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REVIEW OF HEAT ACTION PLANS

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Integrated Research and Action for Development (IRADe)

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Foreword

Climate Change has become one of the major concerns of our time. Heat waves induced by climate change and the artificial Urban Heat Island effect together pose a major challenge to cities across the globe, especially in South Asia. South Asian cities are rapidly growing and the impact of heat is only getting worse every year. Heat related illnesses are subtle and globally recognized to pose serious health threats to urban dwellers. Between 1992 and 2015, they caused 24,223 deaths across the country (NDMA). The severity of heat morbidity is more among the vulnerable section of the population within a city. Therefore, there is an urgency to act and respond to the heat health emergency, as there will be serious consequences of inaction.

Cities across the world have risen up to the challenges and have implemented the heat health plans that aim to equip the authorities and the communities to adapt to heatwave incidences. Heat Action Plans provide the framework for planning and implementing early warning systems, preparedness strategies that address public awareness and community outreach, mechanisms for inter-agency co-ordination, roles and responsibilities during heatwave response, capacity building among health care professionals, mitigating heat exposure and promoting adaptive measures among the vulnerable population in the concerned region. Heat action plans encompasses the entire spectrum of planning, responses and rehabilitation strategies in all three phases – before, during and after heatwave incidents. A well-structured and well-implemented Heat action plan can save thousands of heatwave mortality cases every year. It also enhances livelihood of the most vulnerable communities and contributes to the overall health of a city or region. The action plans also help cities understand how Heat Health actions can help them achieve various sustainability goals under the Sustainable development goals framework.

New York, Toronto, Paris, and Madrid are some among the many cities that have established comprehensive plans to tackle heatwaves. In South Asia, the momentum is building and most of the countries are closely addressing the need for a Heat Action Plan. India, especially, has established a national framework for heat action plans through the National Disaster Management Authority which has took leadership in establishing guidelines and building capacities of the states, cities and districts to follow the framework and have implemented advanced Heat Action Plans (HAPs). It is important to have a critical appraisal of the existing mitigation and adaptation measures in order to inform the gaps and improve the action plans in India and South Asia.

I am glad that Integrated Research and Action for Development (IRADe) has come up with the review report of these existing Heat Action Plans in South Asia. The review report gives a detailed analysis of the Heat Action plans in India and South Asia. It identifies the key strengths, characteristics, and the gaps in the existing HAPs. It also brings to the fore the need for a Climate Adaptive Heat Action Plan which encompasses the historical climatology, thermal hotspots, vulnerability zones and ward-level assessment. This review report is an essential tool for policy makers and stakeholders in the sphere of heat health adaptation policy and action.

We are thankful to International Development Research Centre (IDRC), Canada for funding the research and NDMA for their guidance and collaboration.

Prof Jyoti K Parikh
Executive Director, IRADe

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Mr. Rohit Magotra
Principal Investigator & Deputy Director, IRADe

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Executive Summary

Global Average Temperature has increased by about 1.0°C over the last 115 years (1901–2016) and 2019 was warmer than the 1950-1980 mean by 0.98 °C. The recent few years have been the warmest in the history of modern civilization and have witnessed climate-related weather extremes. These trends are expected to continue over climate timescales. With large scale migration happening towards cities, the impact of climate change will be much higher in the cities. Hence, there is an urgent need for action to protect cities from the impacts of climate change. Mitigation and adaptation are both essential parts of a comprehensive climate change response strategy. Countries all over the world are coming up with Heat Action Plans (HAPs) to combat this threat in cities and at regional scales.

However, there is a lack of a comprehensive database for HAPs in South Asia. This review report details the available Heat Action Plans (HAPs) in South Asia, especially India. It is a qualitative review that identifies the key strategies introduced in the Heat Action Plans from the different states and cities within India. It also highlights the need for a Climate Adaptive HAP which can increase the impact and efficiency of the adaptation and mitigation efforts.

Karachi, Pakistan, Sri lanka, Nepal , Male and Singapore are the only non-Indian South Asian cities to have a comprehensive Heat Action Plan to combat heat waves in the city using mitigation and adaptation strategies. In India, Ahmedabad (Gujarat) was one of the earliest to implement a Heat Action Plan (2013). Odisha has also been proactive in implementation of heat adaptation strategies since 1999. With growing incidences of heatwave deaths, the National Disaster Management Authority in India established the guidelines for drafting Heatwave Action Plans in India (2016).

Following Heat Wave Action measures by the NDMA in 2016 and the subsequent drafting of Heat Wave Action Plans by many states, the number of deaths in the country came down significantly. Taking the success story forward, NDMA in 2017 organized a national workshop on heat wave at Hyderabad in Telangana. In 2018, NDMA conducted a national workshop on Preparedness, Mitigation and Management of Heat Wave with all stakeholders. In 2019, NDMA in collaboration with Govt. of Maharashtra organized a Workshop, the recommendations of which were incorporated in National Guidelines for Preparation of Action Plan, Prevention and Management of Heat Wave (October 2019).

Several cities and states, such as Ahmedabad, Odisha, and Telangana have formulated action plans based on NDMAs updated guidelines. In some cities, the actual impact of HAP has been evaluated and the HAPs have been revised and strengthened periodically. Among the key innovative strategies adopted, Odisha stands out for its climate Adaptive HAP which has used heat impact intelligence (such as vulnerability assessment, heat hotspots, socio-economic factors, etc) to effectively tackle heatwave impact among the most vulnerable to it. This review report is critical for identifying gaps and to improve the existing HAPs. It will also act as a manual for preparation of future HAPs in the South Asia region.

1. Review of Heat Action Plans

1.1 Introduction

Heat-wave is a prevalent climate-related natural hazard. Heat-waves are understood as unusual period of hot and humid or hot and dry conditions which prevail from three to five days during a summer season. *IPCC's Fifth Assessment Report*[1] indicates that the last 50 years have witnessed a hike in the frequency of hot days, nights, and heat waves globally. The yearly global land and ocean temperature have increased on an average rate of 0.07 °C per decade since 1880, average rate increase has been twice since 1980. 2019 was the seventh warmest year on record since nation-wide meteorological records commenced in 1901. Between 1979 and 2017, the frequency of instances of wet-bulb temperatures at or above 27°C (81°F) has more than doubled. Instances over 29°C more than tripled. South Asia is a hotspot for Heat wave and related incidences. Data from weather stations between 1979 and 2017 reveal that the extreme combinations of heat and humidity doubled in much of India, Bangladesh and Pakistan. In some parts of the region, summer temperatures are projected to increase by 3°C–6°C at a scenario of 4°C global warming and by 2°C at a scenario of 2°C global warming by 2100[2]. Around 800 million South Asians—almost half of the region's population—live in heat "hotspots" that will face worse heat waves in the future[3].

1.2 Impact of Heat Wave

Heat wave is a "silent disaster" and adversely affect the health, livelihood and productivity of people. Health impacts of heat are more severe in urban areas, where residents are exposed to higher and nocturnally sustained temperatures due to the Urban Heat Island (UHI) effect (Climate Council of Australia, 2016). Heat stress induced deaths in 2100 are estimated to be about 85 per 100,000 globally[4] and above 100 per 100,000 in lower-income groups. According to the *Global Climate Risk Index 2020*[5], countries in South Asia are among the most vulnerable globally to the impacts of climate change. Globally, 2% of total working hours are projected to be lost every year, either because it is too hot to work or because workers have to work at a slower pace. Lost productivity from heat stress at work, particularly in developing countries, is expected to be valued at $4.2 trillion dollars per year by 2030, driving more inequality. The agricultural sector, where 940 million people earn their livelihood, is set to be harder hit by hotter temperatures, pushing workers, crops and livestock past their physiological heat and drought tolerances. This will result in lost labour, smaller harvests for farmers, higher prices for consumers, and negative impacts on livelihoods.

[1] IPCC (fifth assessment report of working Group I, 2014[#])

[2] https://www.fortuneindia.com/polemicist/not-war-but-climate-change-might-devastate-south-asia/103297

[3] https://blogs.worldbank.org/endpovertyinsouthasia/south-asias-heat-rises-living-standards-decline

[4] Climate Change and Heat-Induced Mortality in India, Climate Impact Lab 2019

[5] Global Climate Risk Index 2020, Germanwatch

1.3 Heat Action Plans

Heat Action Plans have been designed as a critical adaptation measure to manage growing heat stress in South Asia. Heat Action Plans aim to provide a framework for implementation, coordination and evaluation of extreme heat response activities that reduces the negative impact of extreme heat. Past occurrences of heat waves had significant impacts on several aspects of society. Ecosystem services can be affected, as well as increased pressure on infrastructures that support society, such as water, transportation and energy. Recognizing the vast impact of heat waves, especially on the health aspect, the WMO and the WHO have co-published a document titled Heatwaves and Health: Guidance on Warning-System Development (WMO-No. 1142).

2. Global Perspective of Heat Action/Response Plans

Globally, action plans to combat heat have been implemented to help communities mitigate extreme heat during summers. Governments are also issuing guidelines for state and provincial authorities to draft their own heat response mechanisms.

Europe:

Over the last 30 years three major heat waves have occurred across Europe, namely 1976 (late June), 1995 (late July to early August) and 2003 (early to mid-August), all of which have had discernible social impacts[6] .

Country	Casualties
France	14 082
Germany	7 000
Spain	4 200
Italy	4 000
UK	2 045
Netherlands	1 400
Portugal	1 300
Belgium	150

INSERM: "Surmortalité liée à la canicule de l'été 2003", AP September 25, 2003

The severe heat wave began in Europe in June 2003 and continued through July until mid-August, raising summer temperatures 20 to 30% higher than the seasonal average. With a death toll estimated to exceed 30 000, the heat wave of 2003 is one of the ten deadliest natural disasters in Europe for the last 100 years and the worst in the last 50 years. Elderly people were most affected (UNISDR)[7]

It is now estimated that the mortality peak from the heat wave in France (in 2003) is higher than that from the COVID-19 outbreak of 2020 in France[8].

Following the incidences of August 2003, June & July 2015, July 2018, August 2019, all major countries in Europe have developed Heat Action Plans. Important among these are France, Germany, England, Austria, Portugal.

Canada & USA

[6] Mcgregor G et al (2007): 'The Social Impacts of Heat Waves" Environment Agency, Science Report – SC20061/SR6 https://www.researchgate.net/publication/45513548_The_Social_Impacts_Of_Heat_Waves
[7] https://www.unisdr.org/files/1145_ewheatwave.en.pdf
[8] https://blog.insee.fr/wp-content/uploads/2020/05/deces-chaque-anne-depuis-2010-e1589457997518.png

The 1995 Chicago heat wave was a heat wave that led to 739 heat-related deaths in Chicago over five days[9]. Most of the victims of the heat wave were elderly poor residents of the city, who could not afford air conditioning and did not open windows or sleep outside for fear of crime[10].
During mid- to late July 2006, an extreme heat wave affected much of the state of California, breaking daily maximum temperature records at seven sites and exceeding minimum temperature records at 11 meteorological stations, especially from 16 through 26 July[11]. County coroners and medical examiners reported at least 140 deaths from extreme heat recorded between 15 July and 1 August 2006 (California Department of Health Services 2007)[12].

Canada was gripped by ferocious heat in 2018, with Toronto recording temperatures that have exceeded 30C on 18 days in 2018. This figure compares with only nine such days in 2017[13]
In 2019, dangerous and deadly heat wave gripped more than half of the U.S. Heat advisories or warnings were in effect from the Midwest to much of the East Coast, affecting nearly 200 million people.[14], [15]

Such Incidences have led many cities across USA to develop Heat Action Plans like Phoenix, Philadelphia, New York city .

Canada: In Canada, Health Canada has published a "Heat Alert and Response Systems to Protect Health: Best Practices Guidebook"[16] to aid the provincial governments and cities to draft heat response plans. The city of Toronto released its "Hot Weather Response Framework"[17] in 2019. It outlined the implementation and coordination of hot weather response activities with a focus on reducing the negative health impacts of extreme heat.

USA: The United States Environmental Protection Agency (EPA), in collaboration with the Centers for Disease Control and Prevention (CDC), the National Oceanic and Atmospheric Administration's (NOAA's) National Weather Service (NWS), and the U.S. Department of Homeland Security (DHS) developed an "Excessive Heat Events Guidebook"[18]. The Guidebook provides critical information that local public health officials and others need to begin assessing their heat vulnerability and developing and implementing heat notification and response programs.

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[9] Dematte, Jane E.; et al. (1 August 1998). "Near-Fatal Heat Stroke during the 1995 Heat Wave in Chicago". *Annals of Internal Medicine*. **129** (3): 173–181
[10] Klinenberg, Eric (2002). *Heat Wave: A Social Autopsy of Disaster in Chicago*. Chicago, IL: Chicago University Press. ISBN 0-226-44322-1
[11] Kozlowski DR, Edwards LM. Reno, NV: Western Regional Climate Center, Division of Atmospheric Sciences, Desert Research Institute; 2007. Western Region Technical Attachment, No. 07-05, February 27, 2007: An Analysis and Summary of the July 2006 Record-Breaking Heat Wave across the State of California.
[12] California Department of Health Services. Review of July 2006 Heat Wave Related Fatalities in California. Sacramento, CA: California Department of Health Services, Epidemiology and Prevention for Injury Control Branch; 2007.
[13] Global News Meteologists
[14] https://www.cbsnews.com/live-news/heat-wave-2019-extreme-heat-advisory-warning-deaths-latest-weather-forecast-us-nyc-2019-07-20/
[15] https://www.nytimes.com/2019/07/20/nyregion/heat-wave-nyc.html
[16] https://www.hc-sc.gc.ca/ewh-semt/alt_formats/pdf/pubs/climat/response-intervention/response-intervention-eng.pdf
[17] https://www.toronto.ca/wp-content/uploads/2019/05/9030-2019-HWR-Framework-updated-05-22-19.AODA_.pdf
[18] https://www.epa.gov/sites/production/files/2016-03/documents/eheguide_final.pdf

Australia:

The Bureau of Meteorology, New South Wales reported peak temperatures in January, 2019, with temperatures in West Sydney well into 40^0C and Sydney Central Business District (CBD)with fifth consecutive days of temperature above 30^0C in 8 years. A total of 27 places across New South Wales (NSW) and the Australia Capital Territory (ACT) baked in record maximum temperatures, with one town in the northwest of NSW sweltering in oppressive, all-time high heat for two straight days.[19] Along with the melting of roads, Australia recorded hundreds of fires rages[20].

The heat wave response plans are much more comprehensive in high-heat stress countries like Australia: Government of South Australia released South Australia (SA) Health Extreme Heat Strategy[21] outlining a series of SA Health guiding principles to aid in identifying responsibilities and authorities to prepare for the impact of, as well as strategies to manage and recover from, an Extreme Heat event impacting upon SA Health. The government of Victoria has a heatwave plan[22] which acts as a shared resource to coordinate an integrated response to heatwaves in Victoria and provides a clear understanding of the actions and systems in place to support at-risk groups in a heatwave. In 2019, The Queensland Government published the Queensland Health Heatwave Management Sub-Plan[23] to outline the arrangements for the management of heatwaves in Queensland across preparedness, response and recovery. The aim of the plan was to enable Queensland to mitigate the effects of, prepare for, respond to, and recover from heatwaves.

3. Heatwave Action Plans in South Asia

A number of countries in South Asia have developed Heat Action Plans and others have implemented strategies to combat heatwaves.

Nepal: Nepal has included Heat wave as a Disaster in its 2017 Disaster Management Act. Nepal's Heat Wave Action Plan[24] points out that Nepal is prone to heatwaves in the coming decades and outlines the thresholds for heatwave, the government institutions in charge of heat response, strategy to identify vulnerable groups, and communication for early warning and adaptation.

[19] https://www.news.com.au/technology/environment/roads-melt-as-heatwave-escalates-across-parts-of-australia/news-story/ea23d38d583ccafa24c6a42b9574b06f

[20] https://www.bbc.com/news/world-australia-50817963

[21] https://www.sahealth.sa.gov.au/wps/wcm/connect/33e7f9004708784eb87ff822d29d99f6/SA+Health+Extreme+Heat+Strategy+V6.11.pdf?MOD=AJPERES&CACHEID=ROOTWORKSPACE-33e7f9004708784eb87ff822d29d99f6-n5jgPny

[22] http://docs2.health.vic.gov.au/docs/doc/45C7A59BDE5B1E95CA257A360015AAB5/%24FILE/Heatwave%20plan%20for%20Victoria.pdf

[23] https://www.health.qld.gov.au/__data/assets/pdf_file/0032/628268/heatwave-response-plan.pdf

[24] https://saarc-sdmc.gujarat.gov.in/sites/default/files/programmes_doc_upload/Heat-Wave-Action-Plan-of-Nepal.pdf

Maldives: A heatwave action plan has been published for the city of Male[25]. It defines roles and responsibilities of different government bodies and the process for drafting action plans for different thresholds.

Afghanistan: Afghanistan's heat action plan is still in the process of development and their official documents reveal that the process if delayed by lack of temperature data[26].

Sri Lanka: Sri Lanka heat action plan[27] comes under the Sri Lanka Disaster Management Act; No.13 of 2005. It lays out roles and responsibilities for different departments, the response mechanism and the activities. Heat alerts are issued by the health ministry and department of meteorology.

Pakistan: Karachi in Pakistan has a well-defined Heatwave Action Plan (HAP) which elaborates the thresholds for heatwave, the response mechanism, the roles and responsibilities and the early warning communication systems.

India: A large number of states and cities in India have implemented Heat Action Plans. A number of them (like Kerala) are in the process of drafting their HAPs. According to Indian Government's National Disaster Management Authority (NDMA)[28], "The Heat-Wave Action plan should aim to provide a framework for implementation, coordination and evaluation of extreme heat response activities in cities/towns in India that reduces the negative impact of extreme heat. The Plan's primary objective is to alert those populations at risk of heat-related illness in places where extreme heat conditions either exist or are imminent, and to take appropriate precautions, which are at high risk."

