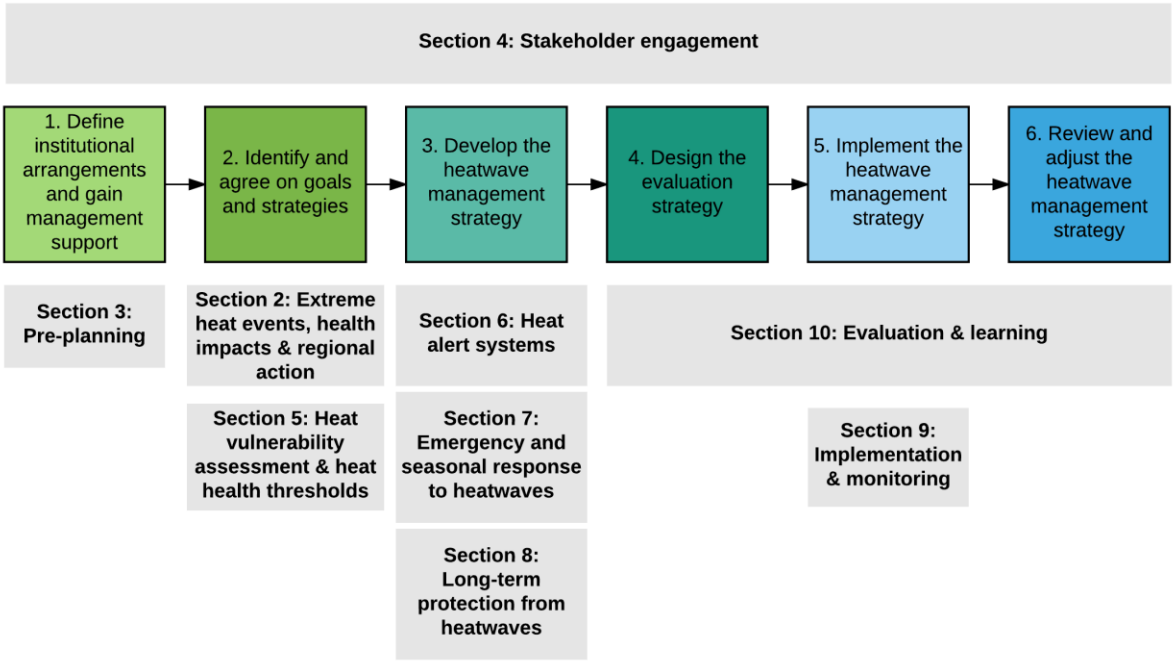


Figure 2: Toolkit structure. The six steps are adapted from State of Victoria, Australia[8].

2 Extreme heat events, health impacts and regional action

2.1 Extreme heat events and their effects

Heatwave definitions

No standard definition exists for an extreme heat event or, what we commonly refer to as, heatwaves. In general, heatwaves are weather conditions that are hotter than usual. The World Meteorological Organization's Task Team on the Definition of Extreme Weather and Climate Events defines a heatwave as unusually hot weather over a region, *"persisting at least two consecutive days during the hot period of the year based on the local climate, with thermal conditions recorded above given thresholds."*[9]

Countries and cities differ in their definition of what a heatwave is and in their decisions on when to call one. Epidemiological studies internationally show that exposure to unusually hot conditions affects health, with impacts including hospitalizations and death. But local context matters greatly in defining thresholds for magnitude and duration of a heatwave event because weather conditions that result in health impacts are a function of a population's sensitivity to heat, acclimatization, and ability to cope. An added complication is that air temperature is not the only way to characterize heatwaves since relative humidity, wind speed and sunshine also influence how hot it feels. Box 1 lists different ways to measure heatwaves.

- **Temperature**—Air temperatures in degrees Celsius as measured and reported by meteorological agencies.
- **Heat Index (HI)**—A *"measure of how hot it really feels when the relative humidity is added to the actual air temperature"* [10] and is reported in degrees Celsius or Fahrenheit.
- **Humidex**— An index (a computed value as opposed to something measured) devised to describe how hot or humid weather feels to the average person. The humidex combines the temperature and humidity into one number to reflect the perceived temperature.
- **Temperature and/or humidex in combination with daily morbidity and/or mortality**— Hospital admissions and coroner reports are factored into the decision-making process to trigger an alert or upgrade to a higher alert level.
- **Wet Bulb Globe Temperature (WBGT) index**—Considers four environmental factors: temperature, humidity, radiant load and air movement, and integrates them into one index that is used to call alerts.

For further information see Table 2 in Health Canada's Heat Alert and Response Systems to Protect Health: Best Practices Guidebook (http://www.hc-sc.gc.ca/ewh-semt/pubs/climat/response-intervention/index-eng.php)

Box 1: Metrics to define heatwaves

Cities and extreme heat

The risk of exposure to extreme heat is increasing with climate change. According to the IPCC, it is *virtually certain* (>99% probability of occurrence) that we will experience more hot temperature extremes over most land areas on daily and seasonal scales. Further, it is *very likely* (>90% probability of occurrence) that

heatwaves will increase in frequency and duration.[11] Even a 2°C increase in global temperatures above preindustrial levels will cause cities such as Karachi and Kolkata to experience conditions equivalent to their deadly 2015 heatwaves every year.[12] Because of the toll on people's health, the prospect of more and/or longer and more severe summer heatwaves is alarming for densely-populated, built-up cities that keep the environment hotter through the "urban heat island effect" (see Box 2).

The Urban Heat Island (UHI) effect is a phenomenon where temperatures in urban areas are several degrees higher than in surrounding areas. UHIs occur due to a combination of factors such as land use, building density, geography, pollution, and high temperatures, amplifying heat within the urban core.[13] The replacement of green areas with paved and dark-coloured surfaces (such as asphalt, stone, and concrete) that absorb and retain heat is a chief cause of UHIs. Urban characteristics that increase UHIs include the city size and population density. Compared to sparsely-populated cities, densely-populated ones have a high output of human-made heat sources (e.g., energy use of space cooling and heating, vehicle traffic, operations of industrial plants), which also leads to increased air pollution. Other important characteristics are the extent of built-up areas, building heights, and the distance between buildings, the disposition of buildings in the city, which influences natural ventilation.

Heat islands exacerbate exposure to extreme heat and compromise human health. UHIs raise daytime temperatures, reduce overnight cooling and increase air pollution, which can contribute to breathing problems, heat-related illness, and death.

Box 2: The urban heat island effect[14,15,16]

As a global region, Asia is highly vulnerable to the impacts of heatwaves. Asia contains 13 of the world's 23 "megacities" – cities with a population of over 10 million[17]. The sheer numbers of people potentially exposed to heat stress is a public health concern. Added to this are urbanization trends in the region that amplify the effect of heatwaves. This includes the widespread use of heat-absorbing asphalt and concrete[18], as well as air pollution from transportation and industrial processes that alter local climates.[19]

The International Disaster Database of the Centre for Research on the Epidemiology of Disasters contains reports of regional deaths related to extreme heat events. According to this database, 59 heatwaves were reported in China, India, Japan, Nepal, Pakistan and South Korea between 1953 and 2015, resulting in 15,878 deaths. Localized studies provide further information on the health burden of heatwaves and criteria used to declare heatwaves:

- **Tehran, Iran.** In the summer of 2010, the city experienced 16 consecutive days of temperature at or above 37.8 °C.[20] As a dense, sprawling city, little room for green space exists, and human activities, including transport, space and water heating and cooling, are adding to the UHI.[21] One study on heatwaves in Tehran defined heatwaves as having three consecutive days with a maximum temperature above 37.8 °C. Based on that criterion, researchers identified 17 heatwaves from 2001 to 2010 and estimated excess deaths. For example, temperatures reached 40°C in 2009, causing 19% more deaths as compared to a baseline.[22]
- **Ahmedabad, India.** In India, the national meteorological department declares a heatwave when local temperatures exceed 45°C.[23] Temperatures reached 46.8°C in Ahmedabad in May 2010, resulting in a number of cases of illness and death throughout the city.[24] A study to determine the rate of excess deaths from the 2010 heat wave estimated a 43.1% increase in mortality compared to reference periods between 2009 and 2011.[25] Ahmedabad is characterized by hot pre-monsoon seasons, March to May, where the average daily maximum temperatures often reach 45°C. The effects of this hot weather are exacerbated by poor air quality and the city's high population density.[26]

- **Shanghai, China.** In August 1998, Shanghai experienced a deadly heatwave, with temperatures exceeding 35°C for 9 consecutive days.[27] The highest daily maximum temperature reached 39.4°C on August 15th, and on August 16th records showed three times the daily average of deaths (752), as compared to the non-heat day average.[28] The heatwave's duration led to such a high mortality rate, and the pronounced UHI effect in Shanghai contributed to the heatwave's severity.[29]

Health effects and vulnerability

Death is the most extreme effect of extreme heat events. However, exposure to heat also leads to illness:

Heat stroke	The most serious type of heat illness is a result of excessive body heat. Signs of heat stroke include a core body temperature of more than 40°C, complete or partial loss of consciousness and/or reduced mental ability. Two types of heatstroke exist: • Classic - accompanied by little or *no sweating*, usually occurring in children, those who are chronically ill and older adults. • Exertional - accompanied by an *increase in body temperature*, because of strenuous exercise or occupational exposure in combination with environmental heat, as well as *sweating*.
Heat exhaustion	Caused by excessive loss of water and salt. Symptoms may include heavy sweating, weakness, dizziness, nausea, headache, diarrhea and muscle cramps.
Heat fainting (parade syncope)	Caused by the loss of body fluids through sweating and by lowered blood pressure due to pooling of blood in the legs. Symptoms include temporary dizziness and fainting resulting from an insufficient flow of blood to the brain while a person is standing.
Heat cramps	Caused by a salt imbalance resulting from a failure to replace salt lost through excessive sweating. Symptoms are sharp muscle pains.
Heat rash (miliaria rubra)	A result of inflammation of clogged sweat glands and accompanied by tiny red spots on the skin, which may give a prickling sensation.
Heat edema	Heat-induced swelling frequently noticeable in the ankles, feet, and hands, and most often seen in people who are not regularly exposed to heat.

Table 1: Heat-related illness, from most to least severe (reproduced from Health Canada 2011)[30]

Using the Heat Index metric, Table 22 illustrates the heat conditions that can lead to a range of health outcomes as applied to Pakistan. Severity is only one element of exposure. Heatwave frequency, duration, and timing of the season also matter. Events that occur early in the heat season generally result in higher health impacts than those later on in the heat season due to acclimatization.[31] It's worth noting that values for the Heat Index would change depending on the location.

Heat Index value	Health effects
32°C-41°C	Heat cramps and heat exhaustion possible with prolonged exposure and/or physical activity
41°C-54°C	Heat cramps or heat exhaustion likely and heatstroke possible with prolonged exposure and/or physical activity
>54°C	Heatstroke highly likely with continued exposure

Table 2: Health effects possible given heat condition in Pakistan[32]

Health outcomes are also shaped by community and individual factors. These factors determine heat vulnerability and increase the likelihood of exposure to heat and extent of harm from being exposed. A

2015 review of 15 heat-vulnerability studies from around the world classified potential vulnerability factors based on the amount of evidence and the agreement of the directionality and role of those factors as determinants of vulnerability.[33] In that review, factors with medium to high levels of agreement of evidence were as follows.

Exposure	Community factors	Individual factors
• Magnitude of heat exposure (+) • Timing (+) • Air conditioning (-) • Duration of heatwave (+)	• Population density (+) • Total population (~) • Housing quality (~) • Urban land use (+) • Open space (~) • Vegetation (-) • Healthcare access (-)	• Age (+) • Education (-) • Pre-existing medical conditions (+) • Acclimatization (-) • Race (+) • Poverty (+) • Deprivation (+) • Social isolation (~)

Table 3: Determinants of vulnerability to heat[34]

Factors tagged with a plus sign (+) denote those that have been found to increase vulnerability, a minus sign (-) decrease vulnerability, and (~) indicates that no significant relationship was found across studies. It's worth noting that only 3 of the 15 studies focused on geographic areas outside of North America and Europe. Therefore, the studies do not take into account factors that may be of particular concern in Asian cities. Religious practice is one of them.

- The 2015 heatwave in Karachi took place during the Muslim holy month of Ramadan. 95% of Karachi's population is Muslim and therefore it was speculated that daytime fasting of food and water during the heatwave led to excess mortality.[35] However, one academic study found that religion was not a significant risk factor and that all groups of people affected, regardless of religion, were between 13 and 25 times more likely to die of heat illness during June 2015 compared to the reference period of June 2014.[36]

Despite regional and local differences, sufficient analysis of morbidity and mortality data from previous extreme heat events worldwide has been undertaken to identify broad population groups that are most vulnerable to extreme heat. These are[37]:

- Older adults
- Infants and young children
- People with chronic illness or who are physically impaired
- Socially disadvantaged individuals and groups (homeless, low-income, isolated)
- Transient populations and newcomers
- Certain occupational groups (outdoor workers, workers exposure to high levels of indoor heat)
- The physically active

People presenting several of these characteristics are at higher risk of heat-related illness and death.

- In a span of 5 to 6 days, the heatwave in **Karachi** in June 2015 affected 65,000 people.[38] 40,000 were treated at hospitals. Around 1,200 people died. Detailed information is available for 1,006 of those who perished. Almost twice as many men as compared to women– 362 women and 644 men – died in the heatwave. The largest number of casualties was reported among the elderly in both the sexes; 175 women and 346 men, all 50 years and above, died. The next vulnerable age bracket was between

25 and 49 years, with 115 women and 208 men perishing in the heatwave. The most protected age bracket was among infants and children aged 4 years old and less. 8 girls and 4 boys died in Karachi during this heatwave.

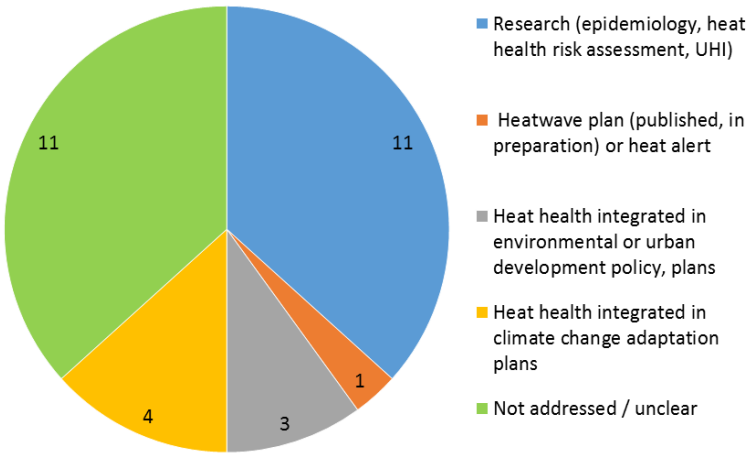
2.2 Regional action to reduce death and illness from extreme heat

Large Asian cities are at different stages in preparing for and responding to heatwaves. Desk-based research on existing efforts to manage health impacts of heatwaves for 30 cities in Asia suggests that very few cities have developed stand-alone plans. However, other findings are worth noting:

- In some cases, academic research on heat vulnerabilities and UHI impacts and responses is available at the city level to guide action.
- In other cases, health protection from extreme heat seems to be occurring by integrating actions to reduce heat vulnerability in local or sub-regional climate change adaptation plans and in environmental planning more generally.
- For just over a third of the cities explored, the web search did not yield evidence of research or plans to address the health impacts of extreme heat.

This rapid analysis of regional action is indicative and may understate the current state of play. It's possible that efforts are underway but not documented in resources available online or that planned efforts are not publicized.

Cities included in this analysis are Dhaka, Chongqing, Shanghai, Beijing, Guangzhou, Wuhan, Tianjin, Shenzhen, Hong Kong, Mumbai, Delhi, Kolkata, Chennai, Bengaluru, Hyderabad, Ahmedabad, Jakarta, Tehran, Tokyo, Osaka, Nagoya, Seoul, Kuala Lumpur, Kathmandu, Karachi, Lahore, Manila, Taipei, Bangkok and Ho Chi Minh City. Their populations exceed 5 million.



Distribution of approaches taken by 30 large Asian cities to manage health impacts of heatwaves

In South Asia, the Climate and Development Knowledge Network (CDKN) has been influential in supporting research, planning, and action to reduce health impacts of heatwaves in a changing climate.

Ahmedabad was the first city in South Asia to prepare a Heatwave Action Plan. A deadly heatwave in May 2010 spurred the Ahmedabad Municipal Corporation (AMC) to partner with the Indian Institute of Public Health, Gandhinagar (IIPH), Public Health Foundation of India (PHFI), Natural Resources Defense Council (NRDC), Mount Sinai School of Medicine, and Rollins School of Public Health at Emory University and launch the city's first Heat Action Plan in 2013. CDKN provided funding and technical assistance to kick-start this process. The Ahmedabad Commissioner, along with the AMC Health Department, led planning and is leading implementation along with local stakeholders.[39]

The 2013 plan provided a framework for other Indian cities to emulate. In 2015, partners to the Ahmedabad Plan held a workshop to share lessons from heat preparedness activities for possible replication by other Indian cities and states.[40] Activities and strategies found to be effective were as follows:

Skills and training

- Enhancing capacity building efforts in health facilities.
- Augmenting heat-health training among medical professionals to ensure proper identification of symptoms.
- Educating reporters on heat health so that they are more sensitized to the messages they publish.

Communication

- Improving media engagement and partnership to target vulnerable communities and working with writers to make heat health more engaging to the public.
- Having graphic designers create city-specific vulnerability maps for media use.
- Involving local newspapers to ensure a wide public reach of heat information.
- Disseminating information on the importance of managing heat risks through environmental institutes.

Research

- Strengthening meteorological infrastructure and hospital surveillance to address research gaps, including a standardized databank format for patient management.

Governance

- Issuing heat-related guidelines and protocols.
- Promoting collaboration among transportation, labor, and education departments as well as the national meteorological department and disaster management authorities to improve a city's emergency response.

Building on three years of implementation in Ahmedabad and initiatives springing up in other cities to mitigate extreme heat, CDKN and partners released a **national roadmap for heat action planning** in **India**. This roadmap, developed by an expert group through a consultative process, was meant to promote a national approach to garner support for sub-national and local efforts.[41] According to the national roadmap, success in heatwave management requires the following:

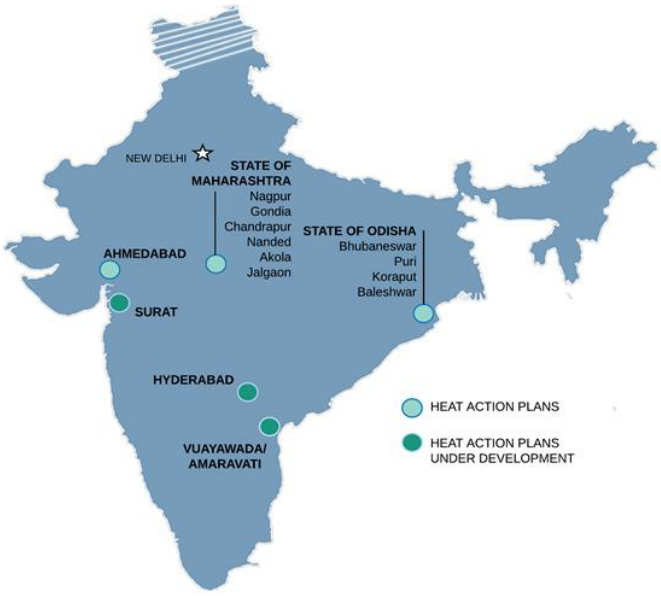
1. *Create a framework that identifies activities before, during and after a heatwave response*, including interventions for the short and long-term. For example, short-term interventions in preparation for heatwave events include creating an early warning system and communicating risks to the public. Long-term interventions include enhancing urban planning to decrease the UHI effect.
2. *Set goals and objectives* for heatwave management. Examples are: "to protect the population from heatwaves and related impacts on health", "to promote heatwave management planning in vulnerable areas".

