Title:
Unpacking Heat Action Plans in 8 Indian Cities: Knowledge Gaps and Opportunities for Intersectoral Heat Governance

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Abstract: Extreme heat in cities poses significant health risks, amplified by urban heat island effects and disproportionately impact vulnerable populations. Anthropogenic climate change has led to heatwaves in India increasing in frequency and duration. To address growing heat intensities and their health impacts, heat action plans (HAPs) have emerged as a key planning instrument for heat governance. This paper uses a benchmarking approach to conduct an assessment of 8 city level HAPs from India in terms of the eight core elements identified by WHO/Europe as crucial components to heat-health action. We have mapped the representation of core elements across the city-level HAPs to determine the plan's coverage and extent of development of each element and its sub-elements. The text in the documents corresponding to the core elements was also analysed.. The HAPs varied in design and scope, with core elements that require long-term institutional and/or intersectoral planning and implementation receiving least attention. These elements included care for vulnerable populations, health system preparedness, long-term urban planning, and surveillance of health outcomes. The study identifies the dominant framing of the issue of heat as a time-limited disaster event (namely ,a heatwave) as a significant barrier in designing HAPs that are responsive to local contexts and presents long-term measures required to shape structural drivers of differential vulnerabilities. In conclusion, a paradigm shift from solely top-down disaster management to coupling with decentralised, community-informed management, is essential to effectively address heat-related health risks in both the immediate and the long-term.

Introduction

Anthropogenic climate change has elevated extreme heat from an 'invisible' public health threat to an urgent challenge disproportionately affecting warmer and poorer regions of the planet (Dasgupta et al., 2024; Gasparrini et al, 2017). Between 2001 and 2013, the population of India exposed to extremely hot temperatures rose by 10 million (Fu et al., 2018). From 1951 onwards, successive hot days (henceforth referred to as heatwaves[1]) have increased in frequency and duration (Singh et al., 2021). The year 2024 experienced India's longest and most intense heatwave year, with June in the northwestern region experiencing an all-time high of 181 heatwave days (Press Trust of India, 2024). Rapid urbanisation has led to hotter cities, amplified by the urban heat island effect. Zhao et al (2021) estimate that cities could warm by 4 degrees Celsius on average by 2100, posing significant health challenges for populations living within dense urban networks. It is well-established that both hot temperatures and heatwaves are associated with excess mortality risk (de Bont et al., 2021; Zhao et al., 2021). Beyond fatalities, extreme heat is also linked to the disruption of the everyday and the ordinary: school closures (Agence France-Presse, 2024), livelihood loss (Ghosh, 2024), water

[1] A heatwave is usually defined as "a period of extreme high temperature that lasts several days" (Gosling et al., 2014), which may occur with high humidity (de Bont et al., 2024). There is no internationally accepted definition of heatwaves. Definitions vary based on how a heatwave is identified and what indicators are used to measure its various dimensions (Xu et al., 2016).

shortages (Dayal et al., 2024), power outages (Dhillon, 2024) and food insecurity (Kroeger, 2023). These impacts on lives and livelihoods are further shaped by one's ability to respond to heat – a relationship mediated by an individual's social, cultural, economic, and physiological status (Hamstead & Coseo, 2020). To address these extreme heat impacts and their differential impact on vulnerable groups, heat action plans (HAPs) have emerged as the dominant planning instrument for heat governance in the Indian urban context.

The historical development of HAPs can be traced back to the early 2000s. Extreme heat events (EHEs) in Europe and North America, particularly the 2003 summer heatwave, created heat-health response plans from a public health perspective. Under the coordination of the World Health Organisation Regional Office for Europe (WHO/Europe), the EURO-HEAT Project (2005-2007) led to the publication of a guidance document on the development of Heat-Health Action Plans (HHAPs) for member states. The guidance formed a blueprint for the design of national and sub-national HAPs, with the key aim being the reduction of negative impacts of extreme heat (Kotharkar & Ghosh, 2022). The eight 'core elements' of a comprehensive HHAP identified by WHO/Europe include: agreement on a lead body for coordination, accurate and timely alert systems, heat-related health information plan, reduction in indoor heat exposure, particular care for vulnerable population groups, preparedness of the health and social care system, long-term urban planning, and real-time surveillance and evaluation (WHO, 2021). Existing HAPs/HHAPs differ based on how each core element has been incorporated, the associated scope and the complexity of its implementation (Martinez et al., 2022).

Similarly in India, a deadly heatwave in Odisha in 1998 led to the development of the first state-level heat response plan the next year (Orissa State Disaster Management Authority, 2020). In the decade following the release of the WHO/Europe guidance document, HAPs began to be launched in the country, starting with the city-level Ahmedabad Heat Action Plan in 2013 (Ahmedabad Municipal Corporation, 2019). Several municipal corporations and state governments have either received funding support or developed HAPs with external technical support from domestic and international organisations and experts[2]. These organisations and experts include academic institutions, international agencies such as UNICEF, and policy consultants. The HAPs vary in terms of design and scope. In an analysis of 37 HAPs, Pillai and Dalal (2023) found significant variations in the actions recommended to be carried out in response to heatwaves, ranging from health systems capacity-building to green roofs.

Considering growing heat intensities in urban centres (such as cities), the HAPs present a crucial opportunity to address thermal inequities stemming from the complex heat-health linkages. Several Indian cities have developed HAPs.

Objective:

This paper has assessed HAPs in their coverage of the eight core elements identified by WHO/Europe as crucial components to heat-health action. While previous studies have examined descriptive details of HAPs, the current study provides unique insights into how Indian city-level HAPs incorporate components deemed essential for comprehensive heat-health action planning, identifying gaps and opportunities for HAP planning and implementation.

[2] For example, Ahmedabad's 2013 HAP was developed in collaboration with the Indian Institute of Public Health (IIPH) Gandhinagar, 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. The Bhubaneswar HAP launched in 2016 was prepared by Integrated Research and Action for Development (IRADe) and supported by the International Development Research Centre, Government of Canada. The 2019 Rajasthan HAP was developed in collaborating with UNICEF Rajasthan's Disaster Risk Reduction Section (Magotra et al., 2021).

