VOLUME-3, ISSUE: 1, MAY 2026
ISSN: 3049-0006 (ONLINE)

Experience Sharing: Extreme Heat and Health Preparedness and Response Implementation at Coastal City Surat

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Abstract

Extreme heat events are escalating globally, posing severe public health risks, particularly in coastal urban centers where high humidity amplifies thermal stress. This paper documents the development and implementation of the Heat and Health Action Plan (HHAP) in Surat, a rapidly urbanizing coastal city in India. Historically perceived as a temperature-comfortable city, Surat has witnessed a significant shift in its climatic profile over the last three decades (1994–2024), necessitating a departure from traditional dry-heat governance models. The methodology involved an interdisciplinary review of long-term meteorological trends and all-cause mortality data to establish local heat-index thresholds. Interventions focused on annual preparedness assessments of urban primary health centers, targeted action reminders for medical providers, and community awareness programs rooted in traditional preventive practices. Results indicate a consistent upward trend in both maximum temperatures and relative humidity, particularly in May, correlating with increased mortality risks. The implementation of the HHAP has successfully strengthened disease surveillance, improved inter-sectoral coordination between municipal departments, and enhanced community resilience through "living" adaptation strategies. This experience highlights that for coastal cities, effective heat adaptation must integrate humidity metrics into early warning systems and rely on decentralized, multi-sectoral governance to transition from vulnerability to climate resilience.

Keywords: extreme heat, heat index, heat action plan, coastal cities, Surat (India)

Introduction

Surat, a major economic hub in Gujarat, has historically enjoyed a moderate coastal climate. However, rapid urbanization, loss of green cover, and the urban heat island (UHI) effect have altered this equilibrium. Analysis of meteorological data over the last 38 years reveals a worrying trajectory: a rise of 0.9°C in average annual temperature and a marked increase of 2.6°C in minimum temperatures, indicating warmer nights that prevent physiological recovery. Once perceived as a "temperature-comfortable" city, Surat is now experiencing a "new normal" of rising heat-health risks that challenge its urban identity.

This paper shares the experience of developing and implementing an evidence-based Heat and Health Action Plan (HHAP) tailored to Surat's specific coastal context. Unlike static policy documents, Surat's HHAP is a dynamic instrument, refined annually through interdisciplinary collaboration. We examine these long-term climatic trends to validate the necessity of the plan and describe the operational mechanisms, ranging from specific departmental Terms of Reference (TOR) to community behavioural change, that contribute to building a climate-resilient urban identity.

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Literature Review

Climate change is driving an increase in the frequency, intensity, and duration of extreme heat events globally, with South Asia identified as a particular hotspot for heat-related mortality. While much of the heat-health discourse in India has focused on the arid, high-temperature zones of the northwest and central plains, coastal cities face a distinct threat: the combination of high temperatures and high relative humidity. This "sultry" heat significantly impairs the body's ability to cool itself through sweating, leading to heat stress at lower ambient temperatures compared to dry regions.

Objectives

• To examine long-term trends in temperature and relative humidity in Surat (1994–2024) and their implications for heat-related health risk.

• To describe the locally tailored trigger and implementation framework of Surat's Heat and Health Action Plan (HHAP), including health-system preparedness and inter-sectoral coordination.

• To summarize key outcomes and transferable lessons for coastal cities where humidity amplifies thermal stress.

Research Methodology

The development of the Surat HHAP followed a mixed-methods approach, integrating quantitative meteorological analysis with qualitative governance reviews.

Data Sources and Analysis Long-term meteorological data comprising daily maximum temperature (Tmax), minimum temperature (Tmin), and relative humidity (RH) were obtained from the India Meteorological Department (IMD) for the period 1994–2024. To account for the coastal factor, the Heat Index (HI), a measure of how hot it really feels when relative humidity is factored in with the actual air temperature, was calculated. Daily all-cause mortality data were sourced from the Surat Municipal Corporation's (SMC) birth and death registration system. A time-series analysis was conducted to identify correlation lags between spikes in heat index and mortality, helping to define locally specific threshold triggers for the HHAP.

Implementation Framework the HHAP is drafted and revised annually through a structured interdisciplinary process involving the Urban Health and Climate Resilience Centre of Excellence (UHCRCE) and the Surat Municipal Corporation. The implementation framework consists of four key components:

System Preparedness: An annual pre-summer assessment of all Urban Primary Health Centres (UPHCs) and major hospitals is conducted to ensure the availability of ORS, IV fluids, and dedicated heat-stroke wards. For the 2025 season, this preparatory phase included a comprehensive situational analysis of 63 Urban Health Centres and Urban Community Health Centres (UCHCs), initiated in February to evaluate facility readiness.

Early Warning and Reminders: A protocol for detailed action reminders was established. Based on IMD forecasts, color-coded alerts are disseminated to public and private health providers.

Inter-sectoral Governance & Terms of Reference (TOR): Beyond health, specific TORs were developed for other municipal departments to ensure a holistic response:

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Labour Department: Mandated to inform outdoor staff about Heat Index alerts, ensure access to drinking water at workplaces, and enforce "split-shift" or alternate working hours to avoid peak afternoon exposure.

