UTTAR PRADESH
STATE DISASTER MANAGEMENT AUTHORITY

Shri Yogi Adityanath

Hon'ble Chief Minister of Uttar Pradesh

UTTAR PRADESH
HEAT WAVE ACTION PLAN
2024

ACKNOWLEDGEMENT

The Heat Wave Action Plan 2023 meticulously crafted by the Uttar Pradesh State Disaster Management Authority aligns with global efforts aimed at climate resilience and disaster risk reduction. This plan echoes the commitments made during the COP 21 or the Paris Climate Conference, where nations pledged to adhere to an international climate agreement, striving collectively to limit global warming to below 2°C, as recommended by the Intergovernmental Panel on Climate Change (IPCC). Moreover, it resonates with the Sendai Framework for Disaster Risk Reduction 2015-2030, emphasizing the necessity for a holistic approach integrating adaptation, sustainable development, environmental management, and disaster risk reduction (DRR). The framework stresses the enhancement of national disaster loss databases and risk analysis, underscoring the critical importance of data in mitigating disaster impacts.

I extend my deepest appreciation to **Dr. Kaneez Fatima**, Project Director (Drought), UPSDMA, and her esteemed team for their exceptional dedication and expertise in spearheading the formulation of the Heat Wave Action Plan for Uttar Pradesh. I extend my sincere gratitude to **Prof. Mahaveer Golechha** from the Indian Institute of Public Health Gandhinagar for his invaluable contributions towards the development of the Heat Wave Action Plan.

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(Lt. Gen Ravindra Pratap Sahi, AVSM)
Vice Chairperson,
UP SDMA

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ABBREVIATIONS

IMD	India Meteorological Department
IEC	Information Education Communication
DM	Disaster Management
THI	Temperature–Humidity Index
AIR	All India Radio
NDMA	National Disaster Management Authority
NDRF	National Disaster Response Fund
SDRF	State Disaster Response Fund
SEOC	State Emergency Operation Centre
DEOC	District Emergency Operation Centre
ULBs	Urban Local Bodies
PHC	Primary Health Centre
CHC	Community Health Centre
UHC	Urban Health Centre
ORS	Oral Rehydration Solutions
ICDS	Integrated Child Development Services
ANM	Auxiliary Nurse and Midwife
SDM	Sub Divisional Magistrate
BDO	Block Development Officer
UPSRTC	Uttar Pradesh State Road Transport Corporation
UP SDMA	Uttar Pradesh State Disaster Management Authority
DDMA	District Disaster Management Authority
WASH	Water, Sanitation and Hygiene

CHAPTER-1

INTRODUCTION AND OVERVIEW

1 Introduction and Overview

1.1 Background

High levels of climate variability are a result of ongoing, unregulated environmental deterioration, including atmospheric pollution with carbon dioxide and other noxious compounds, overuse of aquifers due to a growing human population, and declining water quality in some surface water reservoirs. In addition to increasing the frequency and severity of natural disaster occurrences like floods, droughts, and heat waves, these climatic changes have also caused them. Due to climate change the severity and frequency of extreme heat events are significantly increasing. This is affecting human health negatively. Large-scale population relocation, conflicts fuelled by resource scarcity, overcrowding in already congested metropolitan areas, and resultant unpredictability in disease transmission patterns are common effects of these natural disasters. It should be highlighted with great worry that these events have negative, irreversible repercussions on human life and development, especially on children in the world's poorest countries experiencing some of the harshest effects.

Due to environmental degradation, natural calamities like earthquakes, flash floods and droughts brought have increased significantly in India. In addition, because of ecosystems being overburdened by human requirements, they have become incredibly fragile, which has resulted in decreased access to food and clean water as well as dramatic changes to livelihoods.

Uttar Pradesh and Climate Change Impact

Because of deteriorating climatic conditions, Uttar Pradesh is susceptible to a number of natural calamities. The state has suffered both droughts in areas where water shortage is severe due to depleted aquifers and flash floods from the Ganges. Since roughly three-quarters of the population depends on agriculture, this has put a significant financial and health burden on some of the state's poorest towns. Natural disasters have caused a loss of livelihood owing to crop destruction and animal deaths, but they have also caused food insecurity in the area, which has caused population displacement.

El-Nino Southern Oscillation, which raises summertime temperatures across much of India, also has an impact on Uttar Pradesh. As a result, Uttar Pradesh is projected to see extended periods of above-average temperatures during the summer months of March through July.

The majority of current efforts to combat global warming are directed towards reducing climate change. Yet, there is a compelling need for further scientific study and initiatives on climate adaptation, centred on public health for the most vulnerable communities, in light of forecasts of higher temperatures, rising sea levels, and shifting disease patterns in India. Communities in the area already face health risks from extreme heat, including dehydration, heat cramps, fatigue, heat syncope or heat stroke, and even heat-related death. Extreme heat events will only get worse due to climate change.

Increased temperatures are directly correlated with higher rates of heat-related death and morbidity. In India, where scorching temperatures are increasing to extreme levels and

increasing mortality and morbidity due to climate change, there is evidence of this connection everywhere over the country. All areas of the Indian subcontinent are expected to experience a rise in average temperatures of 5°C by the year 2100 (Kumar et al, 2006). Global climate models predict an increase in both the frequency and length of heat waves. These predictions should concern everyone since rising temperatures and unpredictable precipitation might result in widespread fatalities from drought, illness, floods, famine, excessive heat, and humidity.

Increasing rates of heat-related disease and mortality during heat waves are particularly noticeable in low-income communities, particularly among employees who often labour in extremely hot environments. Public health adaptation measures for heat-related illness are specific to these areas due to the lack of mechanical air conditioning and the constrained infrastructure, including water treatment and distribution networks.

Through improved communication about the factors that make individuals susceptible to heat, people may be encouraged to avoid such situations, heat-related illnesses and deaths in Uttar Pradesh could be substantially avoided.

Heat waves are defined by the World Health Organization as extended periods of unusually high temperatures that raise morbidity and mortality. A heat wave's characteristics as well as the susceptibility of the impacted populations determine the scope and intensity of its health impacts. The frequency and severity of heat waves are increasing globally. Globally, the last three decades have seen all of the warmest years on record (USAID, 2019).

In conjunction with other factors, such as relative humidity, very high temperatures can cause heat waves that can kill thousands of people, ruin crops, and harm infrastructure. Heat waves can also put a burden on essential services. Hospital admissions rise together with the need for water and power for cooling, frequently at rates that exceed hospital capacity.

More heat records will be set every season as a result of climate change, posing threats to the global populace in general and the elderly, young children, pregnant women, people with chronic health conditions, people with disabilities, and those who work outside in particular. In addition, a large portion of the world's workforce is employed outside, including, for instance, farmers, agricultural workers, and construction workers. In addition, a sizable amount of the world's population now resides in cities, where thermal energy is trapped and gradually released by buildings and pavement, subjecting city dwellers to greater temperatures (USAID, 2019).

The susceptibility and exposure of the affected population is a major determinant of the direct and indirect effects of heat waves. The most vulnerable may suffer terrible effects if health services are not equipped to handle heat extremes. Extreme heat can have direct effects on a person's physiological reactions and functions as well as indirect effects on food and water security and other activities that enhance health systems more generally as well as jeopardise hard-won improvements in health, nutrition, and WASH.

1.2 Geo-Physical Details of Uttar Pradesh

Uttar Pradesh is bordered by the state of Uttarakhand to the north-west, Haryana and Delhi to the west, Rajasthan to the south-west, Madhya Pradesh to the south, Chhattisgarh and Jharkhand to the south-east and Bihar to the east. Situated between

23°52'N and 31°28'N latitudes and 77°3' and 84°39'E longitudes, this is the fourth largest state in the country in terms of area, and the first in terms of population.

Geo-morphologically Uttar Pradesh can be divided into three topographical regions:

1. The Shivalik foothills of Himalayas and the Terai region border U.P. on the North.
2. The Gangetic Plains are characterised by a flat topography and highly fertile alluvial soils. Its flat topography comprises of several physical features like rivers, lakes, ponds, elevation ranging from 60 mts in the east to 300 mts in the north-west and a gradient of 2 mts / sq. km.
3. The Vindhya Hills and plateau to region in the south-vindhyas are a discontinuous range of hills and mountains. The southernmost stratum of Gangetic plains in U.P. is rendered by hard and varied topography of hills, high lands and plateaus,

The climate of the state is tropical monsoon. The average temperature varies in the plains from 3 to 4 °C in January to 43 to 48 °C in May and June. There are three distinct seasons - winter from October to February, summer from March to mid-June, and the rainy season from June to September.

Table 1: Uttar Pradesh at a Glance

Population (2021)	24.34	Crores
Total Reported Area	241	Lakh ha.
Division	18	
Districts	75	
Tehsil	351	
Blocks	825	
Gram Panchayat	59075	
Revenue Village	106774	
No. of Farmers	2.88	Crore
Work Force in Agriculture	3.90	Crore
Agro Climate Zones	9	
Net Sown Area	165.38	Lakh ha.
Net Irrigated Area	144	Lakh ha.
Irrigation (Net Sown Area)	87	%
Gross Sown Area	268.59	Lakh ha.
Gross Irrigated Area	217	Lakh ha.
Cropping Intensity	162.41	%
Population Department on Agriculture	68	%
Agriculture in SGDP	23.9	%
Per Capita income of the State (2020-21)	65338	Rs

Source-Agriculture Department, UP

1.3 Climate of India (IMD, 2022)

According to the India Meteorological Department's (IMD) annual climate summary report, the annual mean land surface air temperature across India in 2022 was +0.51^{0}C higher than the long-term average (1981-2010 period). Since national records began in 1901, the year 2022 ranked as the sixth hottest on record. While greater than the previous year 2021 (anomaly of +0.44^{0}C), this is still lower than the maximum warming recorded over India in 2016 (anomaly of +0.71^{0}C) (*Figure 1*).

The all India mean temperatures during the winter (January to February) season was normal with anomaly of -0.04°C while during other seasons, it was above normal (pre-monsoon (March to May) season (anomaly of ±1.06°C), monsoon (June to September) season (anomaly of +0.36°C) and post-monsoon (October to December) season (anomaly of +0.52°C).

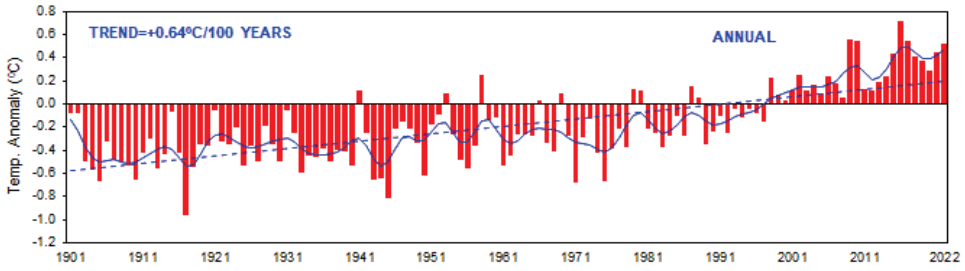

Figure-1: Temperature Trend in India between 1901-2022

Annual mean land surface air temperature anomalies averaged over India for the period 1901-2022. The anomalies were computed with respect to the base period of 1981-2010. The dotted line indicates the linear trend in the time series. The solid blue curve represents the sub-decadal time scale variation smoothed with a binomial filter.

The past decade (2012-2021/ 2013-2022) was also the warmest decade on record with the decadal averaged annual mean temperature anomaly (Actual-LPA) of 0.37°C /0.41°C. The country averaged annual mean temperature during 1901-2022 showed a significant increasing trend of 0.64°C /100 years (Figure) while a significant increasing trend was observed in maximum temperature (1.0°C /100 years) and a relatively lower increasing trend (0.28°C /100 years) in minimum temperature.

1.4 Heat Induced Hazards in the state of Uttar Pradesh

The state of Uttar Pradesh is located in the centre of the Indo-Gangetic plain. Uttar Pradesh's climate ranges from temperate in the east to extremely dry in the west to semi-arid in the Bundelkhand and Agra zone. As a result, it is quite challenging to classify it within a certain climatic context. Nevertheless, the winters are frigid and the summers are extremely scorching. Typically, heat waves start in the northwest of India or across northern Pakistan and

spread to the neighbouring states, including Uttar Pradesh. In the event of development, a heat wave could also form locally across the area**. State experience heat wave condition from March to June** (*Figure: 2-6*)**.** In April the land area becomes hot with daytime maximum temperatures often reaching above 40°C. The temperatures start to rise over Uttar Pradesh in March. At many locations, the difference between the highest and lowest temperatures throughout this season is found to be greater than 15°C. By the end of May and the beginning of June, maximum temperatures quickly increase and surpass 46°C, resulting in extremely hot summers, especially over the SW U.P. (Bundelkhand). When high pressure (3000-7600 metres) in the atmosphere strengthens and stays over a region for several days to several weeks, heat waves result. The air sinks toward the surface when there is a lot of pressure. This falling air covers the atmosphere like a dome. Instead of allowing heat to rise, its cap aids in its retention as per IMD report, Jhansi was the hottest place in Uttar Pradesh with maximum temperature of 46.5 degrees Celsius, Agra with 46.0, Prayagraj 45.7, Kanpur 45.0 degree Celsius in May 2023.

Maximum temperatures went up to 46.8 degrees Celsius in Prayagraj district (*Figure 6 and Table 2*). Further, number of heat wave days have also increased significantly (*Figure 7 and Table 3*).

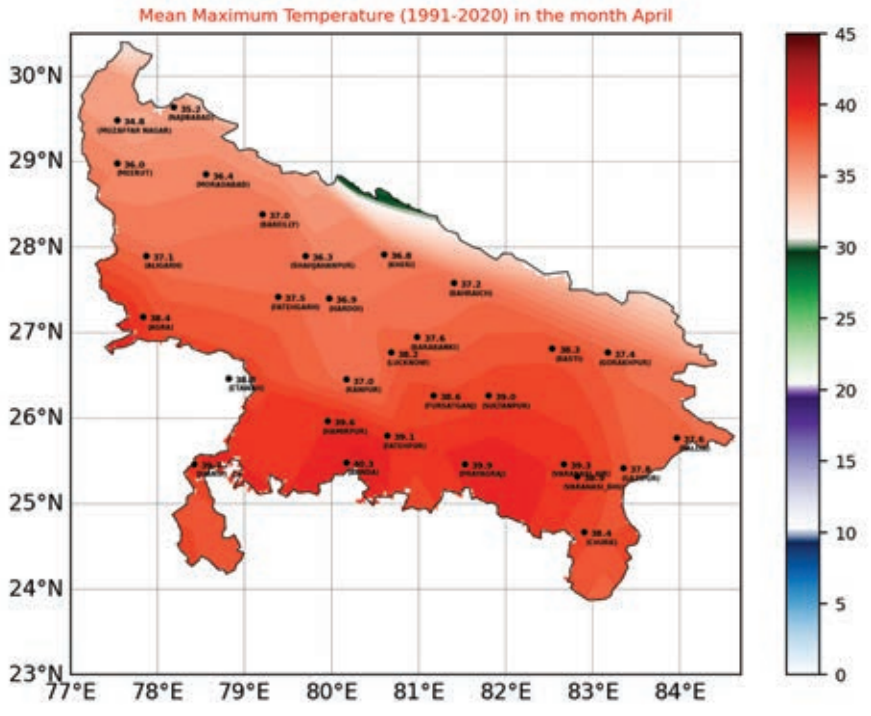

Figure 2: Mean Maximum Temperature (1991- 2020) in the month April

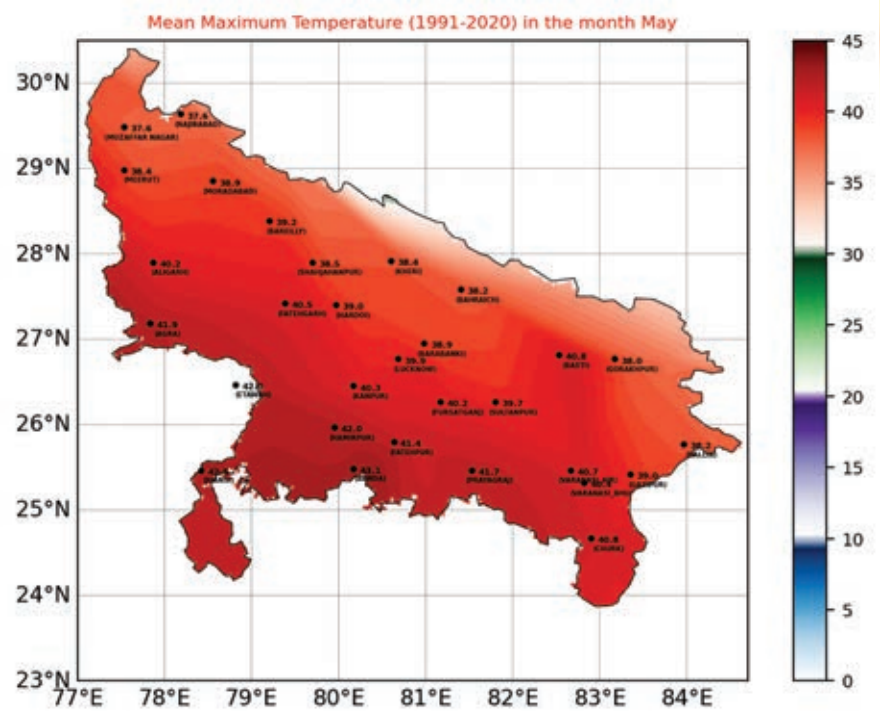

Figure 3: Mean Maximum Temperature (1991- 2020) in the month May

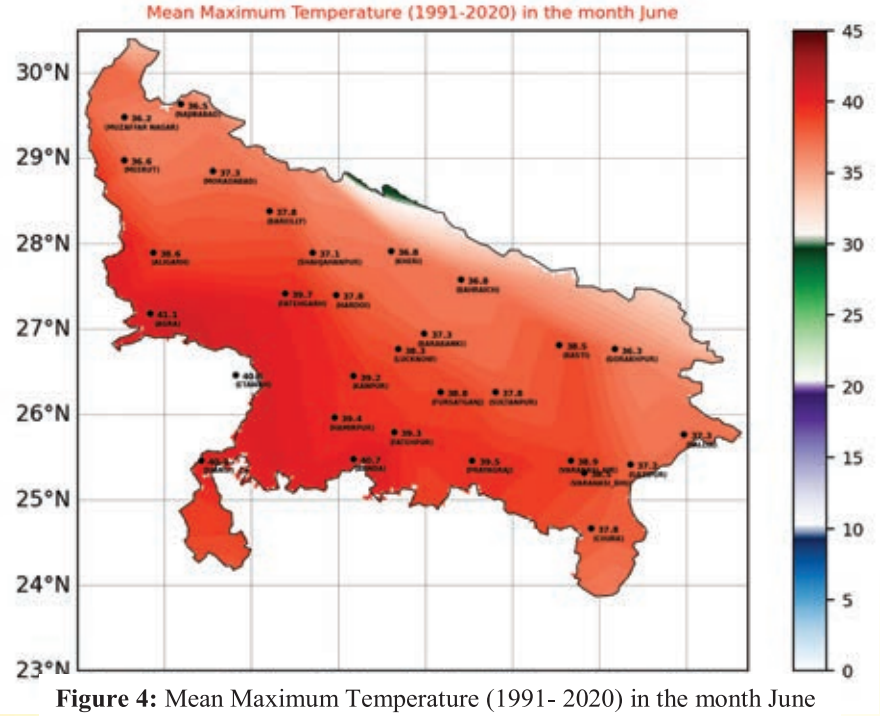

Figure 4: Mean Maximum Temperature (1991- 2020) in the month June

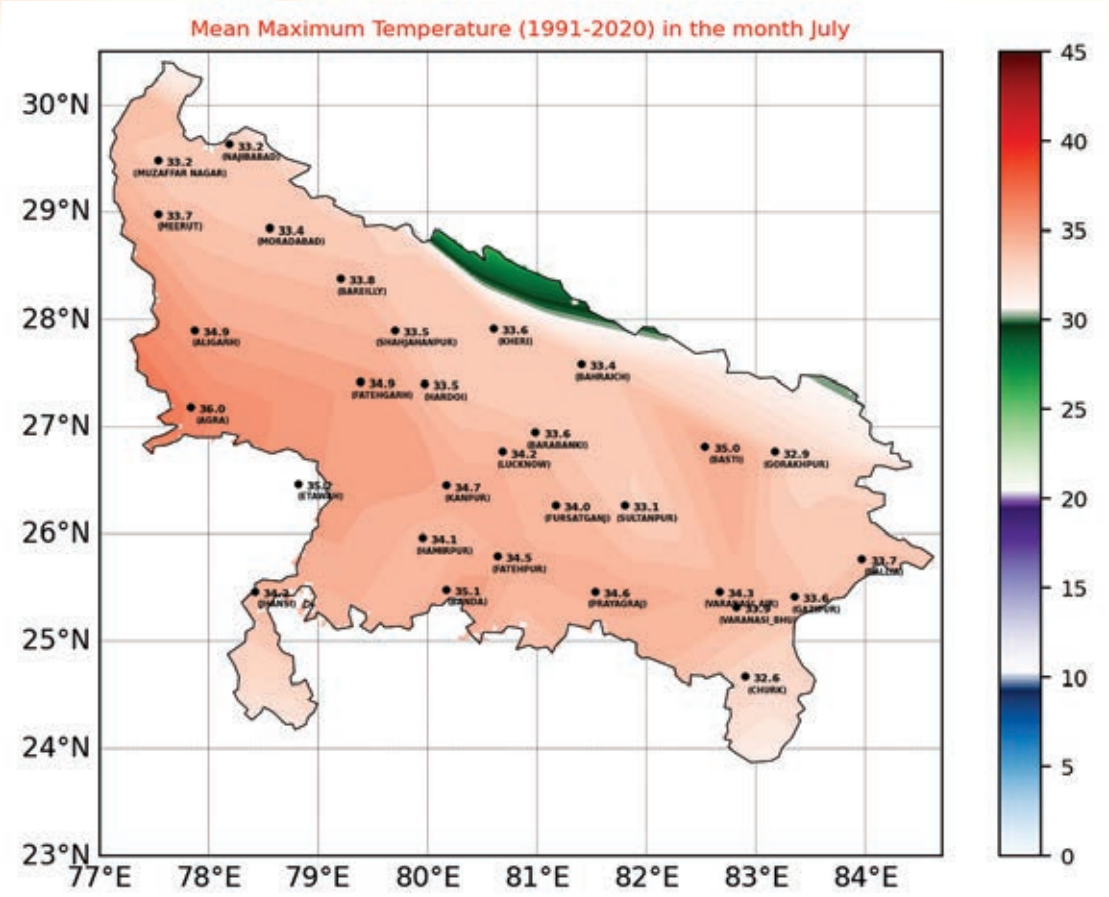

Figure 5: Mean Maximum Temperature (1991- 2020) in the month July

Table 2: Maximum Temperature at Major Station of Uttar Pradesh during the Years 2021, 2022 and 2023

	2023	2022	2021
Station	Maximum	**Maximum**	**Maximum**
Lucknow (AP)	43.2	45.1	41.9
Barabanki	43.5	41.8	40.0
Hardoi (ob)	43.5	43.0	40.2
Kanpur (IAF)	45.0	46.3	42.7
Kanpur(city)	43.0	44.0	42.2
L.Kheri	42.0	42.0	42.2
Gorakhpur	43.7	42.4	41.0
Varanasi AP	44.5	45.2	43.4
Varanasi BHU	43.6	45.0	43.6
Ballia	43.5	41.5	41.4
Churk	44.2	45.0	43.5
Bahraich	42.0	41.4	41.0
Prayagraj(ALB)	45.7	46.8	44.3
Banda	44.6	47.7	45.2
Sultanpur	43.6	44.4	43.0
Ayodhya(FZB)	43.5	42.5	41.0
Fursat ganj	44.5	45.4	42.8
Fatehgarh	43.9	43.8	42.4
Basti	44.0	43.0	43.0
Jhansi	46.5	46.2	44.9
Hamirpur	44.5	44.2	42.2
Bareilly Ob.	41.8	41.2	41.5
Shahajhanpur	41.5	42.4	41.5
Najibabad	40.5	39.8	40.8
Muzaffarnagar	41.2	41.4	40.1
Meerut	41.5	42.7	41.2
Etawah	43.0	42.2	39.0
Agra Taj	46.0	45.6	44.0
Aligarh	43.4	44.2	43.0