Methods

Approach

This study has assessed 8 city-level HAPs in India using a benchmarking approach based on the eight core elements of heat-health action planning identified in WHO/Europe's guidance document for heat-health action planning. It mapped the representation of core elements across the city-level HAPs to determine the plan's comprehensiveness and extent of development of each element and their sub-elements. The document text corresponding to the core elements is also analysed.

Online accessible HAPs were retrieved using a desktop search-engine based search strategy (using Google Search Engine) along with reviewing previous studies and grey literature regarding HAP development in India (e.g. National Disaster Management Authority [NDMA] website). HAPs in India are challenging to access since a national repository is yet to be developed. It is unclear how many HAPs have been developed in India and whether these HAPs are being updated regularly (Pillai and Dalal, 2023). A city-level HAP met the inclusion criteria when it was titled as a 'heat action plan', 'heatwave action plan' or specifically mentioned in the title page that it addresses extreme heat or heatwave response planning. Alongside, it was required that the HAP was an official government policy document released with approval for implementation. Lastly, the study examined HAPs released after the publication of the guidance document for the preparation of HAPs by the National Disaster Management Authority (NDMA) in 2016 to assess its influence on the action plans drafted.

Data

Out of 10 city-level HAPs identified, eight HAPs could be fully accessed in the public domain at the time of the analysis. Two HAPs – for Gondia and Chandrapur – could not be located. The issuing authority and partners of the city-level HAPs that were analysed in this study are as follows:

1. Ahmedabad Heat Action Plan (2019 Update):
2. Heat Wave Action Plan Bhubaneswar City 2020: Bhubaneswar Municipal Corporation and Orissa State Disaster Management Authority (issuing authorities); prepared by Integrated Research and Action for Development; supported by the International Development Research Centre, Government of Canada (IDRC)
3. Delhi Heat Action Plan 2024-25: Delhi Disaster Management Authority (issuing authority)
4. Jodhpur Heat Action Plan 2023: Jodhpur Nagar Nigam North (issuing authority); NRDC (Natural Resources Defense Council) – India and Mahila Housing Trust (MHT) (partners)
5. Heat Wave Action Plan Rajkot City 2024: Rajkot Municipal Corporation (issuing authority); prepared by Integrated Research and Action for Development and Indian Institute of Public Health, Gandhinagar; supported by the International Development Research Centre, Government of Canada (IDRC)
6. Surat Heat Wave Action Plan 2018: Surat Municipal Corporation (issuing authority); supported by Gujarat State Disaster Management Authority and Resilience Strata Research and Action Forum
7. Heat Action Plan for Thane City 2024: Thane Municipal Corporation (issuing authority); prepared by Council on Energy, Environment and Water; in partnership with Majhi Vasundhara Abhiyan, Mission LiFE (Lifestyle for Environment)
8. Heat Wave Action Plan 2024 (Vadodara): Vadodara Municipal Corporation and Gujarat State Disaster Management Authority (issuing authorities)

Analytical Framework

A previous study by Bittner et al (2014) identified sub-elements linked to the eight core elements of HAPs as developed by the WHO/EC EuroHEAT project. Table 1 provides an overview of the core elements and their subelements. Bittner et al.'s (2014) analysis of European HAPs emerged a decade after the release of the first national-level plan for heatwaves in 2005 with Belgium's heatwave plan. The indicator-based approach used in their study examined both the comprehensiveness of the HAP and the extent of its development at the national level. In the present case, doing a similar study would be premature, seeing as five out of the eight plans were formulated within the past year. The

analysis, therefore, is focused on the content of the plans. Furthermore, the primary objective is not a comparative assessment or ranking between cities but rather identifying the critical gaps within the existing plans.

Table 1 Core elements and their sub-elements used to assess HAPs (adapted from Bittner et al., 2014)

Core element	**Sub-elements**
1. Agreement on a lead body and clear definition of actors' responsibilities	Clearly defined lead body
	Governance structure
	Involvement of >1 other agencies
	Regular meetings and/or reviews
	Inclusion in disaster preparedness*
	Synchronicity with district and state-level plans*
2. Accurate and timely alert systems	Threshold definition scientifically sound
	Regionally adapted definitions
	Warning is issued well in advance
	Different alert levels for different levels of action
	Alert is communicated following a clear plan
3. Health information plan	Clearly defined actors/recipients/contents
	Effective dissemination of information (>1 channel)
	Quality of advice
	Public & professionals addressed
	Appropriate timing of information campaign
4. Reduction in indoor heat exposure	Giving advice
	Providing cool rooms/spaces
	Provision or use of mobile coolers
	Planning or support for increased albedo or shading
	Planning or support for better insulation
5. Particular care for vulnerable groups	Identification of relevant groups (>1)
	Activation of a telephone service

	Specific measures (buddies, neighbours …)
	Regular re-assessment of vulnerable population groups
	Information and training for caregivers
6. Preparedness of the health/social care system	Increase of capacity of health services
	Heat reduction in healthcare facilities
	Special precautions in nursing homes
	Special resources for patients/public
	Improving health-care networks
7. Long-term urban planning	Increased green & blue spaces
	Changes in building design (albedo, insulation, passive cooling)
	Changes in land-use decisions
	Energy consumption reduction
	Changes in water supply management**
	Individual and public transport policies
8. Real-time surveillance	Less than 48-h interval
	Involving data from >1 ward*
	Involving data from >1 health effect
	Use for adjustment of measures
	Use for evaluation of effectiveness

*Modified sub-elements; **newly included sub-element.

An iterative protocol was developed to review the HAPs. The retrieved HAPs were initially reviewed to build familiarity with their structure and content. Based on this review, modifications were made for certain sub-elements to reflect the specific city-level context of the retrieved HAPs. This is because the sub-elements were originally intended for national-level plans. Accordingly, the sub-element 'inclusion in national disaster preparedness' was changed to 'inclusion in disaster preparedness,' 'cross-border cooperations' was changed to 'synchronicity with district- and state-level plans' and 'involving data from >1 region/city' was changed to 'involving data from >1 ward' (Table 1). Further, the sub-element 'changes to water supply management' was added to the core element 'long-term urban planning' to include a component relating to heat-wave-linked water supply issues.

