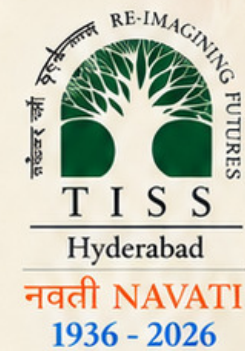


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PREPARING FOR EXTREME HEAT

*A Thematic Review of India's State
and City Heat Action Plans*

Sneha Biswas

School of Public Policy and Governance, TISS Hyderabad

Working Paper No. 02
2026

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Working Paper No. 02 | 2026

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Suggested citation

Biswas, Sneha. 2026. *Preparing for Extreme Heat: A Thematic Review of India’s State and City Heat Action Plans*. TISS Hyderabad Working Paper No. 02. Hyderabad: Tata Institute of Social Sciences.

Published by

Tata Institute of Social Sciences, Hyderabad Campus
Mansa Hills, Rajendranagar, Hyderabad 500 030, Telangana, India

Preparing for Extreme Heat

A Thematic Review of India's State and City Heat Action Plans

Sneha Biswas^{*, **}

Abstract

Heat action plans (HAPs) are aimed at preparedness, early warning, coordination, and the monitoring and evaluation of administrative capacity to manage extreme events such as heatwaves. The IPCC Sixth Assessment Report (AR6) suggests that the frequency of heatwaves and related mortality will increase over the next fifty years. Following the recommendations of the WMO and WHO, several Indian states and cities have prepared structured heat action plans. These plans divide their action points into three phases, i.e., pre-heat season, during the heat season and post-heat season. The present paper critically analyses ten of India's heat action plans by identifying their sectoral specificity, distinctive initiatives and gaps. A systematic thematic analysis of the plans yielded seven major themes cutting across the sectors: vulnerability mapping, early warning and information dissemination, identification of respective authorities, impact on health and medical preparedness, impact on the labour force, impact on the ecosystem, and cooling solutions. The study identifies the lack of community participation, over-reliance on IMD data and the absence of detailed tasks for the respective authorities as major gaps in the heat action plans.

Keywords: heat action plans, heatwaves, climate adaptation, vulnerability mapping, early warning systems, India

Introduction

Heatwaves are usually periods of high temperature that arise as a result of climate variability or climate change. Meteorological organisations have provided several definitions of heatwaves. The World Meteorological Organization (WMO), for example, defines a heatwave as a period in which

* Sneha Biswas is Assistant Professor, School of Public Policy and Governance, Tata Institute of Social Sciences, Hyderabad.

** The author gratefully acknowledges Professor Aseem Prakash for his support, valuable feedback and comments, which greatly improved the paper. The author also acknowledges Ms. Mayisha Anjum Choudhury, who helped in the preparation of the map. The author is also grateful to the editor and the reviewer for their constructive comments.

local excess heat accumulation leads to a sequence of unusually hot days and nights. According to the India Meteorological Department (IMD), heatwaves occur when the temperature crosses a threshold above the actual or usual temperature of a region. According to the National Disaster Management Authority (NDMA), India, heatwaves are weather or temperature anomalies of 5°C above the normal temperature. Heatwaves occur when the temperature crosses 45°C in the plains and 30°C in hilly regions. The *European State of the Climate* report (2023) specifies a number of days and a reference period in its definition. It defines heatwaves as ‘a period of at least three consecutive days when both the daily surface air temperature minima and maxima are higher than the highest 5% of values for the day in question during the 1991–2020 reference period’.¹

Heat action plans are usually designed to disseminate information, provide early warning and inform vulnerable groups so as to avoid heat-related fatalities, losses and illnesses. They capture information on heat-related health effects, both for vulnerable groups and in terms of general health risks. They are also designed to inform and mobilise different line departments and authorities about their respective responsibilities. Heat action plans also provide a framework for coordination, implementation and evaluation. Another aim of heat action plans is long-term urban planning and solutions to avoid the impacts of heatwaves combined with the urban heat island effect in cities. The need for heat action plans (HAPs) emerged from the EuroHEAT project, funded by the World Health Organization (WHO) and the European Commission, in 2009. Later, in 2015, the WMO and WHO jointly published clear guidance for preparing a heat action plan, focusing on health impacts, preparedness, planning and the management of extreme heat situations. The IPCC Sixth Assessment Report also identifies HAPs as one of the major adaptation tools. The study aims to identify the major sectors of importance, communication, preparedness and resource readiness of each state and city through the HAPs. Another goal of the paper is to identify gaps and the scope for improvement in future HAPs.