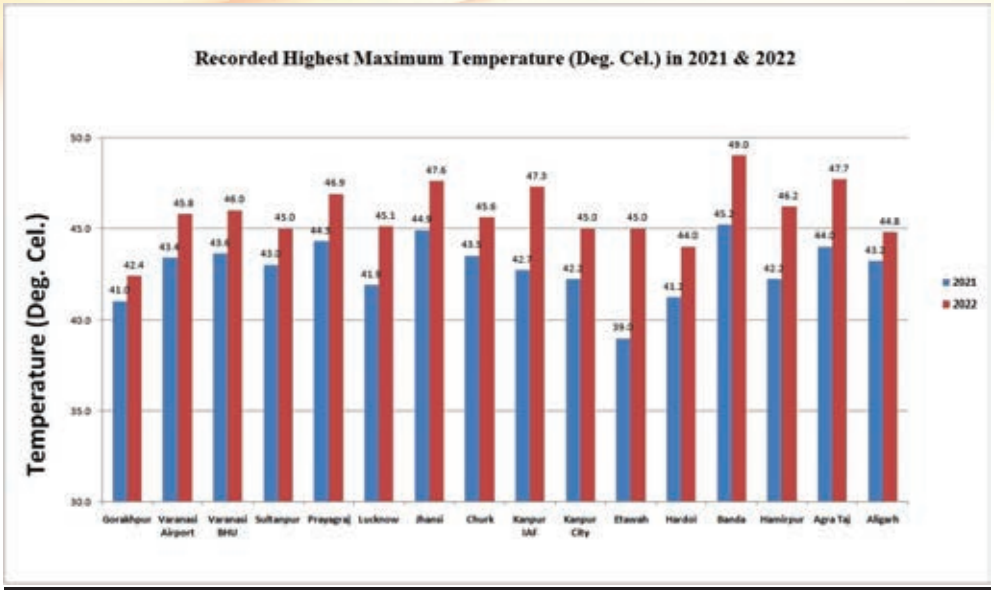

Figure-6: Recorded Highest Maximum Temperature

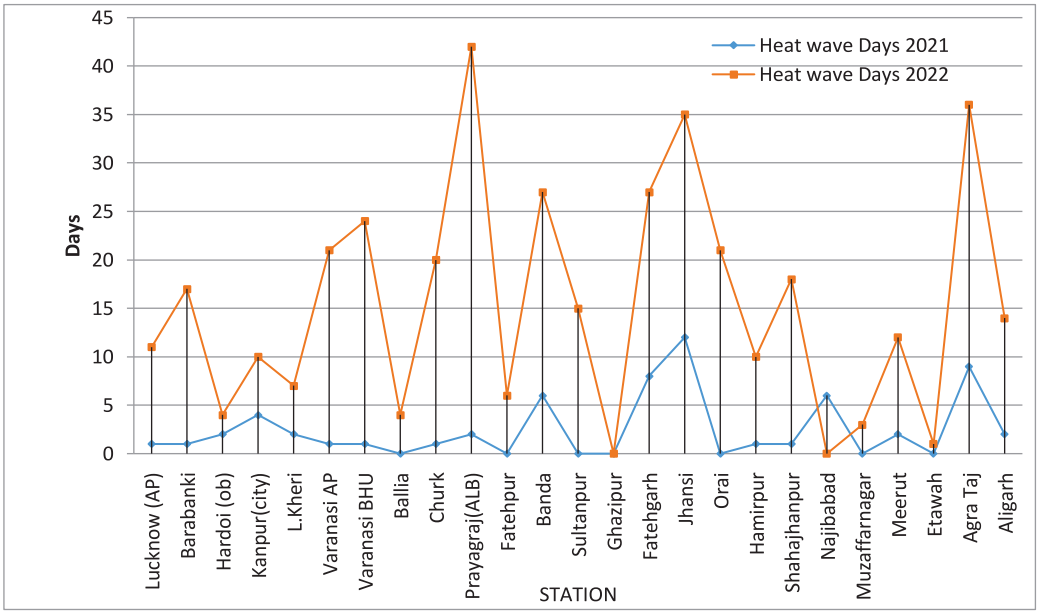

Figure-7: Number of days with Heat wave

Table 3: Number of days with Heat wave in 2021, 2022 & 2023

S. No.	STATIONS	2021						2022						2023					
		MAR	APR	MAY	JUN	JUL	Total Days	MAR	APR	MAY	JUN	JUL	Total Days	MAR	APR	MAY	JUN	JUL	Total Days
1	Lucknow (AP)	1					1	1	8		2		11						0
2	Barabanki	1					1		13		4		17				5		5
3	Hardoi (ob)					2	2		2		2		4						
4	Kanpur (city)	1				3	4		5		5		10		3				3
5	L.Kheri		2				2		7				7		1		2		3
6	Varanasi AP	1					1	1	12		8		21				6		6
7	Varanasi BHU	1					1	1	13	2	8		24				4		4
8	Ballia						0		2		2		4				8		8
9	Churk	1					1	1	11	3	5		20				7		7
10	Prayagraj(ALB)	2					2	3	18	8	13		42		3	1	10		14
11	Fatehpur						0			2	4		6						
12	Banda	1	2			3	6		3	7	11	6	27						
13	Sultanpur						0		5		9	1	15				2		2
14	Ghazipur						0						0						
15	Fatehgarh				1	7	8		11	3	9	4	27						
16	Jhansi	2	2		2	6	12	3	15	9	8		35			6	4		10
17	Orai						0		13	5	3		21						
18	Hamirpur	1					1	1	4	4		1	10						
19	Shahajhanpur					1	1		12		6		18		1				1
20	Najibabad		4			2	6						0						
21	Muzaffarnagar						0		3				3						
22	Meerut				1	1	2		6	1	5		12						
23	Etawah						0			1			1						
24	Agra Taj	2	2			5	9	3	21	6	6		36		2	3			5
25	Aligarh				1	1	2	2	12				14						
	TOTAL	14	12	0	5	31	62	16	196	51	110	12	385	0	10	10	48	0	68

1.4.1 Impact of Heat Wave

Impact of Heat Wave on Life and Livelihood

The human thermoregulatory system has limits. Our muscles generate heat, which must be shed to the environment to maintain our core temperature of about 36.7^0C. Evaporation of sweat helps human bodies to keep cool when it is hot, however, when there is excessive sweating it leads to dehydration with consequent rise in internal body temperature which is fatal. More or less, Uttar Pradesh population might be acclimatized to heat and humidity but there is an upper level of heat tolerance limit. However, acclimatization to heat can only offer limited protection. When temperature soars beyond the tolerance limit, precautionary measures like avoiding the sun and physical exertion, maintaining hydration, and resting in a cool place are suggested.

However, serious challenges arise when extreme heat events linger for prolonged periods, as cessation of activities for weeks is often not an option.

Impact of Heat Wave On Agriculture

Apart from, impact on human life, the Heat Wave has also been found to profoundly affect crop production both in terms of quantity and quality. Primarily, crop loss happened due to flower drop and higher mortality in new plantations. Rabi and Zaid crops are more impacted. Any extreme change in temperature would affect the productivity.

Loss of Labour Hours due to Heat Wave

Extreme weather events, including heat waves, heavy rainfall, and snowfall, have a detrimental impact on the productivity and efficiency of the informal workforce, particularly agricultural workers and manual laborers such as rickshaw pullers, construction workers, and fruit sellers (Li et al., 2016). According to the International Labour Organization (ILO, 2019), if the current global warming trends persist, the overall percentage of lost working hours is projected to rise to 2.2% by 2030. This translates to the equivalent of losing 8 crore full-time jobs or approximately US$ 2,400 billion (ILO, 2019). However, the distribution of lost working hours is not uniform across regions. Southern Asia and Western Africa are expected to experience a loss of 5.3% and 4.8% of total working hours, respectively, corresponding to around 4.3 crore and 90 lakh full-time jobs.

In India alone, between the years 2001 and 2020, approximately 259 billion labor hours were lost annually due to humidity and heat waves, resulting in a total cost of Rs. 46 lakh crores

(Deshpande, 2022). Heat waves impede labor efficiency by hindering workers in physically demanding occupations from operating at their full potential due to excessive sweating, exhaustion, and dehydration. The ILO (2019) further estimates that by 2030, India will lose approximately 5.8% of its total labor hours due to the combined effects of heat and humidity. The loss of labor hours caused by heat stress has severe repercussions for India, considering that roughly 90% of the country's labor force is employed in the informal sector, with a significant portion engaged in physically demanding occupations (Barthwal et al., 2022; ILO, 2019).

This vulnerability exposes the Indian economy to the adverse consequences of heat waves. The agricultural sector is expected to bear the brunt of the impact from lost work hours, followed by the construction sector (ILO, 2019a). The implications of these losses extend beyond immediate economic consequences, affecting the livelihoods and well-being of individuals and communities dependent on these sectors. Additionally, heat stress exacerbates existing social and economic disparities, as marginalized groups and those engaged in informal labor are disproportionately affected by the consequences of extreme heat (Barthwal et al., 2022).

In conclusion, extreme weather events, particularly heat waves, pose a significant threat to the productivity and efficiency of the informal workforce in India. The projected increase in lost working hours due to heat and humidity highlights the urgent need for measures to mitigate and adapt to the effects of climate change. Addressing this issue requires a comprehensive approach that encompasses both immediate interventions, such as improved working conditions and access to protective measures, as well as long-term strategies focused on sustainable development and climate resilience (ILO, 2019). By prioritizing the protection of workers and implementing effective policies, India can work towards reducing the impact of extreme heat on labor hours and securing a more sustainable and inclusive future.

India, the nation hit hardest by heat stress, experienced a reduction of 4.3 percent in working hours in 1995, and it is projected that this number will increase to 5.8 percent by 2030(Table-4). Additionally, due to its large population, India is expected to suffer a substantial loss of approximately 34 million full-time jobs in 2030 as a direct consequence of heat stress. While the agricultural sector will bear the brunt of the impact in India, the construction sector is also anticipated to face a growing loss of working hours as heat stress affects both male and female workers.

Uttar Pradesh has the largest share of the labour force in India, accounting for 19.3% of the total labour force in 2022. This is followed by Bihar (11.5%), Madhya Pradesh (10.3%), and West Bengal (9.4%). The share of the labour force in Uttar Pradesh has been declining in recent years, from 21.2% in 2011. This decline is due to a number of factors, including the decline in the agricultural sector, the growth of the informal sector, and the migration of workers to other states.

The labour force in Uttar Pradesh is young, with a median age of 29 years. The majority of the labour force is employed in the agricultural sector (55%), followed by the services sector (30%) and the industrial sector (15%). The unemployment rate in Uttar Pradesh is high, at 12.2% in 2022. This is higher than the national average of 7.8%. The unemployment rate is highest among youth, with a rate of 22.4% in 2022.

While projecting ILO (2019) this can be inferred that between 2001 and 2020, Uttar Pradesh lost an average of 50.271 billion labor hours per year due to heat waves. This is equivalent to losing 1.38 million full-time jobs for a year. The total cost of the heat waves was Rs. 88,780 crore, which is about $1.1 billion USD.

The government of Uttar Pradesh has taken a number of initiatives to address the challenges facing the labour force, including providing skill training, creating jobs in the industrial sector, and promoting entrepreneurship. However, more needs to be done to improve the quality of life for workers in Uttar Pradesh.

Table 4: Working hours lost to heat stress, by sector and country, Southern Asia, 1995 and 2030 (projections)

	1995						2030					
	Agriculture	Industry	Construction	Services	Total	Total (thousand full-time jobs)	Agriculture	Manufacturing	Construction	Services	Total	Total (thousand full-time jobs)
India	5.87	2.95	5.87	0.63	4.31	15519	9.04	5.29	9.04	1.48	5.8	34056

Source: ILO, 2019

Millions of individuals in the Indian brickmaking industry, most of whom have migrated from impoverished villages to the outskirts of cities, are employed under unfavourable circumstances. These workers, including many young children, face multiple

challenges such as low socio-economic status, harsh working conditions, and inadequate or nonexistent wages. Their work exposes them to various hazards, including high ambient temperatures and radiant heat from brick kilns, while their awareness of occupational safety and health (OSH) matters remains limited.

The workers in this industry endure extreme ambient temperatures, particularly during hot summer months, which can soar to 40-45°C. They also encounter high levels of radiant heat emitted by the kilns where the bricks are fired. Compounding their heat exposure, they lack sufficient on-site cooling options, exacerbating the risk (Lundgren-Kownacki et al., 2018).

Sett and Sahu (2014) conducted an assessment of the impact of heat stress on the productivity and health of female brickmaking workers in West Bengal. Their findings revealed that a mere 1°C increase in temperature led to approximately a 2 percent decline in productivity. The workers surveyed in the study took only short breaks of 10-15 minutes in shaded areas when they were completely exhausted, returning to work thereafter. Elevated temperatures significantly elevated their physiological stress parameters, including peak heart rate and cardiac strain. While the majority of workers were aware of their heat stress symptoms, they lacked the necessary knowledge and resources to implement preventive measures.

1.5 Rationale and key strategies of Uttar Pradesh State Heat Wave Action Plan

Building resilience into health systems can help reduce the burden of heat waves on public health by: -

1) improving preparedness by enhancing forecasting expertise and investing in vulnerability assessments to inform risk management and communicate practical recommendations, especially to the most vulnerable populations, for reducing heat risks, and

2) improving heat interventions by emphasising inter-sectoral collaboration and implementing responsible The development of heat-health action plans (HHAPs), which include a heat wave early warning system (HEWS) and emergency public health interventions, is taking place in several places across the world.

The Uttar Pradesh State Heat Action Plan, serve as the key policy document that outline the processes, duties, early warnings, and reaction mechanisms for line departments and other organisations during a heat wave, are crucial adaptation measures to protect communities and preserve lives from excessive heat.

1.6 Purpose and key strategies of Uttar Pradesh State Heat Wave Action Plan

The Uttar Pradesh State Heat Action Plan aims to provide a framework for the implementation, coordination, and evaluation of extreme heat response activities in the State for reducing the negative impact of extreme heat event. The Plan's primary objective is to develop and implement heat health communication specially targeted towards vulnerable population, those most at risk of heat-related illness. This plan will also involve the inter-departmental coordination framework, which is multidimensional in nature for enhancing collaboration and coordination between all line departments for efficient implementation of State Heat Action Plan. The Standard Operating Procedures have also been laid down by the UPSDMA for the prevention and management of heat related illnesses.

Establish Early Warning System and Inter-Agency Coordination to alert residents on predicted high and extreme temperatures. Who will do what, when, and how is made clear to individuals and units of key departments, especially for health.

Capacity building / training programme. These are very important for mitigation and disaster Risk Reduction. Training of the medical community on various aspects of heat wave – related health hazard is essential to recognize and respond to heat-related illnesses, particularly during extreme heat events. Heat stroke is the medical emergency and training on the identification of heatstroke cases and the process of patient stabilisation before further evacuation should be imparted to the medical community.

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, short video film and Television Commercials (TVCs) on Do's and Dont's and treatment measures for heat related illnesses.

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.

1.7 Objectives of the Uttar Pradesh State Heat Wave Action Plan

1. To develop and implement various strategies for extreme heat events.
2. To develop and implement an early warning system in partnership with IMD for alerting those populations at risk and carrying out activities by the line departments.

3. To take appropriate measures for the Prevention and Mitigation against Heat Related Illnesses.
4. To build capacity of state and district level inter-department officials for efficient and coordinated implementation of state heat action plan.
5. To make more and appropriate use of adaptation and mitigation strategies for reducing heat waves and its impact on human health, livelihood and economy.
6. To identify vulnerable population and heat hotspots.
7. To reduce the heat related illnesses.
8. To enhance resilience of communities against extreme heat events.
9. To make Uttar Pradesh state more resilient against extreme heat wave.

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CHAPTER-2

EARLY WARNING SYSTEM AND HEAT HEALTH COMMUNICATION

2 Early Warning System and Heat Health Communication

2.1 Introduction

Heat wave early warning systems are integral part of with heat action plan and require for reducing the human health consequences of heat waves. In India, Indian Meteorological Department provide forecast for the heat wave event as part of early warning systems (Lowe et al, 2011). This is pivotal for predicting possible health outcomes, triggering effective and timely response plans for the vulnerable populations. Due to significant increase in frequency and severity of extreme heat events, several countries have established early warning systems. Early warning systems are often based on meteorological indicators (typically maximum, minimum, or mean temperatures, and occasionally the level of humidity, as well as a cut-off point at which a significant rise in mortality is anticipated (Issa et al, 2021).

The early warning system is also involving notification of heat wave events, and communication of prevention responses. After several devastating heat wave events in 2010 and 2016, many cities and states across the country-implemented early warning system as a risk reduction strategy (Lowe et al, 2011).

Early warning systems can enhance the preparedness of decision-makers and enhance preparedness against the disaster. Early warning systems for natural hazards is based both on sound scientific and technical knowledge. Accurate and timely alert systems are essential part of early warning system.

2.2 Heat Wave Definition (NDMA, 2019)

Heat wave is a condition of atmospheric temperature that leads to physiological stress, which sometimes may cause death. According to the World Meteorological Organization, a heat wave is declared when daily maximum temperature exceeds the average maximum temperature by five degrees Celsius for five or more consecutive days. Different countries define heat wave differently in contest of their local conditions. In India, heat wave conditions are considered of maximum temperature of a station reaches at least 40°Cor more for plains, 37°C or more for coastal areas and at least 30°C or more for hilly regions.

As per India Meteorological Department (IMD) following criteria is used to declare a heat wave conditions in India:

Criteria for Heat Wave (IMD)

Heat wave need not be considered till Maximum Temperature of a station reaches at least 40º C for Plains and at least 30º C for Hilly regions.

a) Based on Departure from Normal

- Heat Wave: Departure from normal is 4.5 º C to 6.4 º C
- Severe Heat Wave: Departure from normal is >6.4 º C

b) Based on Actual Maximum Temperature

- Heat Wave: When actual maximum temperature ≥ 45 º C
- Severe Heat Wave: When actual maximum temperature ≥47 º C

Source: Indian Meteorological Department, http://www.imd.gov.in

2.3 Temperature Humidity Index

Heat stress is caused by a combination of environmental factors (temperature, relative humidity, solar radiation, air movement, and precipitation). Many indices combining different environmental factors to measure the level of heat stress have been proposed.

Temperature–Humidity Index (THI), combination of temperature and humidity that is a measure of the degree of discomfort experienced by an individual in warm weather; it was originally called the discomfort index. The index is essentially an effective temperature based on air temperature and humidity; it equals 15 plus 0.4 times the sum of simultaneous readings of the dry- and wet-bulb temperatures. Thus, if the dry-bulb temperature is 90° F (32° C) and the wet-bulb temperature is 50° F (10° C), the discomfort index is 15 + 0.4 (140), or 71. Most people are quite comfortable when the index is below 70 and very uncomfortable when the index is above 80 to 85 (*Figure 4*).

The level of heat discomfort is determined by a combination of meteorological (temp, RH, wind, direct sunshine), social/cultural (clothing, occupation, accommodation) and physiological (health, fitness, age, level of acclimatization) factors. There will be no harm to the human body if the environmental temperature remains at 37°C. Whenever the environmental temperature increases above 37° C, the human body starts gaining heat from the atmosphere. If humidity is high, a person can suffer from heat stress disorders even with the temperature at 37°C or 38°C as high humidity does not permit loss of heat from human body through perspiration. To calculate the effect of humidity, Heat Index Values are used in some regions. The Heat Index is a measure of how hot it really feels when relative humidity is factored in with the actual air temperature. Heat index chart used by the National Weather Service of the USA given below shows that if the air temperature is 34°C and the relative

humidity is 75 per cent, the heat index how hot it feels - is 49°C. The same effect is reached at just 31°C when the relative humidity is 100 percent (*Figure:8)*.

Temperature/ Humidity Index

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

Caution | Extreme Caution | Danger | Extreme Danger

Source: Calculated °F to °C from NOAA's National Weather Service

Figure-8: Temperature Humidity Index

2.4 Local Threshold Determination for Early Warning System

The cities of Ahmedabad, Nagpur and Bhubaneswar have chosen the daily Maximum Temperature (T.Max) to determine the threshold. In Ahmedabad, an important reason for selecting T.Max for threshold determination is the climate condition, which is dry and arid. Similarly, Nagpur also has a dry climate in summer.

A simple method used for developing the threshold is response-specific: obtain the long term (10-15 years) daily mortality data for the summer months from the city administration and correlate with the daily Maximum Temperature from IMD. A simple scatter plot of daily Maximum Temperature and daily All-cause mortality will give us the visual representation of the Temperature - Mortality relationship. Shown in below figure, by fitting a curve on the scatter plot, we can see a point of inflection or rapid rise of mortality - this is the threshold point. At this point (Temperature), the curve starts to go up (increase in deaths) rapidly (*Figure 9*).

The scientific community has developed many ways to determine the threshold. One is based only on the meteorological parameters, where the health data is not available or not reliable. A percentile-based threshold (90th, 95th and 99th percentile) of maximum daily temperature could be contemplated as a warning trigger value if climate data is available and health date is not available or reliable. Recent research has indicated that this percentile based threshold works well in the data-sparse regions. This method is also used in developed countries. In Belgium, the 95th percentile of summer maximum temperature has been set as

the threshold to issue warnings. While this threshold is set to capture the most extreme days, it should be noted that they have not been developed from, nor are they related to, any specific health impact, but are location specific.

The Uttar Pradesh State Disaster Management Authority has constituted a team of renowned academicians in the field to devise a localised early warning system for major cities within the state. The research group's preliminary report has achieved a significant milestone by establishing the Heat Threshold and formulating an index specific to the Agra district. This accomplishment stems from a meticulous analysis of daily Temperature and Humidity records spanning from January 1981 to October 2023 (please see Annexure-6). The ongoing analysis includes correlating this data with daily mortality rates. The anticipated completion of the detailed report by February 2024 holds immense significance as it will serve as a cornerstone resource for the implementation of Heat Wave Standard Operating Procedures (SOP) in the approaching summer of 2024.

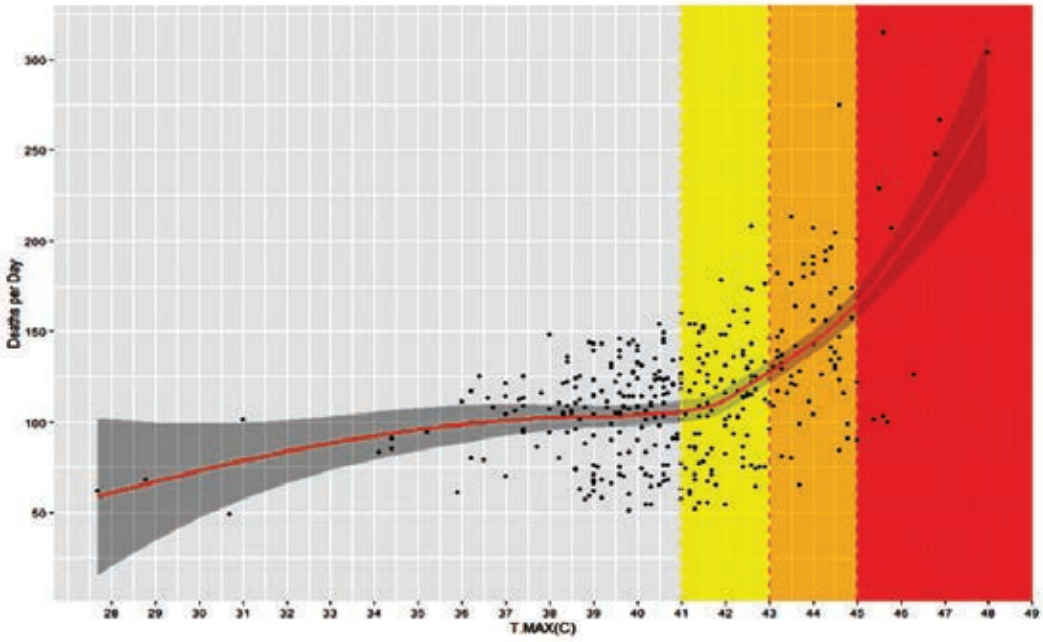


Figure-9: Ahmedabad Temperature and mortality relationship

2.5 Heat Alert Warning Systems in State of Uttar Pradesh:

Early warning systems can enhance the preparedness of decision-makers and their readiness to harness favourable weather conditions. Early warning systems for natural hazards is based both on sound scientific and technical knowledge.