The researchers adopted a consensus-based approach, which involved an unanimous decision-making process in which 4 members in the research team reviewed the HAPs independently and iteratively discussed their ideas until all members agreed on the best representation of the data. The team members collaborated on the principle of "mutual respect, equal involvement, and shared power" (Hill et al., 1997, p. 523; cited in Hill & Knox, 2021, p. 10) and triangulated multiple perspectives of the interdisciplinary team members.

A data extraction form was developed to input the representativeness of core elements and their sub-elements in the HAPs. A colour-based labelling system (Table 2) was finalised after two rounds of HAP reviews. In each round, two researchers independently reviewed the HAPs and noted the sub-elements' representation (or lack thereof) before meeting to build consensus for the labelling criteria. The final review was conducted once consensus was reached, and both the labelling system and consensus criteria were finalised. This review was performed by one researcher and verified by another researcher. In parallel, discussions with the larger research team were regularly conducted to share inputs and feedback.

The researchers drew upon a combination of careful reading of the documents as well as enumeration of relevant keywords with text-analysis (Silge and Robinson 2017) and searching through the PDFs for keywords to see the context of use of those keywords in sentences and paragraphs in the document to aid their judgment and improve the verification process.

Table 2: Colour-based labelling system developed to identify representation of sub-elements in retrieved HAPs.

Colour	Label
	No mention
	Mention without actionable details and/or guidance for implementation
	Mention with actionable details and/or guidance for implementation

Results

Eight HAPs released between 2018 and 2024 were analysed. Table 1 provides an overview of the coverage of the sub-elements across the HAPs.

It should be noted that when interpreting the results, the coverage of the core elements does not shed light on the quality or extent of coverage. For example, in 'long-term urban planning', the HAP could include guidance for increasing green spaces, while another HAP could include guidance for increasing both green *and* blue spaces. However, both are marked green in the benchmarking exercise for the sub-element 'increasing green and blue spaces.' For similar reasons, the benchmarking exercise does not reveal any details regarding the status and extent of implementation of any of the sub-elements. It only sheds light on the comprehensiveness of the HAP document itself.

Amongst the 8 HAPs (Figure 1), Thane has the highest coverage of sub-elements (38 out of 42), followed by Bhubaneswar (37) and Delhi (37). Vadodara has the least number of sub-elements mentioned in the HAP (17 out of 42), followed by a considerable gap with Surat (28). The Thane HAP also has the least number of sub-elements labelled 'orange.' That is, where mentioned, the sub-elements are accompanied by actionable details or guidance, suggesting the HAP to be particularly successful in accompanying policy objectives with the required guidance.

The element 'health information plan' has the best coverage amongst all the core elements in the HAPs, followed by 'agreement on a lead body' and 'accurate and timely alert systems.'. The core elements that require identifying and addressing long-term and/or contextual factors (such as 'particular care for vulnerable groups', 'real-time surveillance' and 'long-term urban planning') are least represented in the HAPs. The core element with the least number of orange labels is 'reducing indoor heat exposure.' The Thane HAP was the only one to include a framework for monitoring and evaluation.

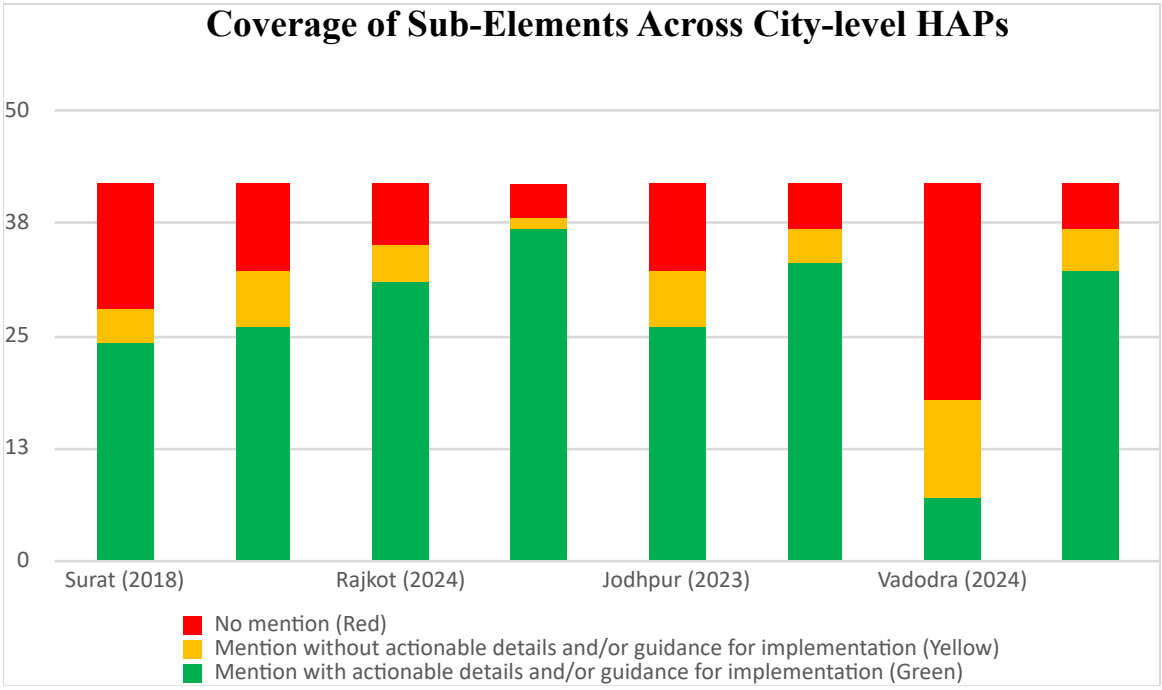

Figure 1: Overview of sub-elements across the eight city-level HAPs.