Bangladesh:
The Government of Bangladesh has developed 'Bangladesh Climate Change Strategy and Action Plan 2009', to achieve a pro-poor Climate Change Management Strategy, which prioritizes adaptation and disaster risk reduction, and also addressed low carbon development, mitigation, technology transfer and mobilization and international provision of adequate finance[29]

The benefits of Heat Action Plan extend beyond its primary purpose and thus act as a bridge towards sustainable development of cities and states. Some of the major benefits are mentioned below.

[25] http://saarc-sdmc.org/sites/default/files/programmes_doc_upload/Heat-Wave-Action-Plan-of-Male-City-of-Maldives.pdf
[26] http://saarc-sdmc.org/sites/default/files/programmes_doc_upload/Heat-wave-Action-Plan-Afghanistan-Team.pdf
[27] http://saarc-sdmc.org/sites/default/files/programmes_doc_upload/Increasing-temperature-preparedness-and-development-of-a-heatwave-action-plan-Srilanka.pdf
[28] https://ndma.gov.in/images/guidelines/guidelines-heat-wave.pdf
[29] https://www.iucn.org/downloads/bangladesh_climate_change_strategy_and_action_plan_2009.pdf

Heat Action Plan aim to provide a framework for implementation, coordination and evaluation of extreme heat response activities in that reduces the negative impact of extreme heat.

Benefits of Heat Stress Action Plan

Prevents deaths associated with heat strokes.

Government commitment to protect the poor and vulnerable citizens.

Reduces chances of illness due to heat waves.

Making Indian cities future ready, Climate resilient cities.

Better preparedness of hospitals/health centers.

4. Components of Heat Action Plan

Every Heat Action Plan has key elements which includes mitigation and adaptive preparedness measures to ensure stable health and productivity in the event of heatwaves.

Some of the key components are *Building Public Awareness and Community Outreach on mitigative and adaptive measures* through media engagement, *Using Early Warning Weather Forecasts* for Inter-Agency Coordination, *Developing Capacity Among Healthcare Professionals* to recognize and respond to heat-related illnesses, *Reducing Heat Exposure and Promote Adaptive Measures* through Identification of high-risk areas of the city, launching advocacy on preventive, adaptive and mitigative methods to deal with heat stress, collaborating with non-governmental organizations to expand outreach and communication with the city's most at-risk communities, and Developing heat emergency response plan. In India, according to most of the HAPs, the State Disaster Management Authority is the control agency for the response to the heat wave, and that other agencies, including the Department of Health, have a supporting role.

Commissioner Disaster Management is the Incident Controller and Nodal Officer for A heat wave—is responsible for the strategic management of the incident at the State Level. The District Collector is the Incident Controller and Nodal Officer at District Level, Commissioner (Municipal) – Nodal Officer for Respective Municipalities. The Responsibilities of Incident Controller and Nodal Officer include:

· Managing all response activities
· Notifying support agencies
· Establishing incident and emergency management teams
· Collecting, analyzing and disseminating information regarding the emergency
· Leading multi-agency response planning
· Issuing timely information and warnings to the community
· Developing incident action plans.

4.1 Overview: Heat Action Plans in India

Heat Action Plan was first developed by Odisha State HAP in 1999 following more than 2000 Heat Wave deaths in 1998. Followed by this, first city level Action Plan was developed by Ahmedabad in 2013 following severe Heat Wave in 2010. Recognizing need for states and cities to have Heat Action Plan, NDMA issued Guidelines for Preparation of Action Plan in 2016. Below is the Below is a list of states and cities in India with HAP

State/City		Heat Action Plans
States with HAP	Gujarat	http://www.gsdma.org/uploads/Assets/other/gujaratstateheatwaveactionplan2020-2104252020024137455.pdf
	Maharashtra	Yet to be Published
	Karnataka	https://www.ksndmc.org/PDF/Heat%20Wave%20Action%20Plan%202018.pdf
	Odisha	https://www.osdma.org/preparedness/one-stop-risk-management-system/heat-wave/#gsc.tab=0
	Uttar Pradesh	https://rahat.up.nic.in/drought2014/Heatwaveplan2018new.pdf
	Delhi	
	Andhra Pradesh	http://www.imdhyderabad.gov.in/apsite/andhra.pdf
	Telangana	https://tsdps.telangana.gov.in/Heat_wave_action_plan.pdf
	Kerala*	In Process. Not Published Yet
	Rajasthan	https://iiphg.edu.in/images/pdfs/2019/RCCPHAP.pdf
	Tamil Nadu	https://tnsdma.tn.gov.in/app/webroot/img/document/heatWaveAction2019.pdf
	Bihar	http://bsdma.org/Publication-Reports.aspx
	Haryana	https://cdn.s3waas.gov.in/s3d18f655c3fce66ca401d5f38b48c89af/uploads/2018/05/2018050149.pdf
Cities and Districts with HAP	Ahmedabad	https://www.nrdc.org/sites/default/files/ahmedabad-heat-action-plan-2019-update.pdf
	Surat	http://resiliencestrata.org/uploads/publication/1D97E6B4-57F2-4371-9DB7-7DF79D93BA21.pdf
	Rajkot	Yet to be published
	Nagpur	
	Vijayawada	http://www.vmcdm.org/knowledge/HAP_VIJAYAWADA.pdf
	Bhubaneswar	https://www.osdma.org/preparedness/one-stop-risk-management-system/heat-wave/#gsc.tab=0
	Gorakhpur	https://www.preventionweb.net/files/68564_68562sopforheatwave2.pdf
	Hazaribagh	https://cdn.s3waas.gov.in/s3ed265bc903a5a097f61d3ec064d96d2e/uploads/2018/05/2018052643.pdf

Table 1- Indian States and Cities with Heat Action Plans

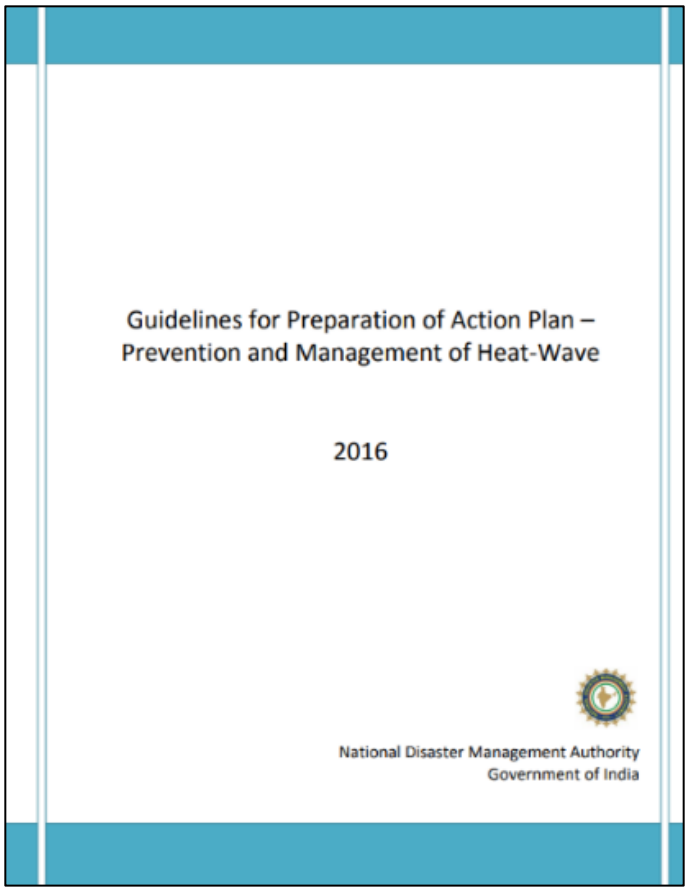
Below is a chronological snapshot of the HAPs in India, along with Karachi, Sri Lanka, and Nepal

Introduction of Heat Wave Action Plans - Timeline

Odisha, India Implements First Heat Action Plan	1999	
	2005	Sri Lanka Heat Action Plan
Ahmedabad, Gujarat Launches Heat Action Plan	2013	
Odisha Heat Action Plan	2015	
National Disaster Management Authority (NDMA) introduces a set of guidelines to enable states to prepare effective Heat Action Plans Telangana Heat Action Plan Andhra Pradesh Heat Action Plan Nagpur Heat Action Plan Hazaribagh Heat Action Plan	2016	
Rajasthan Heat Action Plan	2017	Nepal Heat Action Plan
Uttar Pradesh Heat Action Plan Karnataka Heat Action Plan Maharashtra Heat Action Plan Surat Heat Action Plan	2018	Karachi Heat Action Plan
Tamil Nadu Heat Action Plan Bihar Heat Action Plan	2019	
Odisha Heat Action Plan (Updated) and Climate Adaptive Heat Action Plan Kerala Heat Action Plan	2020	
Telengana Heat Action Plan (updated)	2021	

4.2 National Disaster Management Authority (NDMA) Guidelines

The Indian Government's National Disaster Management Authority (NDMA) introduced a set of guidelines in 2016 in order to enable states to prepare effective Heat Action Plans. Titled 'Guidelines for Preparation of Action Plan – Prevention and Management of Heat-Wave'[30], the report set out elaborate guidelines to combat the impact of heat waves.



NDMA stated that the Heat Wave Guidelines facilitate the stakeholders (Cities and States) in preparing a Heat Wave Management Plan by providing insight into the heat related illness and the necessary mitigative and response actions to be undertaken."

HAPs will also help in mobilization and coordination of various departments, individuals and communities to help and protect their neighbours, friends, relatives, and themselves against avoidable health problems during spells of very hot weather.

https://ndma.gov.in/images/guidelines/guidelines-heat-wave.pdf

The four key strategies for a HAP as mentioned in the NDMA framework are as follows:

1. **Establish Early Warning System and Inter-Agency Coordination**
    - Early Warning and Indicators of heat-wave
    - Forecast and Issuance of Heat Alert or Heat Warning
    - Identification of Color Signals for Heat Alert

2. **Capacity building / training programme** for health care professionals at local level to recognize and respond to heat-related illnesses, particularly during extreme heat events. These training programmes should focus on medical officers, paramedical staff and community health staff so that they can effectively prevent and manage heat-related medical issues to reduce mortality and morbidity.

[30] NDMA Guidelines for HAPs in India
https://ndma.gov.in/images/guidelines/guidelines-heat-wave.pdf

3. **Public Awareness and community outreach** Disseminating public awareness messages on how to protect against the extreme heat-wave through print, electronic and social media and Information, Education and Communication (IEC) materials such as pamphlets, posters and advertisements and Television Commercials (TVCs) on Do‟s and Don‟ts and treatment measures for heat related illnesses Reducing heat exposure and promoting adaptive measures.

4. **Collaboration with non-government and civil society:** Collaboration with non-governmental organizations and civil society organizations to improve bus stands, building temporary shelters, wherever necessary, improved water delivery systems in public areas and other innovative measures to tackle Heat wave conditions.

The NDMA guidelines layout the roles and responsibilities of the administrative units in carrying out a HAP.

Sl. No.	**Tasks/ Activities**	**Central/ State Agencies & Their Responsibilities**			
		Centre	**Responsibility**	**State**	**Responsibility**
1.	Preparation of Heat Wave Action Plan	NDMA	Guideline on preparing a Heat Wave Action Plan	SDMA/ DDMA/ Municipal Corporation and Local Bodies	Preparing a Heat Wave Action Plan and implementing.
2.	Early Warning	IMD	Issue Heat wave alerts and weather forecasts on Short / Medium / Long range duration	State Governments/ District Administration	To disseminate the information received from IMD to the public at large
3.	Mitigating Heat Wave	Ministry of Urban /Rural Development, Department of Drinking Water and Sanitation, Ministry of Surface Transport	To construct shelters/ sheds, bus stands and provide drinking water points at worksites.	Public Health and Engineering Department	To construct shelters/ sheds, bus stands and provide drinking water points in cities, worksites.
		Ministry of Health and Family Welfare	Stockpiling of ORS, creating Medical posts at places of mass gathering, Training of Human Resources	Department of Health	Stockpiling of ORS , creating Medical posts at places of mass gathering
4.	Monitoring and	Ministry of	● Surveillanc	Health	● Surveillanc

	Response	Health and Family Welfare	e ● deployment of Rapid Response Teams ● specific care for vulnerable groups	Department	e ● deployment of Rapid Response Teams ● specific care for vulnerable groups
5.	Occupational Support and advisories	All Ministries/ Departments	Take necessary measures as suggested in Annexure 1, wherever applicable	All Departments	Take necessary measures as suggested in Annexure 1, wherever applicable
6.	Media campaign and IEC activities	Ministry of Information and Broadcasting	Extensive IEC campaigns to create awareness through print, electronic and social media	Department of Information and Broadcasting/ SDMAs/ Commissioners of Relief/ State Govt/ Health Department	Extensive IEC campaigns to create awareness through print, electronic and social media
7.	Documentation	Ministry of Health & Family Welfare through IDSP	Collecting Data from States as per Annexure 2 and maintaining national level data base.	Revenue Departments/ SDMAs/ DDMAs/ Health Deptt.	Collecting Data and Information as per Annexure 2
8.	Long Term Measures	Ministry of Urban Development, Ministry of Environment Forests and Climate Change	Improving the forest coverage and green areas	Forest Department/ SDMAs and other concerned Department	Improving the forest coverage and green areas

NDMA released an update to the guidelines in 2017[31]. The most recent update to the guidelines was released in 2019[32]. NMDA conducted National Workshop on Preparedness, Mitigation & Management of Heat Wave in 2019 to address key themes of Early Warning, Early Action from Heat Wave Management to Risk Reduction. 8 states shared their experience and lessons learnt for heat wave mitigation measures.

NDMA jointly with Karnataka State Government organised National Workshop on Preparedness, Mitigation and Management of Heat Wave for 2020 at Bengaluru on 5th-6th December 2019. Important deliberations on a range of topics were carried out in five technical sessions during the workshop, including the impact on climate change on the heatwave. Some vulnerable states shared their experiences and best practices to help other stakeholders prepare and implement their Heat Action Plans. This was the fourth annual workshop in a series that NDMA (/topic/ndma) has been conducting since 2017 to build

[31] https://www.ndma.gov.in/images/guidelines/heatwaveguidelines2017.pdf
[32] https://ndma.gov.in/images/guidelines/heatwaveguidelines.pdf

momentum ahead of the start of the Heat Wave season. These workshops facilitate States to prepare and implement their Heat Action Plans.

5. India - State Level Action Plans

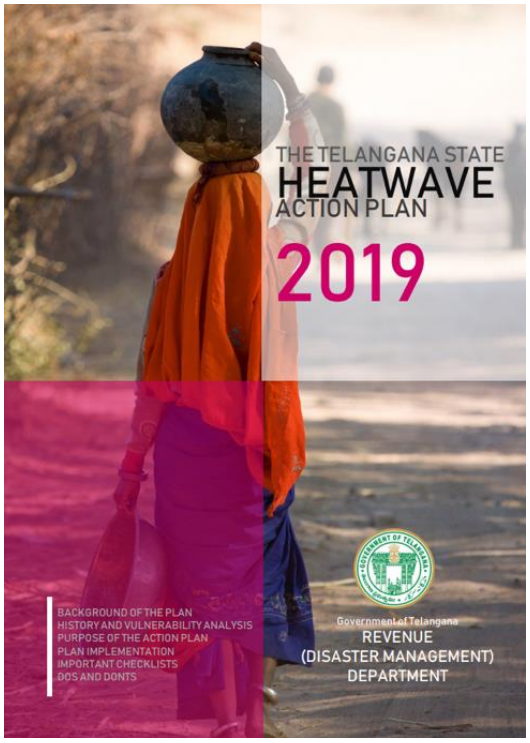
Following NDMA's detailed guidelines on the Heatwave Action Plan, more than 12 states and various cities within them have developed HAPs of their own.

5.1 Telangana Heat Wave Action Plan

Telangana State Heat Wave Action Plan was first prepared in 2016 as per High Court orders and the guidelines issued by the National Disaster Management Authority (NDMA), Government of India and the same was submitted to NDMA. Based on regular inputs from NDMA and Scientific Institutions the Heat Wave Action Plan is revised and updated in 2017, 2018 and 2019 and 2021[33] It is a multi-level plan in which at each level, the responsibilities are divided which makes it easier to implement the plan.

The updated HAP in 2019 included the following key elements

1. Preparedness measures: Heatwaves, Historical data on Heatwaves in India, Historical data on Heatwaves in Telangana, Historical data on Heatwave, Mandal wise maximum temperature recorded from the year 2010-2018, Severe Heatwave days, Heatwave days, Heatwave vulnerability analysis, Heatwave Action Plan Committee, and Purpose of Heatwave Action Plan
2. Information on Implementation Phase: Pre-heat season Phase, During the heat season Phase, and Post heat season
3. Checklists for major stakeholders and line departments.



(Accessible at https://tsdps.telangana.gov.in/Heat_wave_action_plan.pdf).
Please

Key Initiatives and Improvements

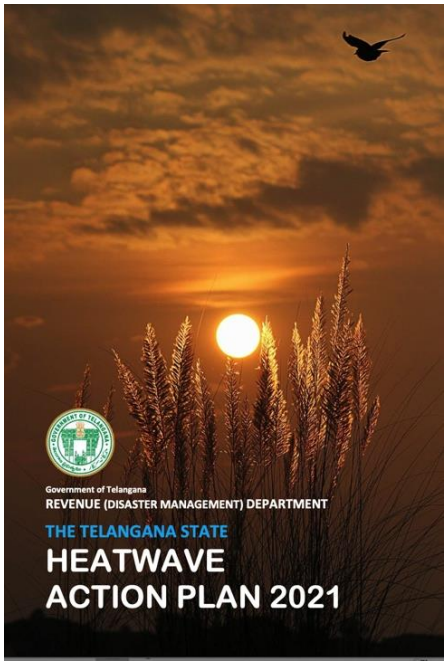
- Telangana state development planning society (TSDPS) has initiated accurate and timely weather forecast and hazard warning to state line departments and public.
- 924 Automated Weather Stations (AWS) provide weather data on an hourly basis.