Accurate and timely alert systems are essential. Collaboration with India Meteorological Department (IMD) is needed to develop heat warning systems (HWS), trigger a warning, determine the threshold for action and communicate the risks.

The IMD provides warnings based on heat index (based on temperature and humidity). It disseminates information to Relief Commissioner (RC), District Magistrates and all other concerned authorities including Doordarshan, All India Radio (AIR) by email. Immediately upon receipt of such a warning, the state and district Emergency Operation Centers make necessary arrangements for flashing the warning through all forms of media. Simultaneously, departments of Health and Family Welfare, Education, Labour, Transport, and other related departments remain alert and put necessary emergency measures in place.

During a Heat Wave condition EOC at Relief Commissioner Office issues directives to all the concerned governmental organizations for a prompt action. Apart from this, Relief commissioner office is also involved in establishing the Heat Wave related mortality recording system.

Heat wave forecast is transmitted to Divisional Commissioners, District Magistrates and all other concerned authorities through email and fax by State Control Room. CUG phones have been given to all commissioner, DMs, ADMs, SDMs and Tehsildars. The warning is sent through mass SMS to all. Apart from this IMD gives this data to All India Radio and also to Doordarshan. AIR and Doordarshan widely displays this alert through their mediums.

Department of information publishes Do's and Dont's in various state level as well local Hindi/ English Daily Newspapers and other electronic media. IMD issues forecasts and warnings for all weather related hazards in short to medium range (valid for the next five days) every day as a part of its multi-hazard early warning system. These warnings updated four times a day.

The operational system of weather forecasts and warning is summarized in the chart below (*Figure 10*):

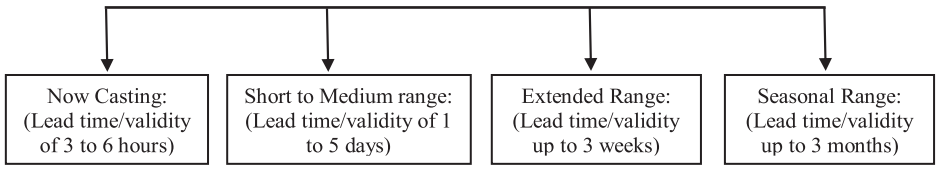


Figure-10: Temperature Forecast

2.6 Declaring Heat wave for the Uttar Pradesh State During 2023

For declaring the heat wave, the above criteria should be met for at least at two stations in a Meteorological sub-division for at least two consecutive days. A heat wave will be declared on the second day. The early warning would be communicated to line department from UPSDMA through Heat Wave Early Warning Communication System (*Figure 11*).

मौसमकेंद्रलखनऊ
भारतमौसमविज्ञानविभाग
पृथ्वीविज्ञानमंत्रालय

Meteorological Centre Lucknow
India Meteorological Department
Ministry of Earth Sciences

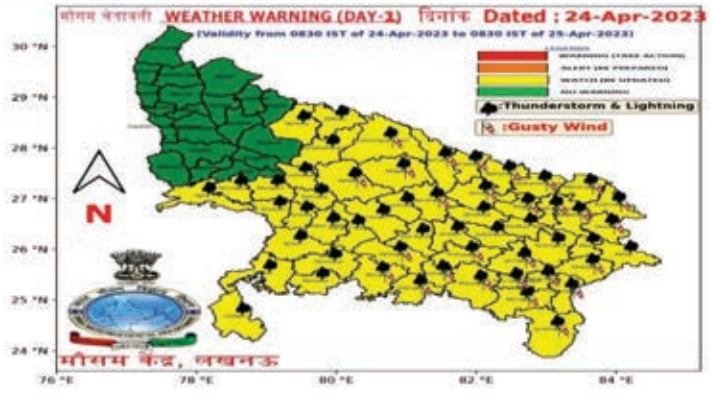
IMPACT BASED FORECAST AND WARNING

WARNING NO.: 2023-04/09 DATE & TIME OF ISSUE: 24th April, 2023 (1200 HRS IST)

District wise Heat Wave Warnings in Tabular Form:-

Date	Warning
1200 Hrs IST of 24th April 2023 to 0830 Hrs IST of 25th April 2023	•Thunderstorm & Lightning with Gusty Wind(40-50 kmph) is very likely over Banda, Chitrakoot, Kaushambi, Prayagraj, Fatehpur, Pratapgarh, Sonbhadra, Mirzapur, Chandauli, Varanasi, Sant Ravi Das Nagar, Jaunpur, Ghazipur, Azamgarh, Mau, Ballia, Deoria, Gorakhpur, Sant Kabir Nagar, Basti, Kushinagar, Maharajganj, Siddharth Nagar, Gonda, Balrampur, Shrawasti, Bahraich, Lakhimpur Kheri, Sitapur, Hardoi, Farrukhabad, Kannauj, Kanpur Dehat, Kanpur Nagar, Unnao, Lucknow, Barabanki, Rae Bareli, Amethi, Sultanpur, Ayodhya, Ambedkar Nagar, Agra, Firozabad, Mainpuri, Etawah, Auraiya, Bareilly, Pilibhit, Shahjahanpur, Jalaun, Hamirpur, Mahoba, Jhansi, Lalitpur and adjoining areas.
0830 Hrs IST of 25th April 2023 to 0830 Hrs IST of 26th April 2023	•Thunderstorm with Lightning is very likely over Kaushambi, Prayagraj, Sonbhadra, Mirzapur, Chandauli, Varanasi, Sant Ravi Das Nagar, Jaunpur, Ghazipur, Mau, Ballia and adjoining areas.

District wise Warnings in Graphical Form-



Heat Wave Early Warning Communication System

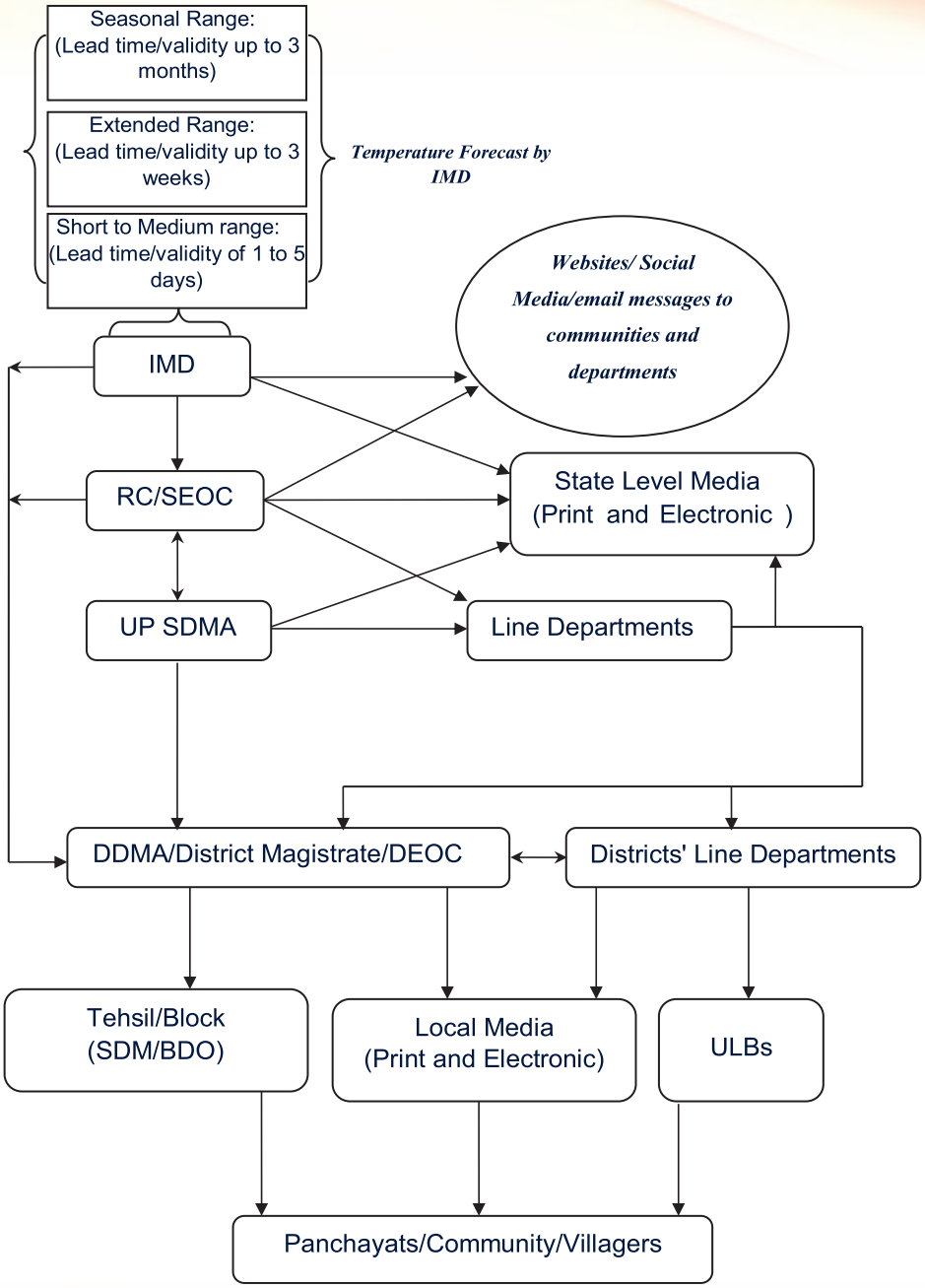


Figure-11: Early Warning Communication System

2.7 Colour Code Signals for Heat Wave Alert and Suggested Actions (NDMA, 2019)

Colour Code	Alert	Warning	Impact	Suggested Actions
Green (No Action)	Normal Day	Maximum temperatures are near normal	Comfortable No cautionary action required temperature	Normal Activity
Yellow Alert (Be updated)	Heat Alert	Heatwave conditions at Isolated pockets persists for 2 days	Moderate temperature. Heat is tolerable for general public but moderate health concern for vulnerable people e.g. infants, elderly, people with chronic diseases	(a) Avoid heat exposure. (b) Wear lightweight, light-coloured, loose, cotton clothes. (c) Cover your head
Orange Alert (Be prepared)	Severe Heat Alert for the day	i) Severe heat wave condition persists for 2 days (ii) Through not severe, but heat wave persists for 4 days or more	High temperature. Increased likelihood of heat illness symptoms in vulnerable and prolonged exposed people	(a) Avoid heat exposure- keep cool. Avoid dehydration (b) Wear lightweight, light-coloured, loose, cotton clothes (c) Cover your head (d) Drink sufficient water- even if not thirsty (e) Use ORS, homemade drinks like lassi, torani (rice water), lemon water, buttermilk, etc. to keep yourself hydrated (f) Avoid alcohol, tea, coffee and carbonated soft drinks, which dehydrates the body (g) Take bath in cold water frequently.
Red Alert (Take urgent action as per Uttar Pradesh State Heat Action Plan)	Extreme Heat Alert for the day	i) Severe heat wave persists for more than 2 days. (ii) Total number of heat/severe heat wave days exceeding 6 days.	Very high likelihood of developing heat illness and heat stroke in all ages	Along with suggested action for orange alert, extreme care needed for vulnerable people. First-aid and immediate hospitalization of heat exhaustion and heat stroke cases

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CHAPTER-3

FINANCIAL PROVISIONS FOR HEAT WAVE IN UTTAR PRADESH

3 Financial Provisions for Heat Wave in Uttar Pradesh

3.1 Heat-Wave and Disaster Management

Section 2 (d) of the Disaster Management Act 2005 defines "disaster" as a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man-made causes, and is of such a magnitude to be beyond the coping capacity of the affected area. Heat-wave has not been notified as a disaster by Government of India yet. Heat wave is not notified in the list of twelve disasters eligible for relief under National/ State Disaster Response Fund norms. However, a State Government may use up to 10 per cent of the funds available under the SDRF for providing immediate relief to the victims of natural disasters that they consider to be disasters" within the local context in the State and which are not included in the notified list of disasters of the Ministry of Home Affairs subject to the condition that the State Government has listed the State specific natural

उत्तर प्रदेश शासन
राजस्व अनुभाग-11
संख्या- 503 /1-11-2016-4(जी)/16
लखनऊः दिनांक: 27 जून, 2016

अधिसूचना

भारत सरकार द्वारा राज्य आपदा मोचक निधि और राष्ट्रीय आपदा मोचक निधि (2015-20) से व्यय के सम्बन्ध में मानक एवं दरों को निर्धारित करते हुये पत्र संख्या-32-7/2014- एनडीएम0-1, दिनांक 08.04.2015 के बिन्दु संख्या-13 में निम्न व्यवस्था दी गयी है-

13.	State specific disaster within the local context in the State, which are not included in the notified list of disaster eligible for assistance from SDRF/NDRF, can be met from SDRF within the limit of 10% of the annual funds allocation of the SDRF.	• Expenditure is to be incurred from SDRF only (and not from NDRF), as assessed by the State Executive Committee (SEC). • The norm for various items will be the same as applicable to other notified natural disaster, as listed above, or • In these cases, the scale of relief assistance against each item for 'local disaster' should not exceed the norms of SDRF. • The Flexibility is to be applicable only after the State has formally listed the disaster for inclusion and notified transparent norms and guidelines with a clear procedure for identification of the beneficiaries for disaster relief for such local disaster; with the approval of SEC.

2. राज्य में बेमौसम भारी बारिश, आंधी/तूफान, आकाशीय बिजली एवं लू-प्रकोप से प्रत्येक वर्ष बड़ी संख्या में जन-धन की हानि होती है। अतः भारत सरकार द्वारा दी गयी उक्त व्यवस्था के दृष्टिगत शासनादेश संख्या-249/1-11-2015-4(जी)/2015, दिनांक 15.04.2015 (यथा संशोधित दिनांक 16.04.2015) को निरस्त करते हुये श्री राज्यपाल महोदय बेमौसम भारी बारिश, आंधी/तूफान, आकाशीय बिजली एवं लू-प्रकोप को राज्य आपदा घोषित किये जाने की सहर्ष स्वीकृति प्रदान करते हैं।

3. उक्त राज्य आपदा से प्रभावित व्यक्तियों/परिवारों को भारत सरकार द्वारा राज्य आपदा मोचक निधि के लिये निर्धारित मानक एवं दरों के अनुसार राहत प्रदान की जायेगी।

4. उक्त राज्य आपदाओं के सम्बन्ध में होने वाला व्यय अनुदान संख्या-51 के अन्तर्गत लेखाशीर्षक "2245-प्राकृतिक विपत्ति के कारण राहत-05-स्टेट डिजास्टर रिस्पांस फण्ड-800-अन्य व्यय-06-स्टेट डिजास्टर रिस्पांस फण्ड से व्यय-09-राज्य सरकार द्वारा घोषित अन्य आपदाओं हेतु डिजास्टर रिस्पांस फण्ड से व्यय-42-अन्य व्यय" से वहन किया जायेगा।

5. प्रदेश सरकार द्वारा लिये गये उपरोक्त निर्णय के अनुसार कार्यवाही सुनिश्चित की जाय।

(सुरेश चन्द्रा)
प्रमुख सचिव।

संख्या व दिनांक तदैव

प्रतिलिपि निम्नलिखित को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषितः-

1- महालेखाकार, (लेखा एवं हकदारी) प्रथम, उ0प्र0, इलाहाबाद।
2- समस्त मण्डलायुक्त, उ0प्र0
3- समस्त जिलाधिकारी, उ0प्र0

(अनिल कुमार)
सचिव एवं राहत आयुक्त।

U.O. 2016 //Pg72

disasters and notified clear and transparent norms and guidelines for such disasters with the approval of the State Authority.

As per above-mentioned clause, State Government of Uttar Pradesh has notified "Heat wave" as State Specific disaster. Thus, now heat wave is also covered for relief from SDRF. Notification issued in this regard is given in the box.

All the concerned departments and District Magistrates have been instructed to take required precautionary measures for mitigating the heat-wave situation.

3.2 REVISED LIST OF ITEMS AND NORMS OF ASSISTANCE FROM STATE DISASTER RESPONSE FUND (SDRF) AND NATIONAL DISASTER RESPONSE FUND (NDRF)

(Period 2022-23 to 2025-26, MHA Letter No. 33-03/2020-NDMA-I Dated 10.10.2022, modified vide letter no. 33-03/2020-NDMA-I Dated 11.07.2023)

Gratuitous Relief	Norms for Assistance
a) Ex- Gratia payment to families of deceased persons.	Rs. 4.00 lakh per deceased person including those involved in relief operations or associated in preparedness activities, subject to certification regarding cause of death from appropriate authority.
b) Ex- Gratia payment for loss of a limb or eyes.	Rs. 74000/- per person, when the disability is between 40 % and 60 %. Rs. 2.50 lakh per person, when the disability is more than 60 % Subject to certification by a doctor from a hospital or dispensary of Government, regarding extent and cause of disability.
c) Grievous injury requiring hospitalization	Rs. 16,000/- per person requiring hospitalization for more than a week. Rs. 5,400/- per person requiring hospitalization for less than a week. Note-injured persons getting treatment under the 'Ayushman Bharat' Yojna will not be eligible for relief under this item.

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CHAPTER-4

PREVENTION AND MANAGEMENT OF HEAT RELATED ILLNESSES

4 Prevention and Management of Heat Related Illnesses

4.1 Introduction

Heat Waves characterized by long duration and high intensity have the highest impact on morbidity and mortality. The impact of extreme summer heat on human health may be exacerbated by an increase in humidity. There is growing evidence that the effect of Heat Wave on mortality is greater on days with high levels of ozone and fi ne particulate matter. The frequency, severity, intensity and duration of heat wave and related mortality is going to increase further due to rapid global climate change.

Thermoregulation is the process that enables our body to maintain a normal core temperature. The hypothalamus regulates body temperature. It causes us to shed heat and maintain a normal core temperature by activating receptors in your skin and other organs. Our body uses sweat evaporation to release heat when it becomes really warm (make the heat go away). If the heat entering person body is more than the rate of heat leaving the body, the core temperature will rise and the person will be at risk for a heat-related illness.

The risk of heat-related illnesses is determined by heat exposure (ambient and internally produced heat from exertion), individual vulnerability (influenced by age, pregnant status, and concurrent disorders), and socio-cultural variables (including environmental exposure, poverty, lack of social cohesion, lack of access to health care, and limited worker protections).

Geographical location, employment (e.g., farming, construction, driving deliveries), social isolation, and time spent outdoors or in hot spots, such as urban heat islands and places with less greenery, all affect how much each person is exposed to heat-related dangers.

Heat-related illnesses range from mild to life-threatening, and heat exposure exacerbates many common health conditions, including cardiac, respiratory, and kidney diseases.

Heat related illnesses can be best prevented if the vulnerable populations/ communities are made aware of prevention tips basic Do’s and Dont's through effective use of various media. Physicians and pharmacists must have knowledge of effective prevention and first-aid treatment of heat related illnesses. It is also crucial to have an awareness of potential side-effects of prescription drugs during hot weather, to ensure the mitigation of heat illnesses.

Acclimatization

Those who come from cooler climatic conditions to warmer places face the risk of Heat Wave illnesses and need to be acclimatized. Acclimatization is achieved by gradual exposure to the hot environment during a Heat Wave. They should be advised not to move out in the open for at least one week to help the body acclimatize to the heat. They should also be advised to drink plenty of water.

4.2 Livestock Preparedness During Hot Weather

Extreme heat causes significant stress to livestock. There is a need to plan well for reducing the impact of high temperatures on livestock. Keeping an eye on the weather forecasts and developing a mitigation plan for high to extreme temperature can be effective in ensuring that the livestock has sufficient shade and water on hot days.

4.3 Vulnerable Population:

Heat waves and hot weather can be deadly and make pre-existing medical issues worse. All age groups and a variety of conditions can have an impact on one's health, but some people are more susceptible than others are to heat-related illnesses and even mortality. Children, elderly individuals, homeless people, persons with pre-existing ailments, outdoor and indoor laborers, emergency responders, members of low-income communities, pregnant women, athletes, and others are among the groups most at risk from heat(*Figure:12*).

Figure 12: Vulnerable Population-Extreme Heat

4.4 Hospital Preparedness Measures for Managing Heat related Illness

Director/In-charge of hospitals, CHCs, PHCs and UHCs should ensure the following measures:

- A detailed action plan to tackle Heat related illnesses well in advance of hotter months.
- Operational framework-preparing specific health adaptation plan, development of guidelines and response plan for climate sensitive diseases.
- Need for updating Heat Health Action Plan and issuing Advisory for Hospital Preparedness, Surveillance and weekly monitoring including Capacity Building.
- Promoting Strategic media coverage of climate and health, linkages at the state level in regional languages to increase support for climate mitigation and adaptation responses.
- Long term measures such as adopting cool roof, improving green forest coverage and analyzing health impacts in urban planning.
- Standard Operating Procedures to tackle all levels of Heat related illnesses. Capacity Building measures for doctors, nurses and other staffs should be undertaken.
- Cases with expected heat stroke should be rapidly assessed using standard treatment protocols.
- Identify search capacities and mark the beds dedicated to heat stroke victims and enhance emergency department preparedness to handle more patients.
- Identify RRT (Rapid Response Team) to respond to any exigency call outside the hospital.
- Ensure adequate arrangements of staff, beds, IV Fluids, ORS, essential medicines and equipment's to cater to management of volume depletion and electrolyte imbalance.
- May try to establish outreach clinics at various locations easily accessible to the vulnerable population to reduce the number of cases affected. Health Centers must undertake awareness in campaigns for neighbourhood communities using different means of information dissemination.
- Primary Health Centers must refer the patients to higher facility only after ensuring adequate stabilization and basic definitive care (cooling and hydration).
- Hospitals must ensure proper networking with nearby facilities and medical centers to share the patient load which exceed their search capacities.