As mentioned above, simple text analysis was also used as a tool for checking our analysis. Text analysis can provide an enumeration of what words/keywords were used in a document (after, as is

common in text analysis, removing words such as of, the, and numbers etc.). Figure 2 shows the top 10 words used in each of the 8 HAPs.

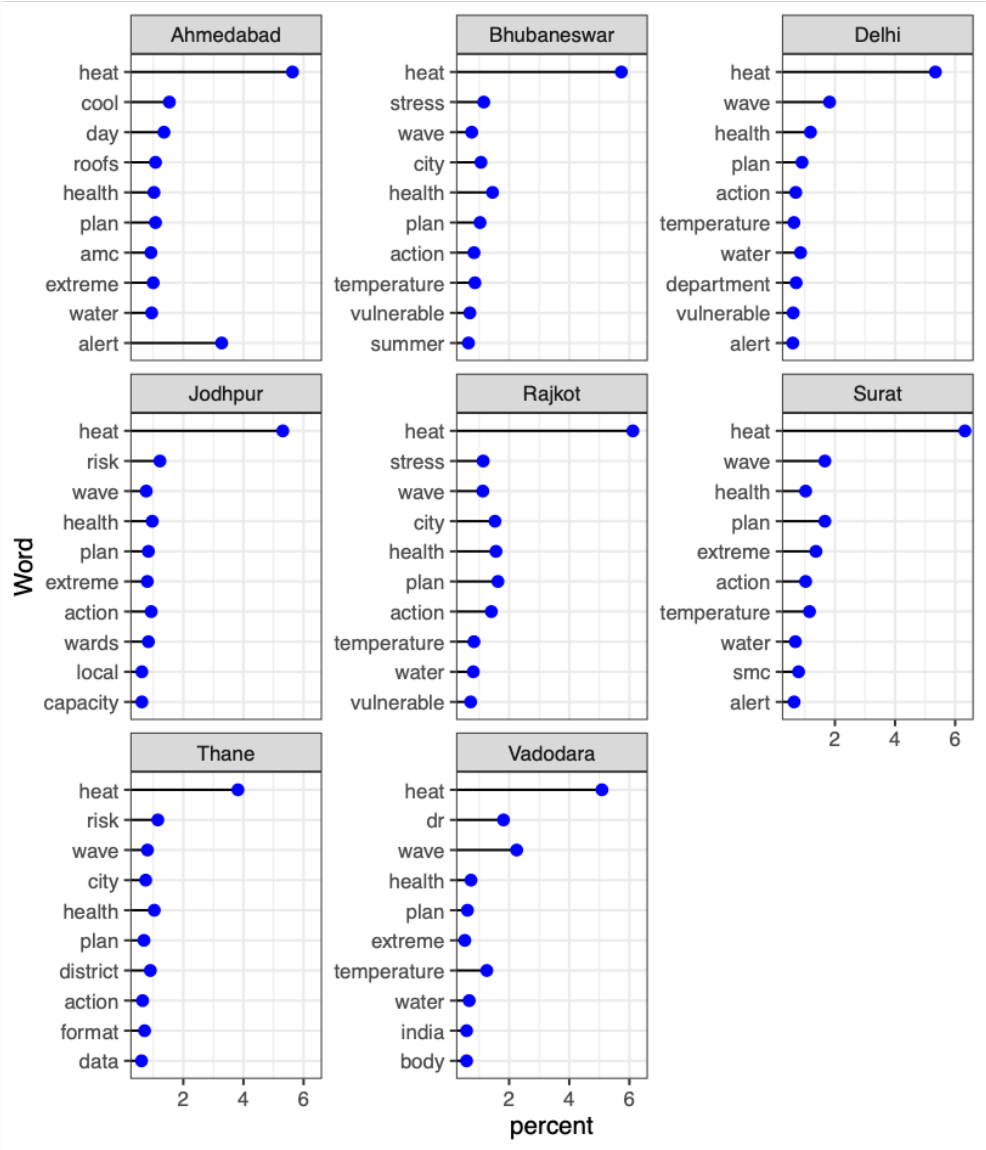

Figure 2: Ten most frequently used words in each HAP, as a per cent of the words in each HAP.

'Heat' is the most used word in each HAP . 'Wave' is among the next most used, along with 'risk' and 'stress'. 'Health' is either the fourth or fifth most used word in the heat action plans. The Ahmedabad HAP uses 'cool' and 'roofs' because that HAP emphasises cool roofs as an adaptation measure. We also find 'water' mentioned frequently in the HAPs. The Vadodara HAP has 'Dr.' because there is a list of doctors provided in the main text of the HAP. In the Ahmedabad and the Surat HAPs, there is frequent use of 'AMC' and 'SMC', which are acronyms for their respective municipal corporations. The Thane HAP has data mentioned frequently. Similar graphs were made for each theme with appropriate keywords, as a tool to check the analyses.

The findings are discussed in details below.