3. *Determine priority strategies and activities* in support of goals and objectives.
    - *Institutional engagement and coordination.* This includes identifying a lead agency to coordinate planning efforts and ensuring roles and responsibilities among partners are clarified prior to an extreme heat event.
    - *Research to help set priorities and reduce uncertainties in implementation.* There is a need to improve the understanding of heat-related mortality and related issues. Research is especially important for identifying vulnerable people and places.
    - *Integrating heatwave management in appropriate policy and planning areas.* Recognition and integration of heatwave management by key institutions are critical to planning success. For example, communication on heat health is part of outreach by public health agencies.
    - *Resource mobilization.* The lead agency should consider how to finance implementation from the onset of planning. Engagement with the private sector and development partners can help.
    - *Capacity building of and communication* with stakeholder groups and citizens to build an appetite for the plan and to raise awareness of health impacts from heat and how to protect the vulnerable.
    - *Monitoring, evaluation, and learning*, to inform adjustments and future practice and policy.

Heat action planning is taking off in India. In March 2016, two other regions in India, Nagpur, and Odisha launched their own heat action plans. Nagpur and four neighboring cities analyzed their mortality rates to determine their own heatwave threshold temperature, setting the orange level (heat alert day) at 43°C and their red level (extreme heat alert day) at 45°C. Decision makers in Odisha have integrated heat action planning in the state's disaster management system. This has allowed for quick implementation of heatwave alerts to the public, and they are continuing to establish community outreach for vulnerable groups.[43]

As of 2016, two Indian states had heat action plans in place and heat action planning was underway in three cities (see Figure 3).

Figure 3: Spread of heatwave planning in India[42]



A deadly heatwave in June 2015 raised heat health to the agenda of **Karachi**'s city government. Building on Ahmedabad's (India) experience in managing heatwaves and supported by CDKN, the Commissioner Office Karachi worked with national and international consultants to develop the city's first heatwave

management plan. The first step in late 2015-early 2016 was to investigate whether key public and private-sector organizations would support such an initiative and how they could contribute. Research for and development of the heatwave management plan began in November 2016. Over six short months, the project team (see Figure 5):

- Drew on multiple lines of evidence to understand social, economic and environmental factors that heightened heat exposure and vulnerability to health impacts in Karachi during the June 2015 event
- Created opportunities for sharing of good practice in managing heatwaves in Pakistan
- Consulted with stakeholders likely to have a role in implementing the plan on its objectives and priorities
- Presented a draft heatwave management plan for review by both senior decision makers and practitioners working at the operational level

At its core, Karachi's heatwave management plan aims to prevent heat-related illness and death in Karachi. The 2017 plan comprises three strategies to solidify the City's heat alert and response system: (1) providing the public with timely and specific information before, during and after extreme heat; (2) empowering implementation agencies to supply the required levels of service and support in a way that is coordinated and efficient during emergencies; and (3) increasing knowledge of the burden of heat-related health outcomes in Karachi to better target heat action planning over time. As the lead agency, the Commissioner Office Karachi is responsible for overseeing the plan's implementation and refinement over time. For example, stakeholders have already identified the need to bolster participation of community networks in preparing and responding to heat. Therefore, the plan's next iteration will define strategies and activities that grassroots organizations can lead or support to boost self-sufficiency among communities and leverage local assets to reduce health impacts from heat.

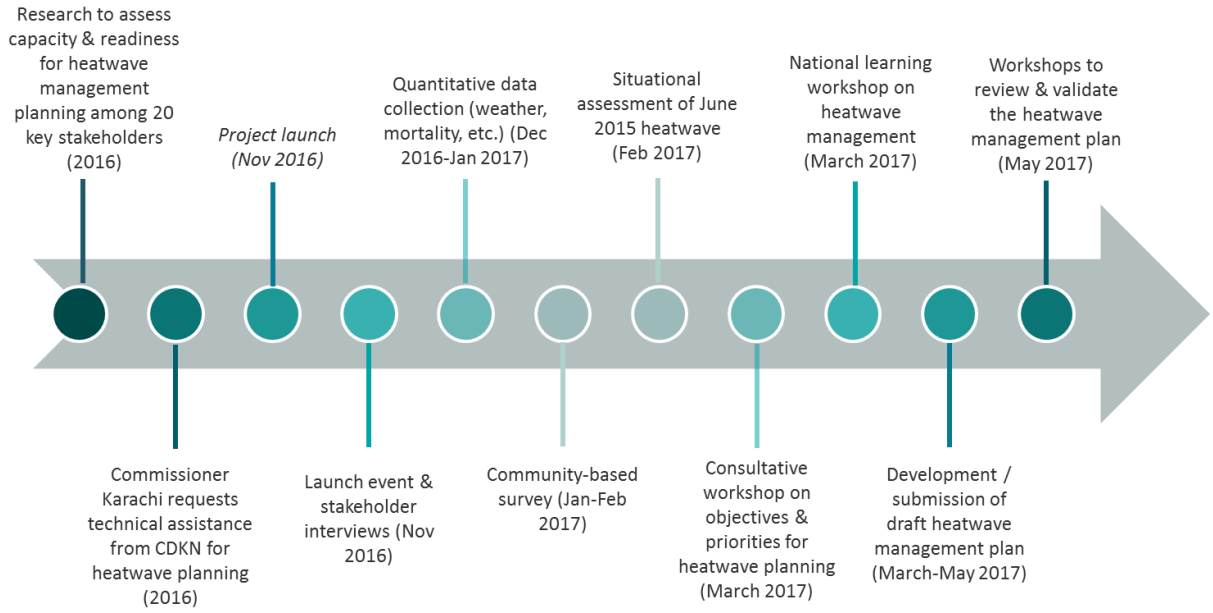


Figure 4: Process to develop Karachi's first heatwave management plan

Besides recent progress in South Asia examples in other parts of the region are worth noting:

In **South Korea**, high temperatures have led to excess deaths in the summer, particularly in large cities such as **Seoul** and **Daegu**, which are highly urbanized and densely populated.[44] Heatwave management is part of the country's national climate change adaptation plan. This plan sets out an organizational framework that puts the Centre for Disaster and Safety Countermeasures in charge and identifies three reporting agencies tasked with heatwave management. Agency roles relate to health care, warning systems, and connecting with local governments during heat events. One of the agencies, the Ministry of Health and Welfare has developed several tools to prevent health impacts from heat waves: (1) health care guidelines for the general population, and specific guidelines targeted to the elderly and teachers; (2) a mobile healthcare program for the elderly; and (3) a surveillance system to increase awareness at medical centres of heat-illness symptoms.[45]

In 2003, the **Shanghai** municipal government developed a multi-hazard early warning system (MHEWS), which includes alert levels for extreme heat. The city has established a response hierarchy so departments and the public are clear on who is responsible for what during a heatwave emergency. The city has a tiered dissemination plan that includes communication with the public through text messages, television, radio, newspapers, and through websites of regional and national weather services.[46] Shanghai was subject to two severe heatwaves: one in 1998 before the warning system was implemented and another in 2003 just after implementation. Weather conditions were comparable across events. However, the 1998 heat wave had a much higher incidence of mortality than the one in 2003, suggesting that the implementation of the heat warning system helped to reduce health risks.[47]

How does Asia compare to other regions?

The United States, Canada, parts of Australia, and 20 European nations have heatwave management plans in place, operating at different scales.[48] Strategies and activities so far implemented in parts of Asia with the most comprehensive responses to extreme heat have much in common with North American, European and Australian responses. Common features include a heat alert system that identifies specific weather conditions that could lead to harm and corresponding levels of stakeholder response. Heatwave management plans that are being implemented commonly use traditional and social media to alert the public of extreme heat events. Generally, plans aim to be clear on leadership and accountabilities. Many plans provide for the establishment of a coordinating agency to organize efforts by many stakeholders before, during and after the heat season. Another similarity in successful heatwave management plans is their learning focus. Many include a review stage, which allows for agencies to assess their plans' effectiveness and adapt measures based on evidence on what is working and what is not. For example:

- **England** has developed a heatwave plan that local governments can adapt to their own strategies. [49] The plan includes a country wide heat-health watch alert system that operates during the summer season and five alert levels – from 0 (long-term planning) to 4 (emergency response). It is meant to trigger responses from different agencies depending on the level of alert. Once an alert is triggered, agencies take commensurate action based on their designated roles as defined in the plan. The plan contains extensive tables for actions that could be taken at various levels of implementation. For example, the Commissioners of health and social care are to use media to communicate public health messages tailored to vulnerable groups upon a level-2 alert.
- The **State of Victoria** in **Australia** has a heatwave framework and plan to reduce the impact of heatwaves on public health. The plan describes the agencies involved in responding to heatwaves and

identifies the lead agency as the Department of Health and Human Services. The government has developed temperature thresholds for each city in the state, according to local conditions[50]. An audit function is also built in, to support continued improvements in effectiveness. An audit in 2014 concluded that further clarification of sector roles and responsibilities was necessary and that public health messages should reach broader audiences. Updates in 2016 addressed these shortcomings.[51]

Key Messages –

Extreme heat events, health impacts and regional action

- Large cities are vulnerable to the effects of extreme heat due to Urban Heat Island which amplifies the impacts of a heatwave. These cities are densely populated and have many structures that are made of asphalt and concrete that absorb the heat.
- Every city differs in their definition of a heatwave due to its local context and the population's ability to acclimatize to extreme temperatures.
- Heat exposure can cause many different illnesses that range from mild to serious. Health outcomes are also shaped by community and individual factors that affect individual's ability to cope with heat stress.
- Large Asian cities are at different stages in preparing for and responding to heatwaves. Ahmedabad's Heat wave Action Plan has helped to establish best practices for the region. The most effective strategies and activities include creating a framework, setting goals and objectives, determining priorities, and utilizing stakeholders throughout the process.
- Karachi's 2017 heatwave management plan aims to provide the public with information during extreme heat events, help to coordinate stakeholder agencies to support emergency actions and increase knowledge about heat-health.
- Countries in North America and Europe are also developing heatwave management plans. Common features include the creation of a heat alert system, establishing lead agencies, and reviewing adaptive measures to ensure effectiveness.

Box 3. Extreme heat events, health impacts and regional action

3 Pre-planning

Heat health is a shared responsibility, often involving stakeholders across levels of government and sectors. A number of policy and planning domains are implicated, including public health, disaster management, weather services, power and water supply services, climate change adaptation, urban development and environmental protection. Cross-cutting issues such as this can be difficult to manage effectively and attract the necessary resources. This section highlights lessons and good practice to prepare the ground for heatwave management. Main activities comprise building strong city-level commitment; exploring institutional and capacity assets and needs and identifying opportunities for embedding heatwave management in existing institutions.

3.1 City-level commitment

Institutional champions, alliances, and committed partners are core to the success of heatwave management, as is citizen support. Securing commitment can be achieved by:[52]

- Obtaining endorsement and a commitment to participate in the heatwave management planning process by the city executive
- Establishing a steering committee of municipal leaders and representatives from external agencies to oversee the planning process. Examples of steering committee members include: an elected member of council, the manager of local government services, the manager of health, an officer in charge of local ambulance services, an officer of the police and managers of social welfare organizations
- Presenting robust evidence on the burden of heat illness and death to increase the relevance of heatwaves to decision makers and the public

Given the number and range of agencies likely to be involved and the complexity of heatwave management issues, coordination is important. Such coordination is best undertaken by a designated lead. The lead agency can set the overall direction of the initiative and coordinate planning, although roles and responsibilities in implementation are distributed across government and non-government stakeholders. The case below is an example where changes were made to improve inter-agency coordination:

- Over the past 20 years, heatwaves have increased in frequency and intensity in the state of **Victoria** (Australia).[53] In 2009 the state rushed to develop a heatwave management framework but left many gaps in determining what agency took care of what tasks. The Victoria Police was assigned as an interim control agency but was not fully recognized by others as the leader for heatwave emergency response. In 2014, an intense heatwave hit the region. The Victoria Police, having not fully taken on the lead role, was unprepared to delegate roles and responsibilities. The 2015 heat-health plan addressed this shortcoming. It clearly sets out the actions that the new lead agency, the Department of Health and Human Services, takes to prepare for and respond to extreme heat events. Clarity in roles has allowed for the Department to set long-term priorities within its own agency and among local governments, health and community service providers, and clinicians. Defining a lead agency with clout and clarifying its roles is a crucial step for responding to heatwaves and adapting in the long-term.

3.2 Institutional landscape and capacities

Understanding a city's institutional context surrounding heat health helps (1) detect current gaps in local capacity to coordinate and act to prevent, respond to and recover from extreme heat; (2) identify areas where further capacity needs to be developed, opportunities to strengthen institutions and to leverage community assets; and (3) understand external influences that factor into heatwave management (e.g., powers of utilities to restore or restrict service). Cities can apply simple frameworks, such as the Strengths-Weaknesses-Opportunities-Threats framework (as shown in Table 4), to gather information.

- In **Karachi**, the consulting team compiling information to develop the city's first heatwave management plan used a Strengths-Weaknesses-Opportunities-Threats (S-W-O-T) framework to organize and analyze qualitative information from primary (from stakeholder interviews and a community survey) and secondary sources. Strengths and weaknesses, in this case, referred to institutional factors such as human resources, finances, organizational structures and culture, decision-making processes and information flows that could have affected the health outcomes of the 2015 heatwave in Karachi. Opportunities and threats referred to factors that could shape heatwave management in the future, including political, social, cultural, economic and technological features.

Strengths	**Weaknesses**

• What went well, with respect to:
  ○ Governance arrangements (clarity of roles and responsibilities, appropriate monitoring, reporting, and learning)
  ○ Preparedness to respond (e.g., plans in place that are evidence-based)
  ○ Activation and response to heatwaves (public education on heat hazards, reach to vulnerable groups, community-based plans, and actions)
• What human, technical and financial resources were successfully drawn upon?
• What were the strengths?
	• What could be improved, with respect to:
	  ○ Governance arrangements (clarity of roles and responsibilities, appropriate monitoring, reporting, and learning)
	  ○ Preparedness to respond (plans in place that are evidence-based)
	  ○ Activation and response to heatwaves (public education on heat hazards, reach to vulnerable groups, community-based plans, and actions)
	• What are others outside the City Government likely to see as a weakness?

Opportunities	**Threats**
• What opportunities are open to the City Government? • What trends could be taken advantage of? • How can the City turn strengths into opportunities?	• What threats could derail effective heatwave management in Karachi? • What threats do weaknesses expose the City to?

Table 4: S-W-O-T analysis framework

Figure 5 summarizes main findings from the S-W-O-T assessment, which the team then used to shape the design of consultative sessions with stakeholder and strategies and actions in the heatwave management plan.

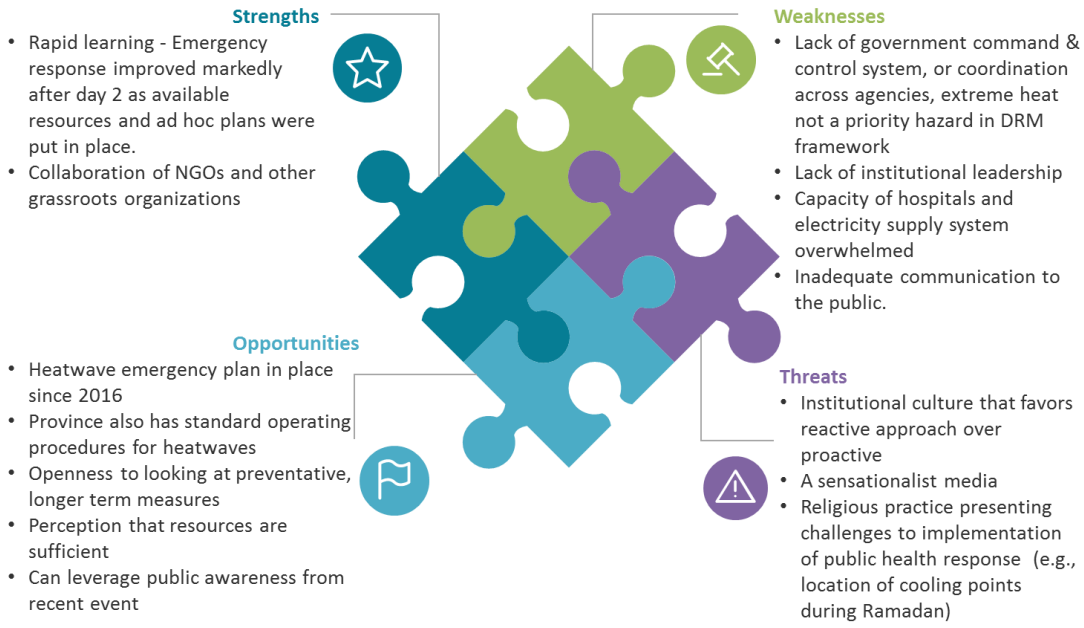


Figure 5: Summary findings from the S-W-O-T analysis for Karachi

3.3 Integration

Explicit recognition and integration of heatwave management issues into existing policies and practices is part of a robust response to heatwaves. Practitioners advise using existing local, regional and national systems for emergency response in planning for heatwaves.[54] Responding to heatwaves draws on generic disaster planning models. One of the risks of creating new or parallel systems is that lessons learned may be lost. And, in crises, tried and tested command and control mechanisms work best.

Experience with heatwave management in India provides broader recommendations on integrating aspects of heatwave management across different policy domains, including:[55]

- Reflecting on opportunities and challenges for integration of heatwave management activities into norms, regulations and planning provisions (e.g., mandatory consideration of heat load and health factors in building approval processes and in the planning of water, road, transport and energy infrastructure).
- Integrating heat-health communications as part of communications by public agencies
- Embed generation of information on health impacts from extreme heat in research and development (R&D) frameworks

Cities are in charge of a range of plans. Some of them may need amending to account for heatwave management. The following are examples:[56]

- Medium / long-term urban development plans
- Strategic land-use plans
- Development orders
- Strategies and plans for waste management and sanitation
- Strategies and plans for energy supplies
- Management plans for coastal zones

- Strategies and plans for water management
- Low emissions development strategies[57]

Key Messages

- The key to success of heatwave management is to have institutional support. This commitment can be achieved by involving municipal leaders and educating the public on the evidence and importance of the burden of heat illness and death.
- Identify a city's institutional context and capacity to respond and recover from extreme heat events and what areas there may be gaps. Understand external influences and apply a simple Strengths-Weaknesses-Opportunities-Threats (S-W-O-T) framework to gather information.
- Integrate heatwave management policies and practices into existing local, regional and national emergency response systems will allow for easier adaptation and create a more robust response.

Box 4. Pre-planning

4 Stakeholder engagement

Stakeholder engagement from the earliest planning stages is critical for the successful implementation of heatwave management plans. This section highlights good practice in stakeholder engagement, including how to engage vulnerable groups and other planning considerations.

For heatwave management to be effective, stakeholder roles, capacities, and contributions should be woven throughout planning and delivery. Figure 6 outlines an approach to help make stakeholder engagement meaningful and systematic. Steps 1 and 2 help identify stakeholders to engage. Steps 3 and 4 guide how to work with stakeholders.