Methods

The current study presents a thematic analysis of ten heat action plans at the sub-national and city levels. First, the author collected all the Indian state and city heat action plans available in the public domain, which yielded 15 action plans. The author then applied inclusion and exclusion criteria to select heat action plans for review. Heat action plans were included on the basis of three criteria:

¹ Copernicus Climate Change Service and World Meteorological Organization, *European State of the Climate 2023* (2024), <https://climate.copernicus.eu/esotc/2023>.

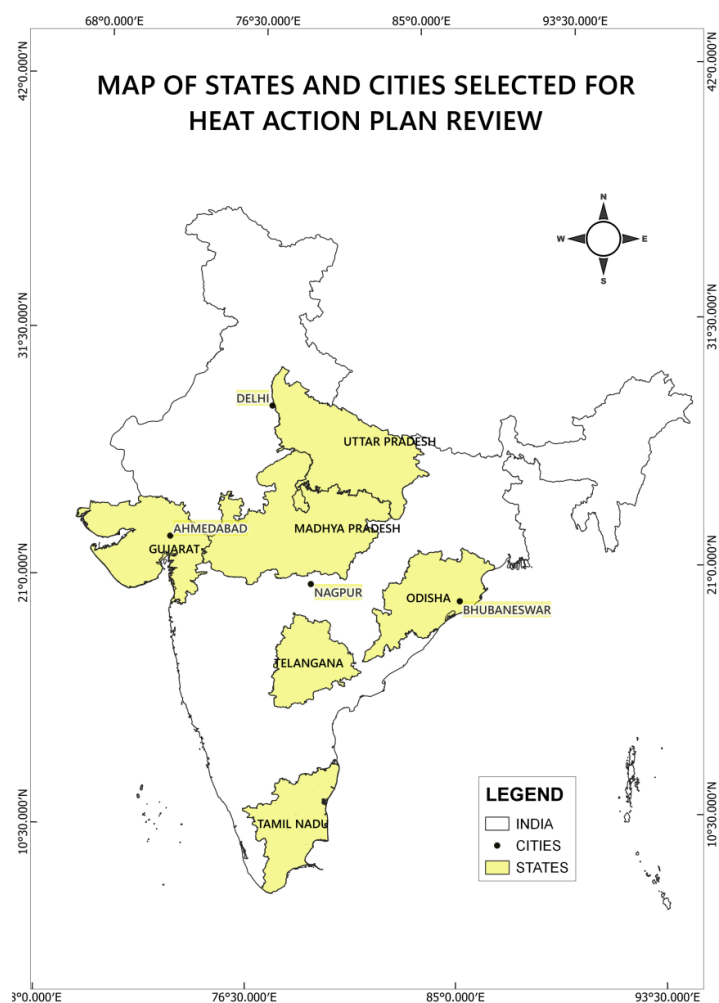
first, the plan is published by a recognised formal institution; second, its title explicitly states that it is a heat action plan or heatwave action plan; and third, it has a weather-based component.² The inclusion criteria also required action plans to be published in English and to address at least five of the eight components recommended by the WHO for heat action plans.³ The study excluded action plans published in a vernacular language (Kerala HAP 2020) and those that did not cover the components (West Bengal HAP 2023, Rajasthan HAP 2025). This yielded ten heat action plans: Uttar Pradesh (2024), Telangana (2024), Tamil Nadu (2024), Madhya Pradesh (2022–27), Gujarat (2020), Odisha (2020), Bhubaneswar (2025), Delhi (2024–25), Nagpur (2022) and Ahmedabad (2019).⁴ Next, the author critically reviewed the action plans to identify similar themes, differences and unique initiatives. First, the author read and re-read all the reports and created codes. The author then went through all the codes and arrived at meaning units. From the meaning units, the author looked for similar patterns and arrived at major themes. The author defined, redefined and renamed the themes and then wrote the full thematic analysis. In total, seven themes and three common phases of action emerged from the review. The themes are as follows: (a) identification of vulnerable groups and areas; (b) identification of respective authorities for response; (c) impact on health (illness-related information and hospital preparedness); (d) impact on economy and livelihood; (e) impact on ecosystem and the environment; (f) cooling solutions and improvement of built environment; and (g) early warning and communications. The three common phases were pre-heat season, during the heat season and post-heat season.

² R. Kotharkar and A. Ghosh, “Progress in Extreme Heat Management and Warning Systems: A Systematic Review of Heat-Health Action Plans (1995–2020)”, *Sustainable Cities and Society* 76 (2022): 103487, <https://doi.org/10.1016/j.scs.2021.103487>.