Agreement on a lead body and clear definition of actors' responsibilities

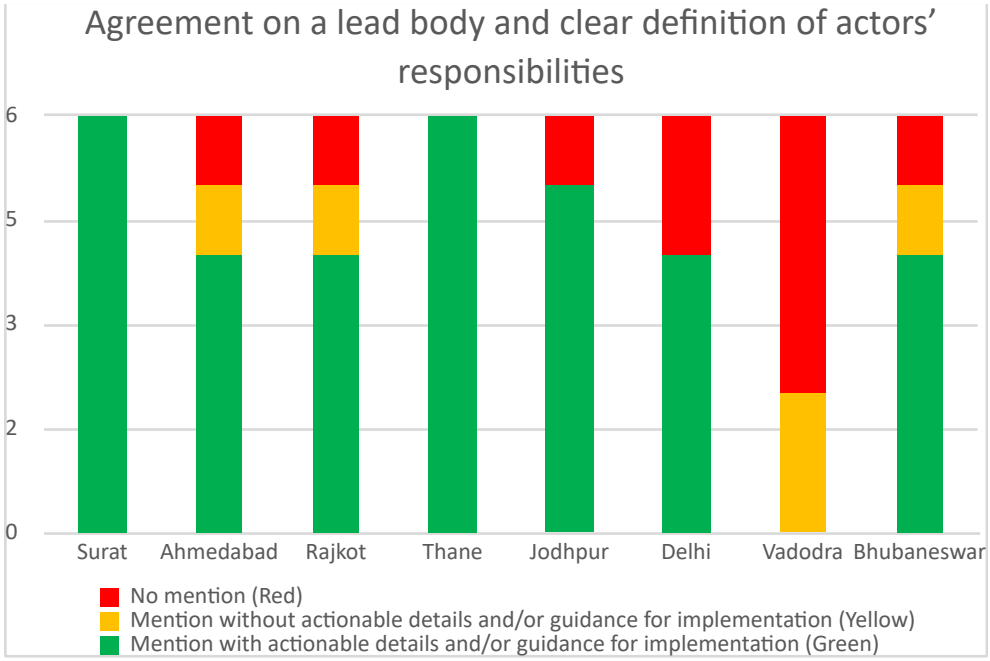

Figure 3: Coverage of 'Agreement on a lead body and clear definition of actors' responsibilities' across city HAPs

The keyword text analysis shows that all the HAPs except Ahmedabad mentioned 'NDMA'. Ahmedabad does mention GSDMA in a flow chart. 'IMD', 'department', 'nodal' etc. are mentioned in the HAPs.

The Delhi and Vadodara HAPs carry no mention of the lead body. However, the Delhi HAP identified relevant actors and assigned responsibilities with their roles. Certain HAPs mandated the establishment of heatwave committees for carrying out the implementation of the HAPs (for example, the Heatwave Task Force in Thane Municipal Corporation, Heatwave Plan Implementation Committee in Jodhpur, and Steering Committee for medical emergency preparedness in Bhubaneswar HAP). Only two HAPs linked city-level HAP action with district- and state-level institutional mechanisms and plans.

The WHO heat-health guidance plan provides country-level guidance. However, guidance documents in India are available at multiple levels: country, state, district and/or city. We are analysing city action plans and in the WHO's framing, this is a primarily a health responsibility. In India, the authority and responsibility at the national level is vested with the NDMA, under the Ministry of Home Affairs, and not with the Ministry of Health and Family Welfare. Further, the HAPs are largely concerned with implementation. Implementation was planned in a phase-wise (pre-, during and post-heat season) manner and specific responsibilities were attached to any given role with each phase. Therefore, governance of heatwaves is primarily framed as a disaster, with an 'event' based formulation, and centred around the heat season,.

Accurate and timely alert systems

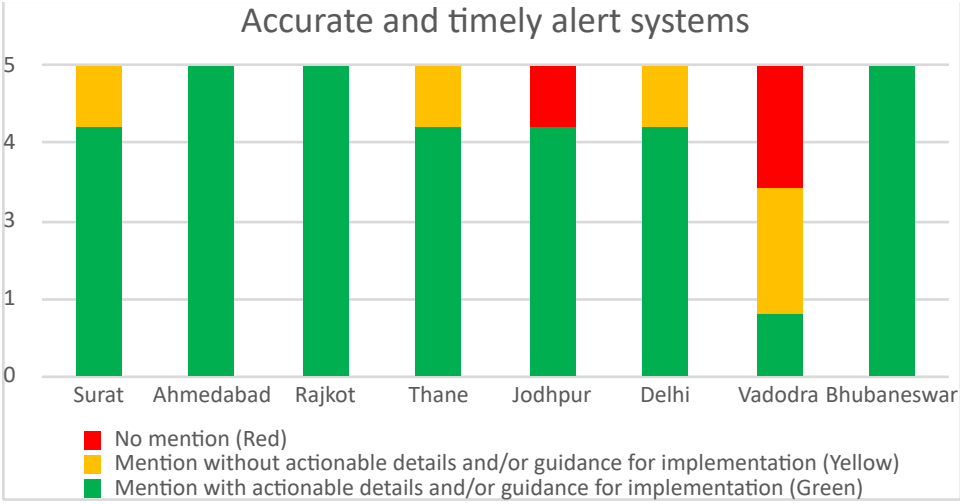

Figure 4: Coverage of 'Accurate and timely alert systems' across city HAPs

All HAPs used India Meteorological Department (IMD) definitions for heatwaves, with only two lacking a regionally adapted definition. The Thane HAP is the only HAP with locally determined heat thresholds based on maximum temperatures and relative humidity.

While most HAPs (62.5%, or five out of eight) carried out different levels of actions for different levels of alerts, Ahmedabad was the only HAP that delineated action linked to each alert level.

Health information plans

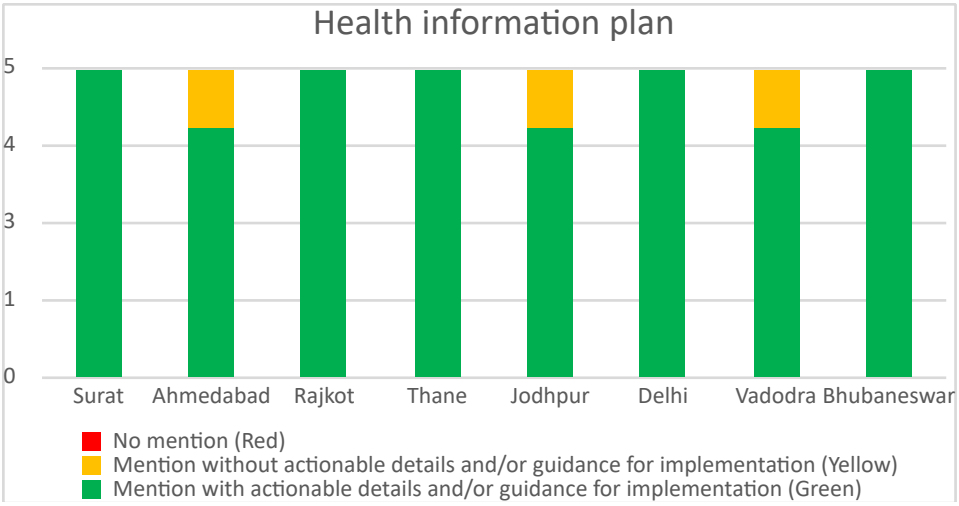

Figure 5: Coverage of 'Health information plan' across city HAPs

'Health information plans' was the best-represented core element, with all sub-elements being mentioned in every HAP. However, information was geared towards the public and medical professionals, largely. There is a noticeable absence of health information tailored for specific populations such as children and other vulnerable populations. The source or scientific validity of health information can be called into question as the source of health information was often unavailable in HAPs.