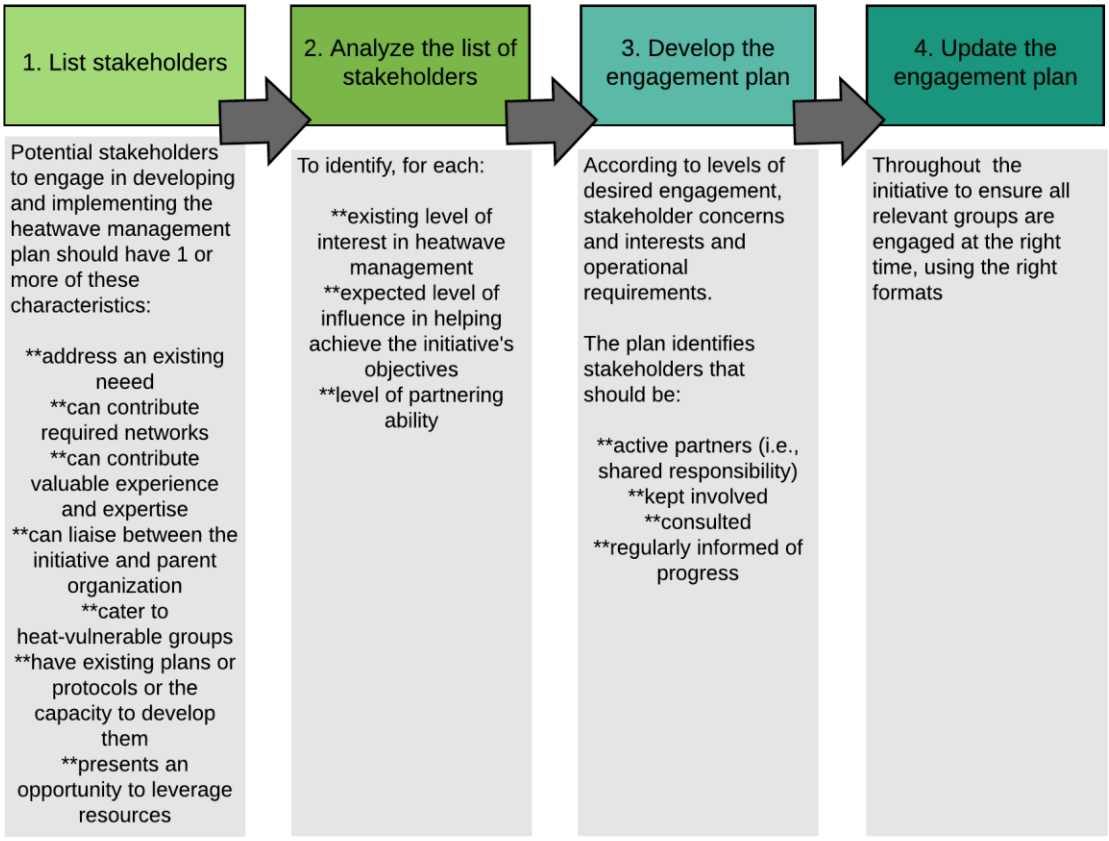


Figure 6: An approach to guide stakeholder engagement. (Adapted from Brisbois et al., 2012.[58])

4.1 Identifying stakeholders

The number and range of stakeholders to engage in heatwave management can vary. The scale of action envisioned and resources available are two reasons for this. As a rule, though, the objective is to identify stakeholders positioned to add value to heatwave management planning, programs, and activities.[59] Further, identifying the types of groups that the heatwave management plan needs to reach helps clarify who specifically should be involved.

An important step in planning and engagement is to determine who the vulnerable groups are and where they are located. A heat vulnerability assessment can help in this regard. Stakeholder agencies can use several methods to collect data for heat vulnerability assessments. These include household surveys, focus group discussions with local community members and use of geographic information systems (GIS) to map known vulnerable populations and variables such as emergency services, cooling stations, and community services. [60]

See Section 5 on Heat vulnerability assessments for further information.

Stakeholder identification and engagement can occur in stages. Often a core group, involved at the outset, helps identify objectives of the heat wave management plan. The stakeholder circle then broadens to include local organizations, especially those working with heat-vulnerable groups, such as community health organizations, nongovernmental agencies, schools, worksites, and faith organizations.[61] Governmental organizations (disaster risk management, public health), community planners, and medical services are among the stakeholders typically involved in planning and delivery. Agencies such as education and labour departments, universities, training institutions, professional bodies and trade associations can also contribute. Roles include ensuring the plan is relevant, communicated appropriately and has the desired effect on the target audience.[62]

Involving locally-based stakeholders is essential. They will be aware of local effects of hot weather, have a vested interest in mitigating heat events and can be readily available for seasonal planning and during an event. Local stakeholders tend to be adept at identifying relevant measures for their city or region, especially in regards to vulnerable groups.[63] For example, grassroots organizations can help ensure public-awareness campaigns provide culturally-appropriate information to diverse groups of people, in formats tailored to those groups.

4.2 Working with stakeholders

Once identified, stakeholders need to be made aware of their roles. A heat wave management plan is a year-round effort and therefore some stakeholders – active partners – will require constant engagement. Other stakeholders are kept involved on some issues, consulted or regularly informed of progress. Stakeholders may ask questions about the heatwave management plan and their contribution to it. Incorporating specific answers to these questions in the plan can help build common ground among those involved.[64]

- Why develop a heatwave management plan now, and why take action on extreme heat over other natural hazards?
- What is the risk to our community from extreme heat events?
- What temperature threshold is used to trigger a heat alert?
- How and when is the public informed?
- Who are most vulnerable to the heat-health impacts in our community and where are they located?
- What role can my organization play in preventing or treating heat-health impacts?
- How will the plan be maintained over the long term?

The lead agency should be a stakeholder capable of coordinating the overall effort and of communicating roles and responsibilities to the other stakeholders in a clear and effective way. Examples of lead agencies that are in charge of heatwave management plans are as follows:

Region / City	Agency	Scale of decision making
Victoria, Australia	Department of Human and Health Services	State government
Minnesota, USA	Department of Health	State government
Andhra Pradesh, India	Disaster Management Department	State government
Toronto, Canada	Toronto Public Health	Local government
Ahmedabad, India	Ahmedabad Health Department	Local government
Karachi, Pakistan	Commissioner Office Karachi	Local government

Table 5: Examples of agencies leading heatwave management, at several scales

During an extreme heat event, communicating on weather and heat health and delivering tailored responses to reach vulnerable groups, such as delivering bottled water and opening cooling centres, are important roles for stakeholders. The sections below discuss both activities.

Communicating heat-health risks and heat-related information

Communications before, during and after an extreme heat event is critical and tends to be a joint effort among stakeholders. Functions range from alerting the public about hazardous weather conditions to developing public-health messages about possible health impacts and protection measures to disseminating these messages using different channels.

Meteorological agencies or organizations with readily available access to weather data generally lead in developing a heat alert, but many others are involved in sharing information on hot weather and risks to health. Heat alerts signal that weather conditions have reached certain thresholds and trigger follow-up actions. Getting information out to the public and to those responsible for follow-up actions requires coordination among government, non-government organizations, and the media.[65] Communications with media and community groups should use consistent, simple messages. Sensitization of stakeholders before the heat season by weather and public health services helps ensure that the heat alerts are received as intended. Keeping the health sector, beneficiary communities and the media continuously informed on weather conditions can help build a routine and improve the effectiveness of a heat alert during a heatwave event.[66]

The messages that are conveyed should be easily accessible, credible and relevant. In Canada, the Health Communication Unit at the University of Toronto's Centre for Health Promotion developed a checklist to evaluate the relevance and appropriateness of public health messages in light of an audience's potential level of understanding and needs.[67] Partners can use Table 6 below to review proposed messages and approve or refine them.

	Excellent	Very good	Fair	Fail
The message will get and maintain the attention of the audience.				
The strongest points are given at the beginning of the message.				
The message is clear (i.e., it is easy for the audience to point out the actions to take; the reasons for taking those actions; evidence to support these actions and any background information or definitions).				
The action you are asking the audience to take is reasonably easy.				
The message uses incentives effectively (more than one type of incentive is used; the audience cares about the incentives presented; the audience thinks the incentives are serious and action is likely to be taken)				
Good evidence for threats and benefits is provided.				
The messenger is seen as a credible source of information.				
Messages are believable.				
The message uses an appropriate tone for the audience.				
The message uses an appeal that is appropriate for the audience (i.e., analytical or emotional).				
The message will not harm or be offensive to people who see or hear it.				
Target audience identity is displayed throughout the message.				
The message is in the language or format most appropriate to the target audience (e.g., takes into account ability to read).				
The message is consistent with other health promotional materials (e.g., air quality, energy-use reduction campaigns).				

Final Recommendation

☐ Use ☐ Modify ☐ Reject

Comments:

Table 6: Checklist to review public health messages. (Reproduced from Health Canada 2011[68]). Communicating the Health Risks of Extreme Heat Events: Toolkit for Public Health and Emergency Management Officials.

Use of social media and SMS texting via mobile phones is an efficient way to deliver information to stakeholders and the public. An Extreme Heat Social Media Toolkit, developed by the United States Federal Emergency Management Agency, is available for widespread use. It includes pre-prepared safety messages to share on social media and encourages the public to re-share the information on their social media accounts for wider dissemination and awareness (see Figure 7). It also includes links to extreme heat graphics and to other materials related to heat awareness and preparedness that anyone can access.[69]

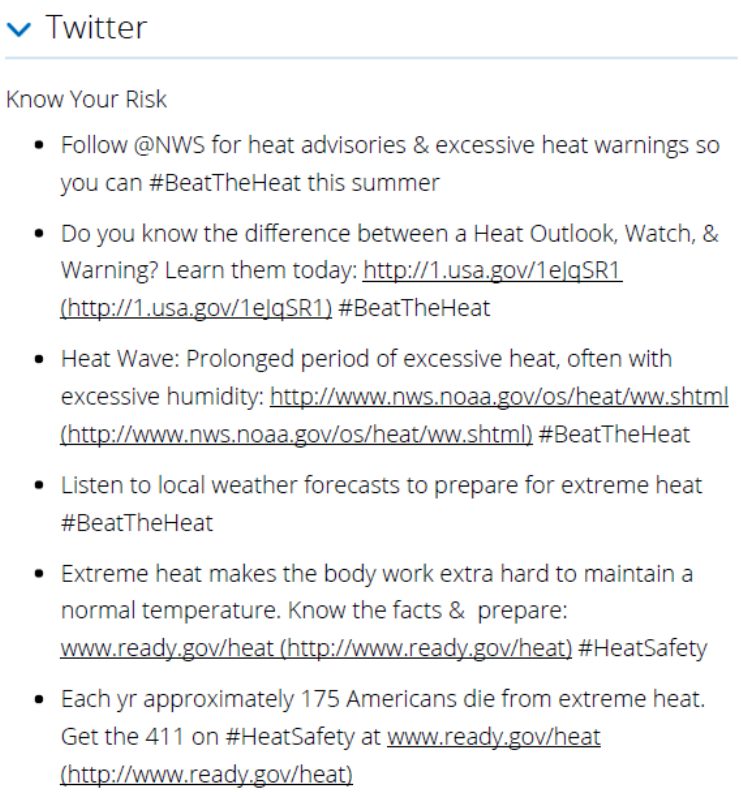


Figure 7: Examples of tweets for use in social media[70].

Not everyone has access to technology so using a range of formats is important. This includes visually attractive, concise materials for distribution or display in areas frequented by vulnerable groups (as in Figure 8). Training and communication materials can incorporate visual graphics to appeal to groups such as slum communities, patients in health centres and school children (see Section 6.3 for more information on communication of health risks).[71]

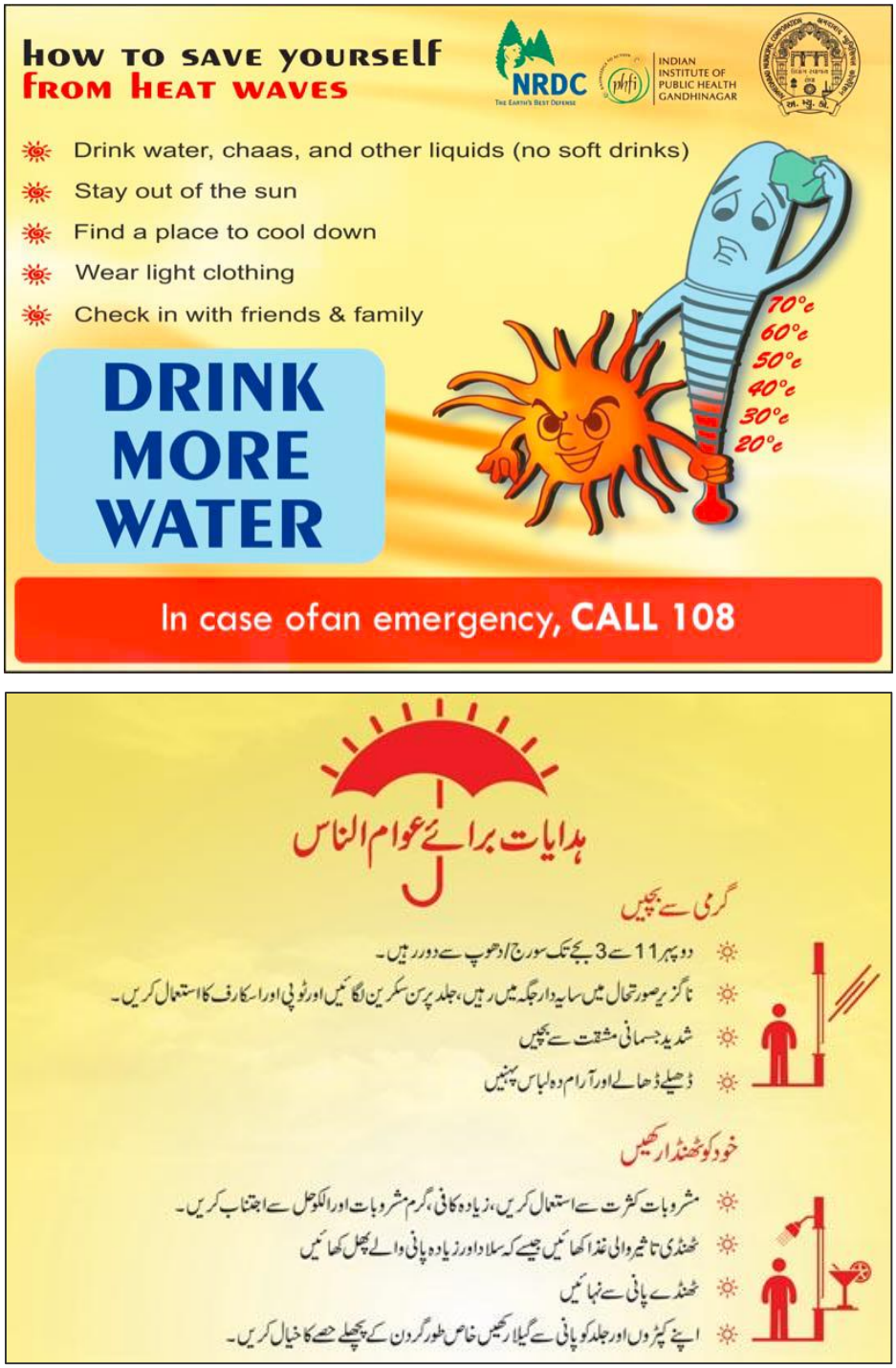


Figure 8: Ads developed to post at Urban Health Centers[72]

Reaching vulnerable groups

Ensuring that heat-vulnerable groups are safe and aware of the risks from extreme heat is central to heatwave management. People and groups involved in outreach with vulnerable populations include

social and health workers, volunteers, faith organizations, other nongovernmental agencies and the police. Activities include visiting vulnerable individuals, such as the elderly, homeless, and those that may be socially isolated, during a heatwave to check in on their adoption of protective behaviours (e.g., fluids are being consumed, appropriate clothing is being worn) and to assist in alleviating symptoms of overexposure. Police, for example, are often aware of areas where at-risk residents can be found and can help identify when people might need to be moved to a safe place such as a cooling centre.[73]

- In **Ahmedabad**, India, stakeholders employed a vulnerability survey and assessment to identify vulnerable groups.[74] Based on findings from that research, the city included recommendations targeting slum communities, outdoor workers, government officials and health professionals in their 2013 heat action plan. Constant stakeholder engagement and public education during the planning process helped garner support for the initiative and identify critical issues. Effective outreach to vulnerable communities remains a work in progress, though.[75] The 2017 updated plan extends the range of outreach methods used to target vulnerable groups. Partners have expanded inter-personal communication efforts and alliances with non-governmental organizations working with the at-risk communities of Ahmedabad.[76]

- In **Da Nang**, Vietnam, the International Institute for Environmental Development (IIED) and partners undertook a participatory study to understand working and living conditions of unregistered migrants and outdoor workers and how these relate to policies regarding extreme heat and climate change adaptation plans. Outdoor and migrant workers are susceptible to heat illnesses due to the long, strenuous hours they spend in the direct sunlight. The study included a checklist to use prompts during interviews. Table 7 include examples.

Stakeholder	**Checklist example**
Policymakers	How do existing policies and/or regulations for public services for migrant workers especially those with unregistered status consider heat vulnerability?
Healthcare service providers	What is the capacity of the hospital in dealing with heat-related illnesses?
NGOs, grassroots organizations	What unique situations do migrant workers face that increase their heat vulnerability? What role do you play in monitoring working conditions? What role do you play in advocating for labourers' rights in the workplace?
Unregistered migrants, outdoor workers	How do you feel when you are working in the heat outdoors? How do you adapt to heat at work?

Table 7: Checklist for stakeholder interviews. Adapted from Phuong et al. [77]

- **Abu Dhabi**, United Arab emirates (UAE), has developed a Safety in Heat program aimed at preventing heat illness among outdoor workers and building awareness of health risks among workers, supervisors, and employers. The Health Authority of Abu Dhabi developed a toolkit and distributed it to 600 large companies in the UAE to encourage their participation in the program. Information kits included posters and media materials catered to migrant workers. The 2008 pilot program was successful and roll out continues every summer. The core content has stayed the same but specific material and intended reach have evolved over time. The program now includes training for supervisors on the thermal work limit and has broadened its engagement with companies across additional sectors.[78]

Figure 9: Examples of awareness posters from the Health Authority of Abu Dhabi "Safety in the Heat" program[79]

Some studies have shown that **gender** is a factor in heatwave mortality, by virtue of the different roles males and females can play in society, as well as differences in behaviors and attitudes that could help staying healthy in extreme heat. The World Health Organization highlights the higher rates of mortality that women tend to have during extreme heat events, as compared to men.[80] This can be attributed to physiology, with women having a higher core body and skin temperature, and set-points for sweating in comparison to men.[81] Males tend to suffer occupational heat exposure, either from working in overheated conditions or outdoors. It's important to think about sex and gendered aspects of responding to and preparing for extreme heat.

"Sex" refers to the genetic, biological and physiological characteristics that generally distinguish women from men. "Gender" refers to the socially-constructed norms, roles and relations that societies consider appropriate for men and women. Gender determines what is expected, permitted and valued in a woman or a man in a determined context.

Source: WHO. What do we mean by "sex" and "gender"? Geneva, World Health Organization, 2011 (http://www.who.int/gender/whatisgender/en/index.html).

Key Messages: Stakeholder Engagement

- Stakeholder engagement from the earliest planning stages is critical for the successful implementation of heatwave management plans.
- Identify stakeholders to determine what actions can be taken and what resources are available. There will often be a core group of stakeholders who develop the objectives of the heat wave management plan; other stakeholders will be brought in as roles are defined and as the plan takes shape.
- Locally-based stakeholders are essential to the development of a heat plan since they have a vested interest, are readily available on location and have a solid understanding of the situation.
- Stakeholders must be aware of their roles in order to effectively contribute to the plan year-round. A lead agency should be established to delegate responsibilities and facilitate plan implementation.
- Communicate with stakeholders throughout extreme heat events to disseminate weather information and protection measures. This can be done through social media, SMS, texting, educational materials, and print and radio advertisements.
- Vulnerable populations should be identified and an outreach effort should be made to ensure they are safe and aware of how to protect themselves from heat-illnesses.

Box 5: Key Messages – Stakeholder Engagement

5 Heat vulnerability assessment and heat-health thresholds

Everyone is vulnerable to extreme heat but some people are more vulnerable than others. Setting priorities for heatwave management requires robust evidence on vulnerable groups, their location in the city as well as local weather conditions linked to heat-related deaths and illness. This section summarizes approaches used in the region and globally to assess heat vulnerability of cities and set heat-health thresholds based on evidence.

5.1 Vulnerability and its influences

Vulnerability to extreme heat is a function of physiological sensitivity to heat stress, and the ability of an individual or community to take the necessary measures to protect their health.[82] Many conceptual frameworks exist that describe factors shaping vulnerability (see Figure 10). As outlined in Section 2.1 individual (e.g., age, poverty, pre-existing medical conditions) and community (e.g., population density, health care access) factors determine heat vulnerability and increase the likelihood of exposure to heat and extent of harm from being exposed.