[33] Telangana Heatwave A https://tsdps.telangana.gov.in/Heat_wave_action_plan.pdf

- Prepared Heatwave Atlas -2019 consisting of analysis of heatwave conditions of the state since last 09 years.
- Development of a mobile App (T-Weather) to know about the village level weather conditions from the nearest AWS for the use of department officials, expert agencies and common public. The App will also give information on top ten hottest locations in the state. App will facilitate transmission of real-time weather updates and alerts for public and official use.
- IT Department built 'The Telangana State Disaster Management Control Portal' and upload data such as maximum, minimum and average temperatures, humidity and wind speed recorded by 885 AWS sensors deployed across the state by TSDPS.

The updated HAP in 2021 included the following key elements

1. Incorporation of both traditional and present technologies to mitigate the impact of heat waves.
2. Forecast reports and weather data shared by India Meteorological Department (IMD) and Telangana State Development Planning Society (TSDPS) are analysed and used for the purpose of Heat Wave Action Plan following the NDMA guidelines.
3. The Key Strategies include: Ensuring COVID-19 protocols
4. Heat Wave Impact: Impact of COVID-19 has been considered in socio-economic vulnerability aspects at each Ward/ mandala level



(Accessible at https://telangana.gov.in/PDFDocuments/Telangana-State-Heatwave-Action-Plan-2021.pdf

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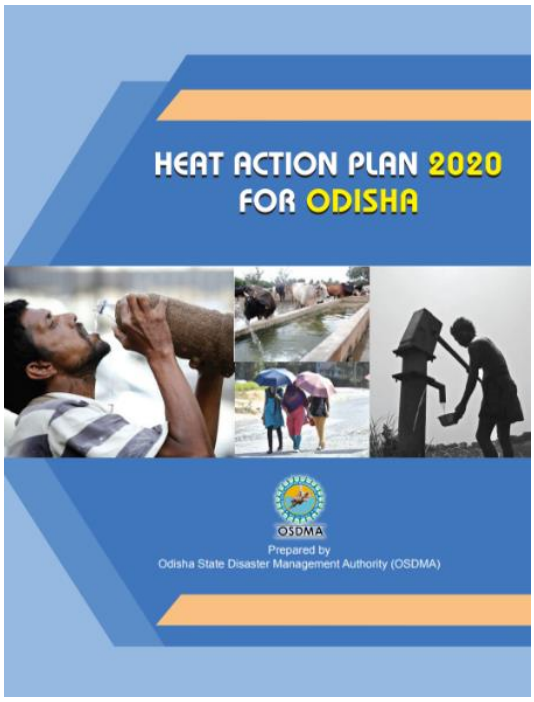
Consecutive summers in Telangana over 2015, 2016 and 2017 have seen unprecedented heat waves across and temperatures recording around 47 degrees centigrade in some locations. According to State records about 108 deaths occurred in 2017, due to heatwave (Telangana Heat Wave Action Plan, 2018). But the numbers were much less than the previous two years and HAP is likely to have aided in the mitigation of heat stress.

Table 2: Heat Related Death,

No of Deaths as per DMD			
Year	Deaths	Year	Deaths
2008	17	**2015**	541
2009	9	**2016**	324
2010	11	**2017**	108
2011	0	**2018**	12
2012	144	**2019**	64
2013	516	**2020**	9
2014	31		

Telangana(2008-2020)

5.2 Odisha Heat Wave Action Plan



In 1999, the state implemented the 1st Heat Action Plan (HAP), after witnessing 2042 people die from Heat Wave in 1998. In spite of having HAP in place, the state still experienced massive heat wave causalities of 236 in 2005. Since then the state has been proactive in development of strategic Heat Action Plans. The latest Heat Action Plan was released in 2020[34]. The HAP 2020 (Accessible at https://www.osdma.org/preparedness/one-stop-risk-management-system/heat-wave/#gsc.tab=0) has been prepared by inclusion of action plans of all stakeholders' departments.

Key Initiatives and Features

1. In the updated version of HAP (2020), a climate adaptive heat action plan was included for the city of Bhubaneswar, to support the city in prioritizing and integrating adaptive resilience with the agenda of climate resilient smart cities. The plan evaluated the Heat stress vulnerability across the identified wards in hot spot areas of Bhubaneswar and used a comprehensive index to prioritize HAP in different wards of the city. The plan also enlisted Prevention, Preparedness and Mitigation Measures for the city of Bhubaneswar.

[34] Odisha State Heat Action Plan 2020 https://www.osdma.org/preparedness/one-stop-risk-management-system/heat-wave/#gsc.tab=0

2. The Heat Action Plan 2020 for Odisha outlined the Standard Operating Procedures (SOP) for different departments, district administrators and others.

3. On the adaptation front, the focus is on developing coping mechanisms to deal with heat stress in the hotspot regions. This involves coordination among agencies such as the Indian Meteorological Dept. (IMD), state government agencies, and urban local bodies. It has been recommended to increase the number of Automatic Weather Stations (AWS) especially in the heat-wave prone districts to obtain a spatial distribution of temperature. Odisha State Disaster Management Authority (OSDMA) to undertake capacity building measures to deal with emergency response and preparedness for the heat wave and heat island effects, especially among the health workers and district medical officers.

4. The Odisha HAP 2020 proposes strengthening of the previous heat action plans by adding two strategic factors: A. Determining threshold temperature for multiple cities and towns of Odisha and B. Conducting vulnerability assessment in more cities and designing an intervention.

The first Odisha HAP came out in 1999 when the first worst heatwave hit the state in 1998 which took 2042 lives. The number of deaths did not come to zero but a large number of deaths were seen in the year 2005, 236 lives. The overall death toll has reduced which shows that HAP has been preventive. Although, it needs to get strengthened to be more accurate in reducing the deaths to zero.

5.3 Andhra Pradesh Heat Wave Action Plan

In 2015, taking cognizance of the serious situation arising out of the intense Heat Waves on general public leading to high fatalities, the Government of AP issued Orders to prepare a Comprehensive Heat Wave Action Plan and released the first ever Heat Wave Action Plan for Andhra Pradesh in 2016 [35] (Accessible at http://www.imdhyderabad.gov.in/apsite/andhra.pdf).

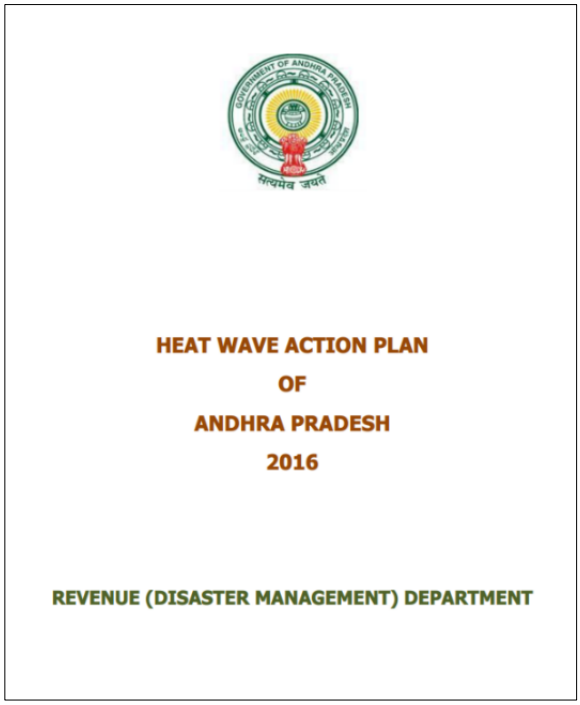
The HAP's primary objective was to reduce heat-related morbidity and deaths through issuing heat-health warnings, with particular emphasis on the most vulnerable population groups, provide timely advice and announcements of upcoming Heat-waves raise awareness amongst the public and health workers to take appropriate precautions and coordinate and mobilize all available resources promptly to prevent and reduce the negative health consequences of heat-waves. It aims to achieve this objective by providing a framework for implementation, coordination of an integrated response and continuous evaluation of extreme heat response activities.

Key Features of the AP Heat Action Plan

- Identifying vulnerable populations and the health risks specific to each group.
- Developing effective strategies, agency coordination and response planning that addresses heat-health risks.

[35] Heat Wave Action Plan of Andhra Pradesh 2016 http://www.imdhyderabad.gov.in/apsite/andhra.pdf

- Heat Health Information Surveillance System—to monitor and assess the impact of heat waves on human health.
- Capacity Building among Health Care Professionals to recognize and respond to heat related illnesses, particularly during extreme heat events.
- Reducing Heat Exposure and Promoting Adaptive Measures by launching new efforts including mapping of high-risk areas, access to potable drinking water and cooling spaces during extreme heat days.
- Collaboration with non-governmental organizations as a means to expand outreach and communication with the most vulnerable communities. Evaluating and updating the Heat Action Plan regularly.



http://apsdma.ap.gov.in/latestupdate_pdfs/heatwave/March2019/Heat%20wave%20Action%20plan%202019.pdf

After consequent, collaboration efforts of Government of Andhra Pradesh, through the implementation of heat wave action plan by Andhra Pradesh State Disaster Management Authority, and line departments, efforts on *continuous monitoring and early warning* has significantly reduced the death of sunstroke in the year 2018, to a single digit of 8 deaths [36]. An updated Heat Wave Action Plan - 2019 was introduced by the State Disaster Management Authority, detailed on the Heat Health Threshold temperature. Defining the effect of temperature and Humidity as Heat Index to measure Human Discomfort. During the summer heat wave of 2014, 15, 16 &17 in Andhra Pradesh.

5.4 Kerala Heat Action Plan

Kerala State Disaster Management Authority (KSDMA) is projected to release the Kerala State Heat Action Plan in 2020. The HAP will include guidelines and strategies for tackling heat stress in the state. It will list measures to be adopted by government departments and agencies, District Disaster Management Authorities and the public for tackling heat-related health issues in humans and animals. The HAP will define the roles and responsibilities of concerned departments. Threshold temperature conditions and longer-term weather

[36] http://apsdma.ap.gov.in/latestupdate_pdfs/heatwave/March2019/Heat%20wave%20Action%20plan%202019.pdf

forecasts will be made available to departments to alert the public under KSDMA's guidance.[37]

5.5 Maharashtra Heat Action Plan

The State Government has prepared a Heat Wave Action Plan for the State in 2018-19. The Plan has been prepared on the lines of the National Guidelines for preparation of Heat Wave Action Plan. The Action Plan is activated in the vulnerable areas whenever heat wave conditions prevail in the State. This year, Maharashtra's Vidarbha and Marathwada were prioritized for Heat Action response and mitigation. Nagpur and surrounding districts have also been area of focus. Nashik, Dhule, Jalgaon, Gondia and Wardhaare yet to update their exiting heat action plan. The Maharashtra State Disaster Management Authority, Maharashtra Disaster Management Unit, Maharashtra State Health Department, and local IMD office work closely together on public awareness and preparedness for the state.

5.6 Karnataka Heat Action Plan

Karnataka came up with a Heatwave Action Plan in 2018[38]. The HAP defines the major components of the Action Plan as follows

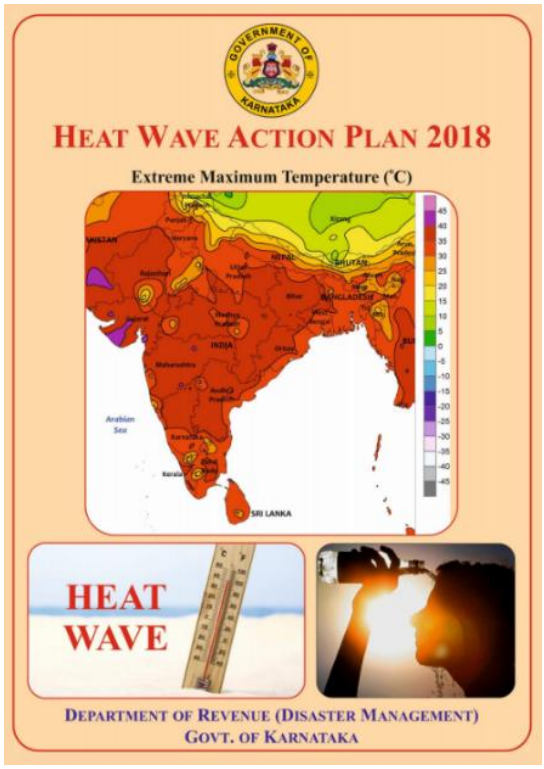
1. Building Public Awareness about heat wave, do's and don'ts and management through innovative IEC activities focusing mainly on vulnerable communities. Community Outreach Program at ward level and panchayat level.
2. Dissemination heat wave alert to community using Early Warning System
3. Capacity Building among Health Care Professionals and community
4. 4. Reducing Heat Exposure and Promoting Adaptive Measures

Key Components and Initiatives

- Roles and Responsibilities of Departments in Managing Heat Wave Conditions has been clearly defined in the HAP.
- Karnataka State Natural Disaster Monitoring Centre (KSNDMC) employed various modes for disseminating disaster related information, alerts and advisories at real time to all stakeholders.

[37] https://www.nrdc.org/sites/default/files/india-heat-resilient-cities-ib.pdf
[38] Karnataka Heat Wave Action Plan
https://www.ksndmc.org/PDF/Heat%20Wave%20Action%20Plan%202018.pdf

- KSNDMC installed 920 GPRS enabled solar powered telemetric 920 weather monitoring stations across the State (one each for hobli). Weather monitoring stations has thermal sensors which records temperatures at real time and relayed to KSNDMC server through GPRS towers, near real time temperature is flashed in the KSNDMC dashboard. Heatwave alerts and forecast received from IMD at SEOC and KSNDMC are immediately disseminated to all concerned.
- The HAP also outlines a detailed overview on "suggestive adaptive measures to mitigate adverse impact of Heat Wave in livestock" management during heatwaves.



Accessible at
https://www.ksndmc.org/PDF/Heat%20Wave%20Action%20Plan%202018.pdf

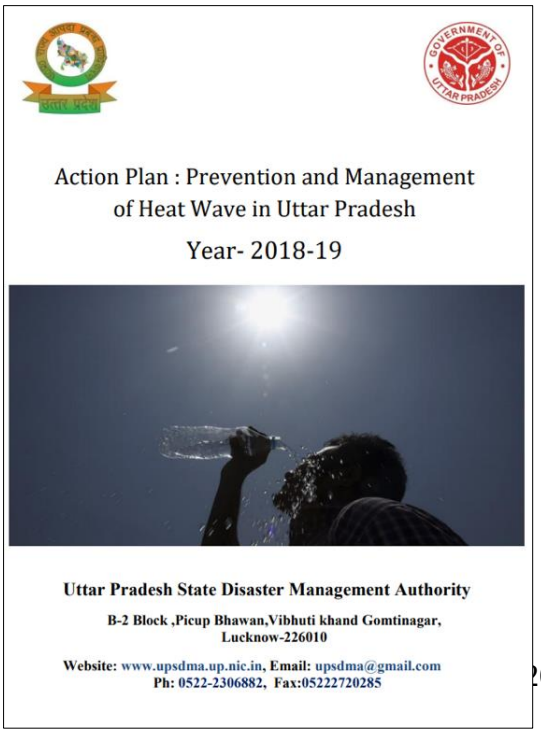
5.7 Uttar Pradesh Heat Action Plan

The Heat Wave Action Plan of Uttar Pradesh was prepared to spell out a district-wise standard action and operation mechanism for disaster management. In 2018, the UP government published the HAP titled "Action Plan: Prevention and Management of Heat Wave in Uttar Pradesh"[39].

Key Measures and Components of Uttar Pradesh HAP

- Uttar Pradesh HAP gives a detailed overview of "Financial Provisions" available for heat wave management in Uttar Pradesh. State Government of Uttar Pradesh has notified "Heatwave" as State Specific disaster. Thus now heat wave is also covered for relief from State Disaster Relief Fund.

- The HAP also has a special focus on "Dealing with Heat related illnesses". It defines heat related illnesses, symptoms, causes, and ways to combat them, including preventive measures,



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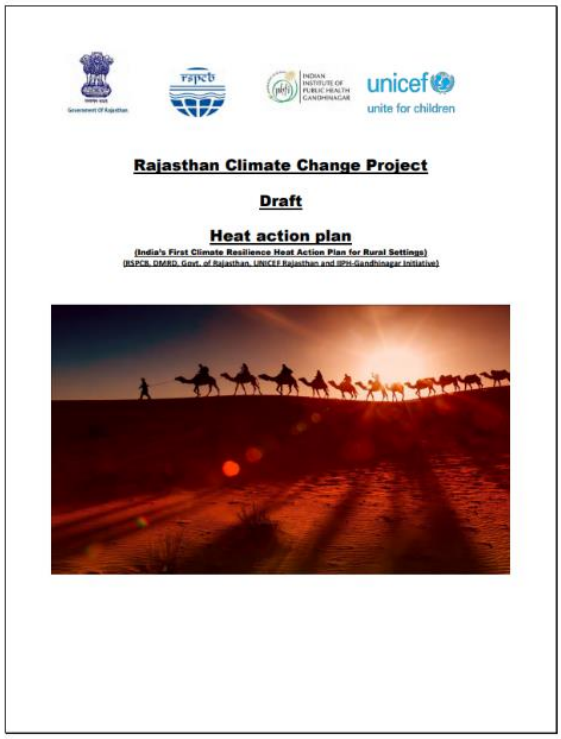
treatment protocol and response measures.

https://rahat.up.nic.in/drought2014/Heatwaveplan2018new.pdf

5.8 Rajasthan Heat Action Plan

Government of Rajasthan, Indian Institute of Public Health-Gandhinagar and Disaster Risk Reduction (DRR) Section of Unicef, Rajasthan have developed and implemented Heat Action Plan (HAP) in 2019[40] under the guidance of the Disaster Management and Relief Department (DMRD) and Rajasthan State Pollution Control Board (RSPCB). The HAP objective is to act as a catalyst for bringing together key players from line department and policy-makers, as well as the general public, for initiating action concerning the overall management of heat as a hazard.



Key Measures and Initiates – Rajasthan HAP

- Has the distinction of being India's First Climate Resilience Heat Action Plan for Rural Settings
- The Hap lays out a 3-phase implementation strategy with clearly defined roles and responsibilities for various departments and authorities.
- Importance given to improving the HAP - Assessing the impact after implementation of HAP (feedback for reviewing and updating the plan).