³ World Health Organization, “Planning Heat–Health Action”, WHO Regional Office for Europe, accessed 30 June 2026, <https://www.who.int/europe/activities/planning-heat-health-action/planning-heat-health-action>.

⁴ Uttar Pradesh State Disaster Management Authority, *Uttar Pradesh Heat Wave Action Plan 2024* (Government of Uttar Pradesh, 2024); Revenue (Disaster Management) Department, *The Telangana State Heatwave Action Plan 2024* (Government of Telangana, 2024); Tamil Nadu State Planning Commission, *Tamil Nadu Heat Mitigation Strategy* (Government of Tamil Nadu, 2024); Department of Public Health and Family Welfare, *Madhya Pradesh State Action Plan on Climate Change and Human Health 2022–27* (Government of Madhya Pradesh, 2022); Gujarat State Disaster Management Authority, *Gujarat State Action Plan: Prevention and Mitigation of Impacts of Heat Wave 2020* (Government of Gujarat, 2020); Odisha State Disaster Management Authority, *Heat Action Plan for Odisha 2020* (Government of Odisha, 2020); Bhubaneswar Municipal Corporation, *Heat Wave Action Plan 2025* (Government of Odisha, 2025); Delhi Disaster Management Authority, *Delhi Heat Action Plan 2024–25* (Government of NCT of Delhi, 2024); Vasudha Foundation, *Climate Change and Environment Action Plan of Nagpur District* (Shakti Sustainable Energy Foundation, 2022); Ahmedabad Municipal Corporation, *Ahmedabad Heat Action Plan 2019 Update: Guide to Extreme Heat Planning in Ahmedabad, India* (Ahmedabad Municipal Corporation, 2019).

Figure 1: Map showing the selected states and cities with heat action plans



Results

The current analysis is a review of ten heat action plans. It includes six state action plans and four city- or district-level action plans in India. Based on the data gathered from the heat action plans, seven major themes emerged. These are as follows:

- a) Identification of vulnerable groups and areas
- b) Identification of respective authorities for response
- c) Impact on health (illness-related information and hospital preparedness)
- d) Impact on economy and livelihood
- e) Impact on ecosystem and the environment
- f) Cooling solutions and improvement of built environment
- g) Early warning and communications

Identification of vulnerable groups and areas

Heatwaves have differential impacts according to age, gender, socio-economic condition, built environment and geographical location. A study from India suggests that marginalised caste groups are more exposed to heatwaves, as they have to spend more time working outdoors.⁵ Studies also suggest that mortality is higher among disadvantaged groups, and that heatwave vulnerability is also higher in slums and low-income pockets of urban areas.⁶ Vulnerability assessments help in identifying the groups that need immediate focus. For heatwave-related impacts, it is children, the elderly, women, outdoor workers and homeless people who face greater health risks. Almost all the reports identify the vulnerable groups. However, they do not specifically identify the geographical location of these groups. Tamil Nadu prepared a state vulnerability map using indicators and indices such as

⁵ A. Shah et al., “Caste Inequality in Occupational Exposure to Heat Waves in India”, *Demography* (2024).

⁶ G. Rey et al., “Heat Exposure and Socio-economic Vulnerability as Synergistic Factors in Heat-Wave-Related Mortality”, *European Journal of Epidemiology* 24, no. 9 (2009): 495–502, <https://doi.org/10.1007/s10654-009-9374-3>; Y. Kang, J. Park, and D. Jang, “Compound Impact of Heatwaves on Vulnerable Groups Considering Age, Income, and Disability”, *Scientific Reports* 14, no. 1 (2024): 24732, <https://doi.org/10.1038/s41598-024-75224-4>; C. Zografos, I. Anguelovski, and M. Grigorova, “When Exposure to Climate Change Is Not Enough: Exploring Heatwave Adaptive Capacity of a Multi-ethnic, Low-Income Urban Community in Australia”, *Urban Climate* 17 (2016): 248–65, <https://doi.org/10.1016/j.uclim.2016.06.003>.