4.5 Case Definitions of various Heat related illnesses

Clinical Entity	Age Range	Setting	Cardinal Symptom	Cardinal Signs	Pertinent Negatives	Prognosis
Heat Rash	All, But frequently children	Hot environment; +/- insulating clothing or swaddling	Itchy Rash with small red bumps at pores in setting of heat exposure; bumps can sometimes be filled with clear or white fluid	Diffuse maculopapular rash, occasionally pustular, at hair follicles; pruritic	Not focally distributed like a contact dermatitis; not confluent patchy; not petechial hemorrhages	Full recovery with elimination of exposure and supportive care
Heat Cramps	**All**	Hot environment typically with exertion; +/- insulating clothing or swaddling	Painful spasms of large and frequently used muscle groups	Uncomfortable appearance may have difficulty fully extending affected limbs /joints	No contaminate wound/tetanus exposure; no seizure activity	Full recovery with elimination of exposure and supportive care
Heat Exhaustion	**All**	Hot environment; +/- exertion; +/- insulating clothing or swaddling	Feeling overheated, lightheaded, exhausted and weak, unsteady, nauseated, sweaty and thirsty, inability to continue activities	Sweaty/Diaphoretic; Flushed skin; hot skin; normal core temperature; +/- dazed, +/- generalized weakness, slight disorientation	No coincidental signs and symptoms of infection, no focal weakness, no aphasia, /dysarthria, no overdose history	Full recovery with elimination of exposure and supportive care; progression if continued exposure
Heat Syncope	Typically, adult	Hot environment; +/- exertion; +/- insulating clothing or swaddling	Feeling hot and weak; lightheadedness followed by brief loss of consciousness	Brief Generalized loss of consciousness in hot setting, short period of disorientation if any	No seizure activity, no loss of bowel or bladder continence, no focal weakness, no aphasia/dysarthria	Full recovery with elimination of exposure and supportive care, progression if continued exposure
Heat Stroke	**All**	Hot environment; +/- exertion; +/- insulating clothing or swaddling	Severe overheating, profound weakness, disorientation, obtundation, seizures or other altered mental status	Flushed dry skin (not always), core temperature ≥ 40-degree C, altered mental status with disorientation, possibly delirium, coma, seizures, tachycardia, +/- hypotension	No coincidental signs and symptoms of infection; no focal weakness; no aphasia/dysarthria, no overdose history	25-50% mortality even with aggressive care, significant morbidity if survive

4.6 Symptoms and First Aid for various Heat Related Illnesses

Heat Disorder Symptoms First Aid	Heat Disorder Symptoms First Aid	Heat Disorder Symptoms First Aid
Heat rash	Skin redness and pain, possible swelling, blisters, fever, headaches.	Take a shower using soap to remove oils that may block pores preventing the body from cooling naturally. If blisters occur, apply dry, sterile dressings and seek medical attention
Heat Cramps	Painful spasms usually in leg and abdominal muscles or extremities. Heavy sweating	Move to cool or shaded place. Apply firm pressure on cramping muscles or gently massage to relieve spasm. Give sips of water. If nausea occurs, discontinue.
Heat Exhaustion	Heavy sweating, weakness, Skin cold, pale, headache and clammy extremities. Weak pulse. Normal Temperature possible. Fainting, vomiting.	Get victim to lie down in a cool place. Loosen clothing. Apply cool, wet cloth. Fan or move victim to air-conditioned place. Give sips of water slowly and if nausea occurs, discontinue. If vomiting occurs, seek immediate medical attention, call 108 and 102 for ambulance.
Heat Stroke (Sun Stroke)	High body temperature. Hot, dry Bskin. Rapid, strong pulse. Possible unconsciousness or altered mental status. Victim will likely not sweat.	Heat stroke is a severe medical emergency. Call 108 and 102 for ambulance foremergency medical services or take the victim to a Health center or hospital immediately. Delay can be fatal. Move victim to a cooler environment. Try a cool bath or sponging to reduce body temperature. Use extreme caution. Remove clothing. Use fans and/or air conditioners. **DO NOT GIVE FLUIDS ORALLY if the person is not conscious.**

4.7 Clinical evaluation or differential diagnosis

Mild heat illness: A rectal temperature is most reliable measurement as alternatives; oral, tympanic, axillary and skin temperature are less accurate. Core temperature and absence of central nervous system symptoms will help the diagnosis and treatment of heat related illnesses. In the absence of hyperthermia, presence of central nervous system symptoms suggests the investigation for differential diagnosis.

Heat Exhaustion: In the case of heat exhaustion, the skin may appear pale associated with tachycardia or hypotension. Headache, dizziness, nausea, vomiting as well as diarrhoea and loss coordination may occur. Such patients are advised to be in supine position with elevation of legs. They are instructed to remove excess clothing and are moved in cool shaded environment. Oral fluids are recommended for rehydration. Vital signs should be monitored with the transport to emergency department if symptoms do not improve after 20-30 minutes of onset.

Heat Cramps: Exercise associated muscle cramps are more common during hot and humid environment and is characterized by dehydration, depletion of electrolytes, hyponatremia etc. The treatment includes rest, prolonged stretching of affected muscle groups and oral sodium intake. For severe conditions, intravenous Normal Saline may be very useful for more rapid relief for severe cramping.

Heat Stroke: Heat Stroke requires immediate diagnosis and early treatment. It is characterized by the elevation of core temperature associated with involvement of central nervous system disturbances. Rectal temperature is recommended to obtain as early as possible. Treatment regime includes stabilizing airway, breathing and circulation. Onsite cooling is preferred generally. Applying ice packs or wet towels to axillary, groin, head, neck region is alternative option. The combination of rapid fan movement and spraying moderate temperature mist of water tends to have effective evaporative and convective cooling. Intravenous hydration needs to be recommended to maintain renal blood flow. In rural areas, community settings, patients should be kept in cool shaded environment without excess clothing till ambulance reach. The curative action taken in this time may decide the degree of cell damage leading to organ failure. Prevention of stroke includes the identification of older population having chronic medical disease or physical disabilities, which lack access to air conditioning and providing them the cooler environment.

The clinical evaluation or differential diagnosis is given in the below chart (*Figure 13*)

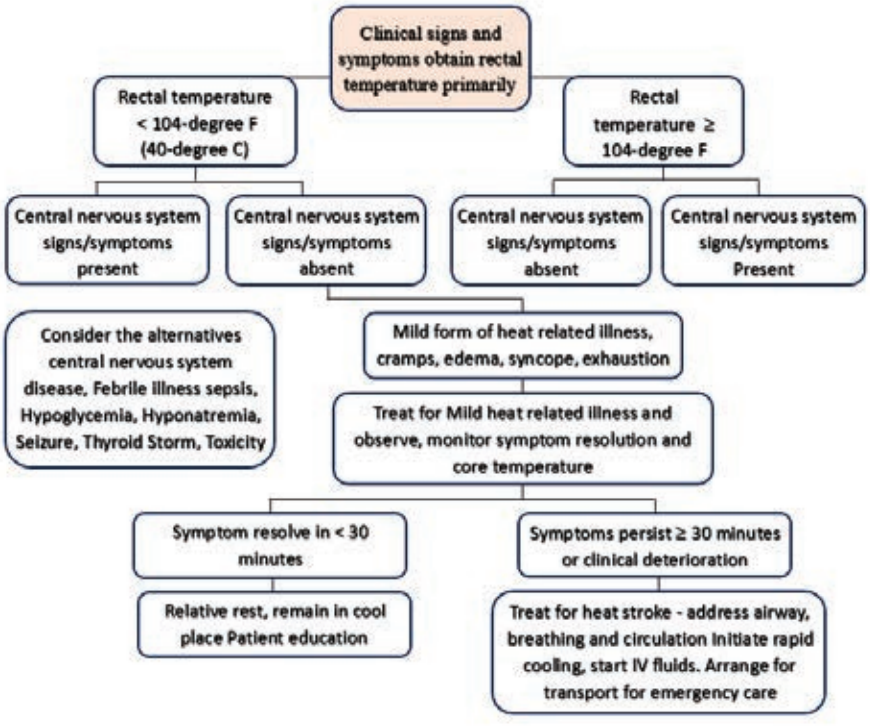

Figure 13: Algorithm for the initial evaluation of a patient with suspected heat related illness

4.8 Heat Illness Treatment Protocol (NDMA, 2019)

Recognizing that treatment protocols may vary slightly in different the settings (EMS, health centers, clinics, hospital emergency departments, etc.), the following should apply in general to any setting and to all patients with heat related illnesses:

1. Initial assessment and primary survey of patient (airway, breathing, circulation, disability, exposure), vital signs including temperature.
2. Consider heat illness in differential diagnosis if:
   a. Presented with suggestive symptoms and signs.
   b. Patient has one or more of the following risk factors:
      - Extremes of age (infants, elderly).
      - Debilitation/physical reconditioning, overweight or obese.
      - Lack of acclimatization to environmental heat (recent arrival, early in summer season).
      - Any significant underlying chronic disease, including psychiatric, cardiovascular, neurologic, hematologic, obesity, pulmonary, renal, and respiratory diseases.
      - Taking one or more of the following:
        - Sympathomimetic drugs.
        - Anticholinergic drugs.
        - Barbiturates.
        - Diuretics.
        - Alcohol.
        - Beta blockers.
3. Remove from environmental heat exposure and stop physical activity.
4. Initiate passive cooling procedures.
   - Cool wet towels or ice packs to axillae, groin, and around neck; if patient is stable, may take a cool shower, but evaluate risk of such activity against gain and availability of other cooling measures.
   - Spray cool water or blot cool water on to the skin.

- Use fan to blow cool air onto moist skin.

5. If temperature lower than 40°C, repeat assessment every 5 minutes; if improving, attempt to orally hydrate (clear liquids, ORS can be used but not necessary; cool liquids better than cold). If temperature is 40°C or above, initiate IV rehydration and immediately transport to emergency department for stabilization.

4.9 Heat Stroke Treatment (Sorensen and Hess, 2022)

Heat stroke is a medical emergency that needs to be treated urgently in order to avoid permanent complications and death. Without prompt treatment, mortality from classic heat stroke approaches 80% and from exertional heatstroke approaches 33%. Central nervous system dysfunction and a core body temperature of more than 40°C are the defining features of heat stroke.

Heat stroke, treatment need to be started with maintaining the airway, breathing, and circulation, immediately followed by rapid cooling. The delay in cooling can be associated with worse outcomes. Initial management should always be focused on rapidly reducing the core body temperature to 38° to 39°C, ideally within 30 minutes after presentation. The most effective cooling methods are cold-water immersion and ice-water immersion. A combination of evaporative and conductive cooling techniques, such as the infusion of cold fluids, the application of ice packs to the neck, groin, and axillae, and fanning, are used as treatment if resource availability, ongoing cardiopulmonary resuscitation, airway compromise, or other factors prevent cold-water immersion (*Figure 14*).

Antipyretic medications should not be used since they make heat stroke patients worse and can exacerbate coagulopathy and end-organ damage. Dantrolene is not often used to treat heat stroke; however, it has been linked to a shorter cooling time without an improvement in recovery rates. Agitation, pain, and shivering can be managed with benzodiazepines.

Successfully cooled patients who make it through the hyperthermic-neurologic phase are at a high risk of progressing to the late hepatic-renal and hematologic-enzymatic stages. The most effective care for these patients should be provided by a multidisciplinary team in an Intensive Care Unit.

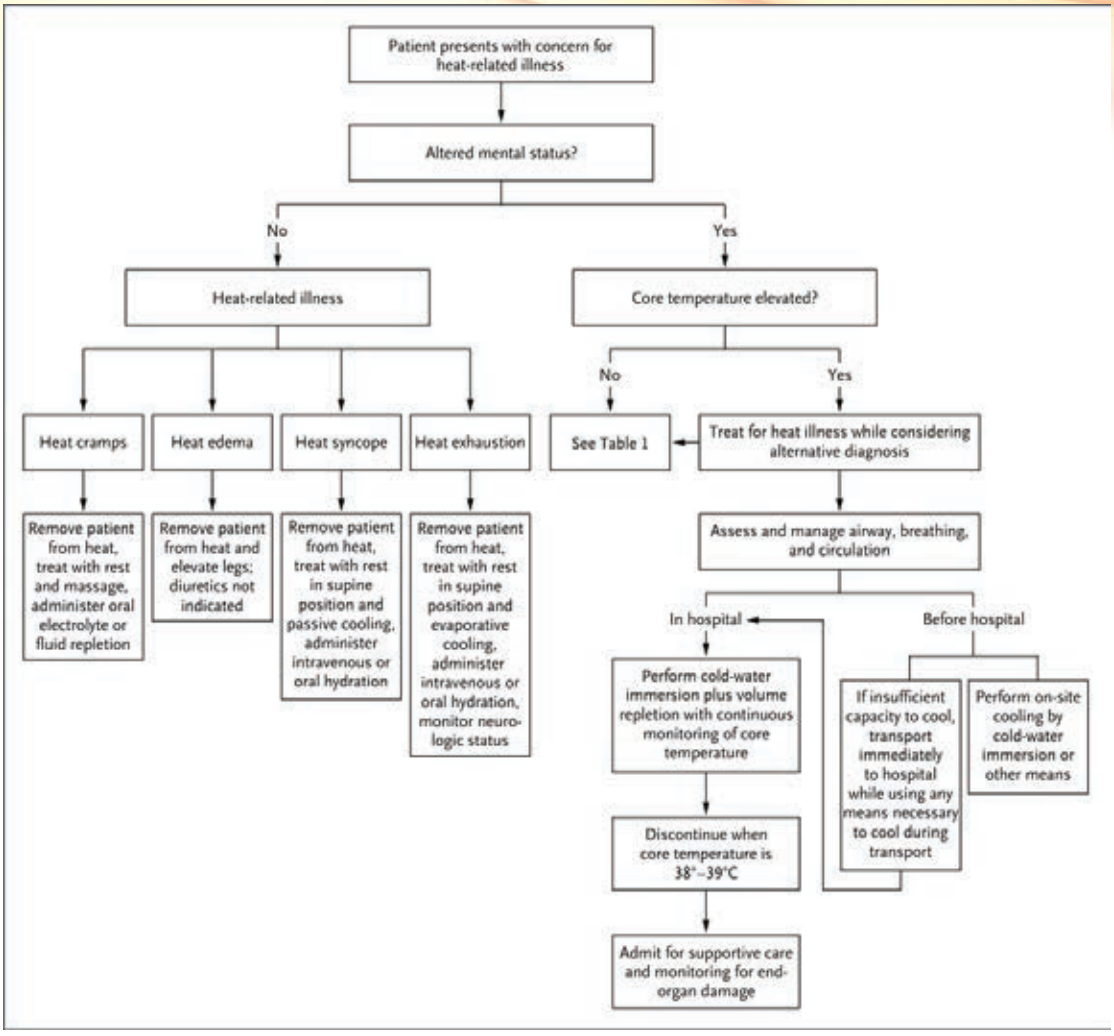

Figure-14: Heat Stroke Treatment Protocol

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CHAPTER-5

INTER-DEPARTMENT COORDINATION FRAMEWORK WITH ROLES AND RESPONSIBILITIES OF LINE DEPARTMENTS

5 Inter-department Coordination Framework with Roles and Responsibilities of line Departments

5.1 Introduction

Inter-department coordination is very essential for successful implementation of Heat Action Plan. As Heat Action plan strategies and activities are multi-dimensional in nature, therefore, active participation of various line departments is essential for effective implementation of heat action plan. Every department is equally important and have some role to play in order to save loss of lives, livelihood and economy due to extreme heat events. In this chapter, the roles and responsibilities of key line departments have been enlisted.

5.2 Phases of Heat Action Plan Implementation

The Heat Action Plan shall be implemented in 3 Phases annually

Phase-I: – Pre -Heat Season (February to March)

Pre-Heat Season is devoted to develop early warning systems, communication plan of alerts to the general public, health care professionals and voluntary groups (care givers) with emphasis on training and capacity building of these groups.

Phase-II: - During the Heat Season (April to July)

High alert, continuous monitoring of the situation, coordination with all the departments agencies concerned on one hand and general public and media on the other hand is the focus of this phase.

Phase-III: – Post -Heat Season (August to October)

In Phase – III concentration is on evaluation and updation of the plan. It is important at the end of the summer to evaluate whether the heat health action plan has worked. Continuous updation of plan is a necessity. Global climate change is projected to further increase the frequency, intensity and duration of heat-waves and attributable deaths. Public health prevention measures need to take into consideration the additional threat from climate change and be adjusted over time.

5.3 Roles and Responsibilities of the Departments

Uttar Pradesh State Disaster Management Authority /DDMA

Phase-I: - Pre Heat season (February to March)

- Constitute a heat wave action plan committee: Prevention and Mitigation of Impacts of Heat Wave, with Chairman and Nodal Officer as Member Secretary, representatives of all departments to be member of this committee.
- Committee should meet at-least 3 times in year, once in pre-heat, during-heat and post-heat season.
- Establish heat mortality tracking system and update datasets.
- Designate point of contact for each department for heat wave.
- To review preparedness instructions to all concerned departments for the heat season.
- Develop and Implement State Heat Action Plan- Capacity Building initiative at state level.
- Preparation of a list of high risk areas in the State / District vulnerable to heat waves for more focus in planning to mitigate adverse effects of Heat wave.
- Convene meetings at state /district level with the concerned Departments/ Agencies/ NGOs involved in response mechanism to Heat waves to review the action plan periodically.
- Develop and Distribute pamphlets and posters with tips to prevent heat stress in local language to hospitals, schools, and professional associations.

Phase-II: - During the Heat Season (April to June)

- Led the implementation of State/District Heat Action Plan.
- Monitoring of implementation of various activities of Uttar Pradesh State/District Heat Action Plan.
- Establishing incident and emergency management teams.
- Monitoring district level heat action plan implementation.
- Organizing meeting with concerned departments during heat season.
- Awareness relating to prevention and management of heat related illnesses.
- Advertisements on safety tips through local newspapers, radio and television channels.

- Issue of timely information and warnings to all key Departments / Agencies, State Emergency Operation Center (SEOC), DEOC etc.
- Communicate locations of emergency facilities and cooling centers/shaded areas with each Department / Organization.
- Inform power supply Companies to prioritize maintaining power to critical facilities (such as hospitals) during extreme heat events.
- Notify all the stakeholders when the heat alert is over.
- Ex-Gratia Relief- After declaring heat wave as State Specific disaster vide notification no- 303/1-11-2016-4(G)/ 2016 dated 27 June 2016, ex-gratia relief of Rs. 4.00 Lakh is given to the family of each deceased due to heat stroke from State Disaster Response Fund (SDRF). A person needs hospitalization due to heat wave is also eligible to get relief from SDRF as per norms.

Phase-III: – Post -Heat Season (July to October)

- Review of quantitative and qualitative data for process evaluation and improvements.
- Annual evaluation of Heat Action Plan by organizing a meeting with key Departments/agencies and relevant stakeholders.
- Evaluate the Plan process based on the reach and impact.
- Revision of Plan based on the feedback and suggestion received from stakeholders.
- Revision of Action Plan ahead of summer season next year for information of all stakeholders.

Medical and Health Department

Phase-I: - Pre Heat season (February to March)

- Designing and initiating targeted training programs, capacity building efforts and communication on heat illness for medical staff at Community Health Centers (CHCs), Public Health Centers (PHCs) / including nursing staff, paramedics, field staff and link workers (ANMs, ASHA Workers, etc.), while paying special attention to the susceptibility of particular wards.
- Up-dation of admissions and emergency case records in Hospitals to track heat-related morbidity and mortality and also to create simple, user-friendly means to track daily heat-related data and behavioural change impacts. Train hospitals to record information on education and communication (IEC) efforts and to ensure recording of cause of death in death certificates.

- Adopt heat-focused examination procedures at local hospitals and urban health centers.
- Developing of SMS facility to reach the field level staff during emergency periods.
- Checking of inventories of medical supplies including ORS powder in PHCs and other Local Hospitals.
- Purchase and distribute reusable soft plastic ice packs for the CHCs, 108 emergency centers, ambulances and hospitals.
- Explore creation of ice pack dispensaries to increase access to vulnerable communities in high risk areas.
- **To provide following services through 108 Emergency Service**
    - Ensure adequate supply of IV fluids.
    - Prepare handouts for paramedics about heat related illness.
    - Create displays on ambulances to build public awareness during major local events.
    - Identifying routes to high risk areas and to reach vulnerable sections of population in shortest time possible by utilizing the list of high-risk areas.

Phase-II: - During the Heat Season (April to June)

- Display of heat-related illness prevention tips and how to stay cool around hospitals, PHCs and CHCs.
- Equip all hospitals/ PHCS/ CHCs with additional supplies of medicines and commodities.
- Ensure adoption of Heat illness treatment and prevention protocols at health facilities.
- Deploy additional staff at hospitals and PHCs/CHCs to attend to the influx of patients during a heat alert, if feasible.
- Keep emergency wards ready in all PHCs / CHCs and Hospitals
- Increase outreach of community health workers in at-risk neighbourhoods during a heat alert.
- Report Heatstroke patients to Nodal Officer on daily basis and generate weekly reports on public health impacts of Heat wave for Nodal Officer, during a heat alert.
- Expedite recording of cause of death in death certificates.
- **Ensure that 108 /104 EMERGENCY SERVICE:**
    - Activate dynamic strategic deployment plan for ambulances.
    - Adequate supply of ice packs, IV fluids and medicines.
    - Keep accurate records of pre-hospital care.
    - Adequate staff on duty and restrict leave if necessary.

Phase-III: – Post -Heat Season (July to October)

- Perform an epidemiological case review of heat-related mortalities during the summer.
- Conduct and gather epidemiological outcomes from the data on heat risk factors, illness and death, based on average daily temperatures.
- Measure mortality and morbidity rates based on data before and after the Plan's interventions.
- Provide data to key Agency / Department.
- Incorporate data and findings into future versions of the Heat Action Plan.
- Participate in annual evaluation of Heat Action Plan review the revised Heat Action Plan.
- To ensure 108 Emergency Service.

Education Department

Phase-I: - Pre Heat season (February to March)

- Review the circulate heat wave action plan department action plan with concerned officials and others stakeholders (School/Colleges, etc.).
- Organize awareness camps classes on heat wave related illness/sunstrokes for teachers and also students.
- Prepare SOP for hot weather impact reduction to education system and safe environment for students.
- Explain importance of proper shade, availability of drinking water and other facilities for Students.
- Distribute pamphlets/posters on heat related illness prevention; Do's and Dont's for display and further distribution to students in Schools and Colleges.
- Ensure availability of ceiling fans in class room's proper shade.
- Ensure availability of ORS, Ice pack, and Cool drinking water.

Phase-II: - During the Heat Season (April to June)

- Display posters and distribute pamphlets on prevention of heat related illness in Schools and Colleges.
- Identify shelter space, shade, drinking water, ORS facilities with signs.
- Restrict working hours as per the weather conditions and monitor early warning when Heat wave is declared.
- No open-air classes to be conducted.

- Ensure school buses are parked in sheds, sprinkle water on the roof of the buses, before commuting.
- Distribute heat protection materials at local schools and orient school teachers to equip them with knowledge of heat protection tips and activities which they can disseminate in classrooms.
- Scheduling of examinations before starting of Heat period normally and also avoid examination during orange and red alert.
- Hostels operated by Social Welfare, Minority, and by Private Institutions to ensure proper measures are adopted to provide sufficient water and arrangements to keep the environment in the hostels cool. Ensure sufficient power supply is available, access to health facility is available, fans/coolers are installed.

Phase-III: – Post -Heat Season (July to October)

- Review implementation and effectiveness of Plan.
- Obtain and give feedback for further improvement of Plan.

India Meteorological Department (Uttar Pradesh Regional Office)

Phase-I: - Pre Heat season (February to March)

- Issue prior Warnings with details of temperature and districts.
- Establish system of early warning and forecasting in collaboration with UP SDMA.

Phase-II: - During the Heat Season (April to June)

- Provide daily/ weekly forecasts.
- Communicate Heat wave alerts/warnings promptly.
- Update heat wave details regularly in their website.
- Determine threshold district wise e.g. Percentile method.

Phase-III: – Post -Heat Season (July to October)

- Provide season report containing duration of Heat wave and location-wise maximum temperatures.
- Participate in annual evaluation of heat action plan.

Information and Public Relations (I & PR) Department

Phase-I: - Pre Heat season (February to March)

- Identification of areas to post warnings and information during heat season.
- Securing advertisement / scrolling slots for announcements regarding Heat waves.

- Designing information and awareness material in the form of pamphlets, posters etc. on Heat waves in local language for distribution to the general public, especially focusing on identified high risk areas in the State and vulnerable groups of population.