Fire Department: Tasked with ensuring all fire vehicles are heat-ready, incorporating heat safety messages into community fire drills, and rescheduling strenuous training activities to cooler parts of the day.

Community Engagement: Awareness programs were designed drawing on "traditional preventive practices" (e.g., dietary adjustments, timing of outdoor work) rather than purely clinical messaging, ensuring higher cultural acceptance.

Research Problem/Hypothesis

In coastal cities, heat-related health risk is driven by the combined effect of temperature and humidity, yet many heat preparedness approaches rely primarily on maximum temperature thresholds designed for dry-heat regions. This can lead to under-preparedness and delayed response in coastal settings such as Surat, where excess mortality is observed at lower temperatures when humidity is high. The paper examines whether a Heat Index–based trigger system and decentralized, multi-sectoral preparedness measures improve heat-health preparedness in Surat.

Analysis and Interpretation/Findings

Climatic Trends (1994–2024) The analysis of meteorological data confirms a consistent upward trend in thermal indicators. As noted, the minimum temperature (Tmin) has increased by 2.6°C over nearly four decades, significantly impacting night-time thermal comfort. The data indicates that May is the critical month where the compound impact of temperature and humidity peaks. The frequency of "high humidity" days during the summer months (April–June) has risen, necessitating interventions that address not just heat, but "sultry" heat.

Threshold Determination and Mortality Retrospective analysis indicated that excess mortality in Surat does not strictly align with the 45°C thresholds often used in North Indian plains. Instead, mortality spikes were observed at lower ambient temperatures (e.g., 40°C–41°C) when coupled with relative humidity exceeding 50-60%. Consequently, the Surat HHAP adopted a "Heat Index" based trigger system, activating alerts at lower dry-bulb temperatures than inland cities.

Programmatic Outcomes and Health system load The implementation of the annual preparedness assessment has led to a measurable improvement in health system readiness. Reporting of heat-related cases from private practitioners has improved due to the structured "action reminders." Specific interventions by the Labour Department, such as rescheduling work hours for outdoor staff, represent a shift from health-centric to multi-sectoral resilience. The 2025 preliminary report highlighted significant variations in service burden across the city. The Puna UCHC (East Zone A) served the highest population of 291,509, requiring prioritized resource allocation. Furthermore, Katargam UCHC and Bhatena UCHC were identified as high-load facilities for Outpatient (OPD) and Inpatient (IPD) services, respectively.

Regarding heat-specific morbidity, official surveillance recorded a total of 3 confirmed cases in 2024 (located at Variyav Tadwadi, Fulpada, and Kathodada). While this low

incidence could suggest effective preventive measures, the HHAP views this data cautiously, emphasizing the need for proactive measures to address potential under-reporting.

The Surat experience underscores the critical distinction between "dry heat" and "coastal heat" resilience. Standardized national guidelines often prioritize maximum temperature thresholds, which may lead to under-preparedness in coastal zones where the heat index is the true killer. By integrating humidity into the alert triggers, Surat has moved towards a more bio-meteorologically accurate warning system.

Project to Program Transition A crucial insight from the 2024–2025 review is the necessity of transitioning from a "project-based" intervention (often initiated under donor frameworks like ACCCRN) to a permanent "program" owned by the Local Self Government (LSG). Sustainable resilience requires specific budget allocations within the municipal annual budget for heat action activities. This financial ownership ensures that system preparedness, such as the maintenance of weather monitoring stations and IEC activities, continues independently of external funding.

Furthermore, the "Experience Sharing" model highlights the importance of institutional memory. The annual revision process acts as a feedback loop, allowing the city to adapt to new data, such as the increasing night-time temperatures.

Conclusion

Surat's journey from a reactive stance to a proactive, evidence-based Heat and Health Action Plan offers a transferable model for other rapidly urbanizing coastal cities in the Global South. Two key recommendations emerge for the future:

Coastal City Advocacy: Pioneer organizations must share their experiences with other coastal cities through advocacy workshops to save time and resources in replicating successful models.

Institutional Ownership: Effective governance requires the Local Self Government to treat the HHAP not as a temporary project but as a core municipal function with dedicated budgetary support.

By institutionalizing annual reviews and fostering a multi-stakeholder ecosystem, Surat has successfully reframed its identity from vulnerable to climate-resilient.

Suggestions/Recommendations

Integrate humidity (Heat Index) into early warning thresholds for coastal cities to avoid relying solely on dry-bulb temperature triggers.

Institutionalize HHAP as a municipal program with dedicated annual budget lines for preparedness assessments, IEC activities, and maintenance of monitoring systems.

Strengthen reporting from private practitioners through standardized action reminders and heat surveillance protocols.

Share coastal-city HHAP experiences through peer learning and advocacy workshops to accelerate replication of effective practices.

Acknowledgment: The authors acknowledge the support of the Surat Municipal Corporation (SMC) and the Asian Cities Climate Change Resilience Network (ACCCRN). We also thank

the medical and paramedical staff of the Urban Health Centres for their dedication to implementing the HHAP.

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