Land Surface Temperature (LST), the Universal Thermal Climate Index (UTCI) and the Heat Index (HI). The Heat Index Chart shows the level of danger from heatwaves by plotting temperature and relative humidity on the X and Y axes. The Odisha HAP identifies ‘heat hotspots’ and vulnerable wards within cities such as Bhubaneswar using thermal hotspot mapping and satellite data. The Delhi HAP identifies areas that are less urbanised, have minimal access to water and sanitation, and have minimal household amenities as vulnerable areas. Among demographic groups, children below five years of age, senior citizens and pregnant women were identified as the most vulnerable in all the reports. In addition, a few action plans identified lactating mothers and people with chronic illnesses, such as heart, renal, respiratory and neurological diseases, or even obesity and diabetes, as vulnerable groups. Across socio-economic categories, people living in slums, low-income habitations and hutments, residents of old age homes, orphans and persons with disabilities were identified as vulnerable. Poor living conditions in places such as slums and huts usually worsen the impact of heatwaves, owing to the use of heat-trapping materials such as tin and asbestos, overcrowding and the lack of electricity. Among occupational categories, it is mostly outdoor workers who are identified as vulnerable, such as MGNREGA workers, agricultural labourers, construction workers, street vendors, brick kiln workers, emergency responders, traffic police, industrial labourers, and glass and metal workers. The Ahmedabad HAP also identifies migrant labourers as a vulnerable group. The Delhi, Tamil Nadu and Telangana plans have identified geographical hotspots within their jurisdictions. The Delhi HAP has identified 10 heatwave hotspots by overlaying vulnerable areas with vulnerable sections or groups. The Telangana HAP’s heatwave vulnerability index categorised 6 mandals as severely heatwave-vulnerable, 106 as critical, 189 as semi-critical, 287 as vigilant and 24 as safe. This categorisation is based on past years’ data on heatwave days and severe heatwaves, but it fails to identify vulnerable groups. The Gujarat and Odisha HAPs plan to map ‘heat islands’, ‘heat hotspots’ and vulnerable wards within major cities. The Telangana HAP first identifies districts with excess, normal and deficient rainfall. A mandal-wise (sub-division) vulnerability map is prepared based on drought vulnerability, and another district-level vulnerability map based on the depth of the groundwater level. The drought vulnerability map identifies five vulnerability categories: 76 mandals are very highly vulnerable, 98 highly vulnerable, 91 vulnerable, 90 moderately vulnerable and 87 less vulnerable. The identification of vulnerable areas or groups helps in identifying priority areas and disseminating alerts accordingly.

Identification of respective authorities for response

Heatwaves, like other extreme events, need preparedness and quick response. All the reviewed heat action plans identify the State Disaster Management Authority (SDMA) as the major agency responsible for the task. Gujarat identified a nodal agency and the respective authority at each administrative level. It also has a District Heat Action Task Force (DHATF). Tamil Nadu also runs a specific, collaborative ‘Heat Action Network’ that includes representatives from different line departments, such as health, agriculture, education, environment and forests, and water. Telangana, on the other hand, forms a state-level committee with representatives from the building and energy department, the transport department, affordable housing, schools, response units, emergency services, helplines and frontline workers such as ANM, ASHA and Anganwadi workers. Engaging these departments involves various responsibilities, from limiting working hours for labourers and MGNREGA workers to rescheduling school timings and restricting water usage. The Delhi HAP lists the name of the concerned authority, its activities and responsibilities, and clear phase-wise directions. The Telangana HAP also sets out department-wise action points. It also suggests both long-term and short-term mitigation measures for each department. Overall, the HAPs identify a central-level agency, such as the IMD, as responsible for timely forecasts and early warning to local governments and frontline workers.

Impact on health (illness-related information and hospital preparedness)

All the HAPs identify heat-related illnesses in detail, including rashes, heat cramps, dehydration, fatigue, mental distress, delirium and coma. Heatstroke is marked by a body temperature over 104°F and incoherent behaviour. According to a study in India, 5,157 males and 1,254 females died between 2011 and 2015, an average of more than 1,000 deaths per year across the country.⁷ Hospital readiness measures (which were similar across all the state and city action plans) include ready emergency wards, dedicated AC wards or beds for sunstroke victims, and stocks of ORS packets, IV fluids and ice packs. Capacity building is mandated for medical officers, nurses, paramedical staff and ASHA/ANM workers on rapid treatment protocols and on identifying early symptoms in communities. Surveillance includes the reporting of suspected cases and of daily heatstroke cases and deaths by hospitals. In Gujarat, the Integrated Disease Surveillance Programme (IDSP) tracks daily heat-

⁷ A. Kumar and D. P. Singh, “Heat Stroke-Related Deaths in India: An Analysis of Natural Causes of Deaths, Associated with the Regional Heatwave”, *Journal of Thermal Biology* 95 (2021): 102792, <https://doi.org/10.1016/j.jtherbio.2020.102792>.

related morbidity and mortality. In Odisha, hospitals are mandated to follow standard heat illness treatment protocols, stabilise patients before referral and activate Rapid Response Teams (RRTs). The Nagpur HAP recommends conducting extensive epidemiological studies and maintaining an open-source data bank on heat-related mortality and morbidity to refine response protocols.