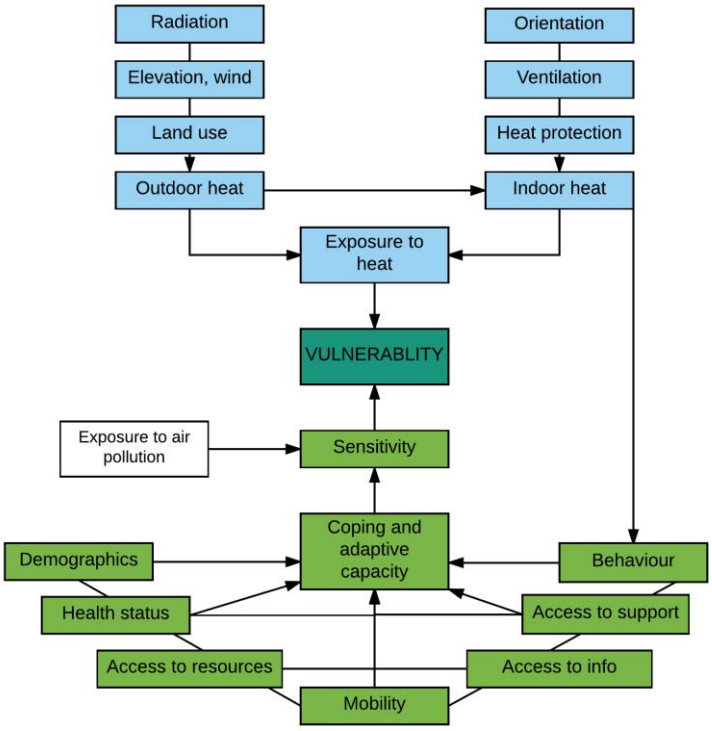


Figure 10: Conceptual diagram of heat vulnerability (Adapted from Wolf and McGregor, 2013[83])

Consulting research and secondary sources is a good place to start for cities thinking of undertaking heat vulnerability assessments. However, local data and knowledge on the relationships between heat, vulnerability and health outcomes are critical to develop solutions made to measure.

5.2 Conducting heat vulnerability assessments

Understanding of vulnerable groups and places is the basis for heatwave management planning. Heat vulnerability assessments contribute to gaining this understanding. Sources of data and information to undertake heat vulnerability assessments include:

- primary data, such as historic temperature data, mortality data, and city land use[84]
- household surveys, interviews and focus group discussions with local community members to reveal in-depth information on why groups and individuals might be disproportionately affected by extreme heat

Data analysis techniques include construction of heat vulnerability indices, use of geographic information systems (GIS), statistical and optimization methods. Besides aiding in planning, heat vulnerability maps, developed using GIS, can be useful communication tools.[85]

A number of frameworks are available to guide the conduct of a heat vulnerability assessment. Frameworks differ in their consideration of future vulnerability and risk related to projected changes in climate conditions. Some frameworks, such as the one in Figure 11, integrate action planning with heat vulnerability assessment. The majority emphasize stakeholder engagement throughout the process.

Cities may face data, resource and time constraints, which will dictate the scope and level of detail of an initial heat vulnerability assessment. Data and resource gaps should not delay action. As in the example below, cities can work with best available information, refining their techniques and approaches over time as new datasets and research emerge.

- Lacking more complete datasets in the time available for the initiative, the consulting team supporting the development of **Karachi**'s heatwave management plan relied on data from the June 2015 heatwave to explore heat vulnerability in the city. The team gathered climate, demographic, land-use, response capabilities and heat-related mortality datasets and used three different analytical techniques to help understand the issues: (1) GIS analysis to explore the spatial pattern of mortality across Karachi, (2) an optimization technique called "regression tree analysis" to explore relationships between the number of deaths and characteristics associated with the neighborhoods in which the deceased resided and (3) trend analysis to characterize weather (air temperature, humidity, heat index) conditions surrounding the 2015 event. Analysis of heat-related deaths in June 2015 revealed clusters of vulnerability in the city, with housing quality and type, population size, low-income levels and a lack of education as factors likely to have increased heat vulnerability during this event.[86] Learning is central to the heatwave management plan. It includes a strategy and activities designed to increase knowledge of the burden of heat-related health outcomes in Karachi to better target heat action planning over time.[87]

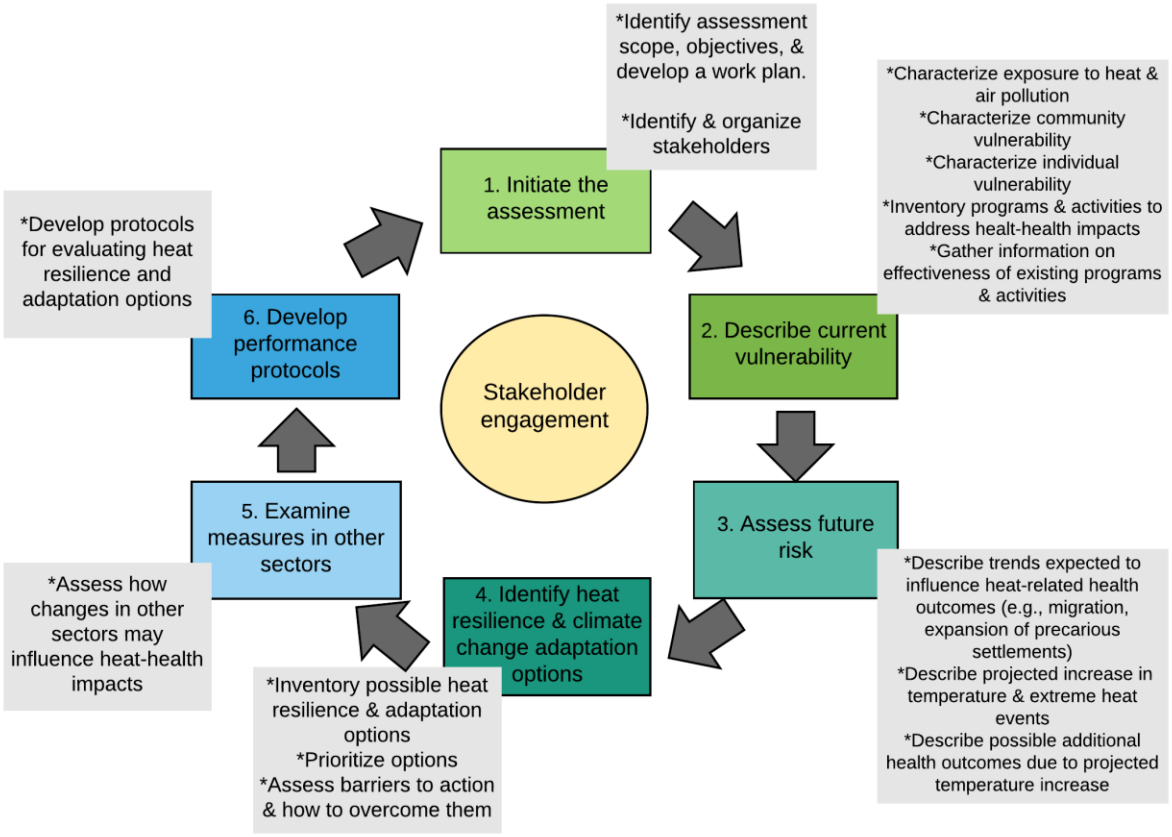


Figure 11: Steps for conducting a heat and health vulnerability assessment. (Adapted from Corvalan and Ebi, 2011[88])

Use of heat vulnerability indices and spatial information

Heat vulnerability indices combine several types of information related to exposure, sensitivity and response capacity into one aggregate measure at a given spatial unit. Indicators related to temperature, poverty, age, population density, race, and housing quality are commonly used.[89] However, indicator sets and their aggregation methods should be tailored to each city or region. Use of spatial data and analysis is key in constructing heat vulnerability indices. Basic steps include (1) overlaying temperature data against physical attributes of cities, such as the extent of different land-uses, as well as demographic data related to socio-economic status, age and education level; (2) and using spatial analysis to segment areas into different vulnerability classes. Heat vulnerability maps are outputs policymakers and planners can use to target their responses to areas of the city presenting vulnerability "hotspots". [90]

- Researchers developed a heat vulnerability index for the Greater City of **London** (England).[91] They employed a six-step method that involved reviewing the literature of heat risk factors; extracting data for nine variables from the 2001 London census that represented heat risk factors; performing statistical ("principal component analysis") and spatial analysis on the data; then overlaying mapped vulnerability data with temperature data from the 2003 heatwave event. The nine variables selected to represent vulnerability were: households in rented dwellings, households in a flat (apartment),

population density (people / hectare), households without air conditioning, population above 65 years old, population with long-term limiting illness, households receiving any kind of social benefit, single pensioner households, and ethnicity. The resulting map shows areas, in darker red, where the most heat-vulnerable populations live, according to the analysis. The analysis shows that heat vulnerability is unevenly distributed across the city, although vulnerability cluster is apparent in central London (see Figure 12).

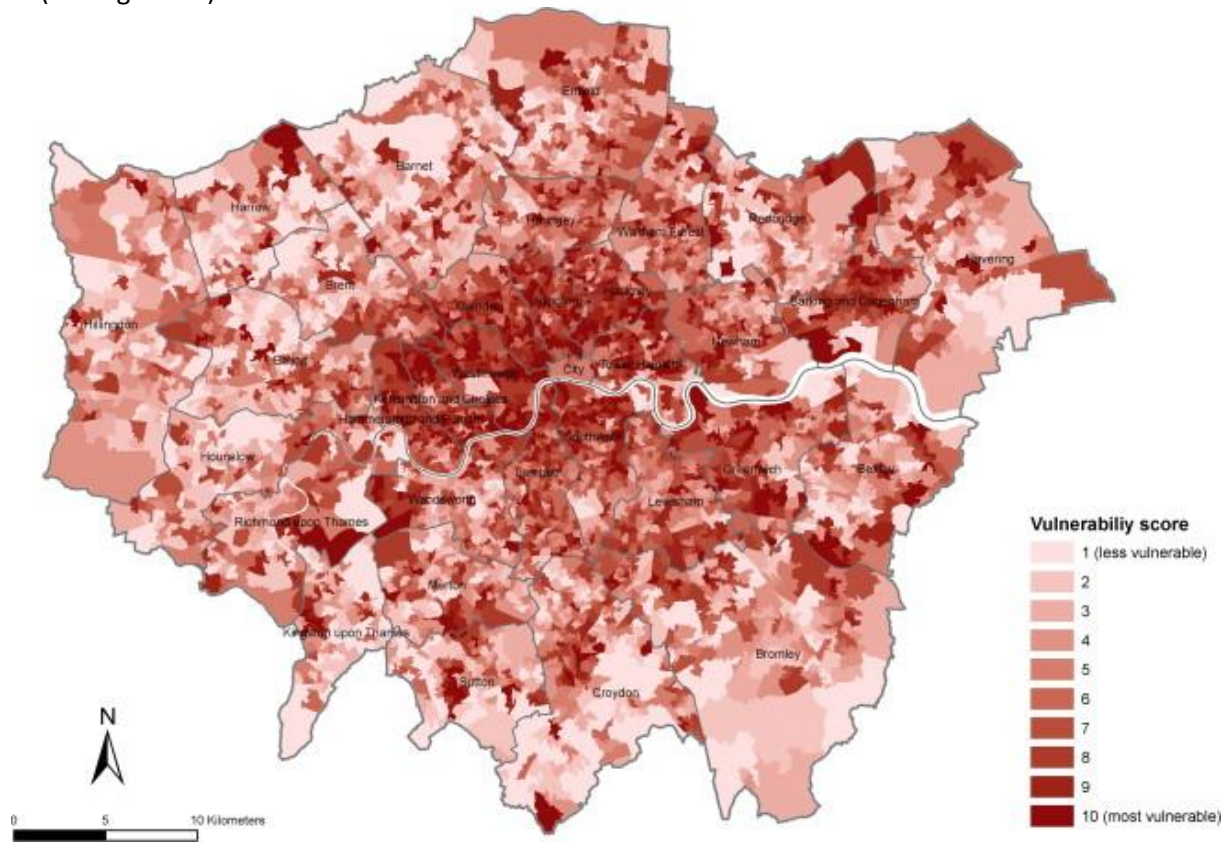


Figure 12: Spatial distribution of the heat vulnerability across Greater London as categorized by 10 heat vulnerability classes. Heat vulnerability increases from 1 (lowest) to 10 (highest)[92].

- The city of **Philadelphia** mapped areas with high populations of older adults and people living below the poverty line and their proximity to cooling centres, including spaces like movie theaters and malls that are accessible to the public. This allows the City to identify areas currently lacking cooling centres and inform decisions about the designation of new ones.[93]

Heat vulnerability maps are resources to aid in planning in the short and long-term and to help address operational and strategic aspects of heatwave management. In creating mapped outputs practitioners should be clear on the types of decisions the maps will inform, as this will influence what information is displayed and how.

Operational	Strategic
• Support resource allocation, staffing, case loads • Assist with preparation for heat-alert days • Support targeted, door-to-door outreach • Confirm know or assumed areas of vulnerability • Identify existing clients (e.g., individuals receiving medical treatment) in at-risk areas • Support collaboration among agencies during peak demand • Support delivery and emergency power setup during power outages	• Inform public health planning and urban planning • Identify locations for permanent cooling centres • Guide development of heat registries • Adapt neighborhood plans and building codes • Enable targeted green/cool roof programs • Prioritize artificial shading in public spaces • Devise a geographically diversified heat alert program • Study the influence of the built environment and other land uses on surface temperature

Table 8: Operational and strategic uses of heat vulnerability maps. (Adapted from Toronto City, 2011)[94]

5.3 Establishing heat-health thresholds

Responding to heatwaves depends on a system of alerts that trigger institutional activities and notify the public about upcoming risks to heal from heat (see Section 6 of this report). Alert triggers protect human health when they are based on knowledge of local weather conditions that result in increased heat-related morbidity and mortality.[95] If alert triggers are too lenient (e.g., the system uses a low-temperature threshold) the city could end up issuing frequent heat alerts that do not reflect sufficient severity of health impacts to warrant a comprehensive response. This can be costly and lead to desensitization of the community to heat alert messaging. Alternatively, if alert triggers are too stringent (e.g., the system uses a high-temperature threshold) a city may fail to deploy measures to alleviate the impacts of heat, which can lead to losses of life, illness, and a loss of economic productivity that could have been avoidable.

It's important then, whenever possible, to develop heat-health thresholds based on analysis of time series of local weather (temperature, humidity, air pressure) and mortality and morbidity data. These data generally reside with government agencies and research institutes. Experience from heat-action planning in Ahmedabad (India) suggests that grassroots and social welfare organizations can be good sources of information as well. They may track and hold data on health outcomes, such as heat-related death and illness, which may be missing from public health records.

Several studies show a quantitative relationship between temperature (and other weather variables) and health outcomes, although most of these studies cover OECD countries and regions (see Box 6). Even if results are not transferable, analytical approaches can be, so consulting the studies below or similar ones is recommended.

Box 6: Examples of studies exploring the burden of heat-related death and illness

Year of publication	Title	Comment
1998	International study of temperature, heat and urban mortality: the 'ISOTHURM' project (McMichael et al.)[96]	Includes mortality and morbidity curves for Bangkok, Chiang Mai, and Delhi
2012	A Data-driven Approach to Setting Trigger Temperatures for Heat Health Emergencies (Henderson and Kosatsky)[97]	The focus is on Vancouver, Canada
2013	Excess Mortality during Heat Waves, Tehran Iran: An Ecological Time-Series Study (Ahmadnezhad et al.)[98]	
2014	Heat-Related Mortality in India: Excess All-Cause Mortality Associated with the 2010 Ahmedabad Heat Wave (Azhar et al.)[99]	
2016	Guide to identifying alert thresholds for heat waves in Canada based on evidence (Gachon et al.)[100]	
2016	Estimating the burden of heat illness in England during the 2013 summer heatwave using syndromic surveillance (Smith et al.)[101]	

- Stakeholders in **Karachi** are working on the city's first heatwave management plan. Analysis to inform the plan took place under compressed timelines and the team worked with data and information that was easy to access. Data on health outcomes (mortality in particular) were limited to 2015. Therefore, developing a heat-health threshold based on local evidence of the relationship between climate and human health effects was not possible for this first iteration of the heatwave management plan. Instead, the team developed four sets of heatwave alert triggers based on approaches taken by others that could reasonably be transferred to Karachi. The team then applied the four triggers to the historic data set from 2006 to 2015 for Karachi to see how they would have triggered different heat alerts in the past. These four options represented a range of stringencies in the number of alerts that would have been issued. The team provided an interim recommendation on alert triggers based on this analysis and consulted with the Pakistani Meteorological Department and the Karachi Commissioner's Office for technical validation of the criteria and thresholds as well as to ensure recommendations best represented the risk tolerance of decision makers.

The checklist in Table 9 below outlines steps involved in establishing heat-health thresholds, based on the work done in Ahmedabad.

Activity	Deadline	Status with Date	Next Steps
Collect historic extreme heat temperature and mortality data, and assess the impact of extreme heat events on the city			
Collect daily health data (e.g., total all-cause mortality numbers, and—if recorded—numbers of heat-related emergency room visits, heat-related hospital admissions, and heat-related deaths)			
Gather daily temperature records and forecast information (e.g. daily temperature maximums, heat and humidity index, length of forecast, and methods of communicating temperature and weather forecasts)			
Develop first draft of analysis on mortality/morbidity and temperature and identify gaps			
Oversee expert review and discussion of analysis on mortality/morbidity and temperature			
Develop second draft of analysis on mortality/morbidity and temperature and identify gaps			
Identify local heat-health thresholds to help determine alert levels			
Hold discussion with experts on local heat-health thresholds, corresponding heat alert levels			
Discuss thresholds for heat alerts with municipal / state / provincial departments leads and other potential response agencies (i.e., what temperature range should correspond with which level of heat alert; what capacities exist to carry out response actions at various thresholds)			
Get signoff from the city lead agency, public health, disaster risk management and meteorological departments on heat-health threshold			

Table 9: Checklist for establishing heat-health threshold temperatures. (Adapted from NRDC, 2016[102])

Key Messages: Heat vulnerability assessments

- Vulnerability to extreme heat is due to variable physiological factors, and the ability of an individual or community to take the necessary measures to protect their health.
- To understand the vulnerability of an individual or community, assessments should include local data such as historic temperature, mortality data, city land use, household surveys and interviews with stakeholders.
- Each city should tailor their vulnerability indices to their population. Commonly used indices are temperature, poverty, age, population density, race, and house quality. Combined with spatial data, heat vulnerability maps can be produced to reveal where vulnerable populations are located in the city. This will aid in the planning of operational and strategic aspects of heatwave management.
- Heat-health thresholds should be developed based on an analysis of a time series of local weather, as well as mortality and morbidity data. Thresholds will determine when a heat alert should be triggered to warn the public of the heat level.

Box 7: Key messages – Heat vulnerability assessments

6 Heat alert protocols

A heat-alert protocol is the weather-based component of a heat alert and response system (HARS). Heat alerts warn stakeholders and the public on impending dangerous hot weather. This section presents an overview of best practice and illustrative examples of heat alert protocols. It's worth noting that terminology can get confusing, as heat alert protocols can be synonymous with heat-health warning systems or early warning systems. What's important to recognize is that all three issue warnings but exclude intervention and response strategies, as shown in Figure 13. This Toolkit uses the term alert protocol unless referring to a specific system operating in a city.