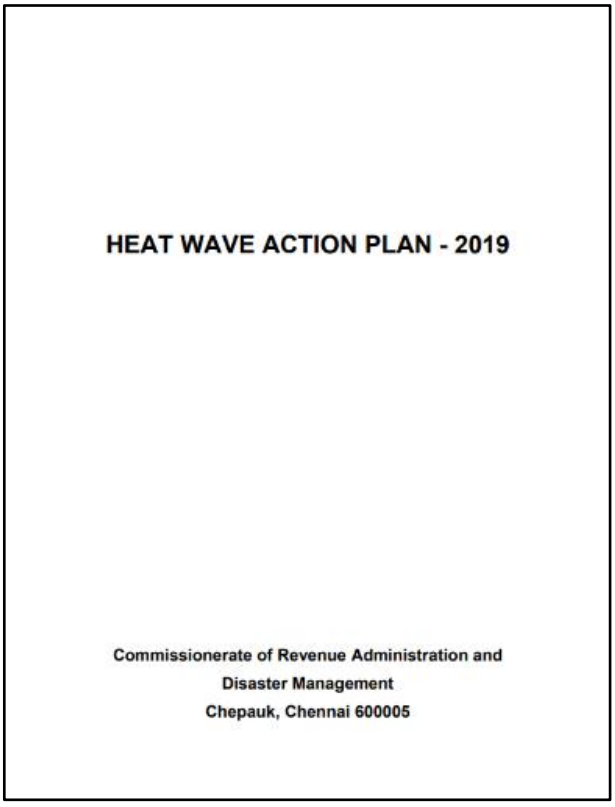
(Accessible at https://iiphg.edu.in/images/pdfs/2019/RCCPHAP.pdf).

5.9 Tamil Nadu Heat Wave Action Plan

Tamil Nadu released its Heat Wave Action Plan in 2019. It follows the standard guidelines set by the NDMA. Tamil Nadu HAP details a list of long term adaptation strategies with a focus on Urban Areas. It recommends the Urban Local Bodies to follow the Policy guidelines issued by the Ministry of Urban Development for strengthening Urban Greens (Urban Greening Guidelines 2014). Some of the key policy guidelines are enlisted below

[40] Rajasthan Heat Action Plan 2019, https://iiphg.edu.in/images/pdfs/2019/RCCPHAP.pdf

- The Energy Conserving Building Code 2017 issued by the Ministry of Power may be followed while new construction/ renovation of existing buildings are taken up.
- Corporations, the Municipalities, Town Panchayats, and Village Panchayats, may have to promote establishment of Bio Shields in their area and increase the Green Cover. Also, they have to enhance the storage Capacity of Water bodies in their jurisdiction and increase the Water availability which indirectly helps mitigation of the adverse impacts of Heat Wave.
- The National Highways, State Highways, and the Rural Development Department may have to promote Tree planting along the Roads.
- The Educational Institutions both Govt and Private, Govt/Private Office premises, all Industrial Units, Hospitals Temples and places of Worship, may have to establish Green Cover through Tree planting.
- Solid Waste Management and removal of dumped wastes can reduce the intensity of heat waves. The Local bodies must ensure such dumping yards in the vicinity of public places and residential colonies are removed.
- Cool Roofs and their extensive benefits may be popularized among people
- In order to reduce the intensity of radiation, the Govt/Private Buildings, Educational Institutions, Hospitals, Temple Premises etc shall provide Chemical Coating of Roof tops, exposed walking areas with a Chemical Coating.

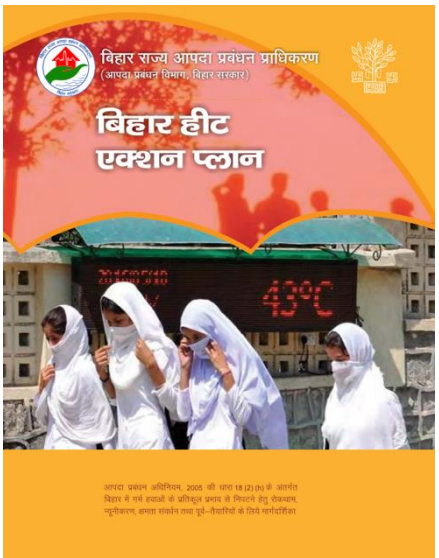


https://tnsdma.tn.gov.in/app/webroot/img/document/heatWaveAction2019.pdf

- The Local bodies may provide shelters in public places with facilities of drinking water.
- The Forest Department may continue to increase the green cover through the various Programmes in collaboration with the Local bodies.
- Establishing Bio Shields, enhancing the storage of water bodies are the other Long-term mitigation strategies.

5.10 Bihar Heat Action Plan

Bihar Heat Action Plan was published by the Bihar State Disaster Management Authority in 2019.

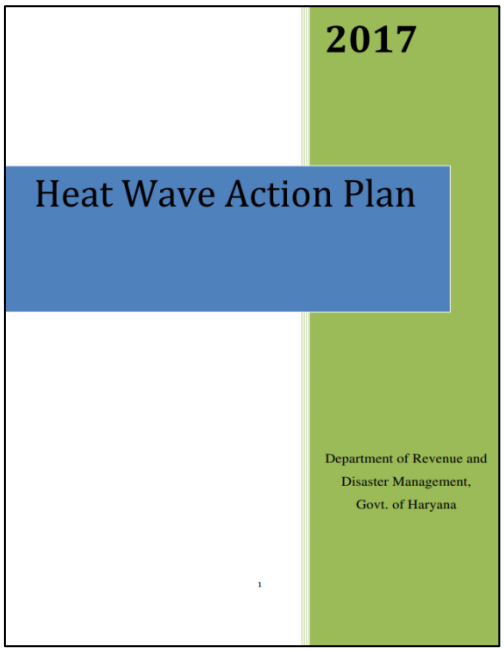


http://bsdma.org/Publication-Reports.aspx

5.11 Haryana Heatwave Action Plan

The Haryana heatwave action plan was published by the Department of Revenue and Disaster Management, Govt. of Haryana in 2017.

- The Haryana HAP is prepared with an "aim to prepare for, alert people to, and prevent, the major avoidable effects on health during periods of severe heat."
- It has a detailed SOP for all the concerned departments and units within the state administrative framework.
- The HSDMA acts as the main executing body under the leadership of the Additional Chief Secretary & Financial Commissioner (Revenue & Disaster Management) during a Heat Wave condition and issues directives to all the concerned governmental and non-governmental organizations for a prompt action.

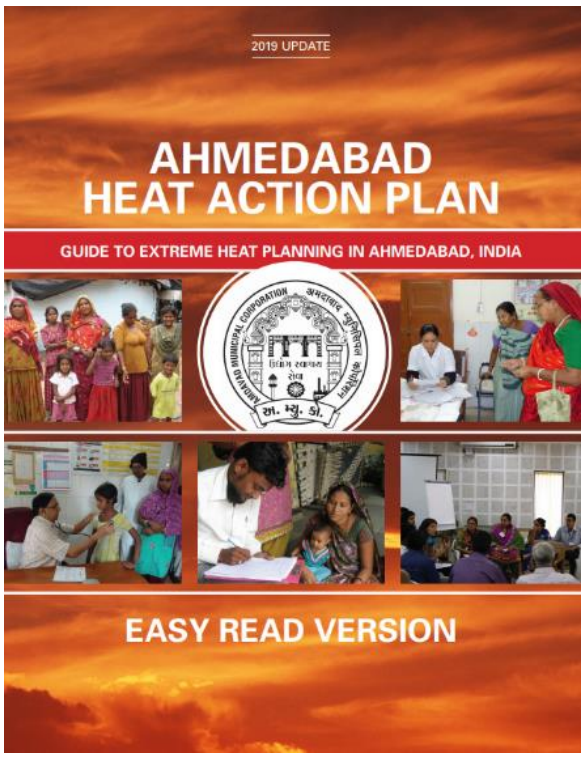


https://cdn.s3waas.gov.in/s3d18f655c3fce66ca401d5f38b48c89af/uploads/2018/05/2018050149.pdf

6. India City Level Action Plans

6.1 Ahmedabad Heat Wave Action Plan

Ahmedabad's action plan was developed in collaboration 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 partnered with the Ahmedabad Municipal Corporation(AMC).



The [first ever Heat Action Plan in India was launched in 2013] by the Ahmedabad Municipal Corporation. The prime focus was on the vulnerable groups, which are mostly affected by the heat waves such as slum communities, outdoor workers, police men, elderly, children etc occurred in May 2010. After 2013, the plan has revised several times and the latest plan has come out in 2019[41].

(Accessible at https://www.nrdc.org/sites/default/files/ahmedabad-heat-action-plan-2019-update.pdf)

Key Initiatives and Strategies in the Ahmedabad HAP

- The HAP gives out a detailed Ahmedabad Heat Action Plan (HAP) departmental wise suggested activities during heatwave days for Yellow, Orange and Red alert days.
- Appointment of an AMC Nodal Officer to head the coordination of stakeholders and ensure implementation of the Heat Action Plan.
- Promotes the use of reflective paint for keeping the roofs cool.
- Aims to increase the availability of drinking water along with promoting the use of ORS, coconut water etc.
- Spread awareness and alerts through laces of religious importance.

Outlines four key mechanisms to implement HAP

1. Building Public Awareness and Community Outreach
2. Initiating an Early Warning System and Inter-Agency Coordination

[41] Ahmedabad HAP 2019 https://www.nrdc.org/sites/default/files/ahmedabad-heat-action-plan-2019-update.pdf

3. Capacity Building Among Health Care Professionals
4. Reducing Heat Exposure and Promoting Adaptive Measures

6.2 Nagpur Heat Wave Action Plan

Nagpur heatwave action plan was implemented in 2016. The Nagpur Regional HAP has coordinated between Nagpur and four neighbouring cities, creating a regional approach to heat wave planning. As a part of the HAP, mortality rates were analysed in Nagpur – identifying a threshold temperature of 43°C (109.4°F) for a heat alert day (orange) and extreme heat alert day (red) for temperatures of 45°C (113°F) or greater. Children and women were part of the vulnerable populations. Nagpur has been proactive in making its HAP more popular through publicity in Nagpur, Gondia, Chandrapur, Nanded, Jalgaon.

6.3 Surat Heat Wave Action Plan

Following Ahmedabad, the highly humid coastal city of Surat developed a HAP. UHCRC (Urban Health and Climate Resilience Centre) Surat prepared the HHAP-S (Heat and Health Action Plan- Surat) the HAP in 2016. It is the first coastal city plan in India. the plan is divided into phases out of which the first phase was piloted in 2016 summers. In the first phase, a plan was made for three seasons, pre-heat, heat and post season. The second pilot phase came in 2017, in which the implementation of the pilot plan, 2016 was implemented in the summers of 2017. An updated version of the Heat Action Plan was released in 2018[42].

Key features of the Surat HAP 2018

The Surat HAP has a detailed communication plan for effective management of heat wave in the city. Key features of the Surat HAP are as follows:

- The Health and Hospital Department of the Surat Municipal Corporation is nodal and lead agency for monitoring and supervising overall plan of the city. They will monitor heat early warning system and disseminating public health massages to Information System Department (ISD) of the Surat Municipal Corporation.

- The Plan also focuses medical professionals and organizations, such as Major Hospitals, Urban Health Centres (UHCs) and community workers, who frequently meet with vulnerable people

[42] Surat Heat Wave Action Plan http://resiliencestrata.org/uploads/publication/1D97E6B4-57F2-4371-9DB7-7DF79D93BA21.pdf

and can provide early diagnosis of heat-related illnesses and preliminary treatment.

Surat Heat Wave Action Plan http://resiliencestrata.org/uploads/publication/1D97E6B4-57F2-4371-9DB7-7DF79D93BA21.pdf

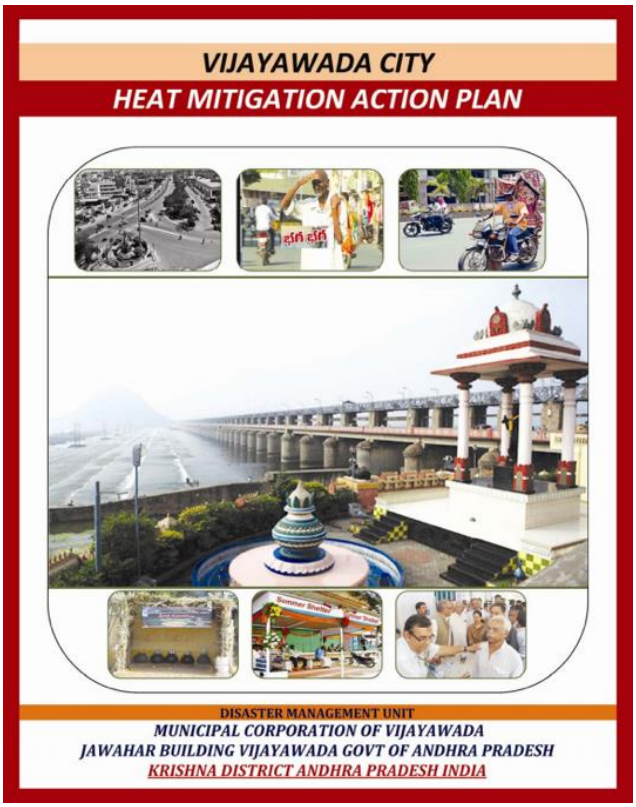
- NGOs, CBOs, SHGs, Individual, FM radio channels and the media are also part of the information dissemination to the vulnerable group and support fighting the effects of extreme heat.

6.4 Vijayawada City Heat Mitigation Action Plan

Vijayawada Municipal Corporation prepared a Heat Mitigation Action plan[43] to mitigate and adaptation by public to overcome heat stress and heat waves impact various actions and initiatives and facilitate preparedness of city functionaries by involving all key stakeholders in the city. It did so by taking reference of expert recommendations and heat action plan of Ahmadabad City.

Key Features Vijayawada Heat Action Plan

- The HAP calls for Emergency Operation Center, which will be the e-Information centre to aim for an effective and realistic City Heat Mitigation Plan with full proof communication, coordination and accurate database in order to make optimal utilization of Men, Material and Resources to prevent, preparedness and implementation of plan for minimize the loss to lives as well as property and ensuring fastest restoration of the situations.



Vijayawada Heat Mitigation Action Plan http://www.vmcdm.org/knowledge/HAP_VIJAYAWADA.pdf

- The HAP calls for implementation of the plan in three phases
    1. Preparation phase [January to March]
    2. Alert phase [April to June]

[43] Vijayawada Heat Mitigation Action Plan http://www.vmcdm.org/knowledge/HAP_VIJAYAWADA.pdf

3. Evaluation phase [July to September]

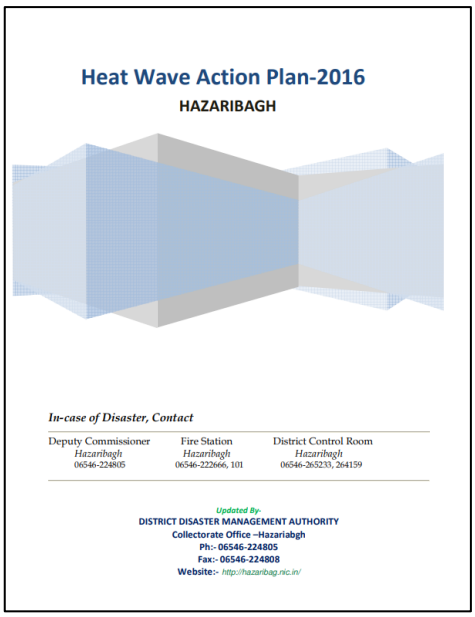
- It lists out a set of Core Initiatives for adaptation and resilience mechanisms in the city, including options for long-term adaptation.

7. India District Heat Action Plans

7.1 Hazaribagh Heat Action Plan

Heat Wave Action Plan of Hazaribagh has been prepared to spell out a standard action and operation mechanism for disaster management district wide.

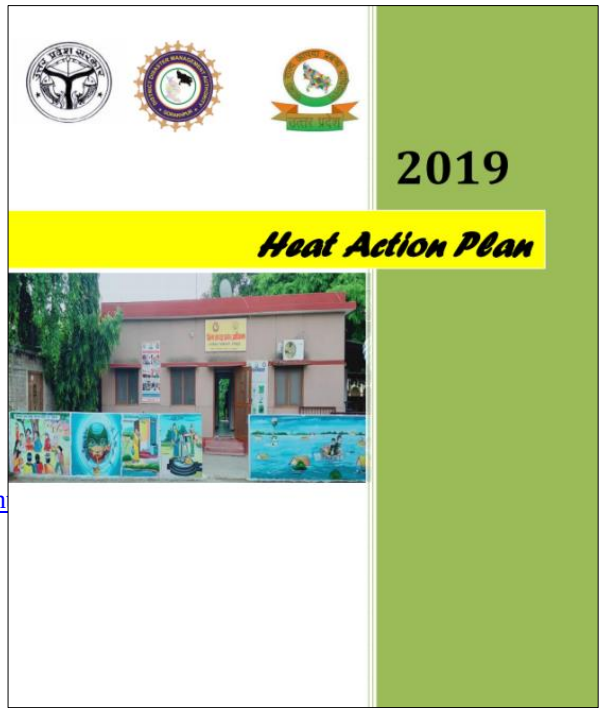
- Hazaribagh district is still in the process of strengthening its HAP. In order to prepare, and take necessary mitigative action the Hap proposes collection of data on the age group, sex and occupation of those who die of heat wave, heat impact in indoors and outdoor, and the economic status of the people heat wave victims.
- The HAP lists out Vulnerable groups of population, the reason for inadequate coping in those vulnerable groups and the treatment protocol for the same.



https://cdn.s3waas.gov.in/s3ed265bc903a5a097f61d3ec064d96d2e/uploads/2018/05/2018052643.pdf

7.2 Gorakhpur Heat Action Plan

District Disaster Management Authority (DDMA), Gorakhpur prepared a Heat Action plan in 2019[44] to develop strategies and efforts that can contribute in mitigation of heat wave in the vicinity of Gorakhpur. It did so by taking inputs and technical support from UNICEF, Uttar Pradesh.