Reduction in indoor heat exposure

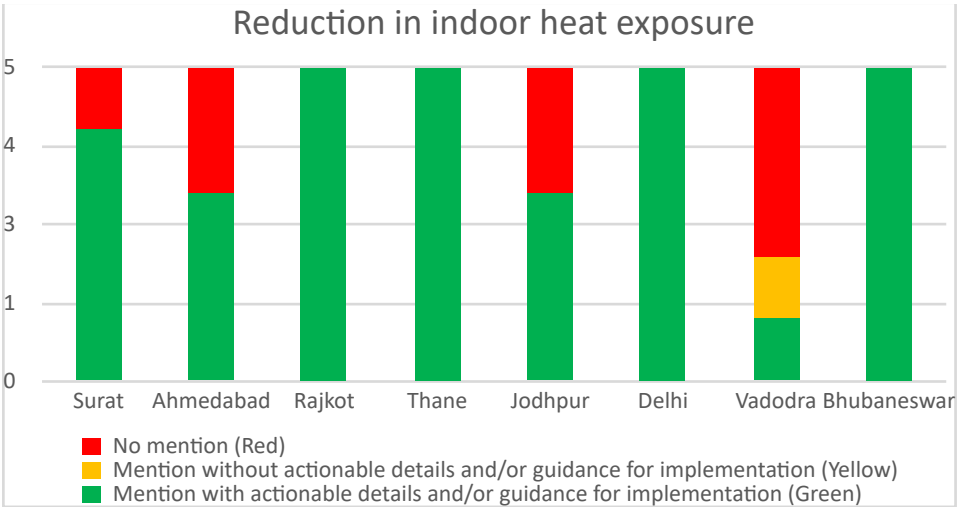

Figure 6: Coverage of 'Reduction in indoor heat exposure' across city HAPs

Improved albedo/shading found more mention than plans for improved insulation. Further, increasing shading carried more mention than increasing albedo. Specific programmes for cool roofs using white reflective paint were included, whereas similar planning for shading was absent. The text analysis revealed that 'cool' and 'roofs' were very frequently used in the Ahmedabad HAP.

Since all the HAPs mention fans or coolers (text analysis), none can be labelled red for the sub-theme provision or use of cooling equipment. Jodhpur does not mention fans but mentions coolers (which work well in Jodhpur).

Regarding the provision of cooling equipment, the only relevant detail in the HAPs was advice to "use fans," suggesting that HAPs carry a gap in addressing the growing use of air conditioners in India and their impacts.

The Rajkot HAP is the only one to discuss indoor heat-health risks addresses and in specific, indoor heat exposure and intimate partner violence. Audience and content were largely limited to health information for the public (such as 'limit heavy work indoors'). There is a lack of specific advice for indoor heat exposure for city planners, medical practitioners, the public, vulnerable populations, and other stakeholders.

Caring for vulnerable groups

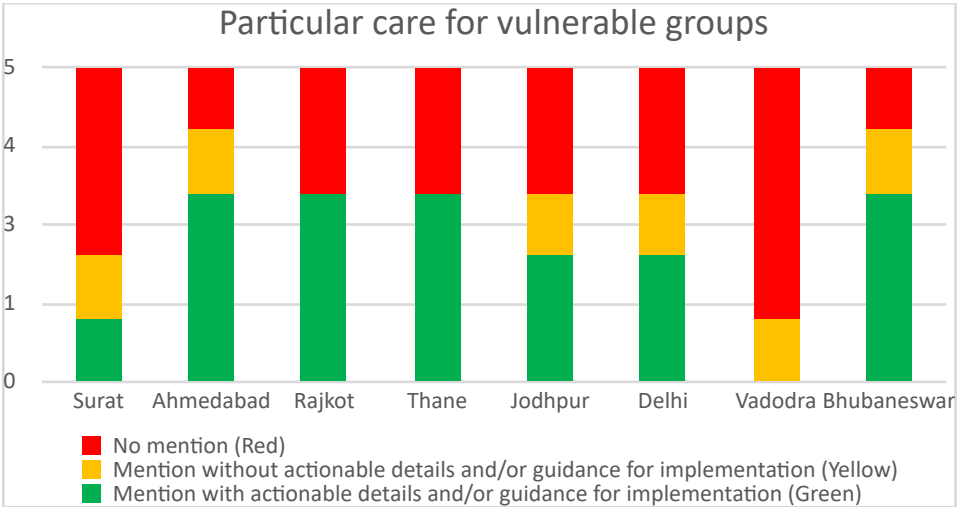

Figure 7: Coverage of 'Particular care for vulnerable groups' across city HAPs

Identification of vulnerabilities and vulnerable communities is a key pre-requisite for public health interventions. Further, as the needs of vulnerable groups evolve over time, regular re-assessments are required alongside ongoing monitoring for active responses All HAPs lacked mention of periodic assessment of vulnerable populations and training for caregivers. The HAPs have not built in methodologies to identify vulnerable groups, and only half of the HAPs provided information regarding why particular groups are made vulnerable to heat-health risks. However, some HAPs conducted vulnerability assessments to identify vulnerable city wards, such as the Thane and the Bhubaneswar HAPs. As for specific measures for vulnerable groups, interventions were largely limited to advice to check in on vulnerable neighbours and expand shaded areas.