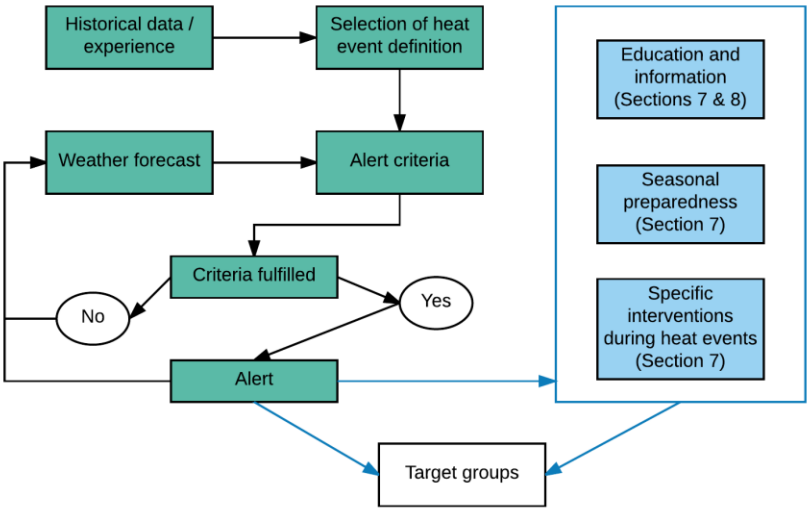


Figure 13: Flow diagram demonstrating the operation of typical heat alert protocols (also referred to as warning systems). Alert functions are in green, whereas response functions are in blue (Adapted from McGregor 2015103)

6.1 Identifying an alert trigger or threshold

Section 5.3 introduced the concept of a heat-health threshold, which establishes human-health tolerance to extreme weather. The threshold is based on a physiological definition of an extreme heat event—one in which the intensity and duration of the event reflects an increased risk of morbidity and mortality of a specific population. Thresholds are numerical values derived from one or more weather parameters (e.g., temperature, humidity) that are forecasted to last for one or more days. When thresholds are exceeded, an alert is issued. The benchmark for issuing an alert varies from place to place because local responses to extreme weather differ markedly:[104]

- Year-round temperatures vary significantly across and within global regions and local populations are adapted to their local conditions. What might be considered hot weather in one city may be the norm for another. These local conditions factor into alert protocols. For example, Winnipeg (Canada) experiences summer maximum temperatures of around 26°C, on average; they communicate a heat alert to the public when 3 consecutive days are forecast to be ≥33°C.[105] In comparison, Ahmedabad

(India) issues a yellow heat alert when forecast temperatures are expected to reach 41°C.[106] Ahmedabad residents experience less fluctuation in seasonal temperatures and higher heat and humidity year round than, say, residents of Winnipeg. Ahmedabad residents are acclimatized to higher temperatures than Winnipeggers and the alert protocol incorporates higher heat thresholds.

Alert protocols can adopt a range of meteorological parameters for measuring heat exposure. [107] Cities should select a method best able to contribute to a reduction in heat-health impacts, including allowing for sufficient lead time to activate a response.

Single- or few-parameter methods

These methods use a single temperature metric or a modified form of apparent temperature. It's the most common approach used in alert protocols. A simple way to identify whether thresholds have been reached and declare heat warnings is to use criteria of exceedance of maximum temperature on a given day. The threshold can derive from a historical benchmark (arbitrarily obtained, on occasion) or by comparison with negative health outcomes within the historical record.

- An example of this single parameter method is the heat alert system developed for the city of **Melbourne** (Australia).[108] Empirical research has shown that when average daily temperature exceeds 30°C (mean of today's maximum temperature and tonight's minimum temperature), the average daily mortality of people aged 65 years or older is about 15 to 17% greater than usual.

Some alert systems incorporate humidity, by using a Heat Index. If humidity is high, a person can suffer from heat-related illness even when temperatures are not unusually high. The Heat Index is a measure of how hot it really feels when relative humidity is factored in with the actual air temperature. As an example, if the air temperature is 34°C and the relative humidity is 75%, the heat index is 49°C. The chart in

Figure 14 provides calculated heat index values at different temperatures and levels of relative humidity.

Other alert systems incorporate more than one trigger or threshold.

- The state of **Odisha** (India) in India has two distinct landscapes, therefore, their heat alert system identifies thresholds specific to each.[109] An alert is triggered by the India Meteorological Department when temperature thresholds are forecasted to be >37°C for coastal areas and 40°C for interior areas from March to May.
- Based on research by Monash University, the state of **Victoria** (Australia) developed thresholds reflecting differentiated levels of resilience to extreme heat across the state. [110]

Relative Humidity %	Temperature °C																
	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
40	27	28	29	30	31	32	34	35	37	39	41	43	46	48	51	54	57
45	27	28	29	30	32	33	35	37	39	41	43	46	49	51	54	57	
50	27	28	30	31	33	35	36	38	41	43	46	49	52	55	58		
55	28	29	30	32	34	36	38	40	43	46	48	52	54	58			
60	28	29	31	33	35	37	40	42	45	48	51	55	59				
65	28	30	32	34	36	39	41	44	48	51	55	59					
70	29	31	33	35	38	40	43	47	50	54	58						
75	29	31	34	36	39	42	46	49	53	58							
80	30	32	35	38	41	44	48	52	57								
85	30	33	36	39	43	47	51	55									
90	31	34	37	41	45	49	54										
95	31	35	38	42	47	51	57										
100	32	36	40	44	49	56											

Caution | Extreme Caution | Danger | Extreme Danger

Figure 14: Temperature/Humidity Index[111] (calculated °F to °C from NOAA's National Weather Service[112])

Heat budget

The heat-budget model determines heat-health thresholds based on perceived temperature (PT). Rather than focus on local climate conditions, PT is the temperature threshold beyond which the physiology of the human body could be affected.

- **Germany** uses the heat-budget model at the national level. The alert system defines four different levels of heat stress: slight, moderate, strong and extreme. A warning is issued if a strong or extreme heat load threshold is exceeded. A warning is also issued if the threshold for a strong heat load is not reached but PT is higher than 34°C.

Synoptic-based systems

Synoptic-based systems incorporate multiple variables (e.g., temperature, dew point, wind direction, wind speed, cloud cover and pressure) to classify air masses into a pre-defined category of ambient conditions. A next step is to determine standardized mean summer mortality per air mass to identify those air masses with statistically significant levels of excess mortality. These systems, currently applied in the United States, require more meteorological information than the systems that use simpler thresholds.

- The City of **Toronto** (Canada) formerly used a synoptic approach to establish heat alerts. However, the province of Ontario how operates under a harmonized system that uses simple metrics (maximum/minimum temperature and humidity), incorporates duration of forecasted conditions and divides the province into three zones. In 2015, Toronto adopted the province's harmonized system to ensure warnings are clear and well understood by its citizens and those of neighboring cities. Located in Southern Ontario, Toronto now issues a heat alert when the Tmax is > 31°C and Tmin is > 20°C or if the Humidex is > 40 for two or more days.[113]

6.2 Warning levels and activation/deactivation protocols

Most alert or warning systems have more than one level of warning and there is little consistency in nomenclature for different warning levels. For example, the "alert" level in one system might mean that a heatwave is expected whereas in another system it could mean that the heatwave is underway. In some systems, the different levels of warnings have no names at all and are referred to as "Level 1", "Level 2", "Level 3", etc. or as "green", "yellow", "orange" and "red".[114] Figure 15 shows an example of heat alert levels.

The purpose of alerts and warnings is to effect behaviour change during heatwave events. Therefore, careful consideration of how warnings are communicated and what the implications might be of different approaches (e.g., staged or hierarchical warnings, terminology and visuals for communication) is important.

WHITE	No Alert	< 41˚C
YELLOW ALERT	Hot Day Advisory	41˚C – 43.4˚C
ORANGE ALERT	Heat Alert Day	43.5˚C – 45˚C
RED ALERT	Extreme Heat Alert Day	> 45˚C

Figure 15: Heat alert levels set for Ahmedabad. The Ahmedabad Heat Action Plan established different heat alert levels corresponding to identified heat-health thresholds115

In deciding whether to move to a higher alert level communities can consider additional factors, such as:

- Surveillance data showing increases in morbidity and mortality (e.g., daily deaths and daily ambulance calls)
- Worsened air quality
- Likelihood of an electrical emergency, existing blackouts or rolling power outages
- Drinking water availability.

Aside from establishing criteria, heat thresholds and graduated levels of alert, the alert protocol should:

- Identify the lead agency or person responsible for issuing an alert
- Outline the communication activities and information flows
- Specify the deactivation point where weather conditions are no longer a health threat

The Ahmedabad Heat Action Plan included an inter-agency communication plan in connection with the heat alert. Figure 16 shows the internal flow of information and protocol for triggering a heat alert.

Continued surveillance of weather conditions and health outcomes is critical when a heat alert is issued. The objective is to determine when heat no longer poses a threat to public health so as to deactivate the alert and related responses. To account for "lag effects" in health impacts and avoid deactivating an alert prematurely, some communities prolong heat-alert activities for a few days after the extreme heat subsides.

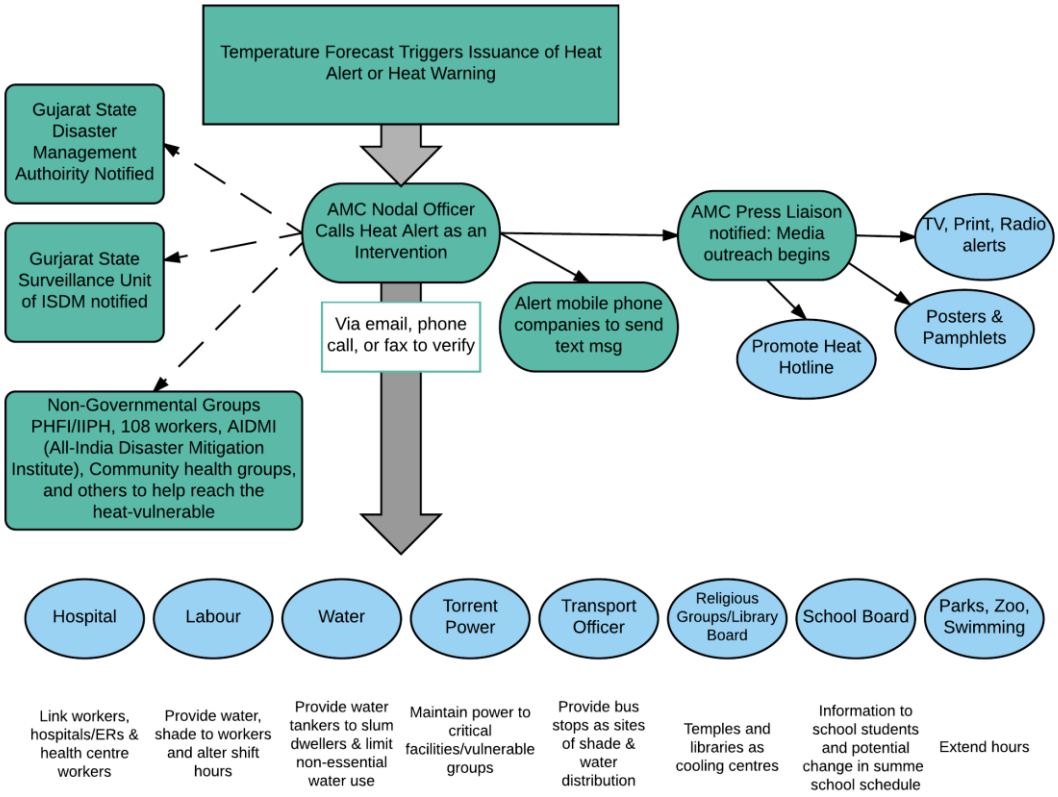


Figure 16: Ahmedabad Heat Action Plan's intergovernmental communication strategy for heat alerts and warnings (Adapted from AMC 2017116)

6.3 Communicating warnings

A warning is the process by which people are alerted to an actual or potential harm. The success of an alert protocol depends on appropriate and timely communications. The following themes emerge from research on the effectiveness of alert / warning systems in preventing heat-related death and illness:[117]

- Awareness of heat events tends to be high for the general public but reaching vulnerable groups is challenging.
- Despite being aware of heat events, few people change their practices in response. One explanation for this lack of action is that the media tend to target specific sub-groups (e.g., outdoor workers, children, etc.) in their messages, leading the general population to believe that warning messages do not apply to them.
- Some confusion in understanding and interpreting public-health messages is apparent, especially in cases where several weather-related alert systems are in place. For instance, during smog days the advice to vulnerable groups is to stay indoors, which conflicts with messages to go to a cooling centre.

Reflecting on the following questions can help sharpen communications:

- How do people currently access and use weather information in their day-to-day lives?
- What are the key differences for different age groups and sexes?
- How do people value, and how might they use, "early warning" information on heatwaves?
- What currently affects their behaviour during a heatwave (e.g., financial issues, illness that limits movement)?

Principles for effective heat risk communication have emerged from international experience, particularly from Europe:[118]

Trust

The overriding goal is to communicate with the public in ways that build, maintain or restore trust.

Announcing early

Establishing trust begins with the first official notification. This message's timing, candor and comprehensiveness may make it the most important of all communications.

Transparency

Maintaining the public's trust throughout an event requires transparency in information gathering, risk-assessing and decision-making processes associated with responses to extreme events. Communication that is candid, easily understood, complete and factually accurate is preferable.

Understanding the public

Understanding the public is critical to effective communication. It is usually difficult to change pre-existing beliefs unless those beliefs are explicitly addressed. And it is nearly impossible to design successful messages that bridge the gap between the expert and the public without knowing what people think.

Box 8: Key principles of heat risk communication[119]

Canadian guidance for public health and emergency management officials offers the following recommendations to enhance communications:[120]

Identify target audiences and analyze their needs: Heat-health communication campaigns should be targeted to four distinct levels: 1) heat-vulnerable individuals; 2) social networks; 3) organizations; and 4) communities. Targeting communication campaigns requires that heat-vulnerable individuals be separated into groups according to their characteristics (e.g., demographics, specific behaviours, attitudes, perceptions of heat-health risks, personal values, lifestyles, and opinions).

Set goals and objectives: The ultimate goal of heatwave planning is to reduce heat-related morbidity and mortality. Communications can contribute to this goal but it's important to establish achievable intermediate objectives, such as raising awareness of dangerous heat conditions, building credibility and engaging stakeholders in heat-health communication campaigns.

Choose the means of communication wisely: There is no single medium that will work for all audiences. Surveys in Canada and the United States have shown that most people receive their extreme weather information from mass/broadcast media, through television, radio and the Internet. Mapping out different communication material and channels likely to reach target the target population is an effective way to inform the communication strategy (see Figure 17).

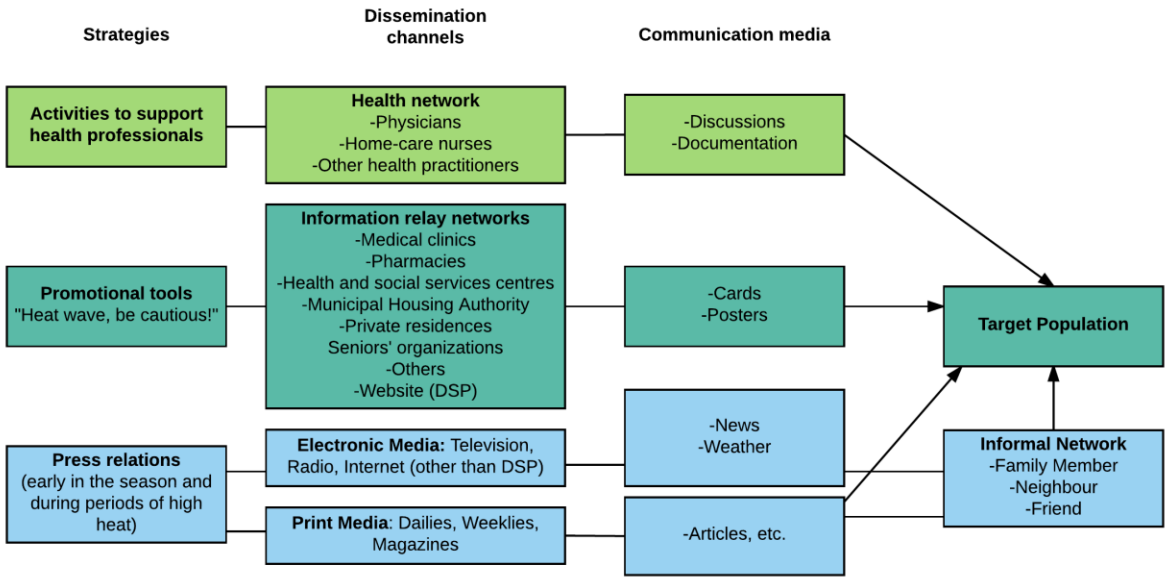


Figure 17: Heat-health communication framework used by Montréal's public health authority (DSP)[121]

- Delivery on **Ahmedabad**'s Heat Action Plan involves disseminating heat alerts on the radio, in local newspapers, via text alerts to mobile phones, posts on social media sites such as Twitter and Facebook, and displays of temperature updates in public places.[122]
- The 2017 Heat Action Plan for **Odisha** state (India) incorporates a range of media to disseminate temperature forecasts and heat alerts, including bulk messages on mobile phones, electronic screens at busy traffic intersections and displays at market places. The states are also developing a website and a mobile phone app to provide heat alerts and help users identify heat shelters and water points along highways.[123]

Communicate throughout the year: Extreme heat and health communication campaigns generally occur over three phases: before the heat season; during the heat season and during a heatwave. To increase the likelihood of retention, communication to the public during heatwaves should emphasize only three to seven bits of information that audiences should remember.

6.4 Evaluating the alert protocol

Evaluation of the effectiveness and efficiency of the alert protocol fosters its continuous improvement and good use of public resources. Criteria in Table 10 can inform the design of and planning for evaluations.[124]

Simplicity: The simplicity of a system refers to both its structure and ease of operation. An HHWS should be as simple as possible, while still meeting objectives. Factors to consider include: - Type of information required to issue a warning; - Number of people and agencies involved in issuing a warning; - Time spent maintaining the system; - Time spent issuing a warning - Time spent monitoring the weather/information needed to issue a warning
Acceptability: The acceptability of a system reflects the willingness of individuals and organizations to participate in it. Factors to consider include: - Interaction among agencies; - Participation of agencies other than the one issuing the warning; - Completeness of response in participating agencies.
Timeliness: Are the warnings timely with respect to the different response activities? Are there any delays in the steps of the alert/warning system?
Sensitivity: The sensitivity of the warning is the number of times a warning is issued and the forecast meteorological conditions actually occurred. Typically, evaluators are interested in how often a warning was not issued but adverse meteorological conditions actually occurred.
Specificity: The specificity of the forecast (the prediction of heat-attributable mortality) should be estimated, as well as the accuracy of the meteorological forecasts on which they depend, in order to avoid false positive forecasts of heatwave mortality, which will undermine the credibility of the system.
Reach: Who is getting the information and what are their main takeaways? Is the message being communicated effectively?

Table 10: Criteria for evaluating a heat alert or warning system (Adapted from McGregor 2015[125])

Evaluation criteria in Table 10 focus on the implementation process. Evaluating the heat alert protocol in terms of outcomes in the formal public-health sense is challenging. Alert protocols are locally implemented. Therefore, they vary widely in structure, partner agencies and related interventions and responses, making comparisons across systems difficult. Activities stemming from heat alerts may also change from year to year in response to events and the changing priorities of partner agencies. Further, heatwaves are rare events and the impact of each one is different. This complicates tracking performance over time.

Key Messages: Heat alert protocols

- Heat-alert protocols are the weather-based component of a heat alert and response system (HARS) to warn stakeholders and the public of extreme heat events. The threshold value at which an alert is issued will vary depending on local conditions.
- Issuing an alert can be based on exceedance of a maximum temperature for a certain amount of days. Humidity can also be incorporated to measure how hot it really feels when relative humidity is factored in with the actual air temperature. Other alert systems can use multiple variables such as dew point, wind direct and speed, cloud cover and pressure to trigger an alert.
- Alert systems will often use more than one level of warning to communicate the severity of the event. This helps stakeholders and the public prepare and react appropriately to the declared heat alert.
- Effective communication about extreme heat events is critical to creating awareness, especially among vulnerable populations. Awareness campaigns should occur year round to ensure the public is prepared during heat season.
- Alert protocols should be evaluated regularly to ensure its effectiveness and efficiency.

Box 9: Key messages – Heat alert protocols

7 Response measures

Response measures or interventions follow up on heat alerts and help prepare for the heat season. They are the active component of a heat alert and response system (HARS). Organizations and individuals can take a range of actions to reduce outdoor and indoor heat exposure. This includes getting people cool by helping vulnerable populations get out of the heat, opening cooling centres, encouraging people to drink water, wear light clothing and avoid strenuous work during peak heat hours.