[44] Gorakhpur Heat Action Plan 2019 https://www.preven

The primary objective and function of the HAP was defined as follows

- Development of a dynamic early warning dissemination network.
- Entrusting stakeholders with responsibilities for enabling communities to combat heat waves in Gorakhpur.
- Catalyzed preparedness of the schools & community level responders like Aapda Mitra
- Promoting adaptive & economical CCA related measures to combat heat waves in Gorakhpur.
- Formulation of a system for public outreach for the dissemination of forecast.

Gorakhpur Heat Action Plan 2019
https://www.preventionweb.net/files/68564_68562sopforheatwave2.pdf

Key Strategies of the Gorakhpur HAP

Pre-heatwave, during heatwave and post-heatwave roles and responsibilities were clearly defined for various authorities like DDMA, Municipal corporation of Gorakhpur, health department, Panchayat raj, Labour department, industrial department, transport & tourism department, electricity and water department, animal husbandry department, and the press media.

7.3 Heat Action Strategies in other States and Cities

7.3.1 Madhya Pradesh

Madhya Pradesh addresses Heatwave adaptation and response strategies in its State Action Plan for Climate Change. The action plan says[45] that "the State is committed to provide health care facilities to the poorest of the poor in the society through primary health care including preventive, curative and promotive care. Objectives have been to reduce infant mortality rates, universal immunisation of childhood diseases, integrated comprehensive primary health care, provision for village level health activities in underserved villages, preparation of panchayat level health action plan, institutionalising district level management of health, increased utilization of 1st referral units."

8. Heat Action Plans in Other South Asian Countries

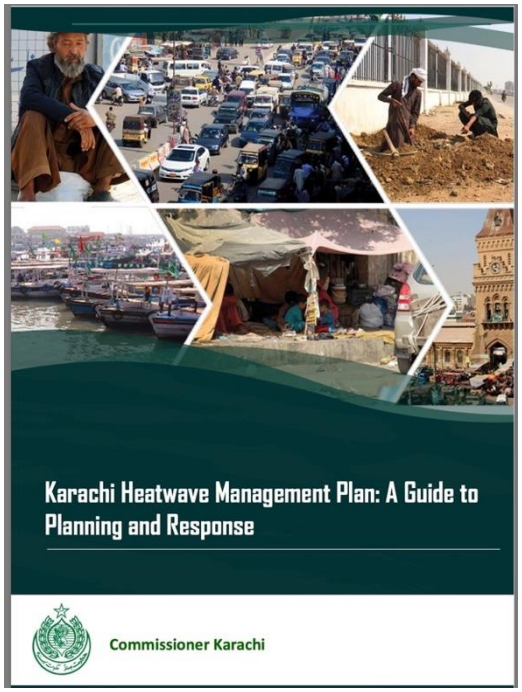
8.1 Pakistan Heat Wave Action Plan

It is a three-tier plan which seeks to help and protect vulnerable communities by informing them about the high temperatures and making them aware of the precautions that can be taken. The plan follows all the guidelines issued by NDMA and suggestions from international experts. The plan looks for long term strategies along with short term strategies. It works on reducing the occurrence of heatwaves as it is difficult to predict its intensity. The

[45] Madhya Pradesh State Action Plan on Climate Change
http://www.epco.in/pdfs/ClimateChange/MP_State_Action_Plan_on_Climate_Change.pdf

plan promotes the tree plantation with the aim that in 5 years, a tree gives a good canopy cover which can help in absorbing atmospheric carbon-dioxide and giver out more and fresh oxygen along with regularizing rainfall, which would in turn reduce the impacts of UHI.

8.2 Karachi Heat Wave Action Plan



In June 2015 Karachi City experienced a severe heatwave that caused over 1,200 deaths and over 50,000 cases of heat illness. The heatwave caught all levels of government and first responders off-guard, highlighting the need for inter-agency coordination, clarity in roles, and a well-publicized trigger to activate a planned response. To address this need and to prevent health impacts from future heatwaves as climate change intensifies, the Commissioner Office Karachi requested support from the Climate and Development Knowledge Network (CDKN) to develop a heatwave management plan. Karachi's first Heatwave Management Plan[46] (2018) is the result of a technical assistance project delivered by national and international experts between October 2016 and May 2017, working closely with the Commissioner Office and other stakeholders. The Plan will be subject to an annual performance review and updated versions will be available to implementation partners accordingly.

The Plan covers all facets of a comprehensive response to heatwave management but focuses on planning and action during the heat season. The Plan is specifically for agencies that could most contribute to managing the consequences of extreme heat and heatwave emergencies in Karachi and for those organizations that deal most directly with people most vulnerable to heat stress. Providers of basic services and major media outlets should also consult this Plan. Leadership will be provided by the Commissioner for Karachi with important roles being played by Local Governments, the Pakistan Meteorological Department, healthcare providers, utilities, and social welfare organizations. Specific roles and responsibilities for each organization are described within the Plan.

(Accessible at : http://www.lead.org.pk/attachments/HeatwaveManagementPlan.pdf)

8.3 Nepal Heat Action Plan (2017)

The Nepal Disaster Management Act implemented in August 2017, recognized Heat Wave as Disaster. The plan elaborated on the increase in the summer maximum and minimum temperature through 2007-2016, however no heat related deaths have been recorded during

[46] Karachi Heat Wave Management Plan http://www.lead.org.pk/attachments/HeatwaveManagementPlan.pdf

the said period. The Plans sets in the Heat/ Temperature Threshold at 43-45^{0}C (summer temperature of Nepaljung city) and identifies the Poor Section/ Slum dwellers, Old aged, Children, local vendors and Hawkers, Daily wages workers, Rickshaw pullar and similar working class people as the vulnerable section.

To mitigate the impact of Heat Wave the Government has taken the initiates like:

- Rapid Response Team- Doctors, nurses social workers, Civil societies, Elected members and Govt officials
- Alert the hospital Pre and Post Disaster
- Create Awareness team for a community
- Media management

Along with Institutional set-up the Plan recognizes the importance of establishing of water Distribution point in public place, community Cool rooms and cool place, allotting additional fund and budget for heat wave management.

8.4 Sri Lanka Heat Action Plan (2005)[47]

Sri Lanka average temperature has increased by 1.0 C over the last 60 years from 1961 to 2010 (Premalal, 2010), along with the number of days with higher temperature values has also been reported during recent years. It has been observed that compared to the global trend of increasing temperature (0.74 C), the increasing trend in Sri Lanka is very significant.

Four main Strategic areas have been identified and activities under the same as the core elements of HAP:

2. Building public awareness & community outreach – by s

3. Capacity building of health systems and health care staff for heat wave actions

4. Promotion of adaptive measures and reducing exposure – advocating

8.5 Male Heat Action Plan

The Plan defines the Roles and responsibilities of the key stakeholders at the city and State level.

1. National Disaster Management Centre- Disseminate Heat wave alerts accordingly, Monitor and assess HW impacts, Facilitate necessary aids during emergency, Public awareness on heat wave, Conduct table-top exercises

[47] http://saarc-sdmc.org/saarc-training-programme-heat-wave-preparedness-and-response-saarc-region

2. Health Protection Agency- Regulate, monitor, evaluate and assess heat wave related health issues in hospitals and clinics, Preparedness at the local level for health system, Collaboration with non-governmental and civil society , Public awareness on heat wave
3. Maldives Meteorological Service - Define heat wave threshold , Public awareness , Issue temperature forecast on timely basis., Monitor and issue HW alerts
4. LGA and NGO's-First responders, Public awareness, Facilitate provisional needs when necessary

9 Impact of Heat Action Plans

9.1 Impact at National Level

India has experienced a lot of heat wave incidences, since 2006. 2017 witnessed the 4th consecutive heat wave in India out of which the year 2016 had the deadliest heatwave. Heatwaves in India took a large number of deaths in 4 years (2014-2017). India experienced a loss of 4,500 lives in 4 years' period alone. The baseline death rate due to heat induced climate change in the early 2000s in India was 550 per 100,000 of the population. India is projected to see 10% increase in death rates due to climate change (Climate Impact Lab, 2019).

Following Heat Wave Action measures by the NDMA in 2016 and the subsequent drafting of Heat Wave Action Plans by many states, the number of deaths in the country came down significantly. Taking the success story forward, NDMA in 2017 organized a national workshop on heat wave at Hyderabad in Telangana. In 2018, NDMA conducted a national workshop on Preparedness, Mitigation and Management of Heat Wave with all stakeholders. In 2019, NDMA in collaboration with Govt. of Maharashtra organized a Workshop, the recommendations of which were incorporated in National Guidelines for Preparation of Action Plan, Prevention and Management of Heat Wave (October 2019).

The Integrated Disease Surveillance Programme (IDSP) under the National Centre for Disease Control (NCDC) of the Ministry of Health and Family Welfare (MoH&FW) is responsible to collect and record data regarding the heat waves and related mortality and morbidity.

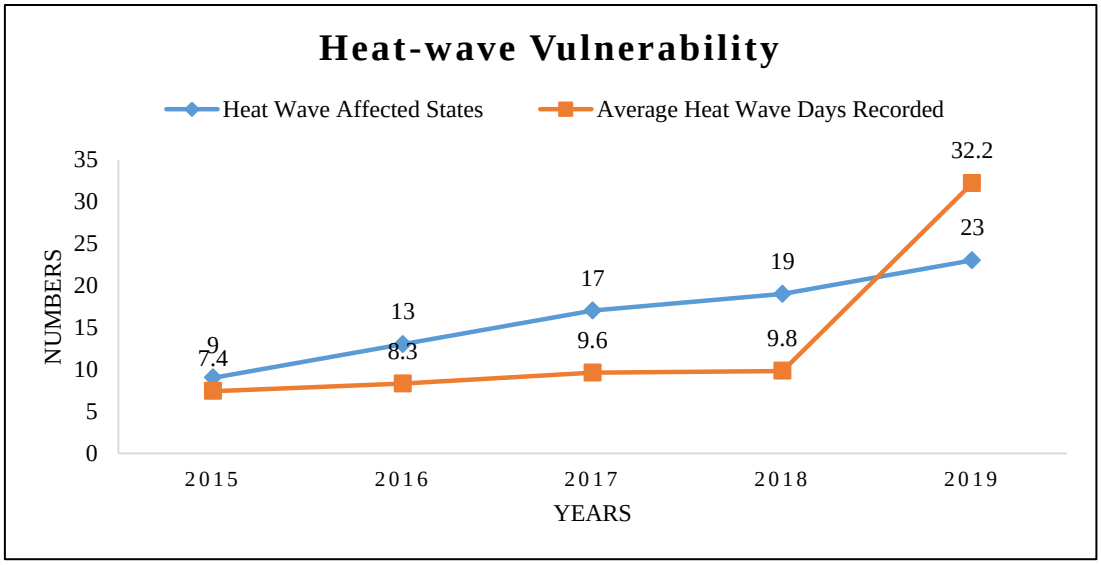


Figure 1:Heat Wave Vulnerability

Source: Forecast Demonstration Project(FDP) for Improving Heat Wave Warning over India, Implementation Report, 2019, IMD, New Delhi

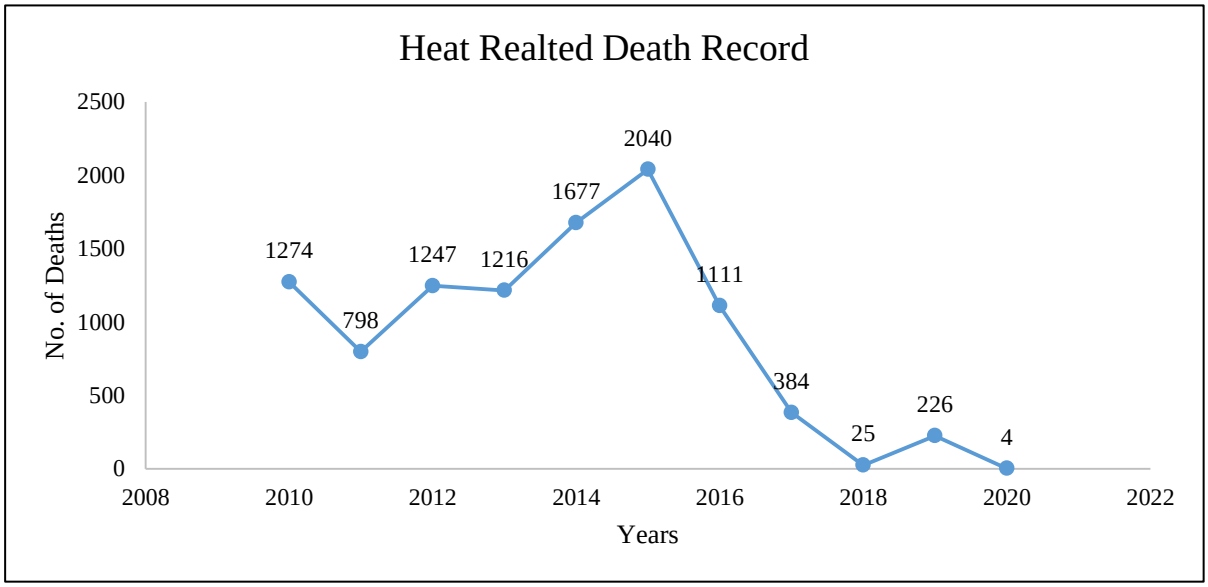


Figure 2:Heat Related Mortality Records (2010-2020)

Source: NDMA

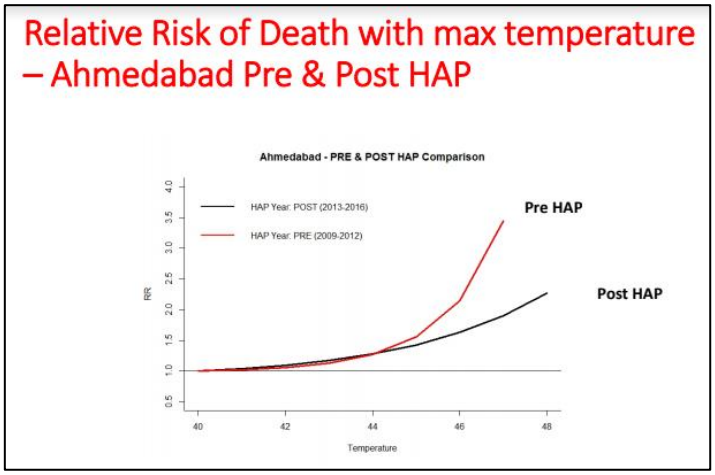
The records suggest that though the phenomenon of Heat waves have been increasing over the past several years across states, districts and cities in India, the heat related mortality has decreased (NDMA)[48]. The introduction and adaption of the Heat action Plans across the cities of India, has helped in decreasing Heat related mortality significantly.

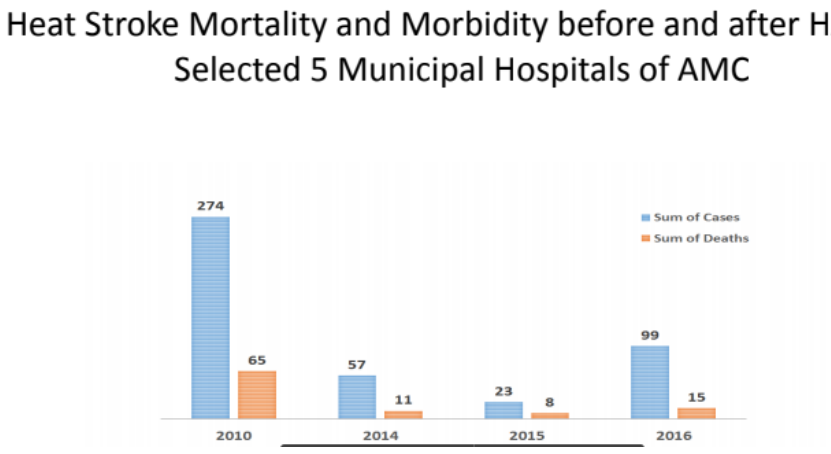
9.1.1 Impact of Ahmedabad HAP

HAP implementation resulted in reduction of all-cause mortality during heat stress period and also decreased heatstroke cases and deaths in the sentinel hospitals. An analysis of the heat death rate in Gujarat from 2016 to 2017 indicates that there has been a sharp decrease in the numbers, which indicates the plan has been successful despite the increase in temperatures. Mortality has come down 20-25% with the implementation of the HAP (IIPH-G – the Hindu, 2017).

[48] https://ndma.gov.in/sites/default/files/IEC/Booklets/HeatWave%20A5%20BOOK%20Final.pdf

Further, a 2018 study evaluated the effectiveness of the Ahmedabad HAP before and after implementation. The study found that an estimated 2,380 deaths were avoided in the post-HAP period. The findings suggest that the Ahmedabad HAP protected health against mortality associated with extreme heat. The study evaluated the HAP's impact on all-cause mortality in 2014–2015 relative to a 2007–2010 baseline and found a decrease in all-cause mortality in the first two years (2014–2015) the HAP was implemented.





An evaluation report[49] that assessed the effectiveness of Ahmedabad's HAP has yielded the following key findings

- The Plan created better awareness of the health dangers of extreme heat among stakeholders through training and capacity building, especially among government, health and emergency response professionals. Given early hesitations about the success of an early warning system DRAFT ISSUE BRIEF 4 and preparedness plan for heat in India – where such a plan had never been implemented previously – the inaugural 2013 Heat Action Plan in Ahmedabad exceeded expectations.
- There have been fewer city-reported deaths during Ahmedabad's annual heat season in the years since the Heat Action Plan was launched. In other words, the Plan may already be saving lives since its implementation in 2013, and it continues to protect more residents each year as the Plan's activities and impact expand.
- Temperature forecasts and corresponding heat alerts have been accurate, building confidence for longer-term forecasts and an early warning system that can offer residents and the government agencies involved in the Heat Action Plan more time to prepare before heat waves hit.

[49] https://www.nrdc.org/sites/default/files/ahmedabad-hap-evaluation.pdf

9.1.2 Impact of Surat HAP

In the past two years, the numbers dying from heat-related illnesses has fallen sharply, from 2,040 in 2015 to a little over 200 in 2017, according to government data. The number of people known to have fallen ill because of extreme temperatures has come down from almost 40,000 cases in 2017 to a little over 1,000 in 2018[50].