The action plans also include some citizen-centric actions, such as taking precautions at peak heat times; keeping the body hydrated throughout the day with ORS and buttermilk; wearing lightweight and light-coloured clothes; keeping the home environment cooler by using curtains and shutters; training citizens about the symptoms of heat-related health conditions through pamphlets; and a list of Do's and Don'ts for the heatwave season.

Impact on economy and livelihood

According to the United Nations, India is projected to lose 5.8% of working hours by 2030 (equivalent to 34 million jobs), with potential national GDP losses reaching 4.5% due to extreme heat and humidity. Most of the HAPs discuss the sectoral impact of heatwaves on agriculture, livestock and labour productivity. Most of the HAPs state that heatwaves adversely affect agriculture in the form of crop loss, reduced yields and increased stress. The Tamil Nadu HAP estimates that yields will decline by 4–5%, alongside a decrease in the nutritive value of food crops. The Odisha HAP identifies crop loss due to flower drop and higher mortality in new plantations. Odisha also observes an adverse impact on rice production during the kharif season. In UP, rabi and zaid crops are particularly affected. Delhi and Nagpur report that heatwaves lead to reduced yields of wheat and jowar, with Nagpur experiencing a 21.8% reduction in wheat yield between 2017 and 2020. Animal husbandry is another sector that suffers direct losses due to extreme heat. The Tamil Nadu HAP identifies that heat stress causes dehydration, reduced fertility and mortality in poultry and cattle, leading to significant losses in milk, meat and egg yields, thus creating the need for cooling solutions for livestock. However, only three state HAPs (Tamil Nadu, Odisha and Telangana) have a dedicated section on livestock. Taken together, the impacts on agriculture and livestock pose potential threats to rural livelihoods.⁸

Lost labour from rising heat and humidity could result in a national GDP loss of up to 4.5% by 2030.⁹ The UP HAP estimates the total cost of heatwaves to the state's economy at ₹88,780 crore

⁸ Amita Bhaduri, "Food, Water and Livelihoods: How Extreme Heat Is Reshaping India's Agrifood System", *India Water Portal*, 19 June 2026, <https://www.indiawaterportal.org/agriculture/food-water-and-livelihoods-how-extreme-heat-is-reshaping-indias-agrifood-system>.

⁹ Delhi Disaster Management Authority, *Delhi Heat Action Plan 2024–25*.

(US\$1.1 billion). The UP and Telangana HAPs identify that gig, outdoor and informal workers face wage losses and reduced productivity owing to their inability to work during peak hours. The Odisha HAP estimates a loss of ₹700 for men and ₹600 for women casual labourers.

Some of the recommendations in the HAPs include shifting or restricting working hours. For example, the Bhubaneswar HAP strongly recommends restricting the working hours of labourers and construction workers during the hottest part of the day (11 a.m. to 3 p.m.). The Gujarat and Ahmedabad HAPs similarly suggest shifting working hours away from 1 p.m. to 3 p.m. for outdoor workers. The suggestions also include working from home, and cool roofs, which can enhance productivity for low-income families. In terms of financial support, the Government of Odisha provides ex gratia relief of ₹50,000 to the next of kin of confirmed heatstroke victims under the State Disaster Response Fund (SDRF). In May 2026, the Government of Telangana announced ex gratia relief of ₹4 lakh for deaths caused by heatstroke.¹⁰ Overall, therefore, the implications of heatwaves for livelihoods cut across agriculture, livestock and the informal economy.

Impact on ecosystem and the environment

Extreme heat can cause higher mortality among wildlife, birds and poultry. Extreme heat leads to decreased access to clean water and to food insecurity, placing stress on the ecosystem. Heatwaves also affect air quality. Extreme heat traps particulate matter and increases ground-level ozone accumulation. The city-level HAPs acknowledge the exacerbated impact of heatwaves owing to the urban heat island effect. City dwellers experience increased night-time temperatures. The Bhubaneswar HAP states that rapid urbanisation and an 89% decrease in dense vegetation have led to the city warming by about 1.8°C compared to surrounding areas. The suggestions include increasing ‘blue-green infrastructure’ in urban areas. Water resources are stressed, affecting both human settlements and wildlife. The Bhubaneswar HAP states that the city has seen a 2% decrease in surface water bodies due to heatwaves. Tamil Nadu has added a section on the impacts on mangroves – the altered biochemical processes and their impact on flora and fauna, the mangrove ecosystem and local livelihoods. The plan suggests long-term monitoring and mangrove restoration.