The combined effect of humidity and raised minimum temperatures contribute to indoor and outdoor overexposure. When temperatures stay high and people cannot get nighttime relief from heat, exposure to heat continues. Several days of exposure increases the risk of overexposure and therefore immediate response measures should be taken to prevent the onset of heat-health impacts.[126]

This section summarizes presents best practice and illustrative examples of short-term actions to prevent health impacts from heat that organizations and individuals can take.

7.1 Educating and informing

A heat alert protocol is of limited use unless stakeholder agencies and the public receive this warning and have been educated in what to do with this information. It is critical to communicate the heat alert to the public, and to stakeholder agencies that are in charge of implementing response measures during heat events. These alerts, discussed in Section 6, communicate the situation to stakeholders so that their defined roles are set in action during the heatwave.

Reaching people to educate them on the risks and appropriate responses during a heat event is also important. To be effective and maximize reach, public and media campaigns should deploy a range of formats and educational approaches, selected based on communication and education objectives and audiences.

- In response to recent deadly heatwave events and to prepare for the future, city and state governments in India and Pakistan developing heat action plans. Lead and stakeholder agencies delivering these plans are working to create and deploy public awareness campaigns. Focused on **Odisha** (India), researchers evaluated the merits of alternative media (newspapers, television, and radio) in helping to reduce mortality from heat stroke. Analysis of 8 years of data on heatwave mortality in Odisha suggested that public health messaging through television contributed most to preventing deaths, followed by newspapers and radio. More people own televisions than radios and television owners are more numerous than and those who read the newspaper. Although behavioural change through media use is a slow process, alert messages broadcast during extreme events can offer information the public can act on.[127]

Media outlets can be key partners in sharing information about dangerous weather conditions and protective actions to take, especially when sensitized about the disservice of sensationalist news. A range of partners can be involved, for example:

- Non-governmental organizations and other community-based agencies can play valuable roles in providing immediate help and relief to the community during a heatwave. For example, in **Toronto**, the Canadian Red Cross operates a heat information line from 9 a.m. to 9 p.m. when a heat alert is in

effect. The line is an accessible communication channel for those in need of assistance or presenting heat-related illness.[128]

7.2 Reducing heat exposure

Direct action to keep people cool is an important line of defense.

The best way to beat the heat and avoid heat-related illness is to spend time in a cool environment, such as an air-conditioned environment.[129] However, not every household has air conditioning for one. For another, high use of air conditioning during heatwaves increases peak electricity demand, which can lead to blackouts and increased vulnerability to heat.[130] Establishing cooling centres in public and private buildings provides relief from heat to people lacking access to air conditioning and reduces the need for households to run their own air-conditioning units. Ensuring cooling centres are in the right places, ready to open as soon as a heat alert is triggered and can run smoothly takes planning. Activities and considerations include the following:

- Work with public and private partners to designate official cooling centres such as temples, malls, and public buildings.
- Identify high-risk areas to inform the number and placement of cooling centres.
- Communicate the locations of cooling centres to the public prior to the hot weather season.
- Once the centres open, ensure they are stocked well with bottled water or can supply clean, cool drinking water.
- Provide free public transportation to cooling centres so that individuals with limited financial resources and mobility can reach them.
- Extend hours of operation during heat emergencies, according to the needs of the community (e.g., staying open all day so migratory populations can get relief).

Other strategies and activities known to be effective include ensuring access to water and electricity, as well as building the health system's response capacity:

- Ensure reliable access to clean drinking water. This includes distributing fresh drinking water in public spaces such as mosques and temples, transit stations and parks. For example, community organizations can distribute bottled water to vulnerable people. Monitoring supply systems to ensure they are working properly and reporting locations running low on supplies are other useful activities, as is working with utilities to suspend all non-essential uses of water to prevent any shortages.[131]

- Ensure reliable access to electricity. This includes informing utilities of the need to maintain power to critical facilities such as hospitals. Because heat vulnerability is spatially variable within a city, working with utilities during the heatwave to identify areas most in need of reliable power supplies is important.[132]

- Increase medical response capacity by providing more space for heat-related illness emergencies. Ensure that doctors and paramedical staff are ready to respond, and allocate ambulances at densely populated areas and near first response centres.

7.3 Individuals taking action

Individuals can readily protect themselves and their family and friends from heat illness. Behaviours and steps people can take during heat events include the following: [133]

- Staying hydrated by drinking plenty of fluids even if they do not feel thirsty and avoiding drinks with caffeine or alcohol
- Listening to the radio for updates and staying aware of the changing conditions
- Eating small meals and eat more often
- Avoiding extreme temperature changes
- Wearing loose-fitting, lightweight, light-coloured clothing
- Slowing down, staying indoors and avoiding strenuous exercise during the hottest part of the day
- Using a buddy system when working in excessive heat
- Taking frequent breaks if outdoor work is unavoidable
- Wearing sunscreen with a high SPF, since sunburned skin reduces the body's ability to cool itself
- Closing windows and shutters during the day, especially those facing the sun, and opening windows and shutters at night when the outside temperature is lower, if safe to do so
- If using air conditioning, closing doors, and windows
- Being cautious in relying on electric fans to provide relief; above 35 °C fans may not prevent heat related illness
- Moving to the coolest room in the home, especially at night
- Being aware of family and friends who may need extra help (e.g., the elderly, young children, and those with a low socio-economic status)
- Checking in with heat-vulnerable family and friends to ensure they are following cooling tips
- Recognizing symptoms of overexposure to heat in family and friends and alleviating the symptoms by moving the person to a cool place immediately (see Table 11)

Outdoor labourers are at high risk of occupational heat illness, but there is a lot they can do to protect themselves during heat events:

- Adapting work schedules so that the worker can start early, take frequent breaks and complete the most intensive tasks in the early morning or late afternoon[134]
- Wearing light, loose, clothing and hats, drinking lightly-salted water regardless of thirst[135]
- Adjusting expectations based on direct exposure to sunshine. For example, for outdoor work in direct sunlight between the hours of 10 a.m. and 5 p.m., adding 1 to 2 °C to the humidex measurement[136]

In general, the public, especially vulnerable individuals or their careers, should know how to recognize and respond to symptoms of overexposure during a heat event.[137] The guidance in Table 11 can help:

Condition	Symptoms	Response
Heat stroke	The most serious type of heat illness is a result of excessive body heat. Signs of heat stroke include a core body temperature of more than 40°C, loss of consciousness and/or reduced mental ability.	Heat stroke is life threatening, seek medical attention immediately. Rapidly cool the person by whatever means available (e.g., cover them with bags of ice).
Heat exhaustion	Caused by excessive loss of water and salt. Symptoms may include heavy sweating, weakness, dizziness, nausea, headache, diarrhea and muscle cramps.	Give the person plenty of cool water, and ensure they are resting in a cool, shady area. If symptoms worsen or do not improve within 60 minutes take them to an emergency room or health centre.
Heat fainting (parade syncope)	Caused by the loss of body fluids through sweating and by lowered blood pressure due to pooling of blood in the legs. Symptoms include temporary dizziness and fainting resulting from an insufficient flow of blood to the brain while a person is standing.	Move the person to a cool area, remove or loosen clothing and apply wet cloths to the skin. Fan and spray the person with water and give them fluids containing electrolytes - 4 ounces of fluid every 15 minutes. Seek medical attention if their condition does not improve or they lose consciousness.
Heat cramps	Caused by a salt imbalance resulting from a failure to replace salt lost through excessive sweating. Symptoms are sharp muscle pains.	Get the person to a cool place and let them rest in a comfortable position. Lightly stretch the muscle and give water or a fluid containing electrolytes.
Heat rash (miliaria rubra)	A result of inflammation of clogged sweat glands and accompanied by tiny red spots on the skin, which may give a prickling sensation.	Try to move to a cooler, less humid environment and keep the affected area dry.
Heat edema	Heat-induced swelling frequently noticeable in the ankles, feet, and hands, and most often seen in people who are not regularly exposed to heat.	Elevate the legs to promote normal blood flow. Brief walking and simple leg movements can ease the swelling. Keep the body as cool as possible to prevent further swelling.

Table 11: Heat-related illness and associated responses (Reproduced from Health Canada, 2011[138])

By pursuing the activities listed below, individuals can take action to prepare for the upcoming heat season and any potential heatwaves:[139]

- Knowing where the nearest cooling centres are
- Taking stock of family, friends, and neighbors that may be unable to respond quickly to heat alerts
- Creating a buddy system with neighbors to check in on each other when a heat alert is in effect
- Keeping informed on weather conditions via television, radio, newspapers and other print media
- Maintaining awareness of potential response actions by government and non-government agencies that could affect day-to-day life (e.g., school closures, reduced or modified work hours, extended hours of relief centres)

Key Messages: Response measures

- Educating and informing stakeholders and the public about dangerous weather conditions and protective actions to take during an extreme heat event is critical. This can be done by using various media platforms such as social media, television, newspapers, and advertisements placed in public locations.
- The best way to prevent heat-illness and overexposure is to spend time in a cool environment. Cities should establish cool centres for the public to go to, especially if they do not have access to air-conditioning. High-risk areas of the city should be identified so that more centres can be established in those areas.
- There are many actions individuals can take to protect themselves including: staying hydrated, staying informed of updates and conditions, staying indoors and avoiding strenuous exercise during the day, checking in with friends and family members, and working during the cooler times of the day.

Box 10: Key messages – Response measures

8 Long-term protection

Taking the long view and putting in place actions to prevent heat illness and mortality is a complementary strategy to seasonal preparedness and response. A lack of climate resilience planning and prevention strategies will lead to a city that is merely coping with heatwaves, rather than adapting and progressing.[140] As climate change intensifies and extreme heat events increase in frequency, severity and/or duration[141], it will become even more important to invest in prevention.

Definitions of climate resilience vary but they tend to capture both end states and properties or qualities of cities:

- "the capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning and transformation."[142]
- "the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of climate stresses and shocks they experience."[143]

Box 11: What do we mean by climate resilience?

This section summarizes preventative strategies tackling education and information-sharing, urban planning and city resilience and the urban heat island (UHI) effect. These strategies have been implemented in the region or reflect good practice internationally. Cities can consider the health, social, environmental and economic merits of these strategies and set priorities according to their needs and circumstances. The pursuit of strategies likely to offer immediate benefits (so-called low or no regrets) in tandem with efforts to study the contribution of the UHI effect to a city's heat profile[144] is a good place to start.

8.1 Educating and informing

The best prevention happens early on. Integrating disaster risk management and knowledge on the impacts of extreme heat into education curricula is a simple strategy to increase heat-health awareness.

- Early environmental education has the potential to instill lifelong attitudes and values. In **Kuala Lumpur**, researchers at the University Teknologi Malaysia worked with children to develop a revegetation strategy to combat the urban heat island (UHI). Forty-four school children around the age of 12 from the elementary school in Johor Bahru participated in three workshops and planted trees between October 2010 and September 2011. Using a GIS framework, researchers combined the children's input on places to plant trees, data on air temperature, wind comfort level and thermal comfort level to create a proposal for landscape improvements. Post-activity surveys showed that 98% of the children gained awareness and knowledge from their participation in this initiative.[145]

Education programs on heat health can target a range of groups. For example, cities can offer workshops for employers and outdoor laborers, and can equip teachers with child-friendly material to lead training at schools.[146]

- **Odisha's** heatwave mitigation plan includes mass education in schools on the health risks of extreme heat and management of heat illness. There is also a special focus in the plan to educate young girls

and mothers on the dangers of heatwaves, especially pregnant and lactating mothers who are at high risk of dehydration.[147]

Active education, combining theory and practice, can offer cost-efficiencies in implementing heat-reduction measures.

- Cities in **Japan** have shown leadership in promoting heat awareness to help protect citizens from the health impacts of extreme heat. Aside from implementing heat alert and warning systems, they have invested in longer-term solutions that actively engage community members. Tajimi, Kusatsu, Kumagaya and Obu have implemented a "green curtain" project to combat UHI in their cities. They are involving senior citizens and children in cultivating climbing plants as an inexpensive and non-labor intensive method to reduce indoor heat exposure.[148]

8.2 Urban planning and city resilience

Building a city's resilience to extreme weather and climate change impacts is a long-term investment that pays off. Changes in urban land use and design – including increasing green cover, improving the urban wind environment, and using pervious and high-albedo surfaces – can help alleviate the effects of extreme heat and deliver co-benefits (e.g., reduced greenhouse gas emissions, reduced runoff, and improved air quality).

Heatwave planning can catalyze a city's transition to climate resilience.

- **Ahmedabad** is the first city in South Asia to develop and implement a heatwave management plan. Within the country, Ahmedabad stands out as an innovation centre and successes in heatwave planning have scaled out to Surat within Gujarat state, Nagpur and other cities of Maharashtra; Bhubaneswar of Odisha. Adaptation to new patterns of climate extremes is taking place at institutional and individual levels. The lead agency in heat action planning, the Ahmedabad Municipal Corporation, pioneered an early warning system and a range of strategies to reduce heat vulnerability. Ahmedabad citizens are shifting office and school schedules and being strategic in their location (outdoor/indoor) and timing of activities throughout the day. Local political leadership has been instrumental in driving innovations, including a new initiative to install cool roofs in slum communities launched in 2017.[149]

Afforestation / greening

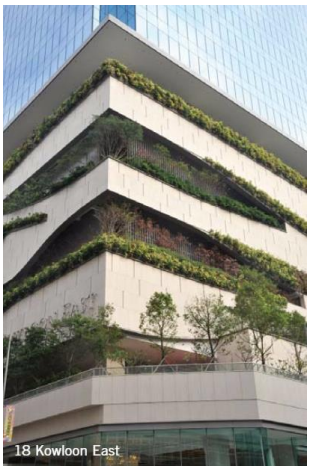
Afforestation or greening is an inexpensive method with the potential to alter the city's microclimate to produce a cooling effect. Even small green spaces can have an impact; a study done in Tel Aviv found that a park of only 0.15 hectares had an average cooling effect of 1.5°C.[150] Afforestation can be incorporated into existing buildings, recreational areas, and along roadsides, allowing even densely built-up cities to take advantage of the cooling properties greening can have. Examples of good practice in city greening include:

- Installing "green infrastructure": vegetating human-made slopes, increasing planting along roadside areas, green roofs and vertical planting on buildings.
- Involving citizens in the greening process, asking for their input for sites and using volunteers to implement the plans.
- Choosing native species that require less water, this is particularly important in arid areas.

- Supporting demonstration projects to create green sites in run-down areas of town, and areas that are covered by asphalt and concrete. They become places of social commune that provide shade.
- Establishing policies and building codes that will enable developers to use the guidelines to create more sustainable and green infrastructure. Promoting private green space is important in dense cities, where a major part of exposed surface is not city owned.

The following measures are "no regrets" in that they offer significant benefits at little cost:[151]

- Demonstrating the value of urban forestry and afforestation by funding landscaping in public projects and imposing 2 or 3 to 1 replacement ratios for trees removed on city property.
- Preserving existing trees during development and construction. Governments may use regulations to protect trees or incentives (e.g., tax credits, expedited permitting) for developers.
- Including tree planting requirements attached to building permits so that new development increases the tree canopy.
- Partnering with utilities and community groups. Utilities can underwrite tree planting programs and communities can play an important role in maintaining the trees planted, even long after the program has ended.



Hong Kong suffered a loss of vegetation due to deforestation and fire. However, afforestation became a government priority. Today, 70% of the total land area is vegetated and about 40% is protected parks and forests. Although there is limited space for greenery projects, the city has developed greening and planting programs that incorporate planting elements into, around, and on top of buildings.[152]

Source: Hong Kong Climate Change Report 2015

Trees and Technology. Tree canopy along urban streets helps to regulate local climate and air quality. In a 2017 study, researchers analyzed over 1,000,000 images from Google Street View to quantify the contribution of green spaces to urban environments. Using imagery from Singapore, the research team quantified the proportion of green canopy in 50-metre grids over Singapore's road network. They then estimated the amount of solar radiation that reaches the surface. This method is relatively inexpensive and allows planners to efficiently identify areas of low shading and prioritize them for the planting of new trees.[153]

Design

A city's design and materials used in its makeup significantly affect air flow and heat retention. Areas that have little vegetation and a high percentage of non-reflective, water-resistant surfaces tend to trap heat.[154] The density and orientation of buildings may exacerbate the problem by trapping hot air within

the city. There are several urban planning design strategies that are relatively inexpensive to implement in cities that have dense infrastructure networks. Examples of actions to support re-design include:

- Creating policies that guide developers to choose designs (building height and orientation) and materials that allow for better air flow between buildings.
- Introducing bylaws or incentives for uptake of cool materials for roofs and pavements, since they store less heat and can lower surface temperatures.
- Promoting the use of light-colored paint-like coating for roofs to create cool roofs, this can be done easily on residential housing.
- Taking advantage of redevelopment and community plans to create cool microclimates within the city by planning for new buildings that will not block air flows, ensuring open spaces are preserved and decreasing building density.

Hong Kong has developed guidelines for building height profiles, street orientation, and breezeways. Existing built-up areas can integrate these design principles in redevelopment projects. Government projects require air ventilation assessments to promote design changes and improve wind penetration.[155]

Ho Chi Minh is redeveloping areas to create cool microclimates within the city. This includes planning new buildings to not block air flows and to preserve open spaces. The plan aims to strengthen the green-blue network by creating interconnecting parks, tree-lined streets, boulevards, waterfronts, fountains and water playgrounds. Pilot studies suggest a positive return on investment due to the long term solutions provided.[156]

Barcelona has an ambitious plan to change the face of the city. The city is creating "superblocks" – mini neighborhoods around which traffic will flow. A superblock consists of nine existing city blocks, with traffic from motorized vehicles (scooters, cars, trucks and buses) restricted to the superblock perimeter. As a result, inner parts of superblocks will be walkable, greener and provide space for citizens to congregate.[157]

Ahmedabad's Shardaben General Hospital took action to reduce temperatures indoors and heat-related illness, particularly among newborn infants. The Hospital replaced its black tar roof with a white china mosaic "cool roof" and moved the neonatal unit –previously on the top floor – to the first floor. With the prospect of a triple dividend (reduced UHI, alleviation of health impacts in extreme heat and savings in space cooling), these techniques then spread across the city. The local government decided to apply them to all of its hospitals.[158]

8.3 Putting controls on human-made heat sources

Densely populated and urbanized cities are increasingly experiencing an UHI effect.[159] Those living in the city are at a heightened risk of heat illness compared to rural residents because of the effects of UHI.[160] This is particularly so for cities prone to UHI that also experience heatwaves.

Altering an existing city's layout to reduce the UHI effect can be difficult and expensive. However, implementation of passive, non-structural approaches can be cost-effective. These focus on controlling human-made heat sources, especially activities that involve community collaboration, energy efficiency, and transportation. Examples include:

Awareness programs

- Delivering outreach and education campaigns for active commuting
- Involving local people and communities in greenery initiatives
- Promoting energy-wise air-conditioning use (where its use is significant)

Transportation

- Making streets, lanes, and paths more pleasant for walking
- Expanding bus and train line networks
- Enforcing quality standards for bus and rail services
- Offering accessible and safe public and pedestrian-friendly transportation

Policy

- Providing subsidies to encourage alternative energy generation and use
- Supporting efficient energy use by communities and businesses
- Creating and enforcing anti-idling bylaws

8.4 Setting priorities

Setting priorities for implementation of long-term measures reduces the likelihood of mal-adaptation and creates an awareness of the dynamic nature of heat health in cities.[161] By planning ahead, remaining flexible in implementation and learning from experience a city can shift from crisis response to building resilience to climate extremes. Faced with many routes to take, getting started can be daunting, however. The approaches below can help move past paralysis into action.

Stakeholder dialogue

Stakeholder dialogue can reveal what matters most for long-term action and where support for action could lie.