9.1.3 Impact of Maharashtra Heatwave Action Strategies

After incorporating the HAPs, the state of Maharashtra developed a state-wide awareness campaign using media, such as text messages, local television advertisements, pamphlets, hoardings, local newspapers, radio jingles, WhatsApp messages, among others.[51] The government has also been working to modify office and school timings, as well as working hours for rural workers to avoid the hottest time of day.

Other efforts include providing drinking water at public transit locations, keeping markets closed in the afternoon, providing public shelters, equipping traffic police with cool jackets and helmets, sprinkling mist at public places and keeping ice bags available at public health centers[52]. HAP helped the form the guidelines for the establishment of long-term measures to combat heat including town planning to reduce heat vulnerability with afforestation, plantation drives, rainwater harvesting, providing shelter for traffic police, using green nets for shade in market areas and strengthening inter-sectoral coordination.[53] These measures are likely to equip vulnerable communities with better adaptive capacity and mitigate the impacts of heat waves.

10.Gaps in Existing Heat Action Plans

Most of the HAPs in India are responsive in nature. i.e., the adaptation and mitigation measures are designed to help authorities and communities to respond to occurrence of a heat wave event, as opposed to proactive measures. For HAPs to be effective, they need to be climate sensitive, contextualized to localized socio-economic patterns, and potential adaptive capacity of the particular communities in focus.

- *Climate Insensitivity:* The HAPs (except Odisha and Rajkot HAPs) lack climate analysis of the city or state where it will be implemented. This is a major disadvantage and drawback, making the HAPs static and rigid in their functional efficiency. A detailed review of historical climatology is essential to understand the areas of importance or heat hotspots where these HAPs are most required. A failure to narrow down on critical areas will result in weakened impact of HAP in those region and inefficient resource use. Inclusion of a

[50] https://edition.cnn.com/2018/06/21/health/india-heat-wave-deaths-decline-intl/index.html
[51] Same as above
[52] Same as above
[53] Same as above

historical climate perspective will enable cities and states to anticipate and prepare for specific trends of heat waves, their magnitude, and onset, thus improving the overall response to the heatwave incidences.

- *Understanding Heat Hotspots:* Besides evaluating the heat hotspots, the HAPs must also include the external factors that influence the heat profile of the areas under focus. Factors like Urban Heat Island and how they interact with the existing heat hotspots must be studied and included to help authorities understand the actual changes in temperatures during, before and after the heatwave occurrences. However, most HAPs lack this analysis.

- *Failure to include assessment of Socio-economic differences in Heat Stress Prone Areas:* The HAPs fail to evaluate the household-level socio-economic status of people living in areas that are prone to severe heat stress. The lack or presence of cooling solutions, ability to affords them, the ratio of size to inhabitants, the community infrastructure – all play a key role in understanding the ability of the residents to respond to heat waves. It also can help inform priority areas for implementing adaptation and mitigation infrastructure.

- *Not Climate- Vulnerability Based:* Ignoring historical climate trends and ground level assessment of hotspots and *socio*-economic status has made the HAPs static in nature. The HAP framework thus is not equipped to make pre-emptive strategies for key vulnerable areas and those facing the highest risk from heat waves.

- *Understanding Climate Change Projection:* Very few Action Plan Strategies (like Telangana Heat Action Plan) have given due consideration to the climate change projections and its cumulative impact of the growing urban population. he impact of urbanisation and climate change on Heat Waves needs to be studied in detail and considered while framing Action Plans.

- *Need to Develop Heat-Wave Index:* Till date the Heat Index (HI) adopted by the National Oceanic and Atmospheric and Administration's (NOAA) National Weather Service (NWS) 1979[54] is being used across India and South Asia. This temperature-humidity Index chart developed by US National Weather Services, may not be applicable in the Indian context, but the heat index calculation based on the chart produces meaningful results. However detailed research is required to develop Heat Wave Index based on Temperature, Humidity and Wind speed

- *Need to develop Ward-level Heat Stress Thresholds*: The threshold temperature for an increase in heat-related mortality depends on the local climate and is higher in warmer locations. However, there are no thresholds computed for Indian cities specific to region, group (gender, age and other vulnerabilities) exposure, occupation. Ward-level threshold for all major cities is required to be developed.

- *Need to Expand Scope of HAPs: Heat wave has been recorded to cause death of cattle and wildlife besides affecting animals in various zoos.[55] It's usually observed that the Main focus of existing HAPs is on Human Health. There is need to expand scope by*

[54] https://journals.ametsoc.org/doi/pdf/10.1175/WCAS-D-15-0037.1
[55] https://vmc.gov.in/pdf/Annoucement/2020/Heat%20Wave%20action%20Plan%202020-21.pdf

considering health and wellbeing of animals, poultry, fisheries, agriculture productivity and forest fire

Heat Wave Early Warning by the IMD is based on broad based Maximum Temperature criteria. The warnings are based on deviations of forecasted temperatures from their climatological normal rather than a consideration of their impact on human population. Mortality based threshold studies (as in the case of Ahmedabad and Nagpur) have shown that Maximum Temperature thresholds are location specific. Determination of location specific threshold requires health (morbidity and mortality) data, which is not readily available. NDMA, India Meteorological Department (IMD), and Indian Institute of Public Health (IIPH) Ahmedabad jointly selected 103 cities for determining local heat-health early warning threshold using city specific temperature and mortality data, wherever available. Study recommended 75th, 85th and 95th percentile values of maximum temperature as yellow, orange and red alert threshold for heat-health early warning systems of respective cities where mortality data was not available. City specific threshold are available in NDMA publication of September 2019 entitled “A Preliminary Study to Estimate Temperature Threshold for Heat Wave Warning in India”. The thresholds proposed in the study needs to be evaluated against all-cause mortality data.

11Climate Adaptive Heat Action Plans

For HAPs to be effective, the most vulnerable areas within a city must be prioritized. This can be done through a comprehensive climate profiling of the city, understanding the socio-economic status of people within the vulnerability hotspots, and identification of the most vulnerable wards within the city. A climate adaptive HAP is essential to addresses the following unique functions in a city’s effort to adapt and mitigate heat stress:

- Provide a climate-sensitive framework for implementation, coordination and evaluation of extreme heat response activities in cities.
- Alert those populations at risk of heat-related illness in places where extreme heat conditions prevail, by adopting dynamic climate intelligence.

Key Phases in the Development of a Climate Adaptive Heat Action Plan being proposed :

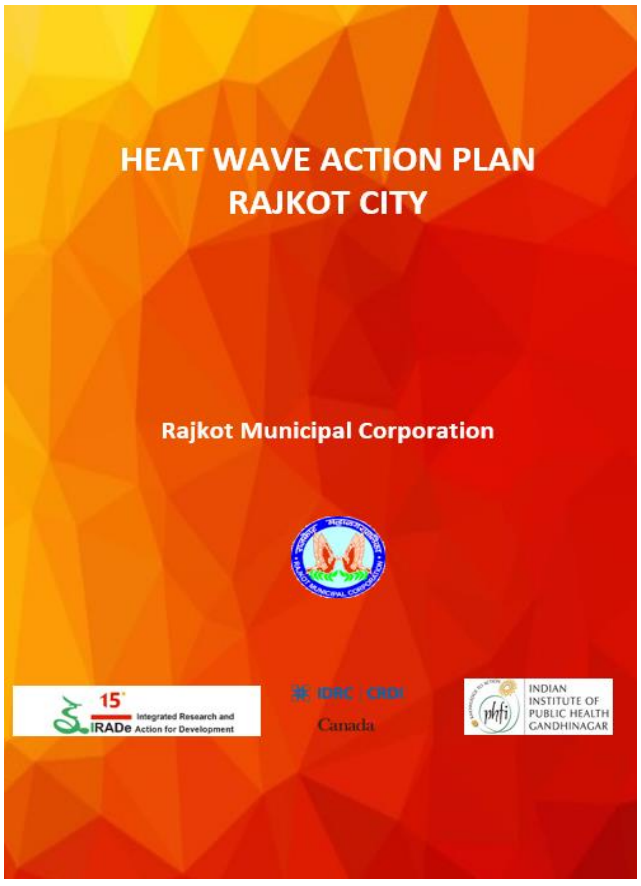
- Climatological variations, historical Climatology Assessment & Climate Projections
- Records of heat related Mortality and Morbidity
- Development of Thermal Hotspot maps
- Identification of ward-level vulnerability to Heat Stress (using the comprehensive index, comprising 10 sectors - Sanitation, Water, Electricity, Health, Transportation, Housing, Cooking, Awareness and Heat symptoms and their respective sub sectors), Green- cover and open space.
- Generation of Vulnerability Hotspot maps (based on thermal hotspots and vulnerability)
- Development of climate and gender sensitive Heat adaptation and mitigation strategies
- Drafting of Climate Adaptive Heat Action Plan with stakeholder engagement and community participation

- Final Climate Adaptive Heat Action Plan that prioritizes the most vulnerable, prescribing heat adaptation and mitigation strategies that are climate sensitive.
- Capacity Building and Sensitization of the community through proper dissemination and outreach activities

So far, only Odisha HAP 2020 has included a climate adaptive HAP. Rajkot Municipal Corporation is in the process of Implementing its climate adaptive heat action plan.

11.1 Rajkot Climate Adaptive Heat Action Plan

Integrated Research & Action for Development (IRADe), in collaboration with International Development Research Centre (IDRC), Govt. of Canada Rajkot Municipal Corporation and Indian Institute of Public Health (IIPH)-Gandhinagar has developed Climate Adaptive Heat Stress Action Plan for the city of Rajkot.



The Climate Adaptive Action Plan provides a framework for implementation, coordination and evaluation of extreme heat response activities in Rajkot, along with creating awareness among individuals at risk of heat-related illness, including concerned departments to reduce the impact of heat waves on health, productivity and livelihood.

Salient Features

The Action Plan incorporated detailed review of historical climatology, ward-level temperature profiling, vulnerability assessment, and the evaluation of heat risks and vulnerability hotspots.

Climatological variance

The climatological Variance was analysed on the parameters of Maximum Temperature (Tmax), Minimum Temperature (Tmin), Relative Humidity measured in the morning at 8:30 AM [RH (830)], and Relative Humidity measured in the evening at 5:30 PM [RH (1730)]. The assessment indicated climate parameters (increase in minimum temperature along with humidity) increasing for the month of March. This has led to the increase in number of heat wave events as well as early arrival of hot days. Hence, Local authorities need to be prepared earlier in the month of March.

Thermal Hotspot Mapping

The Hotspot Maps indicated areas within the city which experience ambient temperature in excess of the average monthly maximum temperature. These helps in focusing on interventions where they are most needed during heat waves. To assess spatial distribution of heat stress at ward level in Rajkot, the researchers first mapped thermal heat spots maps were developed using Landsat 8 data. The LST derived from satellite data (NDVI – Normalised Difference Vegetation Index and LSE –Land Surface Emissivity) was validated with ambient air temperature recorded by IMD station within the city as well as the data received from 20 AWS stations installed within the city by RMC.

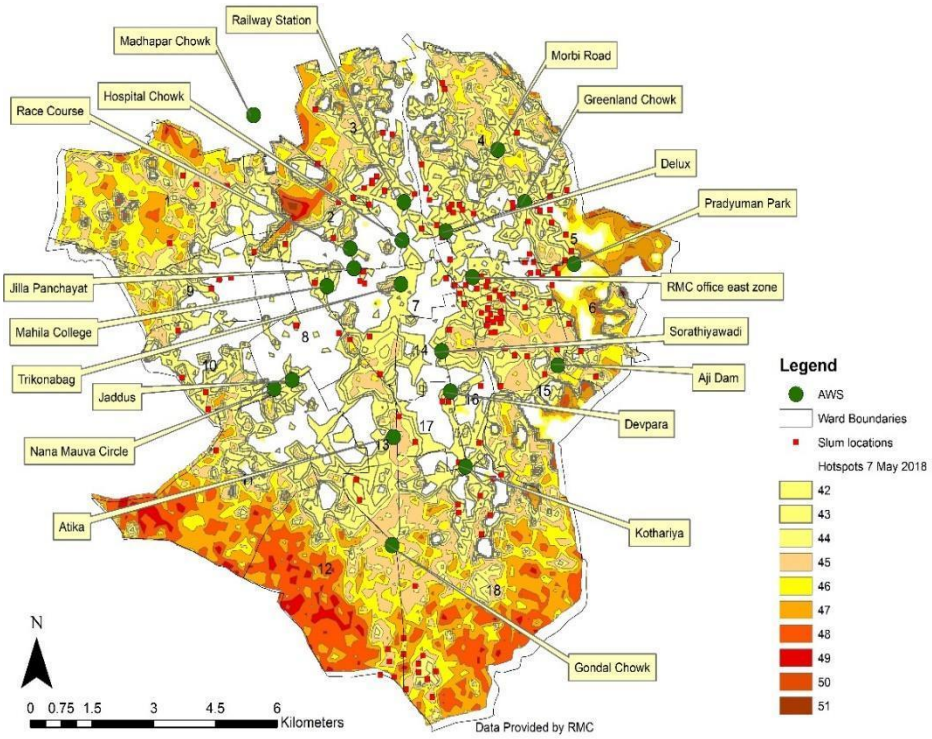
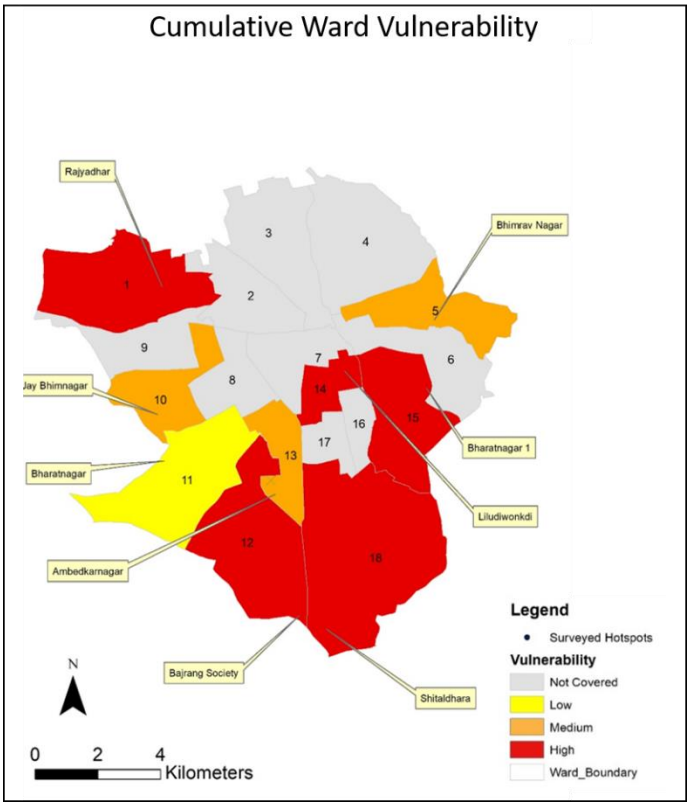


Figure: Thermal Hotspot Mapping - Wards with temperature above 42^{O}C

The analysis indicated hotpots were located in ward numbers 1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 15 and 18. Peripheral regions of Rajkot showed higher temperatures than the central regions

Heat Stress Ward Level Vulnerability Mapping



Heat stress vulnerability across the above identified wards in hot spot areas of Rajkot were analyzed using the comprehensive index, comprising nine sectors - **Sanitation, Water, Electricity, Health, Transportation, Housing, Cooking, Awareness and Heat symptoms** and their respective sub sectors. The **cumulative ward wise heat stress vulnerability analysis** indicated that nearly 5 wards in Rajkot are highly vulnerable and minimum basic amenities available to the vulnerable group to cope with heat stress

Vulnerable wards	Wards Number (Out of 10 Thermal Hotspots)	Total
Low	(11)	1
Medium	(10 , 13 , 5)	3
High	(14 , 15 , 18 , 12 , 1)	5

Impact of Heat Stress on Productivity and Livelihood

Slum distribution in Rajkot was mapped in GIS (Geographic Information System), and overlaid on LST maps to identify vulnerable hotspot maps. The wards identified as most vulnerable to heat stress were: Ambedkar Nagar, Rashulpura, Bajrangnagar, Rajyadhar, Shitaldhar, Jay Bhim Nagar, Bharat Nagar 1, Pradyuman park and Laludiwonkdi.

Vulnerable populations in Rajkot are those who have to stay outside for work all day long and have limited options to protect themselves, for example, vendors, beggars, shopkeepers, policemen, auto/rickshaw drivers. The casual labourers are most affected by the high heat days. As the maximum wage loss is reported in the daily casual labourers (35%).

The average wage loss in the city falls under the category INR 1 to 999 followed by INR 3000 and above. It is observed that the occupation with average wage loss in the category 1 to 999 are majority casual workers. It is observed that the majority of males (75% out of the total) experience wage loss due to heat as compared to the women involved in work.

With the loss in wages the productivity of the individuals is also highly affected. Majority (64%) of the working population had reported the loss in the working days by 1 to 5 days during the heat stress period followed by 10 to 15 days (21%) in a month. Males (64%) are at a greater loss as compared to females.

The final Heat Action Plan, informed by the comprehensive analysis of the climatology and vulnerability of wards in Rajkot, provides a framework for implementation, coordination and evaluation of extreme heat response in Rajkot. It guides on mitigative and adaptive measures to avert loss of life and productivity.

The plan intends upon being more spatially oriented and gender-sensitive while supporting the city's planning especially in prioritizing and integrating adaptive resilience within the agenda towards climate resilient smart city. The Heat Action Plan is designed to bring together all stakeholders for a citywide strategy in enforcing preventive, mitigative and adaptive measures to check heat-related debility among people.