Phase-II: - During the Heat Season (April to June)

- Create awareness among public through advertisements in regional languages
- Display hoardings at important places.
- Create awareness through TV and Radio spots and jingles.
- Conduct regular press conferences at the State level and District level through concerned Ministers, Secretaries and Collectors on the risks and dangers of heat related illness.
- Circulate heat wave warnings i.e. text alerts or WhatsApp messages in collaboration with private sector telecom companies in addition to traditional media.
- Send warnings in bulk to the public via centralized email databases during heat waves.
- Develop SMS alert system from time to time on treatment systems to send messages to private doctors and medical professionals at Government hospitals including PHCs and UHCs.
- Utilize local radio FM broadcast through special programmes and during popular programmes to alert the public.
- Explore other means of communication like Facebook, Twitter and Whats App.
- Collect all news items/reports on Heatwaves daily and report to Government. Conducting regular press conferences at the state level and District level on the risks and dangers of heat related illness.

Phase-III: – Post -Heat Season (July to October)

- Evaluate reach of advertising / public messages and other means of communication like social media (face book, twitter etc.) to target groups.
- Participate in annual evaluation in Heat Action Plan.

Labour and Employment Department

Phase-I: - Pre Heat season (February to March)

- Organize training for employers, outdoor labourers and workers on health impacts of extreme heat and protective measures to be taken during high temperature periods.

- Utilize maps of construction sites and outdoor work spots preferably overlaying with irradiation map from IMD or heat island map to identify more high-risk outdoor workers and to conduct publicity campaigns during high-risk days.
- To regulate construction/work site contactors to provide drinking water, ORS and shelter to worker's labourers.
- To Instruct Factory/industry managements to provide cool drinking water, ORS and shelter to worker's labourers.
- Preparing a list of factory medical officers, contractors and house side non-factory workers to include in heat alert and action communication.
- Heat illness orientation planning for factory medical officers.

Phase-II: - During the Heat Season (April to June)

- Encourage employers to shift outdoor workers schedules away from peak afternoon hours (12 – 4pm) during a heat alert.
- Ensure provision of shelters/ cooling areas, water and supply of emergency medicines like ORS, IV fluids etc. at work sites by employers.
- Report cases of heat related illnesses to nearest public health facilities.

Phase-III: – Post -Heat Season (July to October)

- Obtain feedback on cases, plan, and measures taken.
- Participate in annual evaluation of heat action plan.

Rural Development Department

Phase-I: - Pre Heat season (February to March)

- Collecting information on the works sanctioned under MGNREGS programme and other schemes in High risk areas to plan for mitigation effort during heat period.
- To ensure shade and supply of adequate drinking water at work spots.
- Ensure Adequate drinking water supply.

Phase-II: - During the Heat Season (April to June)

- Reschedule of working hours to avoid intense heat timings in all the works sanctioned under MGNREGS on red alert days.
- Provision of additional drinking water in heat vulnerable areas.
- Training of local volunteer in first aid for heat related illnesses.
- Shelters / cooling areas wherever necessary.

Phase-III: – Post -Heat Season (July to October)

- Participate in annual evaluation of heat action plan.

Urban Development Department / Panchayati Raj Department

Phase-I: - Pre Heat season (February to March)

- High Risk Area mapping and identification of vulnerable groups particularly destitute, homeless, beggar homes and old age homes to concentrate on mitigation efforts during heat alert period.
- Identification of areas to provide shelters and drinking water during heat alert period.
- Special care in restricting outdoor activities and functions during heat period.
- Identification of NGOs / Rotary Clubs / Lions Clubs and Corporate houses (under Corporate Social Responsibility) to provide shelters, drinking water, medical supplies and temporary homes during heat days.
- Adequate drinking water supply.

Phase-II: - During the Heat Season (April to June)

- Disseminate SMS text messages to warn residents of high risk areas and vulnerable sections of population during a heat alert.
- Activate "cooling centers," such as public buildings, malls, temples, schools and State Government or Local body, run temporary night shelters for those without house or access to water and/or electricity at home.
- Expand access to shaded areas for outdoor workers, slum communities, and other vulnerable sections of population.
- Keep open the parks for a longer duration during evenings.
- All non-essential uses of water (other than drinking, keeping cool) may be suspended, if necessary.
- Distribution of fresh drinking water to the public by opening water centers at people congregation points like market places, labour addas, etc. Water may be distributed through pouches to the poor in the identified high-risk areas.
- Actively involve NGOs and Corporate houses in providing shelter and drinking water facilities to vulnerable population.

Phase-III: – Post -Heat Season (July to October)

- Collect data related to implementation of Action Plan and provide feedback to key agency / department.
- Participate in annual evaluation of Heat Action Plan.

Animal Husbandry Department

Phase-I: - Pre Heat season (February to March)

- Review and discuss implementation of Heat Wave Action Plan for safeguarding cattle.
- Prepare material like Posters and pamphlets for tips to take care of cattle and poultry during heatwaves.
- Conduct training for department, field workers as well as for cattle and poultry farmers on heat wave management plan in Animal Husbandry sector.
- Review availability of necessary medicines for treatment of cattle / poultry affected by Heatwave.
- Prepare plan for drinking water for cattle with water department.

Phase-II: - During the Heat Season (April to June)

- Display posters and distribute pamphlets on the precautionary measures to be taken to safeguard cattle and poultry birds during heat period in villages and important junctions.
- Ensure adequate stock of medicines in all veterinary hospitals.
- Ensure visit of field staff during heat wave to villages for follow up action in treatment of cattle / poultry birds.

Phase-III: – Post -Heat Season (July to October)

- Participate in annual evaluation of heat action plan.

Transport Department and UPSRTC

Phase-I: - Pre Heat season (February to March)

- Review the departmental action plan with concerned officials and others stakeholders.
- Review plan with Depot Managers/Zonal Managers.
- To create awareness among the Staff and Passengers through meetings, Pamphlets, Posters and Banners on the ill effects of Heat Wave and Sunstroke during summer.
- Organize heat wave risk awareness programmes for Bus drivers, staff at bus stands.
- Explain importance of proper shade, availability of drinking water and other facilities for passengers in bus stations.
- Distribute pamphlets/posters on heat related illness prevention; Do’s and Dont's for display further distribution to passengers at Bus Stations, Bus Shelters.
- Ensure supply of safe drinking water to its Staff and Passengers in the depots and bus stations.
- Planning to provide ORS, Ice packets etc. and medical services in Bus stations.

Phase-II: - During the Heat Season (April to June)

- Display posters and distribute pamphlets on prevention of heat related illness in bus stands, auto stands etc.
- Ensure availability of shade / shelters, drinking water, ORS packets etc., in bus stands, auto stands etc.
- Ensure availability of water and ORS packets in long distance buses.
- Do not run buses as par as possible during peak hours (12-4 pm) when Heat wave is declared.
- Report heat related illnesses to nearest health facilities.

Phase-III: – Post -Heat Season (July to October)

- Participate in annual evaluation of heat action plan.

Agriculture Department

Phase-I: - Pre Heat season (February to March)

- Review the departmental action plan with concerned officials and others stakeholders.
- Ensure heatwave action plan is revised and all the officials are trained in implementing preparedness measures under the department.
- Organize stakeholder meeting and capacity building programmes for the farmers on implementation of contingency plans.
- Organize convergence meetings and prepare policy needs for plan implementation.

Phase-II: - During the Heat Season (April to June)

- Monitor the implementation of the action plan.
- Ensure support to farmers for documenting and prepare for availing risk transfer facilities for reducing impacts to agriculture due to heatwaves.
- Ensure early warnings, dissemination and its last mile connectivity.

Phase-III: – Post -Heat Season (July to October)

- Participate in annual evaluation of heat action plan.

Women and Child Development Department

Phase-I: - Pre Heat season (February to March)

- Women, children and infants are most vulnerable to heatwave seasons. WCD has to take essential precautionary measures to ensure that essential nutritional services will not get effected during the time of heatwaves.
- Setting up of nutritional resource centres at Anganwadi centres to supplement nutritional deficiency in children.

- Pre heatwave necessary precautionary methods such as provision of proper stock of ORS, buttermilk and other rehydration methods may be arranged well in advance.
- Create surveillance mechanism on tracking children, lactating mothers and women through ICDS and Anganwadi centres in the state.
- Capacity building of Anganwadi Sevikas, Asha workers, ANM nurses and ICDS workers to identify symptoms in women and children and to report it when necessary.

Phase-II: - During the Heat Season (April to June)

- Use opportunities, such as nutrition day, SHG meetings for creating awareness and educate young girls and mothers regarding the dangers of Heat Waves, its related health impacts and the precautionary measures to be taken.
- Display IEC materials at Anganwadis and encourage integrated child development scheme (ICDS) workers to disseminate Heat Wave related information with special focus on infants, children below five years, pregnant and lactating mothers to protect them from heat related illnesses.
- Provision of drinking water and first aid at all the Anganwadi Centres.
- Ensure that visits to homes by AWWs are done early mornings, so as not to be exposed to high temperatures.
- ORS, buttermilk and other dehydration methods should be provided to all the school going children under Anganwadi centres and mid-day meal scheme.

Phase-III: – Post -Heat Season (July to October)

- Evaluate the reach of Anganwadi workers and ICDS programme in reducing the heat related illnesses in all heat wave affected districts.
- Participate in annual evaluation of heat action plan.

Police Department

Phase-I: - Pre Heat season (February to March)

- Review the departmental action plan with concerned officials and others stakeholders.
- Conduct joint capacity building and awareness building activities to the police staff posted in vulnerable blocks and districts on topics such as importance of periodic hydration, working in shade and effects of pollution combined with heatwave.
- Shifting of work hours of Traffic personnel in the early morning and late evening along with convenient shifts throughout the day with enough rest.

- Prepare SOP for managing heatwave related health causalities.
- Address the thick material of police uniforms that trap heat addition to the body heat.
- Update the guidelines for police personnel on duty and creating awareness at all levels.

Phase-II: - During the Heat Season (April to June)

- Provision of drinking water, preferably in earthen pots to keep the police personnel hydrated.
- Proper usage of caps and sun glasses for traffic police in prolonged shifts from morning to afternoon.
- Management of traffic through traffic lights instead of police personnel standing out in the sun.

Phase-III: – Post -Heat Season (July to October)

- Participate in annual evaluation of heat action plan.

Fire Department

Phase-I: - Pre Heat season (February to March)

- Check the readiness of vehicles and firefighting equipment to face any emergency situations.
- Ensure capacity building activities of staff and officials.
- The department shall coordinate community and school children capacity building activities on heatwave preparedness.
- Prepare SOP for managing heat related health causalities. (Handling of the patient's transpiration etc.)

Phase-II: - During the Heat Season (April to June)

- Obtain feedback on Fire calls, plan, and measures taken.
- Monitor the weather situation and early warnings.

Phase-III: – Post -Heat Season (July to October)

- Participate in annual evaluation of heat action plan.

Tourism Department

Phase-I: - Pre Heat season (February to March)

- Ensure capacity building activities of staff and officials working at tourist places.

- Prepare SOP for managing heat related health causalities. (Handling of the patient's transpiration etc.).
- Ensure coordination with DDMA and Local IMD office for timely communication about early warning.

Phase-II: - During the Heat Season (April to June)

- Ensure availability of ORS, Drinking water at various tourist sites.
- Ensure awareness pamphlets, hoarding about prevention from heat related illnesses are available at tourist sites.
- Ensure tourist sites have enough cooling equipment like Air Coolers, AC etc.
- Monitor the weather situation and early warnings.
- During Re-alert change the timing of site visit.

Phase-III: – Post -Heat Season (July to October)

- Participate in annual evaluation of heat action plan.

NGOs, SHGs, Community Groups and Other social organisations

Phase-I: - Pre Heat season (February to March)

- Identification of NGOs, Voluntary Organizations in reaching out to the Public, especially vulnerable groups.
- Conduct training programmes, workshops and outreach sessions with NGOs/CSOs/ Self-help groups and mobilizers such as ASHA workers, Anganwadis, and Ward Committees in Municipalities to inform.
- Encourage discussions for finding early signs of heat exhaustion with local doctor or Health Centre.
- Inform fellow community members about how to keep cool and protect oneself from heat.

Phase-II: - During the Heat Season (April to June)

- Take all precautions to avoid Heat related illness.
- Awareness and community outreach on prevention and management of heat related illnesses.
- Keep cool and hydrated during the heat season by drinking water, staying out of the sun, and wearing light clothing.
- Check on vulnerable neighbours, particularly during a heat alert.

- Limit heavy work in direct sun or indoors, if poorly ventilated, especially during a heat alert.

Phase-III: – Post -Heat Season (July to October)

- Participate in annual evaluation of heat action plan.

District Development officer (DDO)/ District collector/ Municipal commissioner

Phase-I: - Pre Heat season (February to March)

- Constitute a District Heat Action Plan Committee, with District Collector as Chairman and DDO as Member Secretary, with representatives of all departments to be member of this committee.
- The committee should meet at-least 3 times in year, once in pre-heat, during-heat and post-heat season.
- Collector should monitor all-cause death and all hospital admission cases during heat season.
- To review preparedness for the heat season in the district.
- To issue necessary instruction to all concerned departments for better inter-sectoral co-ordination.

Phase-II: - During the Heat Season (April to June)

- Meeting of District Heat Action Plan Committee.
- Collector at district should monitor all-cause death and all hospital admission during heat season.
- To monitor the implementation of the Heat Action Plan.
- To issue necessary instruction regarding strict adherence of the plan.
- To ensure mid-course correction.

Phase-III: – Post -Heat Season (July to October)

- To review the implementation of the heat action plan.
- Participate in annual evaluation of heat action plan.

Block Development Officer (BDO) at Taluka level

Phase-I: - Pre Heat season (February to March)

- Supervise preparedness of the Gram Panchayats.

- To issue necessary instruction to all concerned departments for better inter-sectoral co-ordination.
- Monitor all-cause death and all hospitals admission during heat season.
- Arrangements for establishing rehabilitation centers and materials required thereof.
- Arrangements for supply of good quality drinking water/ORS and other items of basic necessities.
- Explain importance of proper shade and cool roof to the village level.

Phase-II: - During the Heat Season (April to June)

- To monitor the implementation of the Heat Action Plan.
- To issue necessary instruction regarding strict adherence of the plan.
- To deploy monitors/ supervisors to concurrent monitoring and feedback.

Phase-III: – Post -Heat Season (July to October)

- To review the implementation of the heat action plan.
- Participate in annual evaluation of heat action plan.

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CHAPTER-6

INFORMATION, EDUCATION AND COMMUNICATION

6 Information, Education and Communication

6.1 Introduction

Information Education and Communication (IEC) is an important tool in health promotion for creating supportive environment and strengthening community action. The IEC in health programmes aims to increase awareness, change attitude and bring about behaviour change.

IEC provides a platform for the discussion of important health issues to foster an understanding of concepts, underlying principles, and benefits of health initiatives. IEC is essential to achieving better health outcomes in all public health interventions.

It is recognised as a viable and cost-effective approach to addressing broader determinants of health, risk factors, building trust and commitment, fostering community participation, and empowerment towards development and implementation of health initiatives.

Recognising importance of IEC, IEC pamphlet has been developed under Uttar Pradesh State Heat Action Plan for creating awareness regarding prevention and management of heat related illnesses.

It is important to note that these are preventable deaths. Informing the public on the preventive actions to be taken, reporting early to health facility, timely diagnosis and treatment, would reduce the deaths attributable to heat waves. IEC can play an important role in preventing mortality and morbidity due to heat related illnesses.

The IEC- posters can be used in crowded places Bus Station, Railway Station, Schools, Cinemas and for larger awareness. Health advisories can also be circulated through social media- Facebook, WhatsApp, Mass emails etc.

6.2 IEC Material for Awareness and Outreach


उत्तर प्रदेश
स्टेट हीट एक्शन प्लान
लू-तापघात जानलेवा हो सकता है, इससे बचाव ही उपचार है.
ओ०आर०एस० प्रदान करने वाले पेय पदार्थ पियें
सफेद या हल्के रंग के सूती कपड़े पहनें
अधिक गर्मी में घर से बाहर न निकलें
छाया में बैठकर विश्राम करें
बुजुर्गों, बच्चों एवं गर्भवती महिलाओं का विशेष ध्यान रखें
घर की छत पर चूने/सफेद रंग का पेन्ट करें
सिर पर गीला कपड़ा रखें तथा शरीर को कपड़े से ढककर बाहर निकलें
प्यास की इच्छा न होने पर भी बार-बार पानी पियें
उत्तर प्रदेश राज्य आपदा प्रबंधन प्राधिकरण द्वारा जनहित में जारी


Uttar Pradesh State Heat Action Plan
श्रमिकों को तापघात से बचायें ।
श्रमिकों को सुरक्षित वातावरण प्रदान कराना हमारी जिम्मेदारी है ।
श्रमिकों को तापघात से बचाव के तरीके समझायें एवं बार-बार पानी पीने के लिये प्रेरित करें ।
उत्तर प्रदेश राज्य आपदा प्रबंधन प्राधिकरण द्वारा जनहित में जारी


लू से बचें और बचाएँ
https://www.youtube.com/watch?v=AQs0lvQZxxA

6.3 Do's and Dont's

Heat Wave conditions can result in physiological strain, which could even result in death. To minimize the impact during the heat wave and to prevent serious ailment or death because of heat stroke, the following measures are useful:

DO's

- Listen to Radio, watch TV, read Newspaper for local weather forecast to know if a heat wave is on the way
- Drink sufficient water and as often as possible, even if not thirsty
- Wear lightweight, light-coloured, loose, and porous cotton clothes. Use protective goggles, umbrella/hat, shoes or chappals while going out in sun.
- While travelling, carry water with you.
- If you work outside, use a hat or an umbrella and also use a damp cloth on your head, neck, face and limbs.
- Use ORS, homemade drinks like lassi, torani (rice water), lemon water, buttermilk, etc. which help to re-hydrate the body.
- Recognize the signs of heat stroke, heat rash or heat cramps such as weakness, dizziness, headache, nausea, sweating and seizures. If you feel faint or ill, see a doctor immediately.
- Keep animals in shade and give them plenty of water to drink.
- Keep your home cool, use curtains, shutters or sunshade and open windows at night.
- Use fans, damp clothing and take bath in cold water frequently.
- Provide cool drinking water near work place.
- Caution workers to avoid direct sunlight.
- Schedule strenuous jobs to cooler times of the day.
- Increasing the frequency and length of rest breaks for outdoor activities.
- Pregnant workers and workers with a medical condition should be given additional attention.

DON'Ts

- Do not leave children or pets in parked vehicles.
- Avoid going out in the sun, especially between 12.00 noon and 3.00 p.m.
- Avoid wearing dark, heavy or tight clothing.

- Avoid strenuous activities when the outside temperature is high. Avoid working outside between 12 noon and 3 p.m.
- Avoid cooking during peak hours. Open doors and windows to ventilate cooking area adequately.
- Avoid alcohol, tea, coffee and carbonated soft drinks, which dehydrates the body.
- Avoid high-protein food and do not eat stale food.

The best defence against extreme heat is to be prepared, and remember:

Get ready: Take steps now to prepare your home, workplace, and community for preparation and prevention of heat wave.

Get set: Know the symptoms of heat-related illnesses and what to do in an emergency.

Go: Check on those who may need help during an extreme heat event, like children, elderly family members, homebound neighbours, or outdoor workers.

***

CHAPTER-7

BEST PRACTICES

7 Best Practices

Extreme heat events are on the rise, but there are things you can do now—in your own home, workplace, or neighbourhood—to reduce your current and future risks. Here are some ways through which we can reduce the impact of Heat Wave to some extent. In this chapter, some of the best practices are mentioned and these can be implemented at various levels.

7.1 Cool roof (NDMA, 2021)

Now majority of the population is migrating to urbanising cities, where development is soaring and turning open space into paved, heat-retaining roads and roofs. The urban heat island effect is exacerbated, temperatures rise, poor air quality results, and more energy is required to maintain a comfortable temperature through the use of fans and air conditioning. A straightforward and affordable answer to these problems with urbanisation is the use of cool roofs. Reflecting sunlight, cool roofs release less heat. Compared to standard roofs, cool roofs can assist keep indoor temperatures down by 2 to 4°C (3.6 - 9°F) depending on the environment.

The roof is a crucial part of the building envelope since it directly affects the structure's energy requirements and the inhabitants' thermal comfort. The main way cool roofs work is by reflecting more sunlight that strikes the roof back into the atmosphere than a typical roof surface would. Internationally, cool roofs are recognised as an efficient way to save energy and money, keep cities cooler, and lessen the impact of urban heat islands. Cool roof initiatives have been implemented in major cities throughout the globe, including New York City. According to research, planting shade trees and installing highly reflecting pavement and roofs around the city will, on average, lower a city's ambient air temperature by 2 to 4 degrees Celsius during the summer (*Figure 15*).

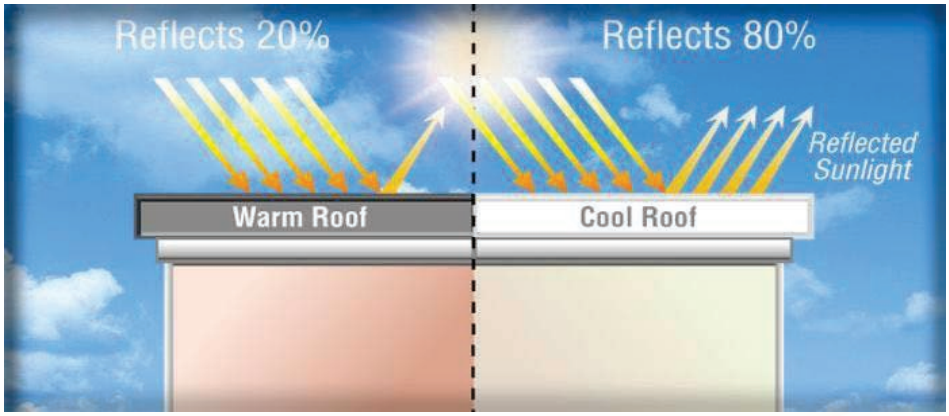


Figure 15: Cool Roof Demonstration

Source: Heat Island Group, Lawrence Berkley National Lab

Cool roofs techniques can be broadly divided into following major categories and building owners can choose from these techniques as appropriate for implementing cool roofs.

Coated cool roofs: these roofs involve the coating of a material or paint with high reflectivity on top of a conventional roof material to increase the roof surface's solar reflectance index. These are liquid applied coatings made of simple materials such as lime wash or an acrylic polymer or plastic technology and are usually white in color.

Membrane cool roofs: these roofs involve using pre-fabricated materials such as membranes or sheeting to cover an existing roof in order to increase the roof surface's SRI. These types of roofs can be polyvinyl chloride (PVC) or bitumen-based.

Tiled cool roofs: these roofs involve the application of high albedo, china mosaic tiles or shingles on top of an existing roof or to a new roof.

Special cool roof materials such as Mod Roof: these roofs, made of coconut husk and paper waste, have been installed in households around Gujarat and Delhi and can serve as an alternative to reinforced cement concrete roofs.

The cost implications vary by the type of material used for cool roofing. However, most of these materials have been applied locally in India and are available through local vendors.

7.2 Use cool paving materials in driveway

Hot pavement also transfers heat to the surrounding air, adding to the urban heat island effect. Cool pavement stays cooler in the sun than traditional pavement by reflecting more solar energy or enhancing water evaporation. Cool pavement can be created from asphalt and concrete, as well as through the use of coatings or grass paving.

7.3 Green Infrastructure for reducing impact of Urban Heat Island

Cities create "urban heat islands" when there are dense clusters of pavement, buildings, and other surfaces that absorb and hold heat in place of natural land cover. This has the impact of raising energy expenditures (for air conditioning, for instance), air pollution levels, and illnesses and deaths brought on by the heat.

For those who live in cities, the Urban Heat Island (UHI) effect is one of the most dangerous environmental risks. The UHI impact is anticipated to become more intense due to climate change. Urban green infrastructure (UGI) may be implemented in this situation to help promote a resilient urban environment and aid in the adaptation and mitigation of climate change.