- As part of an initiative supported by the Climate and Development Knowledge Network, representatives from six provinces in **Pakistan** came together in a national workshop on heatwave management in Islamabad in March 2017. [162] Disaster management, environmental protection and city management agencies were among those represented. In regional sub-groups participants answered a number of questions designed to illuminate issues, perspectives, and priorities for each region. Participants also heard about experiences in Ahmedabad (now in its fifth year of implementing heat action plans) and Karachi (about to issue it first heatwave management plan). Workshop discussions identified commonalities and differences in levels of awareness and engagement as well as needs (see Table 12).

Province	Current situation	Heat vulnerable groups	Planning and implementation needs and priorities
Sindh Province	• Low awareness of heat-related risks or how to respond, although 2015 heatwave in Karachi got attention • Poor urban planning and haphazard development exacerbates UHI • Increased reliance on cars • MOU between Pakistan Meteorological Department and electric utility to stop or decrease load shedding during extreme heat • Provincial Disaster Management Agency launched SMS service to alert citizens of heatwave awareness and protection	Nomads, internally displaced people, slum dwellers, pregnant women, malnourished children, senior citizens.	• Capacity building in use of technology like GIS • Involving grassroots organizations and NGOs in implementation
Punjab Province	• High temperatures and water scarcity are emerging problems • Installing water filtration plans on a large scale and planting trees	Low-income populations, such as those living in semi-urban areas	• Factoring in changing climate in building design • Incorporating disaster risk reduction in school curricula
Balochistan Province	• Low awareness of heat-related risks although some areas reach 52°C in summers	Farmers, laborers, and livestock community due to low awareness levels	• Improving coordination among government departments (meteorology, local administration, environmental protection, health, municipal cooperation)
Khyber Pakhtunkhawa (KP), Gilgit Baltistan & Azad Jammu Kashmir*	• KP is embarking on a revegetation project, "the Billion Tree Tsunami"	Laborers, farmers, slum dwellers and elderly people	• Incorporating disaster risk reduction in school curricula • Improving coordination among NGOs and social welfare organizations

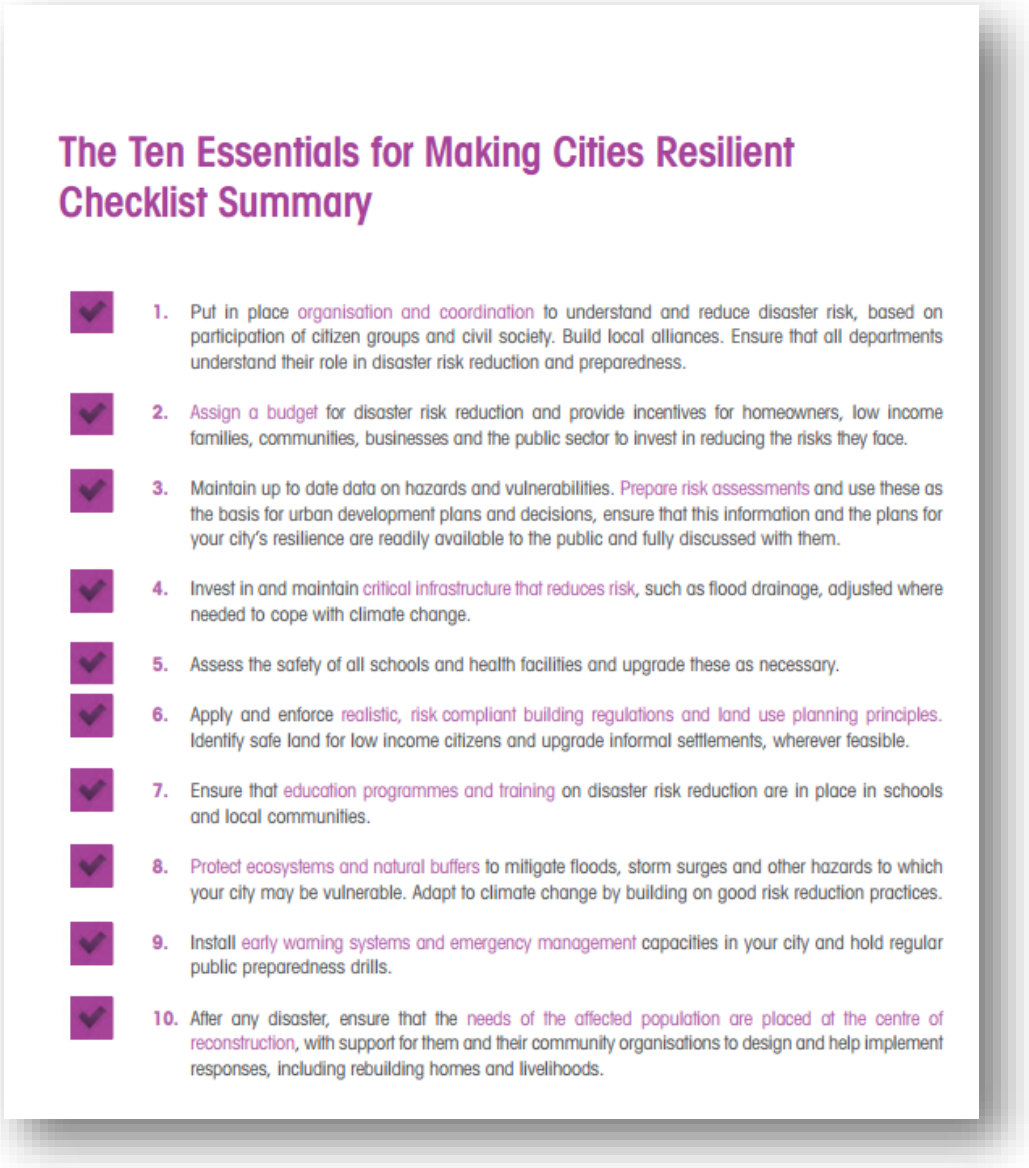
*Due to less representation from these provinces, representatives worked as one group.

Table 12: Some provincial perspectives on heatwave management in Pakistan[163]

City-wide diagnostic

Several frameworks and diagnostic tools exist that cities can apply to (1) assess their baseline situation when it comes to resilience, (2) identify gaps and (3) chart a roadmap to guide action in the long term. The United Nation's office for disaster reduction (UN International Strategy for Disaster Reduction – UNISDR) has published a few of these, including the "Ten essentials" framework and related Local Government Assessment Tool. [164] Both are part of the "Making Cities Resilient Campaign." This campaign

has attracted over 3,500 cities[165] who have pledged to take deliberate steps to improve resilience and work toward the goals/targets of the new Sendai Framework, including Mumbai, Karachi, Chennai, Delhi, Tehran, Bangkok, Taipei, Kuala Lumpur and Kathmandu. Figure 18 shows a checklist that summarizes essential attributes of a resilient city.



The Ten Essentials for Making Cities Resilient Checklist Summary

1. Put in place organisation and coordination to understand and reduce disaster risk, based on participation of citizen groups and civil society. Build local alliances. Ensure that all departments understand their role in disaster risk reduction and preparedness.
2. Assign a budget for disaster risk reduction and provide incentives for homeowners, low income families, communities, businesses and the public sector to invest in reducing the risks they face.
3. Maintain up to date data on hazards and vulnerabilities. Prepare risk assessments and use these as the basis for urban development plans and decisions, ensure that this information and the plans for your city's resilience are readily available to the public and fully discussed with them.
4. Invest in and maintain critical infrastructure that reduces risk, such as flood drainage, adjusted where needed to cope with climate change.
5. Assess the safety of all schools and health facilities and upgrade these as necessary.
6. Apply and enforce realistic, risk compliant building regulations and land use planning principles. Identify safe land for low income citizens and upgrade informal settlements, wherever feasible.
7. Ensure that education programmes and training on disaster risk reduction are in place in schools and local communities.
8. Protect ecosystems and natural buffers to mitigate floods, storm surges and other hazards to which your city may be vulnerable. Adapt to climate change by building on good risk reduction practices.
9. Install early warning systems and emergency management capacities in your city and hold regular public preparedness drills.
10. After any disaster, ensure that the needs of the affected population are placed at the centre of reconstruction, with support for them and their community organisations to design and help implement responses, including rebuilding homes and livelihoods.

Figure 18: The Ten Essentials for Making Cities Resilient Checklist Summary [166]

Techniques for decision support

Deciding on resilience objectives and broad strategies to get there is essential for planning. Moving to implementation requires evaluating alternative measures against pre-defined criteria (e.g., economic efficiency, effectiveness, co-benefits, social inclusion and gender equality). Traditional economic techniques such as cost-benefit analysis and cost-effectiveness analysis are widely applied in policy and project appraisal. Financial and broader economic implications are generally key to decisions but dollar costs and benefits alone can be insufficient to weigh the merits of options to enhance resilience to extreme heat. Multi-criteria decision analysis (also called multi-criteria analysis) is a flexible technique to support decision –making, not only accommodating a range of criteria but also scalable to meet analytical capacities.

Multi-criteria decision analysis or multi-criteria analysis

Where cost-benefit information is unavailable, limited or challenging to derive, or where evaluation criteria selected to prioritize heat resilience options span many metrics, multi-criteria decision analysis is a useful assessment approach.[167] MCDA has wide application in national-level planning for climate change adaptation. Analytical capacity, data availability, time and resources shape the MCDA exercise, but some common steps are as follows:

1. Identify the qualitative and quantitative criteria for options evaluation
2. Develop an evaluation scale to describe the performance of each criterion
3. Assign weights to each criterion to reflect its level of importance, preferably in a way that enhances participation and consensus-building. If all criteria matter equally each criterion receives a weighting of 1.
4. Develop a “performance matrix”, which allows the comparison of alternative heat resilience options across each evaluation criteria.
5. Score each option against each decision criteria. Where weights have been used to emphasize select decision criteria, be sure to multiply each score by the assigned weights. Total scores can then be calculated and heat resilience options ranked by score.

Figure 19 summarizes the results of a qualitative evaluation of alternative measures to support forestry and afforestation in cities. They employ six outcome criteria in total. Four related to physical realities of the implementation context and decision-maker priorities. These are: the potential to alleviate heat, economic costs/ benefits, public health costs/benefits and environmental costs/benefits. Two additional criteria relate to governance and ease of implementation: whether local governments have the administrative capacity for implementation and legal authority.

	Outcome Criteria				Governance Criteria	
	Heat	Economic	Public Health	Environmental	Administrative	Legal
Government Operations						
Publicly-Owned Land	+	~	~	+	~	+
Mandates						
Tree Protection Ordinances	+	+	+	+	~	~
Landscaping Ordinances	+	+	+	+	~	~
Other Mandates	+	+	~	+	+	~
Incentives						
Tree Planting Programs	+	+	+	+	~	+
Financial Incentives	+	~	+	+	~	~
Development Incentives	+	+	~	+	~	~
Public Education						
Spotlighting Tree Planting	~	+	+	+	+	+
Public Education	~	+	+	+	+	+
Community Partnerships	~					

Advantageous (+) The choice maximizes benefits and is feasible.
Neutral (~) The choice may present may present mixed advantages and disadvantages.

Figure 19: Example of an evaluation of alternative measures to support forestry/afforestation in cities[168]

Key Messages: Long-term protection

- Long-term seasonal planning and preparedness will help a city become resilient and adapt to extreme heat events. Educational programs can take place year-round to inform the public, and can also be integrated into schools where children can learn at a young age the value of heat management and protective measures.
- Urban planning is a long-term investment that can provide strategies to mitigate and prevent extreme heat events. Increasing green cover, improving the urban wind environment and using previous and high-albedo surfaces can improve a city's resilience to heat.
- Anthropogenic sources of heat can be lessened through public awareness, improving transportation by offering accessible and safe public and pedestrian-friendly transportation, and implementing policies such as subsidies to encourage alternative energies.
- Priorities should be set to reduce the likelihood of mal-adaption. Stakeholder communications and understanding the baseline situation of a city will help to establish where to start.

Box 12: Key messages – Long-term protection

9 Implementation and monitoring

Successful implementation of heatwave management plans at the city level relies on strong leadership from local governments, support from city leadership and coordinated action of all key stakeholders.[169] Because clarity in roles and responsibilities before, during and after a heat event is critical, heatwave management or heat action plans tend to include standard operating procedures or detailed action tables. Data collection and monitoring activities during heat events are often included, as "real-time" learning can guide course corrections. This section summarizes good practice on these topics and presents templates for use by cities.

9.1 Operating procedures

Standard operating procedures (SOPs) or action checklists are essential guidance for implementation partners to carry out preparedness and response measures aligned with their mandates. For cities new to heatwave management, these SOPs or checklists are particularly pertinent.

- Among the most significant gaps in **Karachi**'s response to the June 2015 event were the lack of inter-agency coordination and unclear roles and responsibilities in the response effort. Therefore, the city's first heatwave management strategy explicitly incorporates strategies to empower implementation agencies such that they are able to supply the required levels of service and support in a way that is coordinated and efficient. The heatwave management plan, for example, includes detailed lists of specific activities entrusted to each implementation partner during the heat season and three alert levels.[170]
- **Ahmedabad**'s Heat Action Plan includes a series of checklists that outline key responsibilities and activities for deployment by implementation agencies pre-season, during the heat season and post season. Other cities and states in India have used these checklists as templates and have adjusted them to suit their needs. Annex I includes these checklists.

9.2 Data collection and monitoring

Communication and collaboration among implementation agencies and other stakeholders before and during heat events help identify and address shortcomings in the response. A key part of this is to collect "real-time" data (less than 48 hours) and report unusual patterns in morbidity, mortality, and demands on the health care system during a heatwave. Emergency services, including hospitals and fire brigades, are key partners in data collection (see Box 13). Useful real-time data include all-cause mortality, emergency calls, emergency department visits and volume of heat line calls (where they exist). Timely information on developments can, for example, highlight areas of the city most affected and assess the sufficiency of emergency services.

- Systematic and centralized collection of morbidity and mortality data is limited in some cities and regions. An approach to filling these data needs, improve analytical capacity and the potential for learning from implementation is to encourage or mandate the use of standardized data collection templates among health practitioners and emergency responders. Appendix II includes templates for recording heat-related deaths and cases of illness per health facility.

In 2006, France experienced a heatwave lasting 19 days (11 to 28 July). To monitor the health impacts of hot weather, indicators were developed to track daily cases of three heat-related pathologies (elevated body temperature, dehydration and low sodium levels in the blood). Correlations between health indicators and temperature showed that emergency departments are a very relevant source of information to monitor environmental health outcomes.

Institutions / agencies	Indicators
Emergency medical services	# of calls/cases
On-duty medical units	# of emergency care unit visits # of emergency care unit visits for children under 1 year # of emergency care unit visits for people > 75 years # of hospital admissions after emergency care unit visits
Fire brigade	# of calls with deaths
Civil registry office	# of deaths and day or death

Box 13: Heatwave and syndromic surveillance in France[171]

In some locations, weather monitoring stations do not provide the coverage necessary to register spatial differences in heat conditions. Therefore, heatwave management plans can include improvements in weather monitoring.

- **Karachi**'s heatwave management plan included a commitment by the lead agency "to install and maintain at least one weather monitoring station per district to be able to register microclimates shaped by built infrastructure and land use".[172]
- In **India**, the think tank TARU is promoting a data collection approach for efficient heat action planning. This approach would rely on crowd-sourced data collection to log temperature and humidity. Field testing is taking place at present.[173]

9.3 Lessons learned to support implementation

Based on contents of heat action plans and literature, it's evident that enablers to successful implementation are the following:[174]

- **Agreement on a lead agency or body** to coordinate activities of multiple agencies and direct responses during a heatwave emergency
- **Accurate and timely alert protocols** that define thresholds for action and orient communication of the risks
- **A communication plan** that describes what is communicated, to whom and when
- **Response measure to reduce indoor heat exposure**, such as advice on how to keep indoor temperatures low during heat episodes
- **Particular care for vulnerable population groups**
- **Preparedness of the health and social care system**, including staff training and planning, and appropriate, accessible health care

- **Long-term urban planning** to address building design and energy and transport policies that will ultimately reduce heat exposure
- **Real-time monitoring** and evaluation

Key Messages: Implementation and monitoring

- Standard operating procedures (SOPs) or action checklists are important guidelines for stakeholders to use to carry out their tasks.
- Collecting real-time data such as mortality, emergency calls, emergency department visits, and volume of heat line calls is useful for highlighting areas of the city that are most impacted and distribute emergency services accordingly. The data can also help to better prepare for future events.
- Collaborating with agencies and stakeholders will help facilitate plan implementation. Data sharing and communicating relevant information can improve response activities during an extreme event.

Box 14: Key messages – Implementation and monitoring

10 Evaluation and learning

Evaluations help validate the effectiveness of heatwave management plans and interventions and provide information to improve heat alert protocols and responses to ensure the most effective use of resources. [175]As with any public-health intervention, strategies to manage extreme heat must be flexible and iterative. As stakeholders accrue more experience, expertise, and data regarding extreme heat and heat action plans, they should be able to easily adjust, evaluate, and improve their strategies over time.[176] This section summarizes approaches, methods, and resources to maximize learning from implementation.

10.1 Definitions

An evaluation plan, comprised of process evaluation (i.e., implementation performance) as well as outcome evaluation (i.e., impact of the plan on health outcomes), is integral to iterative heat planning cycles (as in Figure 20).[177] Yearly reviews or seasonal evaluations are generally part of heatwave management or the heat action plans that have been reviewed to develop this Toolkit. It is important to design evaluations to capture long-term changes, such as the effect of prevention strategies and behavioral change.

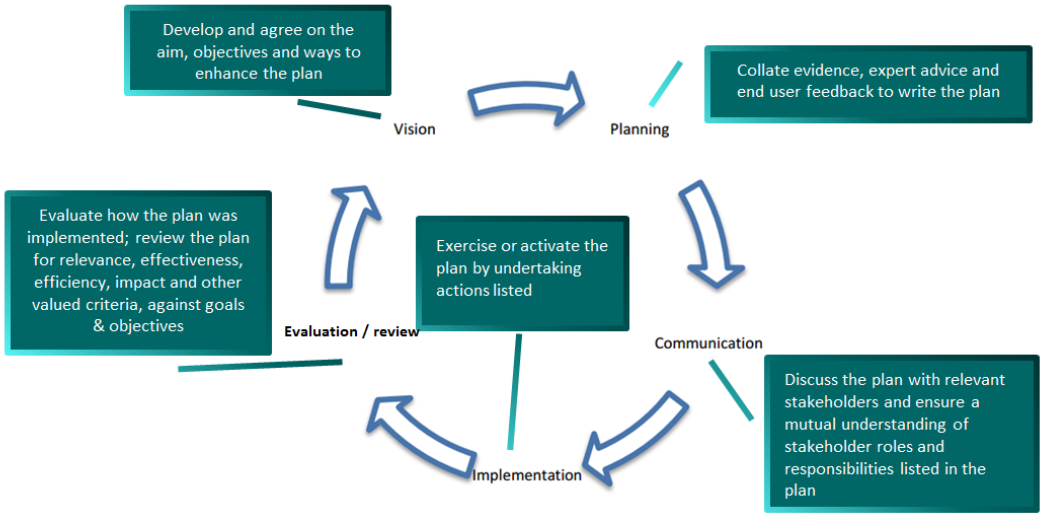


Figure 20: Heat planning framework including evaluation and learning (Adapted from City of Yarra Heat Plan[178])

Process and outcome evaluations differ significantly so it's worth describing their respective characteristics (Table 13). End of season evaluations can incorporate both approaches.