The Action Plan lays out the essential components of preparedness of mitigative and adaptive measures:

- Build Public Awareness and Community Outreach
- Use Early Warning Weather Forecasts for Inter-Agency Coordination
- Develop Capacity Among Healthcare Professionals
- Reduce Heat Exposure and Promote Adaptive Measures

The Plan aims towards medical emergency preparedness and effectively responds to health emergencies during the Pre-heat seasons, During Heat seasons and Post heat seasons. The adaption and mitigation measures has been classified into short term, medium term and long term measures including :

- Awareness Campaigns
- Mitigation measures
- Early warning communication
- Medical Preparedness
- Monitoring and Analysis

The final Heat Action Plan, informed by the comprehensive analysis of the climatology and vulnerability of wards in Rajkot, provides a framework for implementation, coordination and evaluation of extreme heat response in Rajkot. It guides on mitigative and adaptive measures to avert loss of life and productivity. The plan will help alert populations at risk of heat-related illness, such as in places where extreme heat conditions either exist or are imminent, and to take appropriate precautions. The Heat Action Plan is designed to bring together all stakeholders for a citywide strategy in enforcing preventive, mitigative and adaptive measures to check heat-related debility among people.

11.2 Bhubaneswar Climate Adaptive Heat Action Plan

Integrated Research & Action for Development (IRADe), in in collaboration with International Development Research Centre (IDRC), Govt. of Canada, Bhubaneswar Municipal Corporation and Indian Institute of Public Health (IIPH)-Bhubaneswar has developed Climate Adaptive Heat Stress Action Plan for the city of Bhubaneswar.

The Climate Adaptive Action Plan provides a framework for implementation, coordination and evaluation of extreme heat response activities in Bhubaneswar, along with creating awareness among individuals at risk of heat-related illness, including concerned departments to reduce the impact of heat waves on health, productivity and livelihood.

Salient Features

Like Rajkot's HAP, the Bhubaneswar HAP follows the standard research methodology for the inclusion of climate adaptive elements in the HAP. It incorporated detailed review of historical climatology, ward-level temperature profiling, vulnerability assessment, and the evaluation of heat risks and vulnerability hotspots.

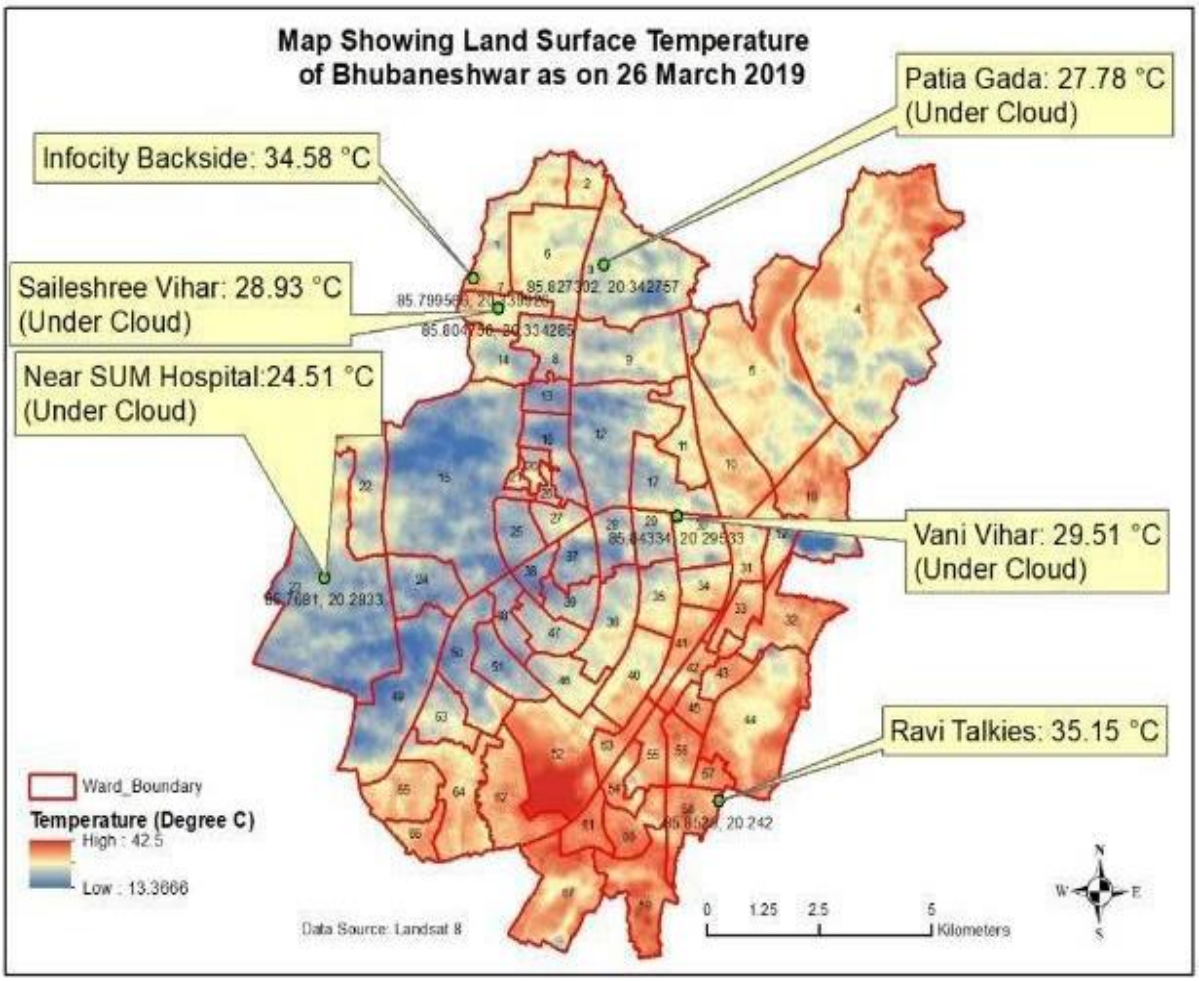
Climatological variance

The climatological Variance was analysed on the parameters of Maximum Temperature (Tmax), Minimum Temperature (Tmin), Relative Humidity measured in the morning at 8:30 AM [RH (830)], and Relative Humidity measured in the evening at 5:30 PM [RH (1730)]. The climate parameter assessment showed a sharp temperature increase in the month of March, which suggests Bhubaneswar is experiencing relatively more heat in the month of March. Increase in minimum temperature along with evening humidity were highlighted as reasons for potential increase in Heat Stress morbidity and mortality in the coming years

Thermal Hotspot Mapping

The Hotspot Maps indicated areas within the city which experience ambient temperature in excess of the average monthly maximum temperature. These helps in focusing on interventions where they are most needed during heat waves. To assess spatial distribution

of heat stress at ward level in Bhubaneswar, the researchers first mapped thermal heat spots maps were developed using Landsat 8 data. The LST derived from satellite data (NDVI – Normalised Difference Vegetation Index and LSE –Land Surface Emissivity) was validated with ambient air temperature recorded by IMD station within the city



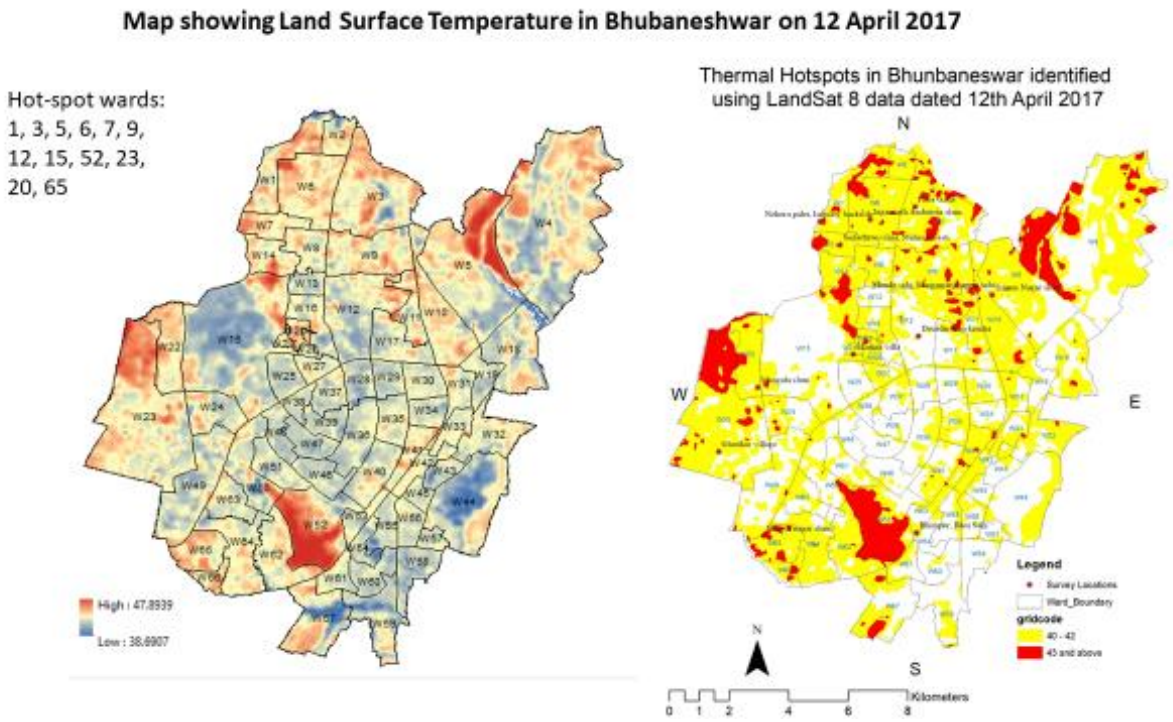
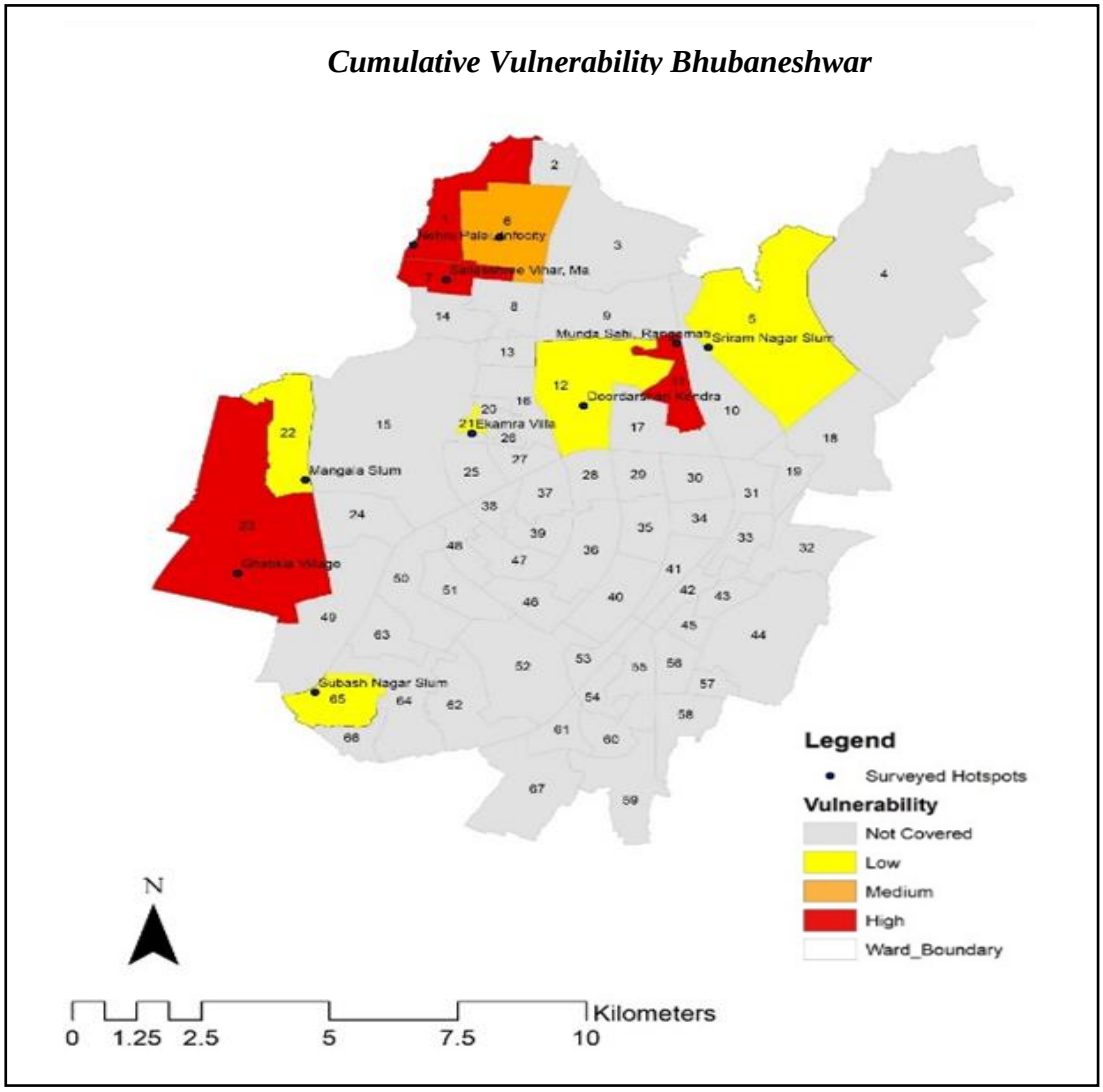


Figure 8: Ward level Hot Spot Map of Bhubaneshwar city, with Temperature above 40^{o}C

The LST maps of April and May 2017, it is observed higher temperature is consistently experienced in ward numbers 1, 3, 5, 6, 7, 9, 12, 15, 52, 23, 20, and 65

Heat Stress Ward level Vulnerability Mapping

Heat stress vulnerability across the above identified wards in hot spot areas of Rajkot were analyzed using the comprehensive index, comprising nine sectors - **Sanitation, Water, Electricity, Health, Transportation, Housing, Cooking, Awareness and Heat symptoms** and their respective sub sectors.



Vulnerable wards	Wards Number (Out of 10 Thermal Hotspots)	Total
Low	(20 , 12 , 15 , 5 , 65)	**4**
Medium	(6)	**1**
High	(7 , 23 , 9 , 1)	**4**

The **cumulative ward wise heat stress vulnerability analysis** indicated, nearly 4 wards in west Bhubaneshwar are highly vulnerable and minimum basic amenities available to the vulnerable group to cope with heat stress

Impact of Heat Stress on Productivity and Livelihood

Distribution maps of Bhubaneswar municipal wards and slums was obtained from BMC. Slum distribution in Bhubaneswar was mapped in GIS (Geographic Information System), and overlaid on LST maps to identify vulnerable hotspot maps. The wards identified as most vulnerable to heat stress were: Nehru palei, Infocity backside, Sriram Nagar slum, Jagannath Ambatota slum, Sailashree vihar, Mahavir vasti, Munda sahi, Rangamatia upara sahi, Doordarshan Kendra, Ekamra villa, Ghatikia village, Mangala slum and Subash nagar slum. Vulnerable population in Bhubaneswar are those who have to stay outside for work all day long and have limited options to protect themselves, for example, vendors, beggars, shopkeepers, policemen, auto/rickshaw drivers

The analysis indicated casual workers are the ones majorly affected by the heat stress. The majority wage loss is observed in the casual labours across various occupations as they are highly exposed to the direct heat. The average wage loss in the city is the range INR 1 to 999*:* Majority of the males reported wage loss due to heat. The average monthly wage loss for women is INR 600 while meals it is INR 700. Almost 40 % of the people reported productivity loss ranging from either 1-15 days, which include a number of reduced working hours and absenteeism from the work. It is observed that majority of the males have reported maximum productivity loss

The final Heat Action Plan, informed by the comprehensive analysis of the climatology and vulnerability of wards in Bhubaneswar, provides a framework for implementation, coordination and evaluation of extreme heat response in Bhubaneswar. It guides on mitigative and adaptive measures to avert loss of life and productivity.
The plan intends upon being more spatially oriented and gender-sensitive while supporting the city's planning especially in prioritizing and integrating adaptive resilience within the agenda towards climate resilient smart city. The Heat Action Plan is designed to bring together all stakeholders for a citywide strategy in enforcing preventive, mitigative and adaptive measures to check heat-related debility among people.

The Action Plan lays out the essential components of preparedness of mitigative and adaptive measures:

- Build Public Awareness and Community Outreach
- Use Early Warning Weather Forecasts for Inter-Agency Coordination
- Develop Capacity Among Healthcare Professionals
- Reduce Heat Exposure and Promote Adaptive Measures

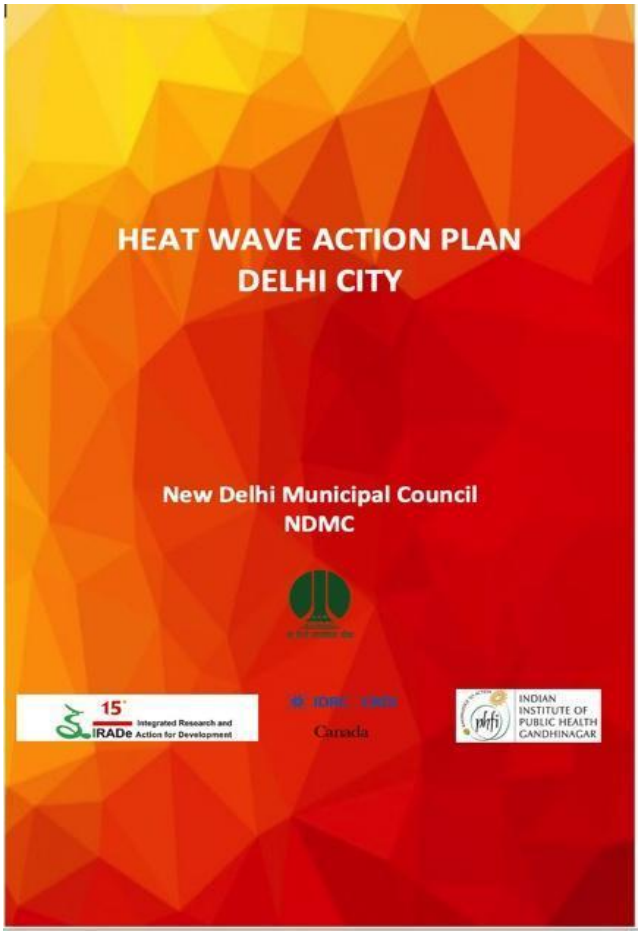
The Plan aims towards medical emergency preparedness and effectively responds to health emergency during the Pre-heat seasons, During Heat seasons and Post heat seasons. The adaption and mitigation measures has been classified into short term, medium term and long term measures including :

- Awareness Campaigns
- Mitigation measures
- Early warning communication
- Medical Preparedness
- Monitoring and Analysis

The final Heat Action Plan, informed by the comprehensive analysis of the climatology and vulnerability of wards in Bhubaneswar, provides a framework for implementation, coordination and evaluation of extreme heat response in a city that already faces challenges from other frequent natural disasters. It guides on mitigative and adaptive measures to avert loss of life and productivity. The plan will help alert populations at risk of heat-related illness, such as in places where extreme heat conditions either exist or are imminent, and to take appropriate precautions. The Heat Action Plan is designed to bring together all stakeholders for a citywide strategy in enforcing preventive, mitigative and adaptive measures to check heat-related debility among people.