¹⁰ The Hindu Bureau, “16 Die of Heatstroke in Telangana, Government Announces ₹4 Lakh Ex Gratia”, *The Hindu*, 23 May 2026, <https://www.thehindu.com/news/national/telangana/sixteen-die-of-heatstroke-in-telangana-government-announces-4-lakh-ex-gratia/article71013963.ece>.

Cooling solutions and improvement of built environment

Cool roofs, increased vegetation cover and green infrastructure are some of the strategies that can build resilience against extreme heat. Some of the HAPs suggest that the adoption of cool roofs (using reflective paint or tiles) and green roofs can reduce indoor temperatures by up to 5°C. The Government of Tamil Nadu has launched a 'cool roof program' promoting solar reflective paints. Telangana also has a cool roof policy that aims for 300 sq. km of cool roofs within five to six years, using reflective paints or tiles that reduce indoor temperatures by 2–4°C. The cool roof policy has three pillars: first, a mandatory programme for government-owned buildings, municipalities and commercial buildings; second, a voluntary programme for residential and small buildings; and third, a vulnerable communities programme that aims to install cool roofs in low-income housing and slum areas. The HAP promotes reflective coatings (such as lime wash), white tiles (China mosaic), prefabricated membranes and traditional materials such as coconut husk (ModRoof). Building materials either trap more heat or release it. The HAPs promote the use of traditional materials such as mud walls, thatched roofs and red oxide flooring as adaptation measures, or the use of low-emissivity K-glass. Other urban architectural suggestions include higher ceilings for better ventilation, integrating the Energy Conservation Building Code (ECBC) and rainwater harvesting systems. The creation of 'sponge parks', 'green belts', vertical gardens and small parks with water fountains is also among the suggested strategies for urban areas. In public places, such as public buildings, bus stops, temples and parks, cooling centres and shaded areas can be added. The Government of Odisha has taken responsive action by introducing 'Jala Jogana Kendras' (water kiosks) and temporary sheds at bus stops and workplaces. Similarly, in Telangana, municipalities establish 'Chalivendrams' (drinking water stations) and activate 'cooling centres' in public buildings, malls and temples. The Delhi and Nagpur HAPs mention the distribution of cooling jackets and helmets to on-duty traffic police personnel as cooling solutions. Thus, the cooling solutions range from architectural changes to setting up local kiosks.

Early warning and communications

Most of the HAPs use the IMD forecast, in which a colour-coded system – White (Normal), Yellow (Hot Day), Orange (Severe Heat) and Red (Extreme Heat) – defines the level of response required. All the HAPs also have a list of Do's and Don'ts according to the respective colour code. The IMD issues regular city-level, district-level and sub-division-wise warning bulletins. Early warning

information is disseminated through SMS, the media, social media, WhatsApp and LED display boards in public places. In Gujarat, auto-rickshaw announcements are also used as communication channels in vulnerable areas such as slums. In Odisha, the ‘SATARK’ mobile and web application provides a checklist of Do’s and Don’ts in both Odia and English. SATARK is a web- and smartphone-based decision support system that helps to provide early warning information for different risks. It was developed by the Odisha State Disaster Management Authority (OSDMA) in collaboration with the Regional Integrated Multi-Hazard Early Warning System (RIMES). Hospitals, health professionals and educational centres are involved in awareness campaigns through announcements and the distribution of pamphlets in regional languages. Folk artists and folk media such as street plays are also included in local awareness campaigns.

Table 1: Comparison of the major state and city heat action plans

Name of the State/City HAP	Thematic Area	Initiatives
Delhi, Telangana, Tamil Nadu, Odisha	Identification of vulnerable groups	• Identification of ‘heat hotspots’ • Vulnerability mapping using satellite data and heatwave data • The Delhi HAP identified ‘heat hotspots’ where heat vulnerability overlaps with vulnerable groups
All the HAPs	Early warning	• All the HAPs use IMD-sourced, colour-coded early warning data • The Odisha HAP has a separate app named SATARK
Odisha, Telangana, Delhi and Nagpur	Citizen response – kiosks, jackets	• Odisha has ‘Jala Jogana Kendras’ • ‘Chalivendrams’ are established for the general public, pedestrians and travellers; cooling centres are also established in public places • The Delhi and Nagpur HAPs mention provisions for providing cooling jackets to the traffic police
Telangana and Tamil Nadu	Cool roof programme	• Telangana initiated a cool roof policy in 2023 to convert an area equivalent to 300 sq. km to cool roofs, making it mandatory for public buildings and voluntary for commercial and non-residential buildings within five to six years. Telangana built on the success of its pilot cool roof programme in 2017. • Tamil Nadu’s cool roof programme is aimed at schools and public buildings.