Urban Green Infrastructure (UGI), which is defined as "a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services, is acknowledged as one of the most crucial

strategies to mitigate UHI and to promote a resilient environment in cities. Green Infrastructure is in fact known to be an effective strategy to reduce heat intensity. With urban forests being the most effective, the cooling capability of UGI can vary significantly and varied across plant species including grass, shrubs, and trees. Trees, green roofs, and vegetation can help reduce urban heat island effects by shading building surfaces, deflecting radiation from the sun, and releasing moisture into the atmosphere.

A new study conducted with data from 93 European cities estimates that one third of deaths attributable to heat islands could be avoided if trees covered 30% of urban space (Iungman et al, 2023) (*Figure 16*).

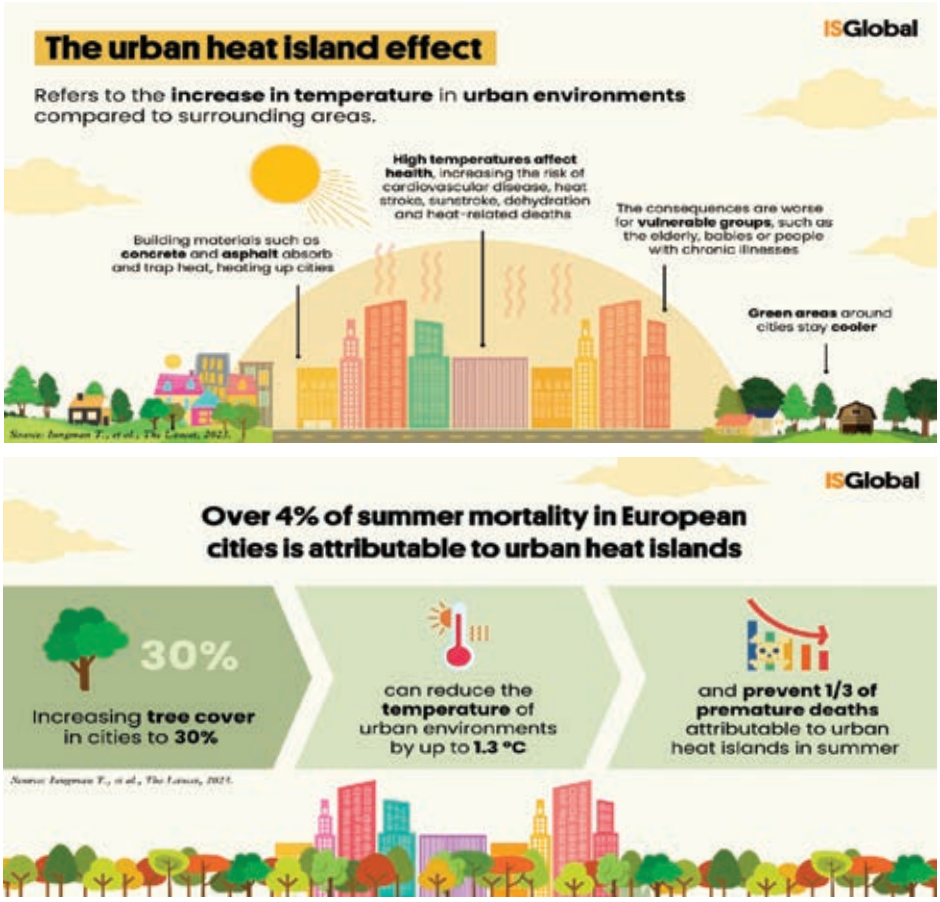


Figure-16: The Urban Heat Island Effect and impact of Tree Cover on Mortality

7.4 Heat-Resilient Health Facilities (Long-term Measures)

Green and Climate Resilient Measures (Adaptation/Mitigation) (*Figure 17*)

- Energy conservation
- Solarisation
- Cool/green roof
- Rainwater harvesting, water conservation
- IPHS standards updated to include climate-resilient measures

Solarization of Health Centre, Chhattisgarh

Tiled Cool Roof & Solar Panels, UPHC, Ahmedabad

Rainwater harvesting, District Hospital Chikkaballapura, Karnataka

Source: NPCCHH, NCDC, NDMA National Workshop Presentation Available on NDMA Website

Figure-17: Climate Resilient Health Facilities

7.5 Data Analysis for understanding impact of heat (NDMA, 2019)

In order to prepare for and take necessary mitigative action against heat wave, we need data on age group, sex and occupation of who die of heat wave. We also need to collect data on whether the deaths occurred indoors or outdoors similarly; data on the economic status of the people who died also needs to be collected. A format for collecting this data is provided at Annexure, which should be used by the DDMAs and SDMAs.

Data from various domains are very much needed to have a sound evidence-based policy and its proper strategization Valid and reliable data is needed for mortality as well as morbidity health outcomes directly as well as indirectly related to heat. Most of the recent work exploring the effects of ambient temperature on human health has not considered the direct heat-related health events such as heat strokes, heat exhaustion and fatigues. However, counter-intuitive it might seem, these direct health outcomes are often not preferred by the research

community. This is because their definitions are not always standardized and the application of definitions often may not be clinically feasible, especially in low and middle income country settings, with sub-optimal health system, such as India, leading to differential underestimation of such events. Moreover, these direct heat outcomes are often biased by other factors the affected area, thus compromising their validity. Instead, the research community has frequently examined the effects of heat on general health indicators that include all-cause mortality, Disease-specific mortality and morbidity - cardiovascular and respiratory events being prominent among them, visits to emergency departments of health facilities, demand for ambulance services and others - which might be causally associated to soaring temperatures. Hence, availability of such data from vital registration systems of local and district bodies, various tiers of health facilities and health departments are essential to carry out meaningful analysis of heat-related health events.

Reliable meteorological data, which constitute the exposure variables, are also necessary for robust evidence generation in this field- this includes data regarding various dimensions of ambient atmospheric temperature, relative humidity, rainfall and wind flow. Standardized atmospheric pollution data are often used to control their variations in these health prediction models, which can refine the dependency estimates of health outcomes on atmospheric heat.

Mortality data must be acquired from Registrar of Birth/Deaths at different levels. The determination of threshold values and characterizing the temperature-mortality relationship and vulnerability assessment. It would help in preparation of heat action plan.

All these data are needed in a time-series format - collected at the same time intervals, at the same locations and for a considerable period of time, so that studies can identify even the smaller but critical effects of heat on the affected population can be based on statistical data. Along with strengthening the vital registration systems, a proper data sharing strategy among all stakeholders should be developed. Each death should be registered at the respective municipality and/or block and the concerned medical officer should provide a medical certificate for the same.

***

ANNEXURES

Annexure-1

ACTION TAKEN REPORT

Heat Wave Action Plan Implementation-2023 (March-July)

1. District Heat Wave Action Plan-2023 developed on prescribe format and shared. (Yes/No)
2. Please list the Nodal Agency/officer Contact details. (District)

S. N.	Name	Mobile	Designation

3. District Heat Action Plan Committee constituted and provided details of meetings. (Yes/No)
4. Maximum temperature and number of heat way days recorded.

S. N.	Districts	Maximum Temp Recorded	No of Heat wave Days

5. Vulnerable areas and heat spot in the district identified.

_____

_____

_____

6. When was the stakeholder consultation conducted and what have been the mechanism for consultation and collaboration with stakeholder (Mention date and list of key stakeholders)

Sr. No.	Date and Place	No of Participants	Key Collaboration with stakeholders

7. Capacity building and training conducted. (DDMAs/Health Dept./Education/veterinary/ICDS etc. Officials)

Sr. No.	Department /Agency	Category of offices and staff trained	Date and place	No of trained personnel

8. Inter-agency coordination, please list the name of departments role played.

Sr. No.	Name of Department	Role Played

9. Review for the availability of ORS, ice pack, IV fluid and medical supplies at public health facilities.

_____

_____

_____

Key initiative/Best Practices

10. What Institutional mechanisms were setup/adopted for Early Warning dissemination and Communication? (Including issued the advisory, IEC materials, instructions, Press relies etc.)

_____
_____
_____

11. Please list the activities that were conducted by DDMAs and line departments for Heat Wave risk mitigation of vulnerable groups (for example water cooling stations in slums, cool shelters for poor, cooling access in maternity wards etc.)

_____
_____
_____

12. Describe any long-term heat resilience measures/action taken (e.g-Water conservation, Watershed development, forestation, cool roofs)

_____
_____
_____

13. What is the Budgetary Provision? (e.g. Under CC/State Disaster Plan, etc.) (attached supported documents)

_____
_____
_____

14. Please share lessons learned.

_____
_____
_____

15. Summary of Data Related to Heat wave :(Please attach separate sheet as per Annexure-5(Deaths reported due to heat wave) of NDMA Guidelines of preparation of Action Plan-Prevention and Management of Heat wave 2019 Available.

16. https://ndma.gov.in/sites/default/files/PDF/guidelines/heatwaveguidelines.pdf)

Particulars	2023
a. Total area affected form heat wave (Sq.Km)	
b. Total No of affected/Illness people (Nos.)	
c. Total No of casualties recorded (Nos.)	
d. Total No of casualties verified (final deaths) (Nos.)	

17. Important case study for reducing vulnerability and mortality (Attached)

18. Photographs of mitigation measures/activities undertaken by state (Attached)

Name:

Designation:

Date: *Signature*

Annexure-2

Format A: Death reported due to Heat Wave (State report to NDMA)

Name of the state: Year: Reporting periods:

Date of Reporting:

District		Location						Occupation					Economy		
		Urban		Rural		Total		Farmer	Labour	Hawkers	Others	Total	BPL	APL	Total
	Age Group	M	F	M	F	M	F								
District 1	0-6 Years														
	7-18 years														
	19-35 years														
	36-60 years														
	61> above														
	Sub Total														
District 2	0-6 Years														
	7-18 years														
	19-35 years														
	36-60 years														
	61> above														
	Sub Total														
Total state															

- If any other information related to heat wave, please enclosed a separate page.

Name and designation of the reporting officer:

Signature with Date

Format B: Details of the death reported due to Heat-wave (record kept with state government)

Sr. no	Name and Address	Age Sex (M/F)	Occupation	Place of death	Date and time of death	Max Temp recorded (Rectal and oral)	Death reported during heat wave period or not	List of chronic disease present (Ask the family members)	Date and time of post mortem (If conducted)	Cause of death	Remark	
											Related to post-mortem	Related to joint enquiry
1												
2												
3												
4												

Annexure-3

Format A

DAILY REPORT OF HEAT STROKE CASES AND DEATHS (District report to state government)

S. No	Village	PHC	Block/city	Name and son/Daughter/wife of	Urban U Rural R	BPL Y/N	Age/Sex	Date of attack of Heat Stroke	Any Antecedent illness	Cause of death	Death confirmed by MOs and MROs

Format B

(To be cumulated at the State Level and sent to Central Government)

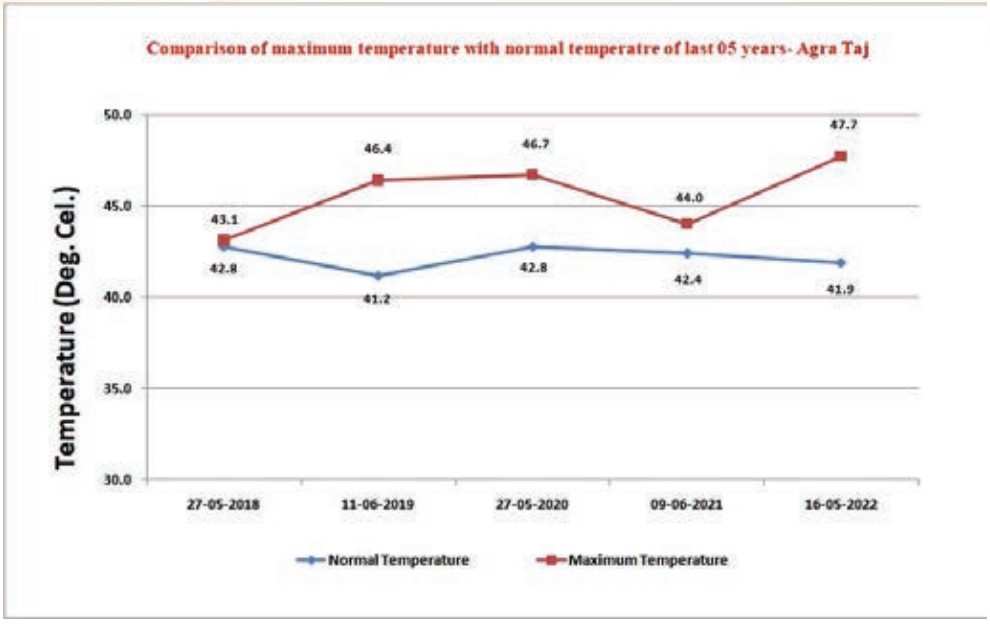
DEATHS DUE TO HEAT RELATED ILLNESS

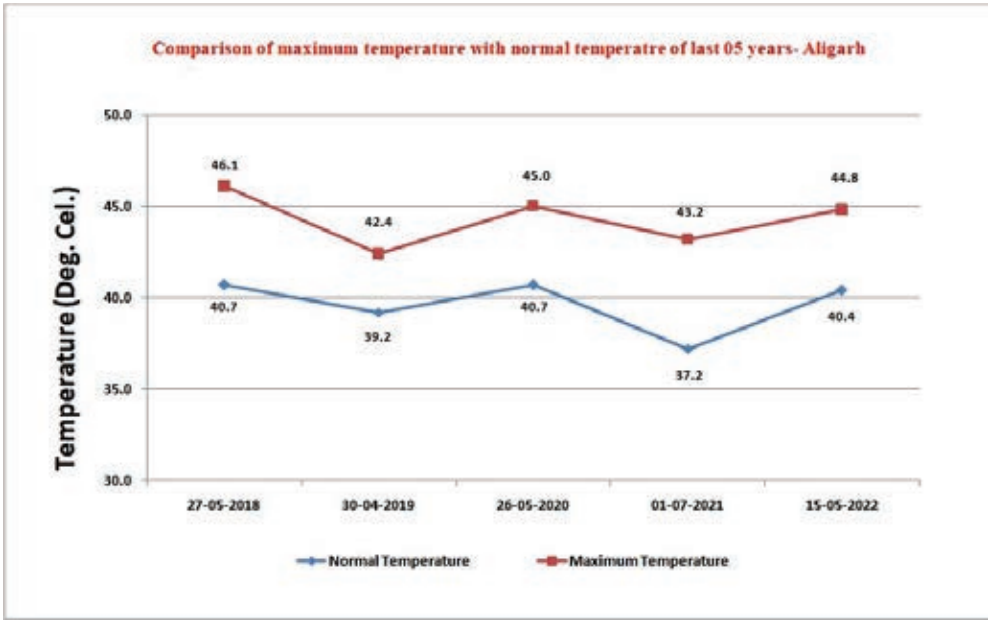
State……. Date:

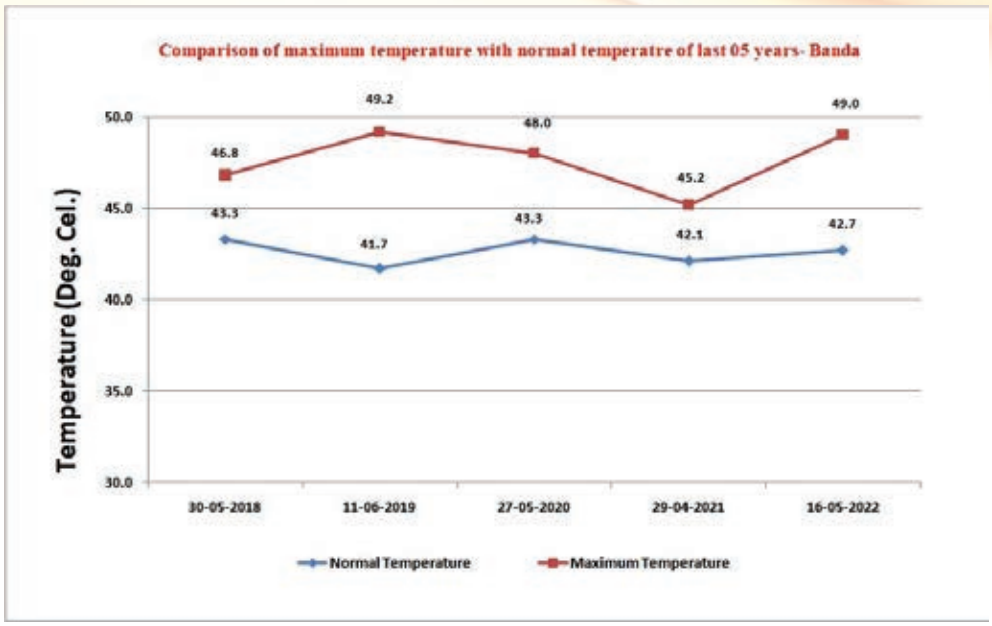
S. No	Name of the district (Name of all districts)	New cases admitted due to Heat Related Illness since the last reporting periods	Cumulative no of cause admitted due to Heat Related Illness since 1st April …….	Deaths reported due to Heat Related Illness since the last reporting period	Cumulative no of deaths due to Heat Related Illness since 1st April …….	Remarks (If any/ shortage of ORS/ IV Fluids/ Treatment facilities etc…)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
TOTAL						

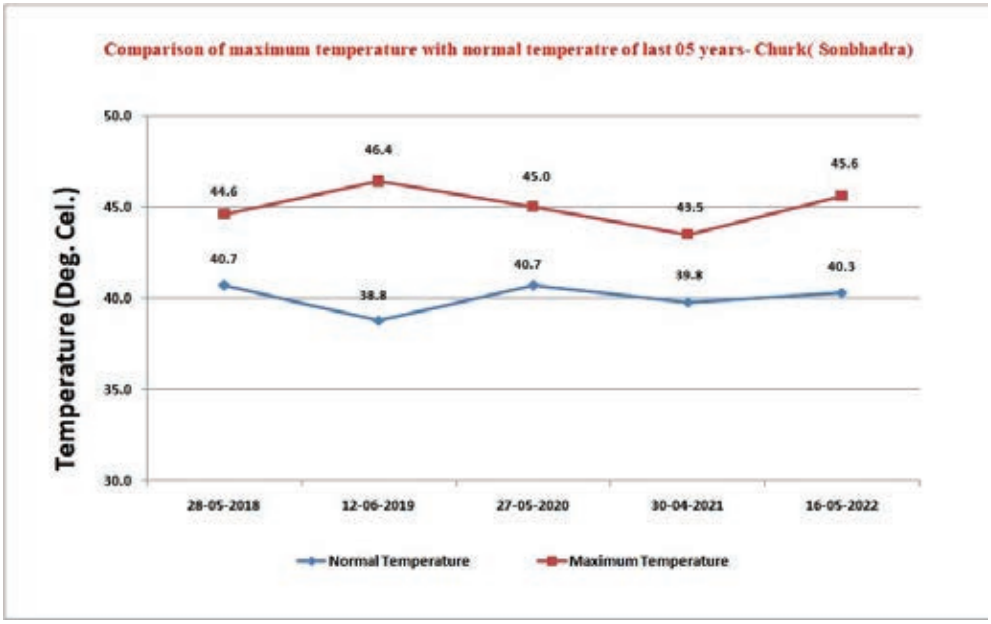
Annexure-4

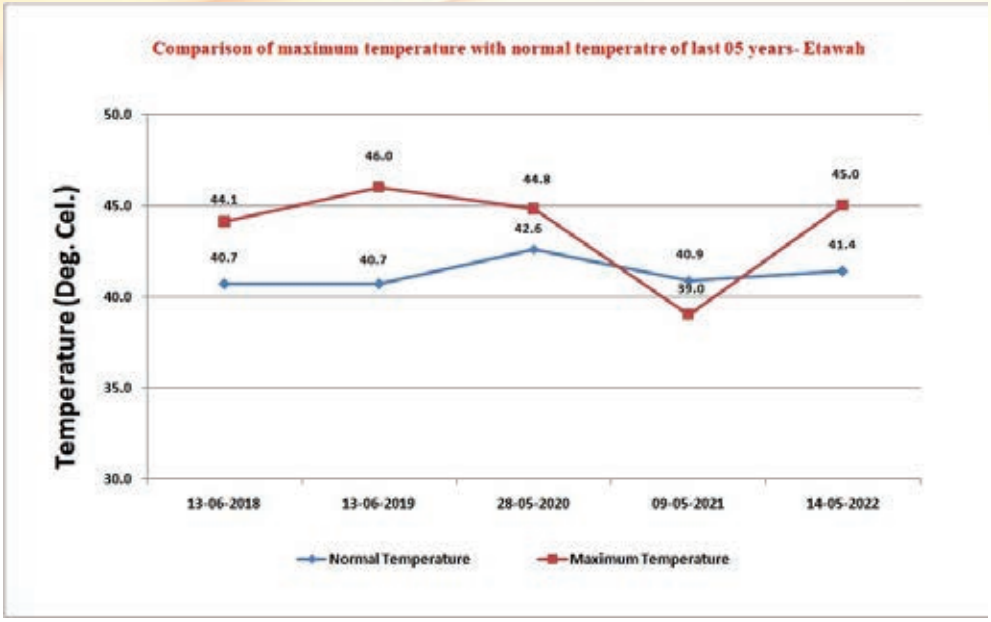
Comparison of Maximum Temperature with Normal Temperature of last 05 Yrs