11.4 Delhi Climate Adaptive Heat Action Plan

Integrated Research & Action for Development (IRADe), in in collaboration with International Development Research Centre (IDRC), Govt. of Canada, New Delhi Municipal Council and Indian Institute of Public Health (IIPH)-Gandhinagar is developing Climate Adaptive Heat Stress Action Plan for the city of Delhi city.



The Climate Adaptive Action Plan will provide a framework for implementation, coordination and evaluation of extreme heat response activities in Delhi, along with creating awareness among individuals at risk of heat-related illness, including concerned departments to reduce the impact of heat waves on health, productivity and livelihood.

Climatological variance

The climatological Variance was analysed on the parameters of Maximum Temperature (Tmax), Minimum Temperature (Tmin), Relative Humidity measured in the morning at 8:30 AM [RH (830)], and Relative Humidity measured in the evening at 5:30 PM [RH (1730)]. The analysis of climatological parameters over a period of 6/9 years, using data collected at Safdarjung, Palam, Ridge and Ayanagar stations of Indian Meteorological Department (IMD) shows that the month of March is getting hotter than rest of the summer months in Delhi, in terms of maximum as well as minimum temperature.

Thermal Hotspot Mapping

The Hotspot Maps indicated areas within the city which experience ambient temperature in excess of the average monthly maximum temperature. These helps in focusing on interventions where they are most needed during heat waves. To assess spatial distribution of heat stress at ward level in Delhi, the researchers first mapped thermal heat spots maps were developed using Landsat 8 data.
Land Surface Temperature (LST) maps were prepared for 30 May 2019 (the day when Delhi recorded a maximum air temperature of 48 °C), and spatial variability of LST in different municipal zones of Delhi was analyzed. The zones Narela and Najafgarh recorded a maximum LST of 60.48 °C and 59.06 °C.

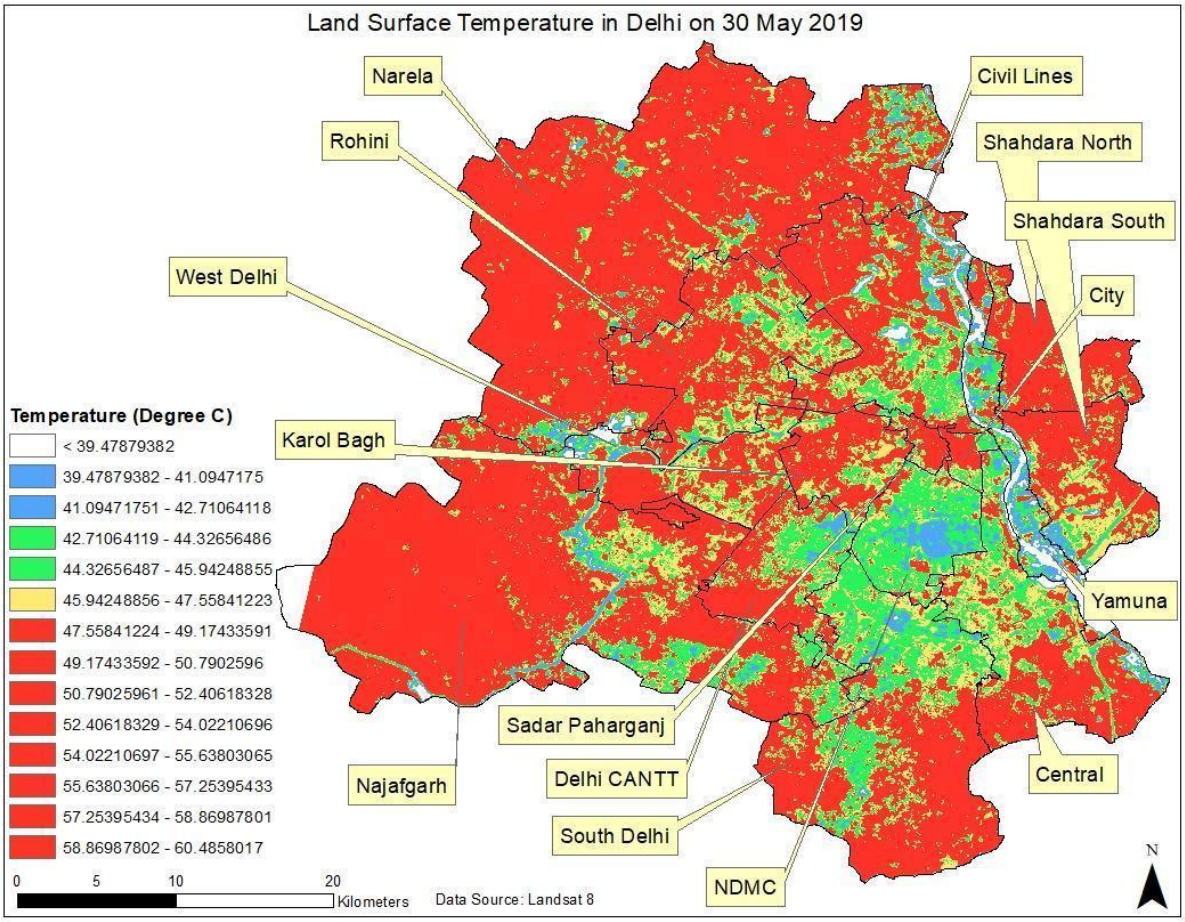


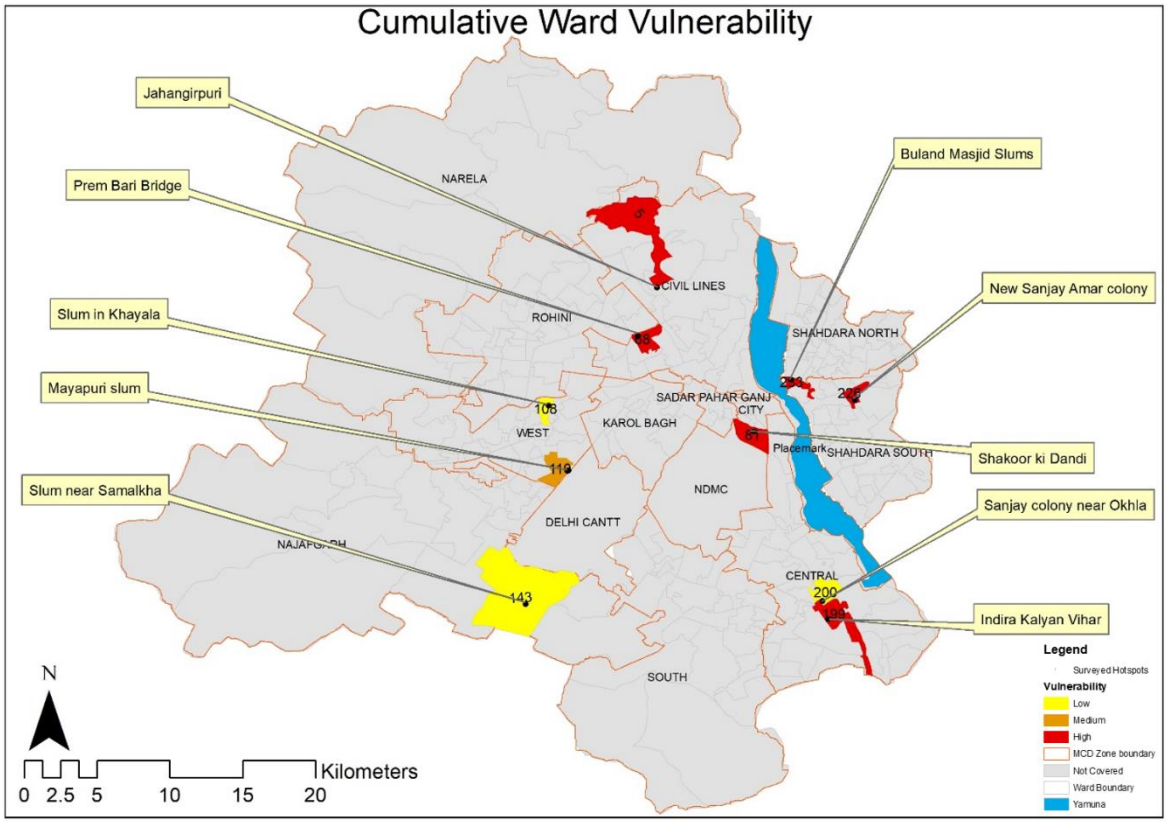
Figure 12: LST Map of Delhi as on 30 May 2019

The LST Maps indicate higher temperatures recording across the wards Harkesh Nagar 092s, Harkesh Nagar 092s, Khyala 008s, Wazir Pur 072n, Bijwasan 048s, Vishwas Nagar 017e, Hari Nagar A 010s, Jahangir Puri 021n, Delhi Gate 088n, Shastri Park 025e

Heat Stress Ward level Vulnerability Mapping

Heat stress vulnerability across the above identified wards in hot spot areas of Rajkot were analyzed using the comprehensive index, comprising nine sectors - **Sanitation, Water,**

Electricity, Health, Transportation, Housing, Cooking, Awareness and Heat symptoms and their respective sub sectors.



Vulnerable wards	Wards Number (Out of 10 Thermal Hotspots)	Total
Medium	(110)	**1**
High	(5, 81, 88, 199, 226, 233)	**6**

The **cumulative ward wise heat stress vulnerability analysis** indicated, nearly 6 wards in west Delhiare highly vulnerable and minimum basic amenities available to the vulnerable group to cope with heat stress

Impact of Heat Stress on Productivity and Livelihood

Slum distribution in Delhi was mapped in GIS (Geographic Information System), and overlaid on LST maps to identify vulnerable hotspot maps. The wards identified as most vulnerable to heat stress were: Harkesh Nagar 092s, Harkesh Nagar 092s, Khyala 008s, Wazir Pur 072n, Bijwasan 048s, Vishwas Nagar 017e, Hari Nagar A 010s, Jahangir Puri 021n, Delhi Gate 088n, Shastri Park 025e

The casual labourers are most affected by the high heat days. As the maximum wage loss is reported in the daily casual labourers (42%). This is due to the high share of involvement and low share of income. This is followed by the office workers experiencing heat exhaustion during high temperature. Hawkers and Maids are least affected amongst the identified occupations. With the loss in wages the productivity of the individuals is also highly affected. Majority (91%) of the working population had reported the loss in the working days by 1 to 5 days during the heat stress period followed by 10 to 15 days (21%) in a month. Similar to wage loss the males (64%) are at a greater loss as compared to females. Majority males and females experience productivity loss in 1 to 5 days.

The final Heat Action Plan, developed through comprehensive analysis of the climatology and vulnerability of wards in Delhi, will provide a framework for implementation, coordination and evaluation of extreme heat response in Bhubaneswar. It guides on mitigative and adaptive measures to avert loss of life and productivity. The plan intends upon being more spatially oriented and gender-sensitive while supporting the city's planning especially in prioritizing and integrating adaptive resilience within the agenda towards climate resilient smart city. The Heat Action Plan is designed to bring together all stakeholders for a citywide strategy in enforcing preventive, mitigative and adaptive measures to check heat-related debility among people.

The Action Plan lays out the essential components of preparedness of mitigative and adaptive measures:

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- Reduce Heat Exposure and Promote Adaptive Measures

The Plan aims towards medical emergency preparedness and effectively responds to health emergencies during the Pre-heat seasons, During Heat seasons and Post heat seasons. The adaptation and mitigation measures has been classified into short term, medium term and long-term measures including:

- Awareness Campaigns
- Mitigation measures
- Early warning communication
- Medical Preparedness
- Monitoring and Analysis
- Urban Planning and engagement of the city-level stakeholders

Heat Alerts Advisories

The Heat Stress Advisory for New Delhi Municipal Corporation was prepared in collaboration with the medical services department of New Delhi Municipal Council. The advisory was handed over to Medical Services Department of NDMC for further dissemination to the concerned departments. Some of the dispensaries under NDMC have already put up the heat advisory in their premises. The Heat Wave Advisory has also being incorporated as 'Measures to prevent heat stress related illnesses' on prescription slips of Hospitals under New Delhi Municipal Corporation.

These three Climate Adaptive HAPs help the authorities be proactive, rather than responding after the onset of heatwaves each year. The comprehensive climate profiling gives a significantly accurate picture of the heat hotspots within developed cities. They also help monitor the impact of HAP on the pre-identified high-risk households in the vulnerability hotspots, thus providing the disaster management authorities with a qualitative and quantitative assessment of heat adaptation and mitigation in the respective hotspots.

12Conclusion

South Asia is one of the highest-risk areas for extreme heat56. These risks have contributed to changing extreme weather patterns from a more extended period of heat season to much hotter heat periods. Broadly, it has strong linkages to climate change; the extreme weather may create impacts even more than anticipated, such as more frequent and more intense weather events in both predictable and unpredictable ways. While it has created an urgency to enable a mechanism to better deal with the heat-health issues, Heat Action Plans (HAP) are emerging as a plausible solution to ensure mitigation and adaptation to heatwaves in South Asia. In India, there is a known association between heatwaves and their associated morbidities and mortalities. There is evidence of a threshold at 40°C above which mortality increases.

In this report, an attempt is made to carry out a detailed analysis of the Heat Action Plans in India and South Asia. While this analysis only underlines the need for heat action plans, it identifies the key strengths, characteristics, and gaps in the existing HAPs. It is observed that linkages between the state-level HAP and the State level climate action goals need to be synchronised well. By strengthening these synergies will help the HAPs to be for it to be more effective. The best practices from the pioneering states of Ahmedabad, Odisha, and Rajasthan need replication with the right contextual caveats best suited to the local conditions. This will help in developing preventive measures that reduce their risk of heat-related illnesses. This review also highlights the need for the development of a database to identify vulnerable areas. The HAPs can include specially designed measures to implement heat adaptive measures and minimise any extreme heatwaves.

Similarly, in the rural areas, the rural hotspots may be identified, and a differentiated HAP strategy should be developed from their urban counterparts. This also suggests that the HAP plans need to take into climate sensitivities, evaluate heat hotspots, conduct socio-economic differences, and evaluate the household-level socio-economic status of people living in areas prone to severe heat stress. The HAPs should also incorporate the historical climate trends so that pre-emptive strategies can also be put into place.

This document will support the development of heat action plans that can incorporate the key demands but can also avoid any shortcomings by learning from the deficiency of other heat action plans. Further, any review of the existing heat action plans will incorporate these gaps and make them more responsive, which will include climate sensitivity (climate change projections), contextualizing localized socio-economic patterns, demarcating thermal hotspots, thermal Index and Temperature Thresholds at ward-levels, along with the

[56] M. Li, L. Mengyang, L. Zhao, D. Weihua, and S. Peijun, “Mapping Heat Wave Risk of the World,” in IHDP/Future Earth-Integrated Risk Governance Project Series, Springer, Berlin, Heidelberg, Germany, 2015. https://link.springer.com/chapter/10.1007/978-3-662-45430-5_9

expansion of its scope to include impact on animals husbandry. Capturing learnings from well-designed plans, working within a regional socio-economic context, differentiating between rural and urban strategies are vital to put in place a comprehensive HAP strategy to tackle heat-related morbidity and mortality.

Heat Stress also has a notable impact on the electricity consumption. A study [57] reveals that on an average, aggregate electricity demand in India increases by 11% or more at temperatures above 30 °C from demand at temperatures of 21–24 °C, with substantial heterogeneity across states. Cities like Delhi has recorded increase in energy demand by 30% or more at temperatures above 30 °C. A recent study by Economic Forum, 2021[58] for the city of Delhi also indicate that almost 43% of the housing units own one AC – most of which were newly bought in the previous two-to-three years – and 11% of homes have all the three cooling devices (fans and coolers and ACs). Hence there is need to develop Heat Action Plans, wherein indigenous strategies and infrastructure/ architectural and nature based solutions/ cooling measures can be adopted to reduce pressure on the power sector and environmental degradation by use of ACs.

Some of these HAP best practices may be taken up at South-Asian Level. It is extremely important that these plans are developed in other South-Asian cities as this region has a broad level geo political and climatic similarities. In this regard, the South-Asian Heat Health Information Network (SAHHIN) can come to plan an important role. This platform will act as an independent scientific platform for scientists, health experts, policy makers, government and stakeholders to collaborate and evolve strategies that expediate heat stress management in South Asian cities.

Similarly, as we are aware that Early Warning System (EWS) for heat help in preparedness and the its management. It could very well be incorporated as adaptation practice that would help in small scale and large-scale heatwave vulnerability reduction. To further strengthen its utility and its effectiveness, the action plans should identify ward level heat hotspot(s) and share heat early warning systems at the ward level.

To conclude, there is an urgent need to adopt HAP to mitigate the adverse impacts of heat waves. As is evident from the growing volatility of climate change and the consequent rise in extreme weather events. Just as the covid-19 caught our public health systems unprepared, it's imperative that South -Asia is equipped better in its preparedness and management systems for the heatwaves, and the HAPs can give it a boost.

[57] Harish, Santosh & Singh, Nishmeet & Tongia, Rahul, 2020. "Impact of temperature on electricity demand: Evidence from Delhi and Indian states," Energy Policy, Elsevier, vol. 140(C).
[58] https://www.weforum.org/agenda/2021/04/guest-post-how-energy-demand-for-cooling-in-india-s-cities-is-changing/

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