Name of the State/City HAP	Thematic Area	Initiatives
Telangana, Odisha and Ahmedabad	No. of deaths/hospitalisation	- The Telangana HAP sources data from the SDMA on the total number of deaths due to heatwaves for the period 2008 to 2023. The number of deaths ranged from 9 in 2012 to 541 in 2015. - Odisha reported 2,042 deaths in a deadly heatwave in 1998 - Ahmedabad recorded an additional 1,344 deaths during a deadly heatwave in May 2010 - The Tamil Nadu HAP mentions 12 heat-related deaths in 2023
Telangana	Ex gratia amount	- The Odisha government provides ex gratia relief of ₹50,000 to the kin or relatives of heatwave victims - The Telangana government has announced ex gratia relief of ₹4,00,000 per victim

One common feature across the HAPs is their phase-wise action plan. The HAPs divide their action plans into three major phases:

- i. Pre-heat season (January to March)
- ii. During heat season (April to June), and
- iii. Post-heat season (July to September)

Most of the HAPs follow a similar timeline.

Pre-heat season (January to March)

This phase focuses on policy formulation, institutional preparedness, baseline preparation and capacity building – essentially, preparing and strengthening institutional capacity before the heatwave arrives. Most of the HAPs, such as those of Telangana, Tamil Nadu, UP, MP, Delhi and Nagpur, identify vulnerability mapping as one of the first preparatory steps. They suggest identifying the most vulnerable areas and geographical hotspots. This can be done using satellite image data, past mortality data and socio-demographic data. This phase also involves capacity building of frontline workers and health workers, and hospital preparedness in terms of beds, ambulance availability, etc. The HAPs also suggest distributing multilingual IEC (Information, Education and Communication) materials, such as pamphlets and posters, to hospitals and schools during this phase.

During heat season (April to June)

This phase focuses on immediate relief, emergency communication and operational adjustments. Its aim is to reduce exposure and mortality. The IMD provides daily/weekly forecasts, and a colour-coded alert system (Yellow, Orange, Red) triggers specific departmental responses; most of the HAPs suggest following the IMD alerts. Schools and colleges reschedule timings to the morning and suspend outdoor physical activities. Time limits are also set for outdoor workers and public buses. Farmers are advised to keep their livestock in the shade during the peak hours of heat. Hospitals activate AC wards, dedicated beds, ORS and ice packs for heatstroke victims. Emergency contacts are also activated, and water kiosks are established in different localities. This phase also involves the regular surveillance of heat-related environmental conditions, illnesses and deaths.

Post-heat season (July to September)

This phase focuses on the evaluation of the previous phases and long-term planning for building future resilience. Departments involved in implementation are invited to a formal review to monitor progress over the previous two phases. Authorities evaluate the impact of cooling programmes such as cool roofs. Local and district governments review their teams' actions and implementation experiences. In UP, the state health department performs an epidemiological case review of heat-related mortality and morbidity based on average daily temperatures to identify risk factors. The HAPs also suggest promoting scientific research on the physiological responses of humans, animals and plants for future mitigation during this phase. Collaboration with institutions such as IIPH and MANAGE is already visible in the HAPs. The MP HAP suggests creating an open-source data bank on mortality, morbidity and weather to enable future research. Overall, findings and feedback from this phase are incorporated into future versions of the heat action plan. All key departments, such as health, education and municipalities, and other stakeholders participate in the evaluation of, and feedback on, the heat action plans. Some of the HAPs have long-term suggestions for restoring water resources and mangroves and increasing forest cover by blending these with existing policies and schemes. For example, Tamil Nadu aims to increase forest cover by 33% by 2030 under the Green Tamil Nadu Mission. Achieving this aim can also reduce the impact of heatwaves in the future. The Telangana HAP clearly divides department-wise tasks and responsibilities according to these three phases. In addition, the Telangana HAP lists short-term and long-term mitigation measures for heatwaves.