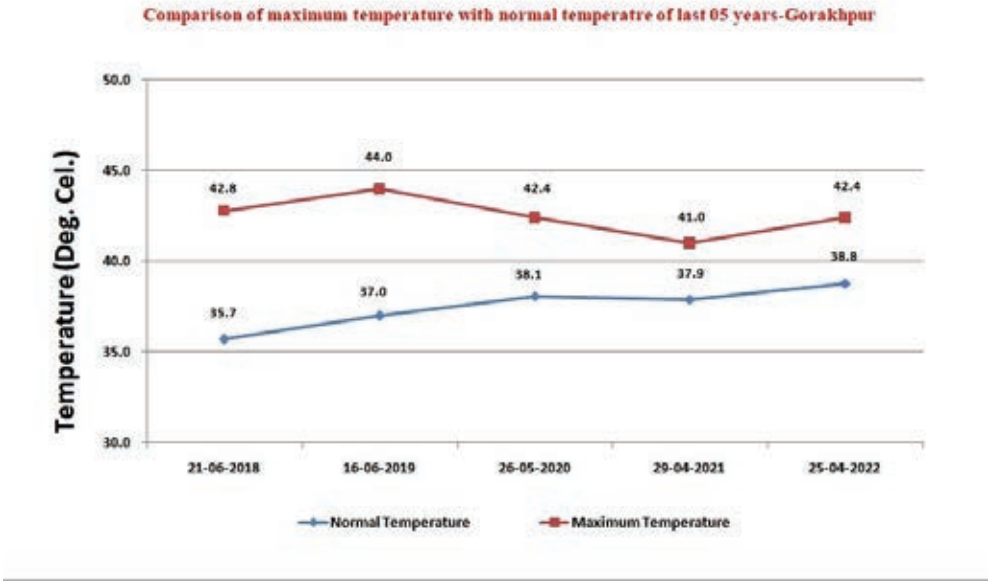


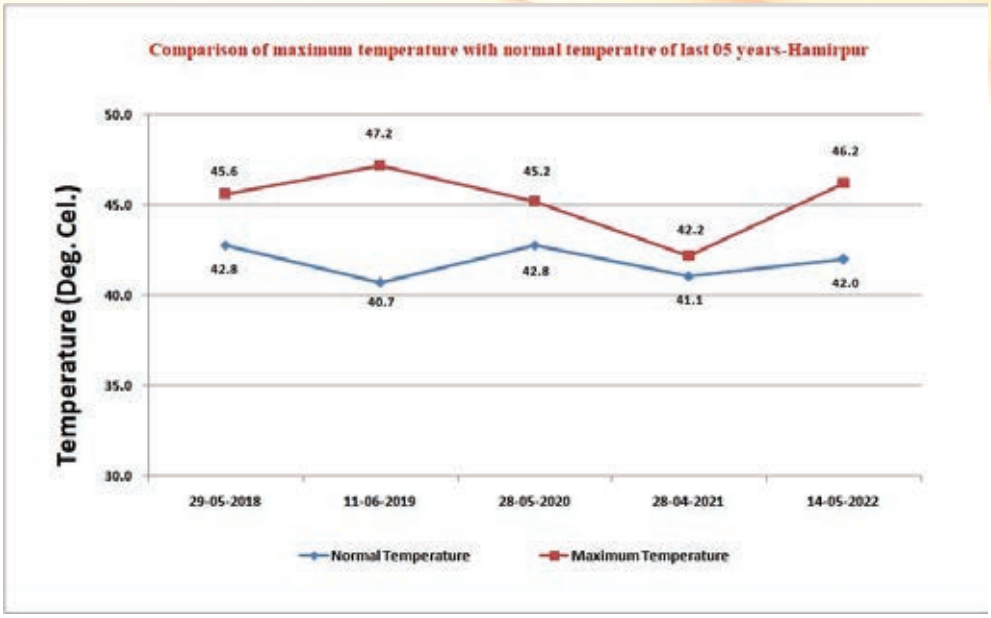


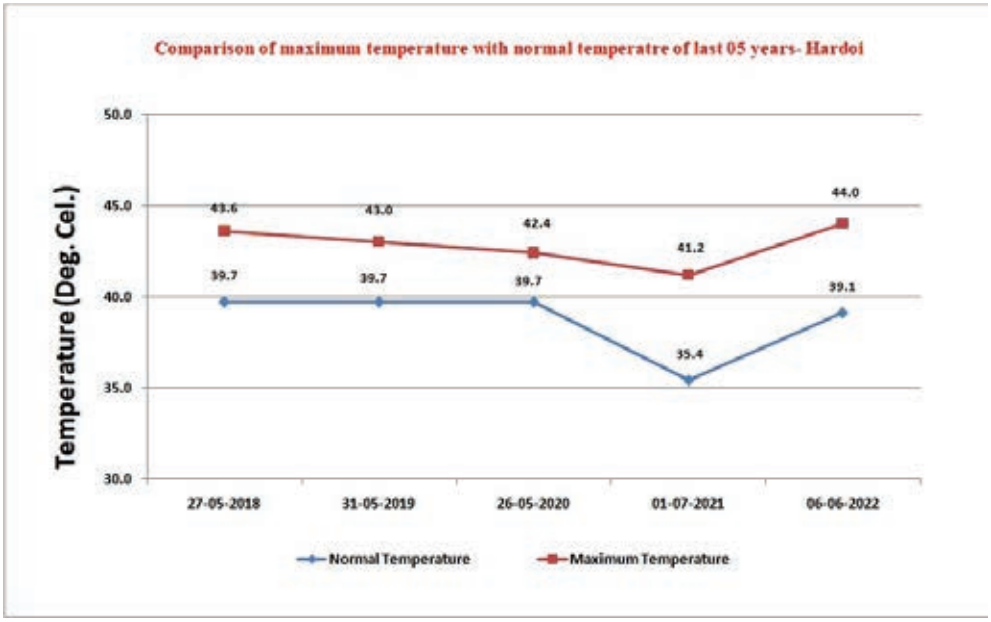

Comparison of maximum temperature with normal temperatre of last 05 years- Banda
Temperature (Deg. Cel.)
50.0
45.0
40.0
35.0
30.0
46.8
49.2
48.0
45.2
49.0
43.3
41.7
43.3
42.1
42.7
30-05-2018
11-06-2019
27-05-2020
29-04-2021
16-05-2022
Normal Temperature
Maximum Temperature

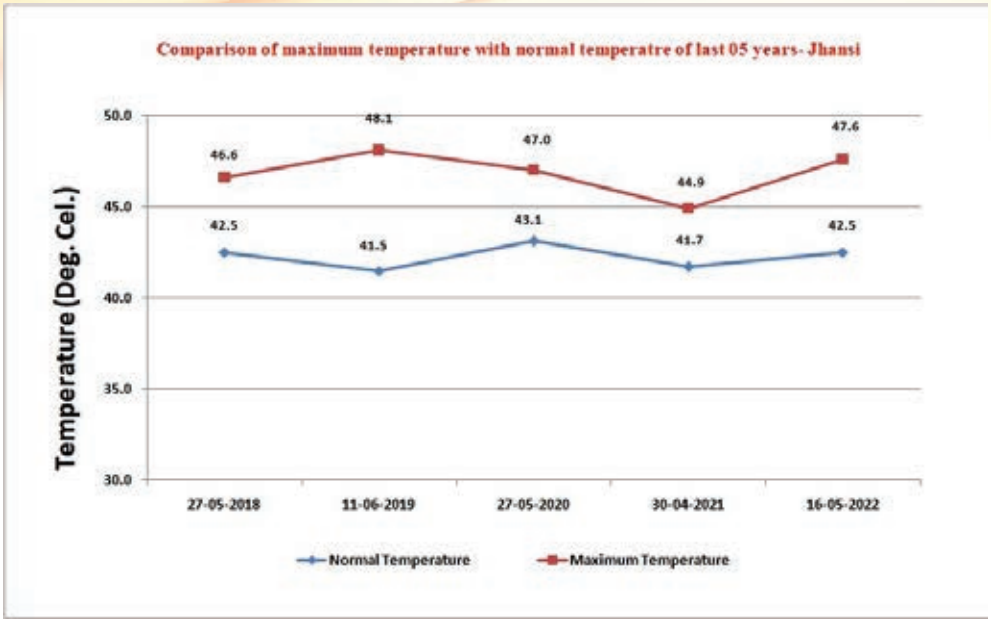

Comparison of maximum temperature with normal temperatre of last 05 years- Churk(Sonbhadra)
Temperature (Deg. Cel.)
50.0
45.0
40.0
35.0
30.0
44.6
46.4
45.0
43.5
45.6
40.7
38.8
40.7
39.8
40.3
28-05-2018
12-06-2019
27-05-2020
30-04-2021
16-05-2022
Normal Temperature
Maximum Temperature

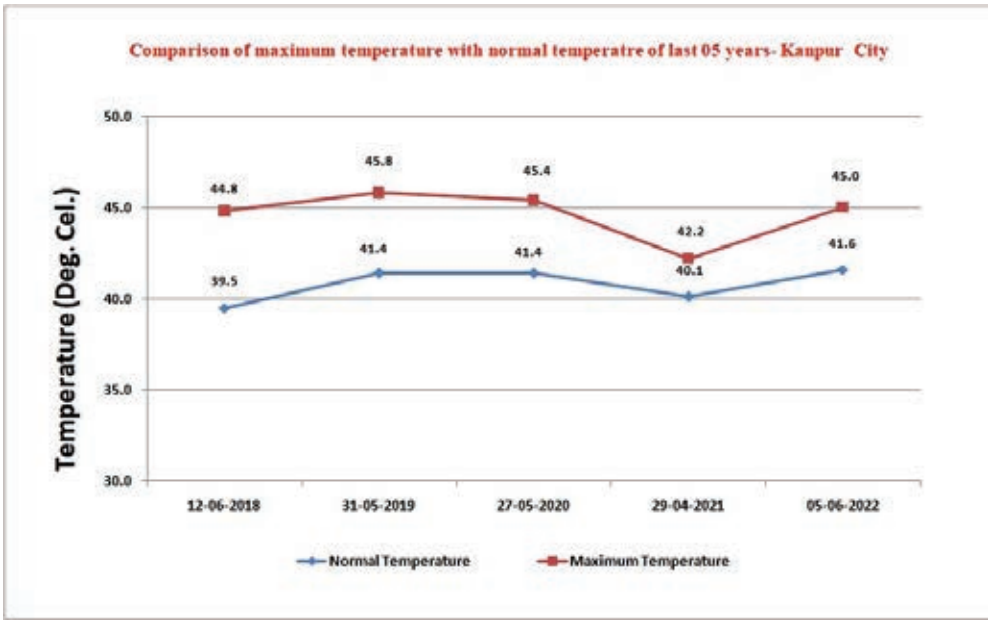

Comparison of maximum temperature with normal temperatre of last 05 years- Etawah
Temperature (Deg. Cel.)
50.0
45.0
40.0
35.0
30.0
44.1
46.0
44.8
45.0
42.6
40.7
40.7
40.9
41.4
39.0
13-06-2018
13-06-2019
28-05-2020
09-05-2021
14-05-2022
Normal Temperature
Maximum Temperature

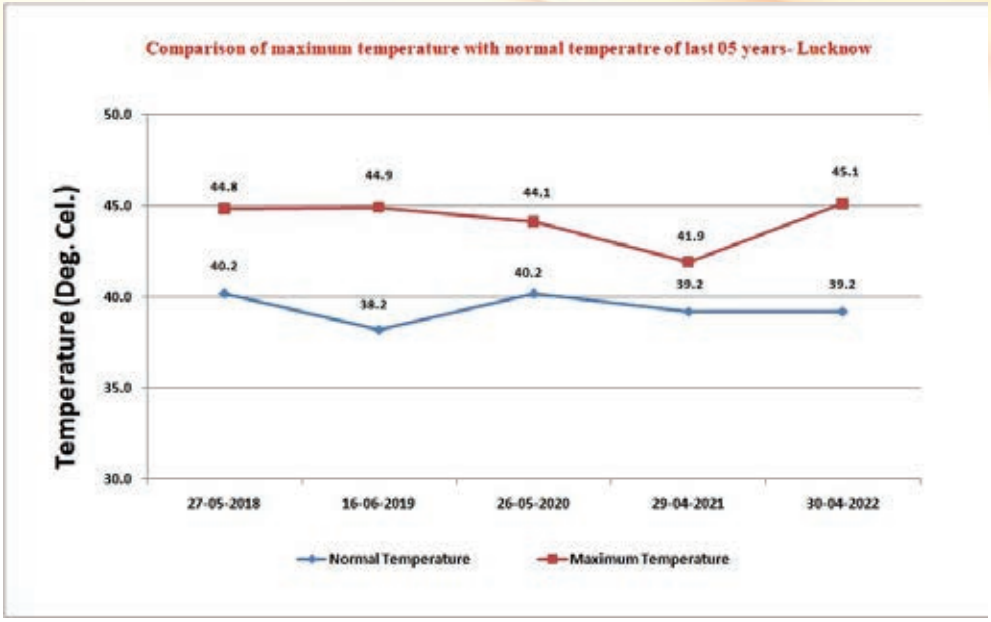

Comparison of maximum temperature with normal temperatre of last 05 years-Gorakhpur
Temperature (Deg. Cel.)
50.0
45.0
40.0
35.0
30.0
42.8
44.0
42.4
41.0
42.4
38.8
38.1
37.9
37.0
35.7
21-06-2018
16-06-2019
26-05-2020
29-04-2021
25-04-2022
Normal Temperature
Maximum Temperature

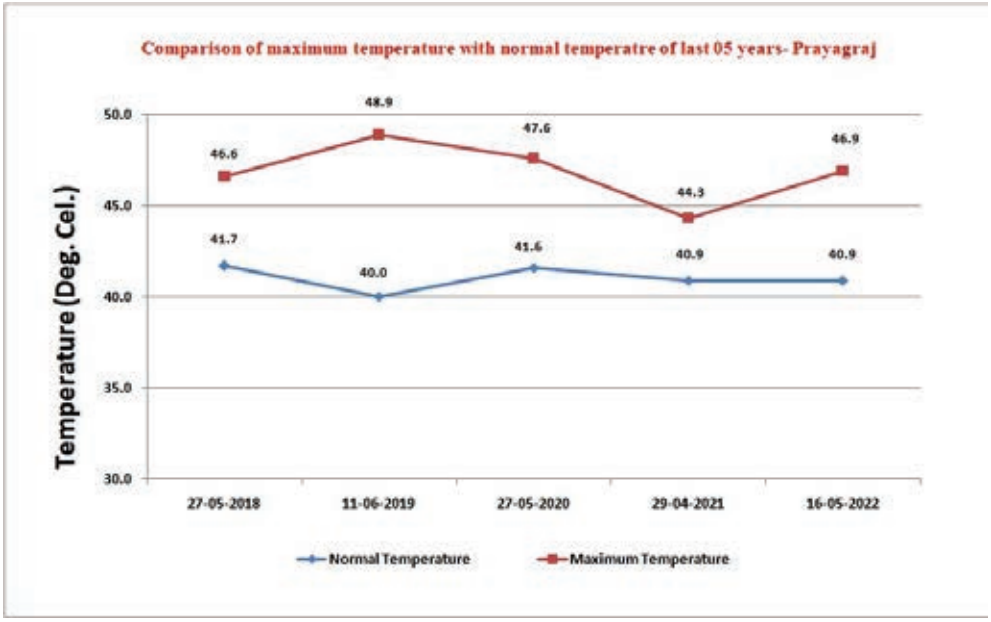

Comparison of maximum temperature with normal temperatre of last 05 years-Hamirpur
Temperature (Deg. Cel.)
50.0
45.0
40.0
35.0
30.0
45.6
47.2
45.2
42.2
46.2
42.8
40.7
42.8
41.1
42.0
29-05-2018
11-06-2019
28-05-2020
28-04-2021
14-05-2022
Normal Temperature
Maximum Temperature


Comparison of maximum temperature with normal temperatre of last 05 years- Hardoi
Temperature (Deg. Cel.)
50.0
45.0
40.0
35.0
30.0
43.6
43.0
42.4
41.2
44.0
39.7
39.7
39.7
35.4
39.1
27-05-2018
31-05-2019
26-05-2020
01-07-2021
06-06-2022
Normal Temperature
Maximum Temperature

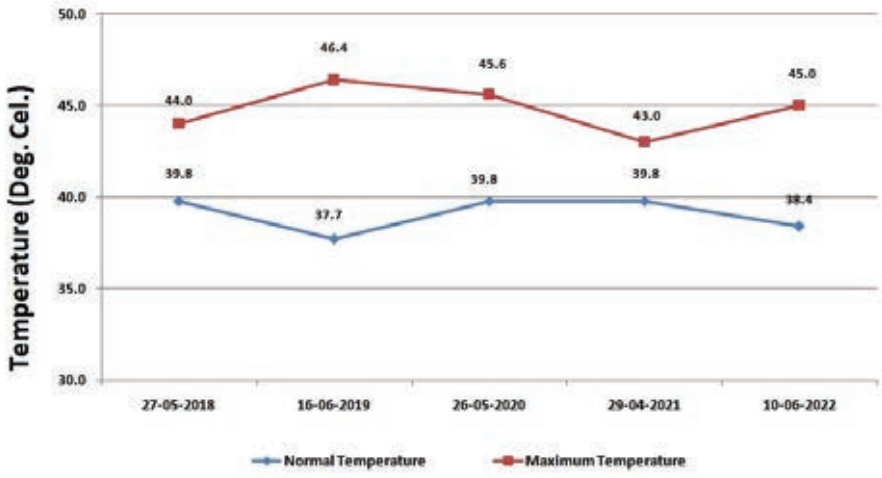

Comparison of maximum temperature with normal temperatre of last 05 years- Jhansi
Temperature (Deg. Cel.)
50.0
45.0
40.0
35.0
30.0
46.6
48.1
47.0
44.9
47.6
42.5
41.5
43.1
41.7
42.5
27-05-2018
11-06-2019
27-05-2020
30-04-2021
16-05-2022
Normal Temperature
Maximum Temperature


Comparison of maximum temperature with normal temperatre of last 05 years- Kanpur City
Temperature (Deg. Cel.)
50.0
45.0
40.0
35.0
30.0
44.8
45.8
45.4
42.2
45.0
39.5
41.4
41.4
40.1
41.6
12-06-2018
31-05-2019
27-05-2020
29-04-2021
05-06-2022
Normal Temperature
Maximum Temperature

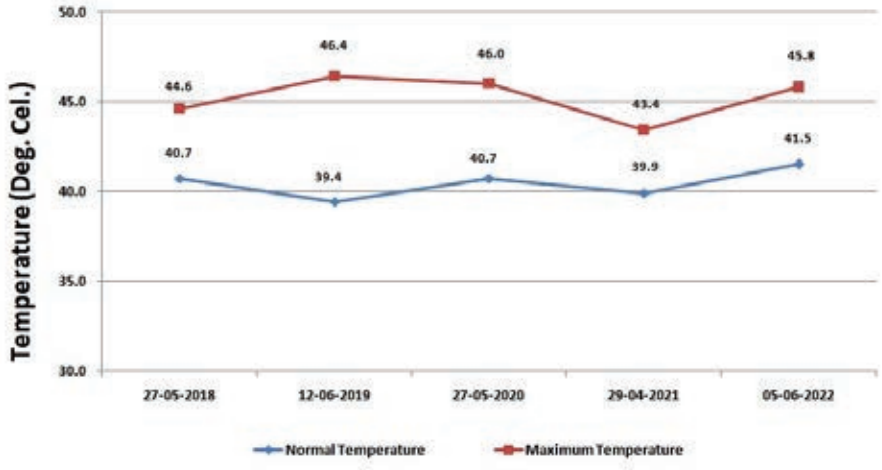

Comparison of maximum temperature with normal temperatre of last 05 years- Lucknow
Temperature (Deg. Cel.)
50.0
45.0
40.0
35.0
30.0
44.8
44.9
44.1
41.9
45.1
40.2
38.2
40.2
39.2
39.2
27-05-2018
16-06-2019
26-05-2020
29-04-2021
30-04-2022
Normal Temperature
Maximum Temperature

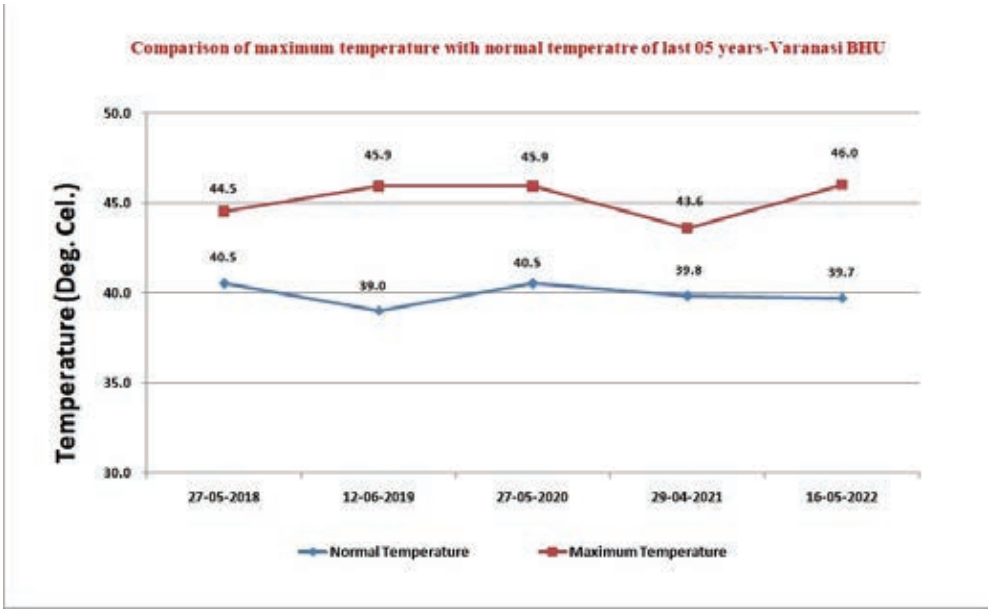

Comparison of maximum temperature with normal temperatre of last 05 years- Prayagraj
Temperature (Deg. Cel.)
50.0
45.0
40.0
35.0
30.0
46.6
48.9
47.6
44.3
46.9
41.7
40.0
41.6
40.9
40.9
27-05-2018
11-06-2019
27-05-2020
29-04-2021
16-05-2022
Normal Temperature
Maximum Temperature

Comparison of maximum temperature with normal temperatre of last 05 years- Sultanpur



Comparison of maximum temperature with normal temperatre of last 05 years-Varanasi Airport




Comparison of maximum temperature with normal temperatre of last 05 years-Varanasi BHU
Temperature (Deg. Cel.)
50.0
45.0
40.0
35.0
30.0
44.5
45.9
45.9
43.6
46.0
40.5
39.0
40.5
39.8
39.7
27-05-2018
12-06-2019
27-05-2020
29-04-2021
16-05-2022
Normal Temperature
Maximum Temperature

Annexure-5

HOSPITAL PREPAREDNESS CHART-PRE HEAT SEASON

INFRASTRUCTURE AND LOGISTICS			LOGISTICS CAPACITY BUILDING			IEC/AWARENESS		
PHC	**CHC**	**DH/MC**	**PHC (MOs, nursing staff, paramedics, ASHA, ANM)**	**CHC (MOs, nursing staff, paramedics, ASHA, ANM, MPHW)**	**DH/MC (MOs, nursing staff, paramedics, MPHW)**	**PHC**	**CHC**	**DH/MC**
• Check inventories for basic equipment and medicines required • Ensure adequate arrangement of staff, • Explore creation of Ice pack dispensaries to increase access to vulnerable communities, • Adopt long-term measures such as cool roofs and improving green coverage of health facility. • Identify Rapid Response Team (RRT) to respond to any exigency call outside the hospitals • May try to establish outreach clinics at various locations easily accessible to the vulnerable population			• A detailed action plan to tackle HRI (update annually) • Fresh/Refresher targeted training course -Maintaining hospital records, improve expedience of recording of cause of death, heat-focused examination procedures • Community involvement of trained staff to create awareness.			• Preparation of Targeted IEC-hoardings, banner, poster, leaflets, factsheets, information cards, media, rallies, song/drama activities, street plays • Planning of dissemination as per assessment of vulnerable area/communities • Conduct sensitization meetings • Prepare handouts for health staff about heat illness • Ensure the availability of funds for above activities		
			• Mapping of susceptible villages (identify areas/population that are vulnerable)	• Mapping of susceptible PHCs (identify areas/population that are vulnerable)	• Mapping of susceptible blocks (identify areas/population s that are vulnerable)			

HOSPITAL PREPAREDNESS CHART- HEAT SEASON								
INFRASTRUCTURE AND LOGISTICS			LOGISTICS CAPACITY BUILDING			IEC/AWARENESS		
PHC	**CHC**	**DH/MC**	**PHC (MOs, nursing staff, paramedics, ASHA, ANM)**	**CHC (MOs, nursing staff, paramedics, ASHA, ANM, MPHW)**	**DH/MC (MOs, nursing staff, paramedics, MPHW)**	**PHC**	**CHC**	**DH/MC**
• Ensure adequate medical supplies available • Identify surge capacities and mark the beds dedicated to treat the heat stroke victims and enhance emergency department preparedness to handle more patients			• Ensure reporting of HRI cases on daily basis • Adopt HRI treatment and prevention protocols • Expedite recording of cause of death due to heat related illnesses			• Ensure IEC dissemination • Target the vulnerable area/communities followed by other areas. • Plan activities as per the Heat		
			• Referral of patients to the higher	• Prepare weekly reports of health	• Prepare weekly reports of health			

			facility only after ensuring adequate stabilization and basic definitive care (cooling and hydration)	impact for nodal officer • Conduct case review during heat season	impact for nodal officer • Conduct case review during heat season	Wave alert issued by IMD
• Increase ASHA/ ANM /MPHW outreach in at-risk villages during a heat alert, if feasible.	• Increase ASHA/ANM/MP HW outreach in at risk PHC during a heat alert, if feasible. • Ensure dedicated bed availability • Ensure ambulance availability	• Increase MPHW outreach in at-risk blocks during a heat alert, if feasible • Ensure dedicated bed availability • Ensure ambulance availability • Dedicated heat corners • Increase staffing at DH/MCs to attend to the influx of patients during a heat alert, if feasible. • Have DNO-CC/SNO- CC visit CHCs to confirm proper preparation has been made for heat related illness and conduct case audits during heat season.				