With 'women' as a term, the benchmarking exercise showed that the proportion of the term in the text analysis is not compatible with gender-sensitive policy recommendations. For instance, the Rajkot HAP has the term 'women' in higher proportion as compared to the other search terms;

Box 1: Gender-sensitive aspects : The case of Bhubaneswar HAP

The Bhubaneswar HAP is a notable exception with respect to actionable guidance linked to gender-based vulnerability. It recommends creating and implementing gender-specific heat health guidelines by adopting gender-specific heat-focused examination procedures at local hospitals and increasing gender-sensitive outreach in slum settlements. Planned activities are presented across pre-heat, during heat and post-heat seasons. In the pre-heat season, the plan recommends workshops for link and frontline workers to support gender-sensitive outreach and community surveillance. During the heat season, the planned activities include gender-sensitive medical examinations at local hospitals and urban health centres, involving health workers such as ASHAs and Anganwadi workers. The plan also calls for adapting pharmacological treatments with 'gender aspects'.In the post-heat season it advises reporting of gender-based surveillance data for evaluation and informed decision-making.

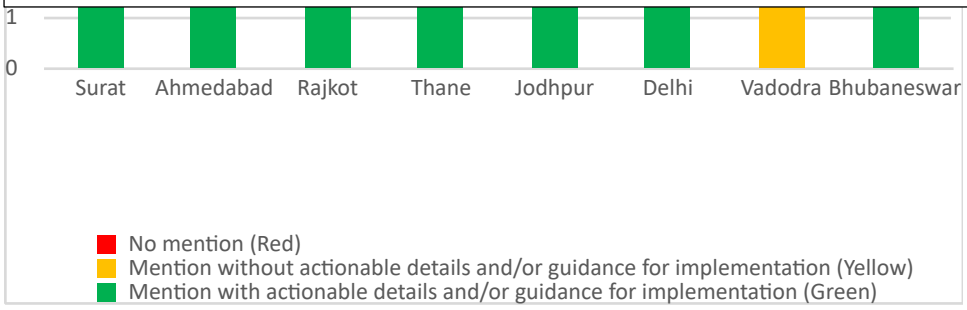

Figure 8: Coverage of 'Preparedness of the health/social care system' across city HAPs

Only two HAPs each carry mention of 'heat reduction in health facilities' and 'special precautions in nursing homes.' The interventions of heat reduction include the opening of AC wards in the Delhi HAP and the setting up of 'cool wards' in the Bhubaneswar HAP. For special precautions in healthcare institutions, the interventions recommended include provision of drinking water in the Ahmedabad HAP and organising workshops for staff members as part of capacity-building activities in the Rajkot HAP. The other three sub-elements ('increase in capacity of health services, 'special resources for people/public' and 'improving healthcare networks') are better represented in the HAPs, albeit with heterogeneity in terms of the actions covered under them.

Long-term urban planning

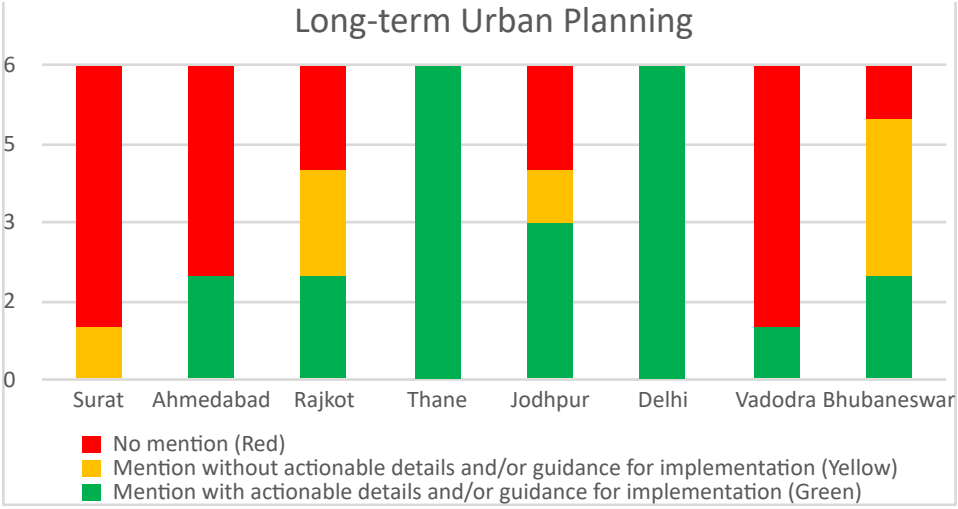

Figure 9: Coverage of 'Long-term Urban Planning' across city HAPs

Long-term measures are poorly represented in the HAPs. While 'increase in green and blue spaces' and 'changes in building design' are covered in most HAPs, interventions that require more complex decision-making by public authorities and that are shaped more explicitly by political factors (such as 'changes in land-use decisions') are less represented.

Real-time surveillance

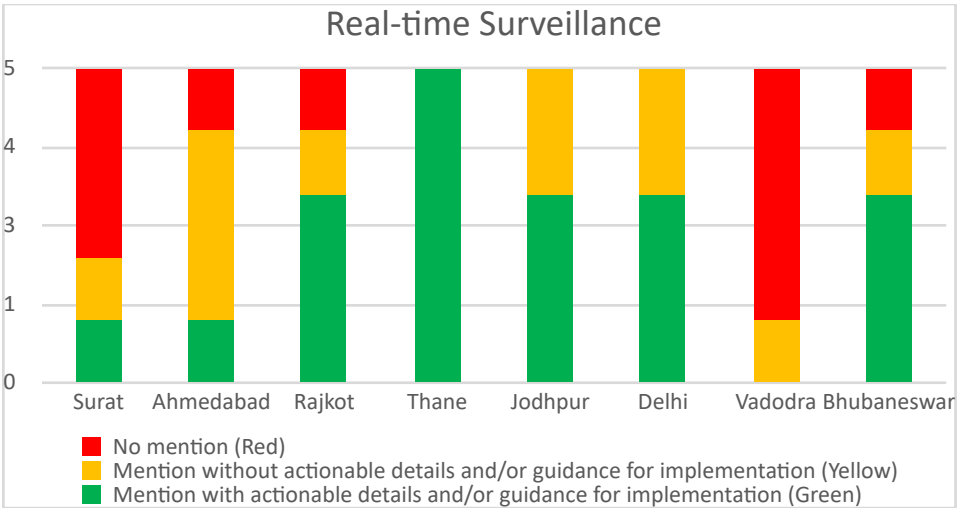

Figure 10: Coverage of 'Real-time Surveillance' across city HAPs

Near-real-time surveillance of health outcome data has been identified as a core element by the WHO (WHO Regional Office for Europe, 2021). Surveillance data is required for the monitoring of health impacts of heatwaves and to inform decision-makers in evaluating and selecting HAP measures. While six HAPs carried the component of surveillance, the use of surveillance data in the adjustment of measures was only mentioned in three HAPs, and there was no accompanying guidance. All HAPs mentioned the use of surveillance data for the evaluation of the effectiveness of the HAP, but only the Thane HAP provided a monitoring and evaluation framework to carry out evaluation activities on an annual basis.