Discussion

A careful thematic analysis of the heat action plans shows that, although the major categories in the heat action plans are similar, there are some distinctive action points and initiatives among the different state and city action plans. For example, Tamil Nadu integrates heat awareness with its Government Pregnancy Scheme to provide financial and medical support for pregnant women. The action plan observes that adding heat risk as a key criterion in regular medical screening can be a simple intervention to improve care for pregnant women. The Tamil Nadu HAP also integrates the Green Tamil Nadu Mission to increase resilience. Tamil Nadu also has a Heat Action Network headed by the State Planning Commission. The network involves representatives from multiple departments, such as health and family welfare, school education, municipalities, animal husbandry, labour welfare and disaster management. It recognises that heatwave-related problems need multi-sectoral coordination. Similarly, Telangana flags its Apathbandhu Scheme, under which ex gratia relief is provided to family members of sunstroke victims. It provides for a three-member committee to certify deaths in order to speed up the compensation procedure. Odisha and Madhya Pradesh use village ‘health walls’ to paint heat-safety ‘Do’s and Don’ts’ in local languages for awareness.

Compared to the state action plans, the city action plans were more detailed and innovative. For example, Delhi uses anti-smog guns (ASGs) at construction sites and on high-rise buildings as part of its dust pollution and heat management strategy. Bhubaneswar mandates personal protective equipment, including caps and masks, specifically for its ‘Swachh Sathis’ (sanitation workers) during summer shifts. Bhubaneswar has constructed large temporary sheds (up to 60 feet long) at traffic squares specifically to protect two-wheeler riders and pedestrians from direct sun while they wait at signals. Nagpur has a long-term plan for phasing out coal mines and moving towards a just transition for workers. Ahmedabad pioneered the use of ‘ModRoof’, made from traditional coconut husk and paper waste. The Ahmedabad HAP also explored the creation of dedicated ice pack dispensaries to increase access to rapid cooling materials for vulnerable communities during red alerts.

Major Gaps and Conclusion

The WHO has recommended eight key components to be embedded in heat action plans:¹¹ establishing clear governance arrangements; timely action through heat alert systems; identifying and

¹¹ World Health Organization, “Planning Heat–Health Action”.

protecting populations at risk; clear and trusted heat-health communication strategies; building resilient health system; immediate and long-term protective measures to reduce exposure to heat; heat-health surveillance; and embedding monitoring, evaluation and review to improve accountability and better preparedness before the next heat season. The selected action plans cover most of these components, including the phase-wise action points. However, the review finds some gaps and areas for improvement. First, all the action plans missed the opportunity to include community engagement in heatwave preparedness, response and planning. Studies suggest that community engagement is important for the implementation of effective early warning systems, spreading awareness and long-term collective action on heat mitigation.¹² The Delhi HAP mentions collaboration with NGOs and other civil society organisations in a scattered manner. Second, detailed responsibilities for each line department are absent. Time-specific action points for the authorities are not covered in all the action plans. Third, the identification of vulnerable groups is visible only in the Delhi HAP. Other HAPs need not only to identify the areas with higher heatwave exposure but also to overlay heatwave-vulnerable areas with the populations at higher risk. Fourth, the HAPs rely on IMD bulletins for early warning information and do not use local resources. Except for Odisha, no other state mentions developing a separate application for heatwave alerts, although all the HAPs mention disseminating early warning information through SMS, the media and social media. Fifth, all the HAPs mention the need for monitoring and future research. This requires collaboration with research institutes, the allocation of funds, an open-source data repository and a strong monitoring mechanism. However, at present there is no such initiative from the central or state governments. At the national level, data on heat-related mortality are stored on the Integrated Health Information Platform under the National Programme on Climate Change and Human Health (NPCCHH) of the Ministry of Health and Family Welfare, but these data are not open-source. Sixth, urban spaces need long-term planning for cool infrastructure and climate-resilient cities. Lastly, HAPs should ensure the legal enforceability of restricted working hours and of enabling working conditions for outdoor workers.

¹² P. Berry and G. R. A. Richardson, "Approaches for Building Community Resilience to Extreme Heat", in *Extreme Weather and Society* (2016), 351–88, https://doi.org/10.1007/978-3-319-30626-1_15; M. Guardaro, D. M. Hondula, and C. L. Redman, "Social Capital: Improving Community Capacity to Respond to Urban Heat", *Local Environment* 27, no. 9 (2022): 1133–50, <https://doi.org/10.1080/13549839.2022.2103654>.

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