	Outcome evaluation	Process evaluation
Objective	To assess whether the plan made a difference	To assess how the plan is being implemented
Issues to be assessed	- Mortality – daily temperatures and deaths before, during and after heatwave periods, mortality in different settings such as care homes - Morbidity - Health care utilization - Non-health-related outcomes such as productivity and work absence - Assessment of the temperature-mortality function - Health behavior changes related to heat	- Whether key messages were provided to the population - If the population was aware of the plan and its messages - Whether warnings were issued at the right time and reached the intended target group(s) - Whether the organizations and professionals acted appropriately and if they followed the plan - Whether the organizations and professionals found the plan helpful - Possible unintended consequences of the plan - Contextual factors facilitating or hindering the plan's implementation
Methods	- Quantitative, qualitative - Formal assessment of epidemiological data such as daily mortality or of intermediate endpoints such as changes in knowledge or behavior	- Qualitative, semi-quantitative - Data collected by interviews or telephone surveys, face-to-face interviews with key participants and providers - Contextual analyses
Limitations	- Can be very difficult to identify to obtain data needed at the appropriate resolution - Attribution can be difficult - Ethical issues for experimental studies; cannot deny part of the population heat–health protection measures unless there is real uncertainty about their effectiveness	- Need to identify key players in advance - Small numbers of people - Cannot provide definitive answers

Table 13: Characteristics of process and outcome evaluations (Adapted from Matthies and Menne 2008[179] and McGregor 2015[180])

All evaluations, regardless of the type, should consider the following factors in their design:[181]

- Clarifying the goals and objectives of plan subject to evaluation and of the evaluation itself
- Incorporating relevance and effectiveness criteria to be able to assess whether the plan is doing the right things and doing things right
- Incorporating efficiency criteria to be able to assess whether the plan is cost-effective
- Developing a list of indicators required to measure each evaluation criterion
- Tailoring data collection and analysis methods to the evaluation objectives
- Clarifying who will use the evaluation results and how
- Disseminating the evaluation results and following up on them

10.2 Process evaluation

Process evaluations concentrate on examining the process of an intervention. In the context of a heatwave management plan, this would be the implementation of the various components of the plan, from stakeholder engagement and communication activities to the alert system, heatwave response and mitigation measures.

The process evaluation will determine[182] if all actors understand their roles and responsibilities and are able to undertake them during a heatwave. It would also identify any barriers to communication or cooperation that exist within the system. Successful interventions require information- and data-sharing between the relevant health and meteorological agencies.

Key process-evaluation questions should include:

- What is the frequency and type of heat alerts over a specific period?
- What is the effectiveness of the cascade of information to health and related professionals?
- What actions were taken in response to the various levels of alert and the barriers and facilitators to action?
- What were the outcomes and how did these differ across the "high-risk" or targeted groups?

For persons responsible for the actions outlined in the plan, key process-evaluation questions could include:

- Who possesses awareness and knowledge of the written heat plan and associated documentation?
- Is the plan implemented as widely as intended?
- Is there good communication between agencies?
- Are roles and responsibilities understood?
- What are the barriers (financial, information, etc.) to implement relevant activities?

10.3 Outcome evaluation

There is limited evidence from studies on the evaluation of warning systems and heat–health action plans, especially in terms of effectiveness of interventions to achieve the intended health outcomes. This type of evaluation generally focuses on mortality[183] as the outcome measure; for example, temporal variations in the temperature–mortality relationship within a city can give an indication of the change/reduction of the impact of heat on health. However, other endpoints can be used (emergency hospital admissions, contact with primary-care services or helplines). Outcomes must be shown to be sensitive to the effects of hot weather on the population in question, which usually requires epidemiological analysis.

Assigning mortality data to heat is complicated as there are several confounding factors that can affect the results. The number of prevented deaths can be estimated as the difference between the observed deaths and the numbers expected during the heat-wave (based on the previous quantification of the temperature–mortality relationship). Estimates can be broken down by major age categories and can be generated for all deaths and for deaths specifically associated with heat-waves.

Another approach is to compare deaths on hot (heat-wave) days with and without warnings but there are potential ethical issues associated with this approach. Another approach is to compare interventions more formally in different areas. It would be unethical to provide no heat–health protection in a given area but,

given the level of uncertainty around effectiveness for specific interventions, it would be appropriate to compare different strategies in different areas within a given city or district and even randomly allocate interventions at the community level.

Table 14 presents the outcome evaluation that was performed for Ahmedabad's Heat Action Plan[184] based on pre and post-HAP all-cause mortality data.

Table 14: Ahmedabad HAP's mortality evaluation

Ahmedabad HAP's mortality evaluation

The Heat Action Plan (HAP) for the city of Ahmedabad was launched in April 2013. Daily mortality data from the 2005-2014 hot season (March-May) were available. Using the average of daily May all-cause mortality in the 2009 and 2011 reference period (100.6 mean daily May mortality), excess May mortality was compared in years 2010 (average daily mortality of 143.9 during the May 2010 historic heat wave), then in 2013 (the 1st year post-HAP launch, with relatively cool temperatures), and 2014 (the 2nd year post-HAP launch, with relatively hot temperatures). Results show that average daily mortality in May 2013 was 120.5, and 133.0 in May 2014. While there were an estimated 1,344 excess deaths in 2010 relative to the reference period (2009 and 2011), in 2013 there were 617 excess deaths estimated by this method, and in 2014 there were 1,004. This suggests that, even in a very hot year like 2014, there was as much as a 25% decrease in May's excess all-cause mortality after the launch of the HAP. These methods suggest that daily all-cause summer mortality in Ahmedabad has dropped in the years since the HAP was launched.

It should be noted that there are several potential confounders that could also affect comparisons across different years of daily temperature-mortality relationships. These include:

- Population growth in the city at large, and specifically among the most heat-vulnerable groups
- Air pollution
- Outbreaks of infectious diseases or disasters that cause acute spikes in mortality
- Increased (or decreased) access to air-conditioning
- Changes in environmental heat exposure

10.4 End of season evaluation

After every heat season, the city or state must assess the efficacy of its heat action plan, including the processes, outcomes, and impacts. Stakeholders should then identify changes and improvements for the next heat season. It is important that the result of any evaluation is disseminated to the participants in the implementation of the heatwave management plan. Regular process evaluations will build awareness and confidence in the system. Table 15 shows an example of a checklist for end of season evaluation.

Table 15: Example of checklist for end of season evaluation[185]

Example of checklist for end of season evaluation

- **Assess the efficacy of the heat action plan: processes, outcomes, and impacts**

- Examine the processes (e.g. communications, logistics, and implementation) of the most recent plan. Questions might include:
  - Which processes worked well?
  - Which processes did not work well or as anticipated?
  - What feedback was received from partners and participants?
  - Was implementation cost-effective?
  - Were there bottlenecks to communication and/or logistics?
- Examine the outcomes and impact of the most recent plan. Questions might include:
  - Did the plan work as anticipated?
  - Were the most vulnerable populations well-served?
  - What do scientific data and health records show regarding the impacts of the heat season?
  - Did the heat plan make a difference?
  - What feedback was received from residents and the media?
  - Did awareness and behaviors improve?
  - Did morbidity and mortality rates decline compared to previous heat seasons?

- **Identify changes to the plan for next year to improve outcomes and processes for the next heat season**

- **Update the plan**

- **Disseminate updated plan to officials and participants**

Key Messages: Evaluation and learning

- An evaluation plan should be put in place to review a heat wave management plan on a yearly or seasonal basis.
- The evaluation should capture long-term changes such as the effect of prevention strategies and behavioral change.
- Evaluations should clarify goals and objectives of the plan, assess the relevance, efficiency, and effectiveness, develop a list of indicators required to measure each evaluation criterion, clarify who will be using the evaluation results and how, and disseminate the results.
- Conducting a process evaluation will determine if all roles and responsibilities in the plan are understood and being carried out appropriately.
- Outcome evaluations often use mortality as a measure, other measures that are sensitive to the effects of hot weather on the population, such as emergency services can be used as well.
- An end of seasonal evaluation will help stakeholders to identify any necessary changes or improvements that should be made for the next heat season.

Box 15: Key messages – Evaluation and learning

Annex I: Agency checklists

Checklist for AMC Nodal Officer

Pre-Summer

- ✓ Designate heat health point of contact for each department
- ✓ Reengage key agencies to facilitate communications and schedule monthly meetings
- ✓ Establish heat mortality tracking system and update datasets
- ✓ Establish Heat Action webpage on AMC website
- ✓ Educate school children and send home age-appropriate pamphlets about the heat season
- ✓ Create list of high-risk areas of city heat-wise

During Heat Event

- ✓ Contact point person in each department announcing heat event at least five days in advance
- ✓ Maintain contact with department points of contact for updates on conditions
- ✓ Ensure staff presence and availability of supplies with each department – including distributing fresh drinking water
- ✓ Communicate locations of emergency facilities and cooling centers/shaded areas with each department
- ✓ Monitor heat alert and increase level when severe forecast

Post-Summer Evaluation

- ✓ Review quantitative and qualitative data for process evaluation and improvements
- ✓ Call meeting for annual evaluation of heat plan with key agency leaders and community partners
- ✓ Post revised heat action plan online for stakeholders

Checklist for Medical Colleges and Hospitals

Pre-summer

- ✓ Adopt heat-focused examination materials
- ✓ Get additional hospitals and ambulances ready
- ✓ Update surveillance protocols and programs, including to track daily heat-related data
- ✓ Establish more clinician education
- ✓ Continue to train medical officers and paramedics

During Heat Event

- ✓ Adopt heat-illness related treatment and prevention protocols
- ✓ Equip hospitals with additional materials
- ✓ Deploy all medical staff to be on duty
- ✓ Keep emergency ward ready
- ✓ Monitor water borne diseases, malaria and dengue
- ✓ Keep stock of small reusable ice packs to apply to PULSE areas
- ✓ Report heat stroke patients to AMC daily
- ✓ Expedite recording of cause of death certificates

Post-summer Evaluation

- ✓ Participate in annual evaluation of heat action plan
- ✓ Review revised heat action plan

Figure 21: Agency checklist for municipal nodal officers (left) and medical staff (right) developed as part of Ahmedabad's Heat Action Plan

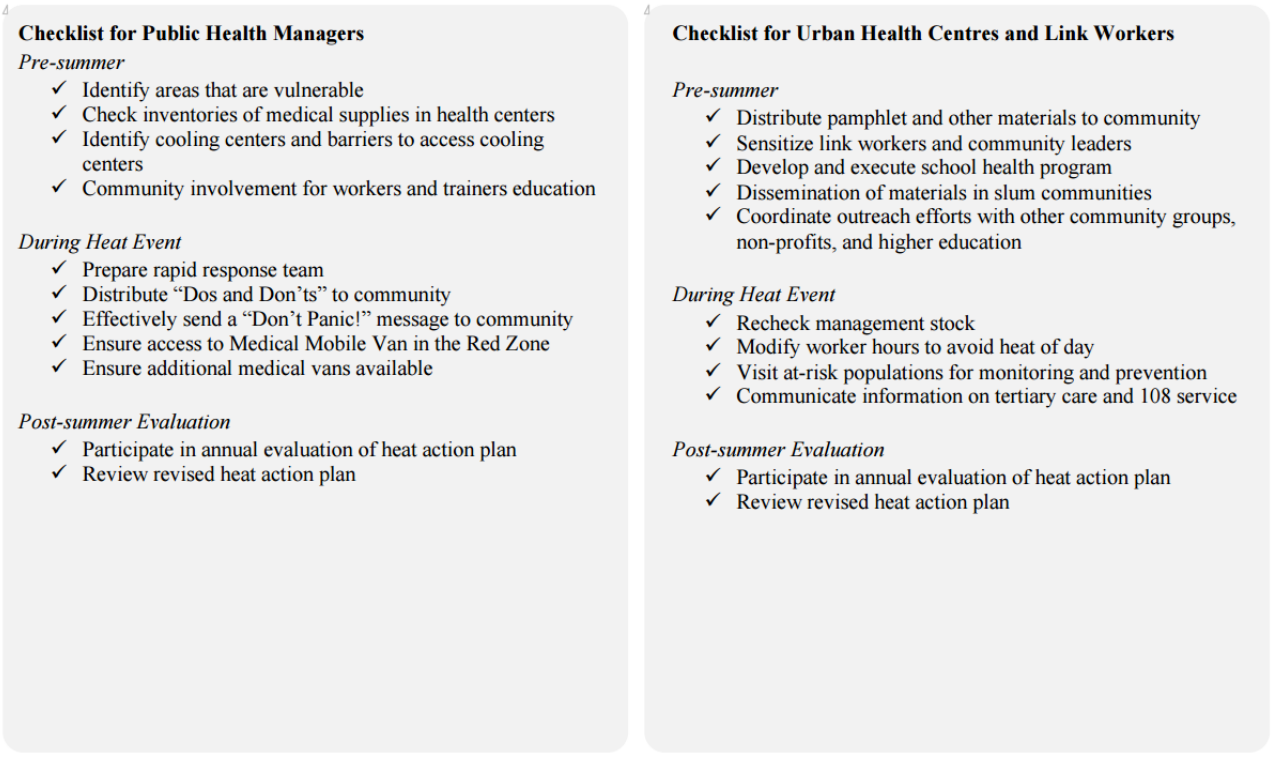


Figure 22: Agency checklist for public health managers (left) and health centers and link workers (right) developed as part of Ahmedabad's Heat Action Plan

Checklist for AMC Press Officer

Pre-Summer

- ✓ Secure commercial airtime slots for public service announcements
- ✓ Identify areas to post warnings and information during heat season
- ✓ Organize training for health workers and medical professionals
- ✓ Activate telephone heat hotline
- ✓ Begin placing temperature forecasts in newspapers
- ✓ Increase installed LED screens with scrolling temperature data

During Heat Event

- ✓ Issue heat warnings in heat and electronic media
- ✓ Contact local FM radio and TV stations for announcements
- ✓ Use SMS, text and WhatsApp mobile messaging and centralized mobile databases to send warnings
- ✓ Contact BRTS and transport department to place warnings on buses

Post-Summer Evaluation

- ✓ Evaluate reach of advertising to target groups and other means of communication such as social media
- ✓ Participate in annual evaluation of heat action plan
- ✓ Review revised heat action plan

Checklist for Labor Department

Pre-Summer

- ✓ Heat illness orientation for factory medical officers and general practitioners
- ✓ Generate list of factory medical officers and contractors to include in heat action communications from Nodal Officer
- ✓ Communicate directly about heat season with non-factory workers
- ✓ Utilize maps of construction sites to identify more high-risk outdoor workers.
- ✓ Conduct publicity campaigns during high-risk days in identified high-risk areas

During the Heat Season

- ✓ Provide water at work sites
- ✓ Request use of A/C at factory facilities
- ✓ Extended hours at Occupational Health Centers
- ✓ Consider extended afternoon break or alternate working hours for workers

Post-Summer Evaluation

- ✓ Participate in annual evaluation of heat action plan
- ✓ Review revised heat action plan
- ✓ Pilot project to provide emergency ice packs and heat-illness prevention materials to traffic police, BRTS transit staff and construction workers

Figure 23: Agency checklist for the press (left) and the labor department (right) developed as part of Ahmedabad's Heat Action Plan

Checklist for 108 Emergency Service

Pre-Summer

- ✓ Prepare handouts for paramedics about heat illness
- ✓ Create displays on ambulances to build public awareness during major Spring events
- ✓ Establish Dynamic Strategic Deployment Plan for ambulances
- ✓ Ensure adequate supply of IV fluids
- ✓ Identify at-risk areas
- ✓ Prepare SMS messages to disseminate during emergencies
- ✓ Identify media point of contact

During the Heat Season

- ✓ Ready medicine stocks
- ✓ Keep accurate records of pre-hospital care
- ✓ Send messages to all employees alerting them of heat action plan
- ✓ Activate Dynamic Strategic Deployment Plan
- ✓ Staff surplus employees and restrict leave

Post-Summer Evaluation

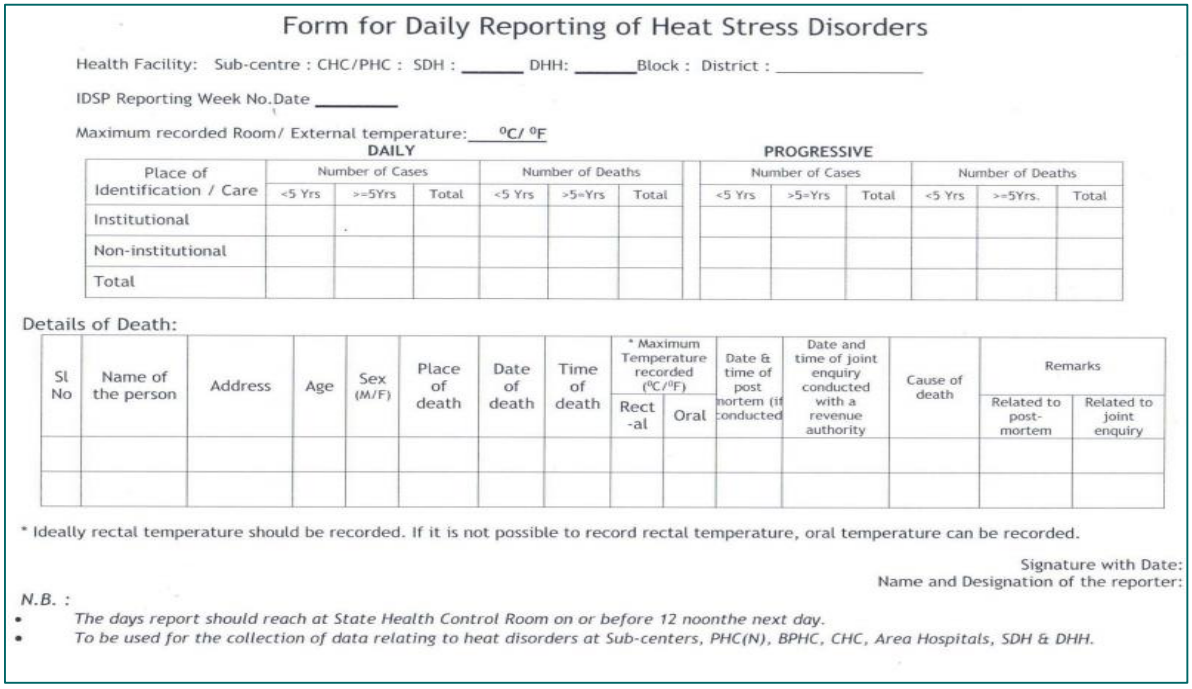
- ✓ Provide data to key agency leaders
- ✓ Participate in annual evaluation of heat action plan
- ✓ Review revised heat action plan

Figure 24: Checklist for emergency services developed as part of Ahmedabad's Heat Action Plan

Annex II: Data collection templates

District	Details Death reported in 20--										
	Age group	Urban		Rural		Economic Status		Location of Death		Occupation of the Deceased	Remarks
		Male	Female	Male	Female	APL	BPL	Indoor	Outdoor		
Tehsil/ Taluka/ Block	< 1 year										
	1-4 years										
	5-9 years										
	10-14 years										
	15-24 years										
	25-34 years										
	35-44 years										
	45-54 years										
	55-64 years										
	65-74 years										
	75-84 years										
	85 +										
District											
State											

Figure 25: Example of proposed data collection template for mortality data (Source: National Disaster Management Authority Government of India 2016[186])



Form for Daily Reporting of Heat Stress Disorders

Health Facility: Sub-centre : CHC/PHC : SDH : _____ DHH: _____Block : District : _____

IDSP Reporting Week No.Date _____

Maximum recorded Room/ External temperature: ___ °C/ °F

Place of Identification / Care	DAILY Number of Cases			DAILY Number of Deaths			PROGRESSIVE Number of Cases			PROGRESSIVE Number of Deaths		
	<5 Yrs	>=5Yrs	Total	<5 Yrs	>5=Yrs	Total	<5 Yrs	>5=Yrs	Total	<5 Yrs	>=5Yrs.	Total
Institutional												
Non-institutional												
Total												

Details of Death:

Sl No	Name of the person	Address	Age	Sex (M/F)	Place of death	Date of death	Time of death	* Maximum Temperature recorded (°C/°F)		Date & time of post mortem (if conducted	Date and time of joint enquiry conducted with a revenue authority	Cause of death	Remarks	
								Rect -al	Oral				Related to post-mortem	Related to joint enquiry

* Ideally rectal temperature should be recorded. If it is not possible to record rectal temperature, oral temperature can be recorded.

Signature with Date:
Name and Designation of the reporter:

N.B. :

- *The days report should reach at State Health Control Room on or before 12 noonthe next day.*
- *To be used for the collection of data relating to heat disorders at Sub-centers, PHC(N), BPHC, CHC, Area Hospitals, SDH & DHH.*

Figure 26: Example of template for daily reporting of heat stress disorders (Heat Action Plan for Odisha[187])

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