Discussion

This analysis of eight Indian city-level HAPs has unpacked the eight core elements and sub elements of HAPs as developed by the WHO/EC EuroHEAT project (WHO, 2021) in.

'Agreement on a lead body', 'health information plans', 'accurate and timely alert systems' and 'reduction in indoor heat exposure' find greater emphasis in the HAPs than core elements that require long-term institutional or intersectoral planning and implementation such as 'particular care for vulnerable groups', 'preparedness of health/social care system', 'long-term urban planning' and 'real-time surveillance'.

Key to understanding the challenge in addressing long-term adaptation and mitigation of extreme heat are the specific characteristics of extreme heat. In discussing heat as a hazard, Stone (2020) argues that heat has distinct characteristics that set it apart from other extreme weather phenomena. Firstly, heat is invisible. A hazard is made visible to us through instrumentation and the movement/displacement of material objects including damage to life and property. Surface and air measures used to "sense temperature in most cities are extraordinarily sparse or imprecise, obscuring ways in which the built environment produces microclimates over small distances" (Hamstead & Coseo, 2020; p 4). Property damage due to heat is visible in extreme cases but other impacts, such as heat stress, are sensitive to seemingly small changes in temperature and rely on the subjective experiences of thermal comfort. Secondly, urban centres (cities) experience greater heat intensity. Lastly, heat is not an episodic hazard – like flooding or hurricanes – with immediate destructiveness. Unlike wind, water and earth movements that cause physical damage, "... heat impacts people first, with more minor impacts on property" (Hamstead & Coseo, 2020). The conceptualisation of extreme heat as a time-limited or acute disaster can thus limit the scope of planning for heatwaves and addressing social vulnerability. Unlike air pollution in India that has a four-level Graded Response Action Plan (GRAP) system there is no legal sanction to carry out the guidelines in the case of heatwaves.

These HAPs recognise the role of social vulnerability in adapting to heat but were unable to translate these to developing specific strategies to reduce vulnerability. Pillai and Dalal (2023) have critiqued that most solutions are at the individual level and do not address the structural drivers of differential vulnerability and the intersections between social determinants of health. The magnitude of heat is frequently characterised as the primary public health threat but explanations using solely objective heat measures, such as dew point temperature, relative humidity or heat index, fail to explain and map differential impacts of heat (Hamstead, 2023). As an illustration, all older individuals are not equally impacted by heat. Examining the role of socio-economic status, age, caste, and gender in shaping heat-health relationships in older individuals not only acknowledges the differential impact of extreme heat, but also allows for the development of targeted strategies that are more relevant to the impacted groups.

An important consideration is the concept of equity that allows an understanding of heat-health vulnerabilities from a holistic framework, integrating individual-level heat-health impacts with the social and political structures within which these impacts are manifested. . The integration of equity can be improved upon in the development and implementation processes of HAPs in India. How one understands and studies heat will shape how causal pathways are defined and which solutions are presented as feasible. While previous reviews of HAPs in India have examined HAP designs and interventions, reviews are yet to explore the ontological and epistemological assumptions made regarding heat and how they shape policy and practice. By narrowly defining heat as a meteorological state, the subjective experiences of individuals and communities are masked. A more nuanced understanding of heat that acknowledges the subjective experiences of individuals and communities experiencing thermal inequities could lead to more effective management of heat-health risks.

Operationalising a framework centred around community needs requires the participation of community members. Heat Action Plans (HAPs) increasingly acknowledge the importance of community engagement and mobilisation in mitigating heat-related risks. While the identification of vulnerable groups is a common component, assessments and strategies often rely on secondary

data, limiting their specificity and effectiveness. HAPs primarily focus on awareness-building interventions, training, and outreach sessions. However, a reactive approach characteristic to disaster planning can hinder meaningful long-term adaptation and mitigation efforts with communities.

To address these limitations, HAPs must move beyond awareness-building and examine risk signatures, resource availability, and access. Developing action plans in partnerships with communities is essential to ensure their suitability, acceptance, and ownership, particularly in hotspots and among vulnerable populations. Research and data collection should capture the lived experiences of heat-related suffering, considering localised histories and place-based vulnerabilities.
A paradigm shift from top-down disaster management to decentralised, community-informed models is essential to effectively address heat-related risks. This transition involves moving from a 'community-placed' to a 'community-based' approach, centred on community participation and knowledge (Ziegler et al., 2019). Community-Based Participatory Research (CBPR) is a promising 'bottom-up' strategy. Residents can map heat islands, identify vulnerable populations, and develop localised cooling solutions. Community-based campaigns using low-cost temperature sensors can further enhance urban heat island mapping and inform targeted interventions.

Community Emergency Response Teams (CERTs) can play a crucial role in assisting vulnerable populations, such as the elderly and those with disabilities. Initiatives like NDMA's Aapda Mitra Scheme which trains community volunteers in disaster response can potentially transform local resilience during extreme heat events.

Climate Resilience Hubs are locally managed neighbourhood centres that can serve as safe havens during extreme heat events. These hubs can provide essential services like cool drinks, emergency supplies, and health information along with acting as a 'safe' space for marginalised and homeless persons, for instance (Baja, 2021). By fostering community engagement and self-determination, these strategies can contribute to more effective and equitable heat management in urban areas.

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