HOSPITAL PREPAREDNESS CHART-POST HEAT SEASON								
INFRASTRUCTURE AND LOGISTICS			**LOGISTICS CAPACITY BUILDING**			**IEC/AWARENESS**		
PHC	**CHC**	**DH/MC**	**PHC (MOs, nursing staff, paramedics, ASHA, ANM)**	**CHC (MOs, nursing staff, paramedics, ASHA, ANM, MPHW)**	**DH/MC (MOs, nursing staff, paramedics, MPHW)**	**PHC**	**CHC**	**DH/MC**
• Review to assess/identify gaps-if any e.g., o Any shortage of equipment, medicine, staff. o Any long term measures adopted and maintained • Enlist/document the lessons learnt for the next			• Review to assess/identify gaps-if any e.g., o Any flaw/fault in reporting channel/format/efficiency o Number of deaths reviewed • Enlist/document the lessons learnt for the next season			• Review to assess/identify gaps-if any e.g., o IEC messages o Dissemination area/community o Efficient use of resources • Enlist/document the lessons learnt for the next season		

Annexure-6

District Wise Heat Wave Threshold Determination for Uttar Pradesh

(First Draft for Agra District only, report by research group working on determination of Heat Wave Threshold)

1. Introduction

The IPCC defines *heatwave* as "a period of abnormally hot weather, often defined with reference to a relative temperature threshold, lasting from two days to months" (IPCC, 2022) *World Meteorological Organization* definition is based on the *Heat Wave Duration Index* that a heat wave occurs when the daily maximum temperature of more than five consecutive days exceeds the average maximum temperature by 5 °C (9 °F) (Frich, A. 2002). So heatwave is generally defined as "A period of abnormally and uncomfortably hot and usually humid weather."

2. What is a heat wave in India?

The IMD says a heat wave happens when the temperature of a place crosses 40ºC in the plains, 37ºC in coastal areas, and 30ºC in the hills. The weather agency declares a heat wave when a place registers a temperature that is 4.5 to 6.4ºC more than the normal temperature for the region on that day. If the temperature is over 6.4ºC more than the normal, the IMD declares a 'severe' heat wave. The IMD also uses another criteria to declare a heat wave which is based on absolute recorded temperatures. If the temperature crosses the 45ºC mark, the Department declares a heat wave; when it crosses 47, a 'severe' heat wave is declared. Heat wave conditions in India are typically experienced between March and July, with acute heat waves occurring mostly between April to June. Heat waves primarily affect the plains of northwest India, central and eastern regions, as well as the northern part of Peninsular India. In recent years, extreme temperatures are becoming more frequent across India, even in regions that have not historically experienced heat waves, such as Himachal Pradesh and Kerala. Record-breaking heat events are already a major health threat for vulnerable communities in India and other parts of the world.

3. What is criterion for declaring heat wave in India?

IMD Criteria for Declaring Heat Wave in India: Heat wave is considered if maximum temperature of a station reaches at least 40°C or more for Plains and at least 30°C or more for Hilly regions.

3.1 Based on Departure from Normal:

Heat Wave: Departure from **normal is 4.5°C to 6.4°C.**

Severe Heat Wave: Departure from **normal is >6.4°C.**

3.2 Based on Actual Maximum Temperature:

Heat Wave: When actual **maximum temperature ≥ 45°C.**

Severe Heat Wave: When actual **maximum temperature ≥47°C.**

If above criteria met at least in 2 stations in a Meteorological sub-division for at least two consecutive days and it declared on the second day.

4. What is Heat Index?

The Heat Index is a parameter that considers both temperature and humidity to calculate the apparent temperature or "feel like" temperature for human beings. It helps in understanding the impact of humidity on high temperatures and how it contributes to human discomfort during hot weather. The Heat Index has been launched on an experimental basis by the India Meteorological Department (IMD). It aims to provide general guidance for regions experiencing higher apparent temperatures causing discomfort to people.

5. Indication of Heat Stress:

- High Heat Index values indicate a greater risk of heat-related stress and health issues.
- It serves as a warning for potential heat-related illnesses and dangers.

6. Categorization of Heat Levels: The Heat Index categorizes the apparent temperature into different levels using color codes:

- **Green:** Experimental heat Index **less than 35°C.**
- **Yellow:** Experimental heat Index in the **range 36-45°C.**
- **Orange:** Experimental heat Index in the **range 46-55°C.**
- **Red:** Experimental heat Index **greater than 55°C.**

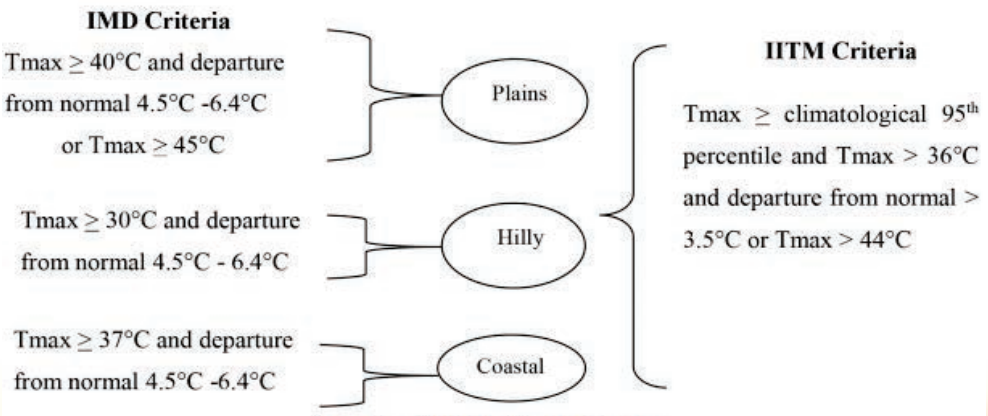


Fig. 2. IMD and IITM Criteria for Heat Wave Events.

7. Methodology for calculating the heat wave of Agra district

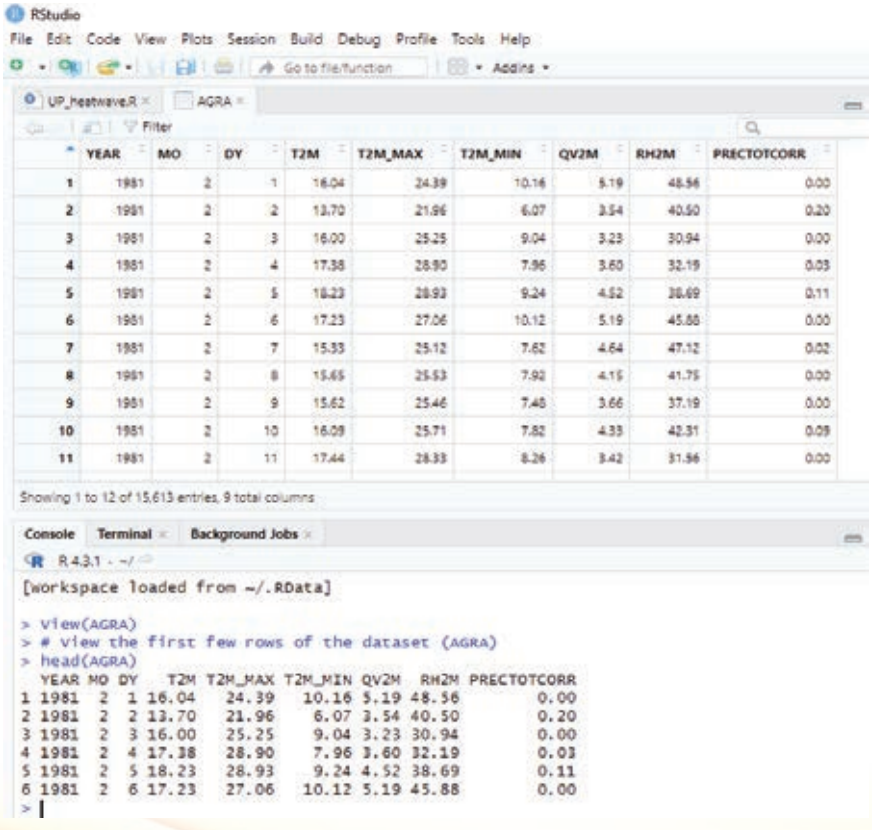
R code for a combined heatwave index based on both daily average temperature and humidity data using percentiles (e.g., 75th, 85th, and 95th percentiles) This combined index can help determine heatwave conditions by integrating temperature and humidity.

d) **Step 1:** Load daily average temperature and humidity data for the specific district into R studio. Please arrange the dataset includes columns for dates, daily average temperature, and daily average humidity for the chosen district.

e) **Step 2:** Utilize statistical functions to analyze the distribution and characteristics of daily average temperature and humidity data for the chosen district.

f) **Step 3:** (Calculating Heatwave Threshold Index) Determine criteria for defining a combined heatwave threshold index based on percentiles of daily average temperature and humidity data for the district. Here's an example R code that calculates the combined heatwave threshold index using the 75th, 85th, and 95th percentiles of daily average temperature and humidity data for a specific district:

Table 1: View the first few rows of climate data of Agra in R.



RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

UP_heatwave.R | AGRA

Filter

	YEAR	MO	DY	T2M	T2M_MAX	T2M_MIN	QV2M	RH2M	PRECTOTCORR
1	1981	2	1	16.04	24.39	10.16	5.19	48.56	0.00
2	1981	2	2	13.70	21.96	6.07	3.54	40.50	0.20
3	1981	2	3	16.00	25.25	9.04	3.23	30.94	0.00
4	1981	2	4	17.38	28.90	7.96	3.60	32.19	0.03
5	1981	2	5	18.23	28.93	9.24	4.52	38.69	0.11
6	1981	2	6	17.23	27.06	10.12	5.19	45.88	0.00
7	1981	2	7	15.33	25.12	7.62	4.64	47.12	0.02
8	1981	2	8	15.65	25.53	7.92	4.15	41.75	0.00
9	1981	2	9	15.62	25.46	7.48	3.66	37.19	0.00
10	1981	2	10	16.09	25.71	7.82	4.33	42.31	0.09
11	1981	2	11	17.44	28.33	8.26	3.42	31.96	0.00

Showing 1 to 12 of 15,613 entries, 9 total columns

Console Terminal Background Jobs

R 4.3.1 · ~/

```
[workspace loaded from ~/.RData]

> View(AGRA)
> # view the first few rows of the dataset (AGRA)
> head(AGRA)
  YEAR MO DY   T2M T2M_MAX T2M_MIN QV2M  RH2M PRECTOTCORR
1 1981  2  1 16.04   24.39   10.16 5.19 48.56        0.00
2 1981  2  2 13.70   21.96    6.07 3.54 40.50        0.20
3 1981  2  3 16.00   25.25    9.04 3.23 30.94        0.00
4 1981  2  4 17.38   28.90    7.96 3.60 32.19        0.03
5 1981  2  5 18.23   28.93    9.24 4.52 38.69        0.11
6 1981  2  6 17.23   27.06   10.12 5.19 45.88        0.00
>
```

Figure 1: Summary statistics for temperature and humidity of Agra district.

Showing 1 to 12 of 15,613 entries, 9 total columns

Console | Terminal | Background Jobs

R 4.3.1 · ~/

```
> # Summary statistics for temperature and humidity of Agra district
> summary(AGRA$T2M_MAX)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  13.76   29.01   33.53   33.93   38.98   49.29
> summary(AGRA$RH2M)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
   4.31   24.62   38.88   43.14   60.19   94.25
>
```

Figure 2: Boxplot code for maximum temperature and relative humidity for Agra district.

Console | Terminal | Background Jobs

R 4.3.1 · ~/

```
> summary(AGRA$T2M_MAX)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  13.76   29.01   33.53   33.93   38.98   49.29
> summary(AGRA$RH2M)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
   4.31   24.62   38.88   43.14   60.19   94.25
> # Boxplot for temperature and humidity for Agra district
> boxplot(AGRA$T2M_MAX,main = "Daily Maximum Temperature")
> boxplot(AGRA$RH2M,main = "Daily Relative Humidity")
>
```

Figure 3: Output boxplot.

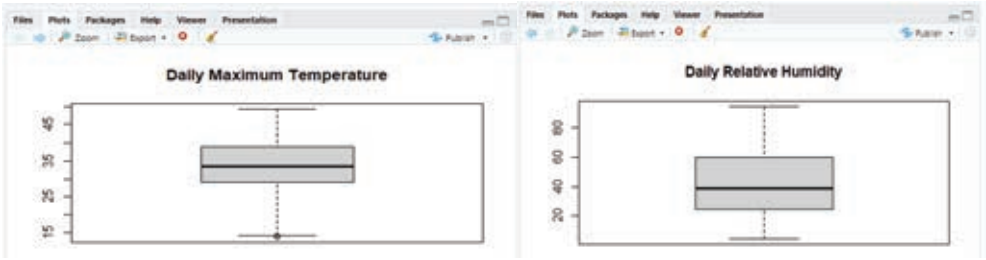


Figure 4: Histograms Codes to Visualize Distributions of max temperature and relative humidity of Agra.

```
Console  Terminal  Background Jobs
R 4.3.1 · ~/

> # Histogram for temperature
> hist(AGRA$T2M_MAX,col = "skyblue", xlab = "Temperature", main = "Distribution of Dail
y Maximum Temperature")
> # Histogram for relative humidity
> hist(AGRA$RH2M,col = "lightgreen", xlab = "Humidity", main = "Distribution of Daily R
elative Humidity")
>
```

Figure 5: Output histogram.

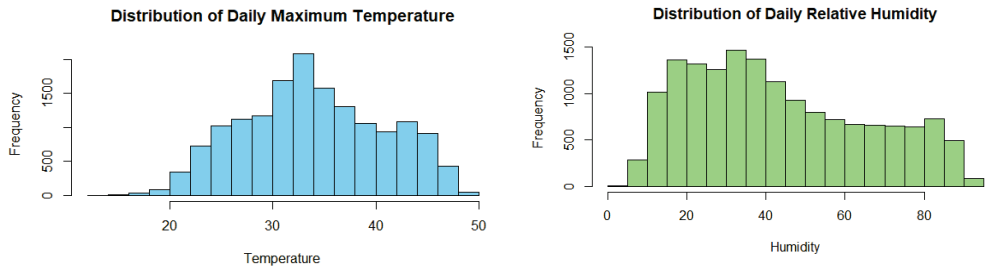


Figure 6: Scatter plot Codes for maximum temperature vs. relative humidity of Agra district.

```
Console  Terminal  Background Jobs
R 4.3.1 · ~/

> # Scatter plot for maximum temperature vs. relative humidity
> plot(AGRA$RH2M, AGRA$T2M_MAX,
+      xlab = "Relative Humidity", ylab = "Maximum Temperature",
+      main = "Scatter plot: Temperature vs. Humidity")
>
```

Figure 7: Output scatter plot.

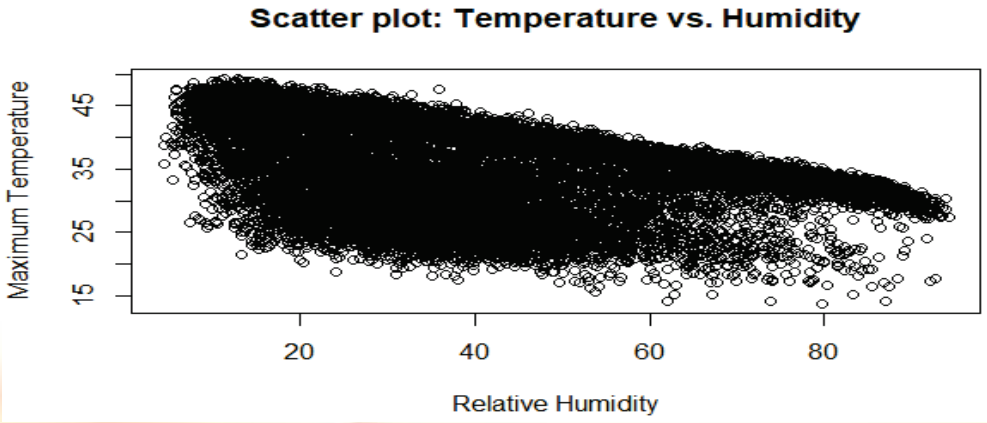


Figure 8: Correlation between maximum temperature and relative humidity of Agra

```
Console  Terminal ×  Background Jobs ×
R 4.3.1 · ~/

> # Correlation between maximum temperature and relative humidity
> cor(AGRA$T2M_MAX, AGRA$RH2M)
[1] -0.3504654
>
```

Figure 9: Density Plot Codes for Maximum Temperature and Relative Humidity.

```
Console  Terminal ×  Background Jobs ×
R 4.3.1 · ~/

> # Density plot for maximum temperature
> plot(density(AGRA$T2M_MAX), col = "blue",
+      main = "Density Plot: Daily Maximum Temperature")
>
> # Density plot for relative humidity
> plot(density(AGRA$RH2M), col = "green",
+      main = "Density Plot: Daily Relative Humidity")
>
>
```

Figure 10: Output density plot.

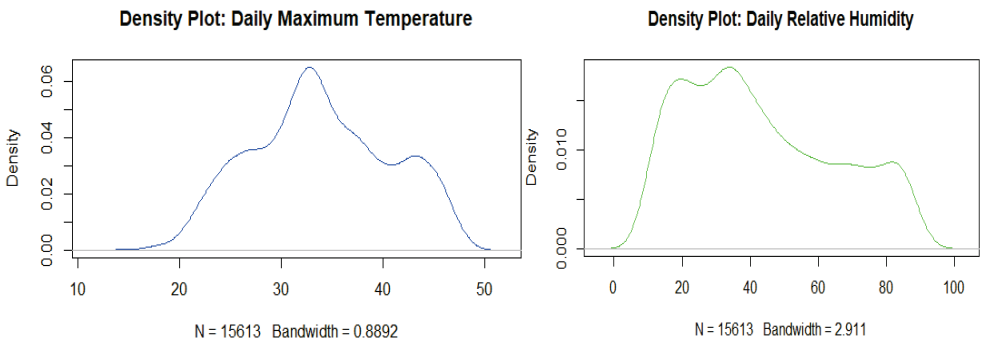


Figure 11: Scatter plot with maximum temperature and relative humidity trend line.

Codes as follows:

```
Console   Terminal ×   Background Jobs ×
R 4.3.1 · ~/
> # Scatter plot with maximum temperature trend line
> plot(AGRA$T2M_MAX, xlab = "Date", ylab = "Max Temperature",
+      main = "Temperature Trend Analysis")
> abline(temp_lm, col = "red")

> # Scatter plot with relative humidity trend line
> plot(AGRA$RH2M, xlab = "Date", ylab = "Relative Humidity",
+      main = "Humidity Trend Analysis")
> abline(RH2M, col = "blue")

>
```

Figure 12: Output Scatter plot.

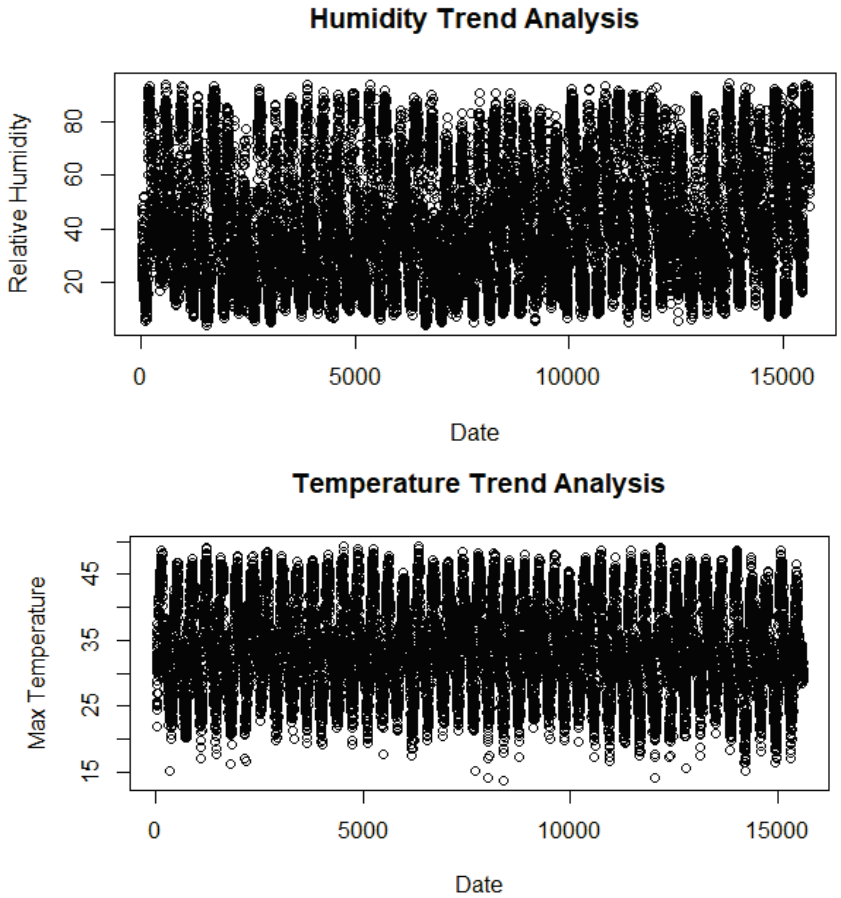


Figure 13: Calculating Heatwave Threshold Index.

#Load and Prepare Data

Check the structure of the data

Using the code str (AGRA)

```
Console  Terminal  Background Jobs
R 4.3.1 · ~/
> str(AGRA)
Classes 'spec_tbl_df', 'tbl_df', 'tbl' and 'data.frame':        15613 obs. of  9 variables:
 $ YEAR       : num  1981 1981 1981 1981 1981 ...
 $ MO         : num  2 2 2 2 2 2 2 2 2 2 ...
 $ DY         : num  1 2 3 4 5 6 7 8 9 10 ...
 $ T2M        : num  16 13.7 16 17.4 18.2 ...
 $ T2M_MAX    : num  24.4 22 25.2 28.9 28.9 ...
 $ T2M_MIN    : num  10.16 6.07 9.04 7.96 9.24 ...
 $ QV2M       : num  5.19 3.54 3.23 3.6 4.52 5.19 4.64 4.15 3.66 4.33 ...
 $ RH2M       : num  48.6 40.5 30.9 32.2 38.7 ...
 $ PRECTOTCORR: num  0 0.2 0 0.03 0.11 0 0.02 0 0 0.09 ...
 - attr(*, "spec")=List of 3
  ..$ cols   :List of 9
  .. ..$ YEAR       : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
  .. ..$ MO         : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
  .. ..$ DY         : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
  .. ..$ T2M        : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
  .. ..$ T2M_MAX    : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
  .. ..$ T2M_MIN    : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
  .. ..$ QV2M       : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
  .. ..$ RH2M       : list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
  .. ..$ PRECTOTCORR: list()
  .. .. ..- attr(*, "class")= chr [1:2] "collector_double" "collector"
  ..$ default: list()
  .. ..- attr(*, "class")= chr [1:2] "collector_guess" "collector"
  ..$ delim  : chr ","
  ..- attr(*, "class")= chr "col_spec"
```

Figure 14: Codes to calculate Percentiles for maximum Temperature and Relative Humidity.

Codes and output value as follows:

```
Console  Terminal  Background Jobs
R 4.3.1 · ~/
> # Calculate percentiles for temperature
> # Calculate percentiles for maximum temperature
> temp_percentiles <- quantile(AGRA$T2M_MAX,probs = c(0.75, 0.85, 0.95), na.rm = TRUE)
> # Calculate percentiles for humidity
> humidity_percentiles <- quantile(AGRA$RH2M,probs = c(0.75, 0.85, 0.95), na.rm = TRUE)
> # Output the calculated percentiles
> print(temp_percentiles)
  75%   85%   95%
38.98 42.26 45.30
> print(humidity_percentiles)
  75%   85%   95%
60.19 71.81 83.62
>
```

Figure 15: Codes to calculate combined heatwave threshold index for Agra district.

Codes and output values are as follows:

Table 2: Final heat wave index of Agra district based on Temperature and Humidity records from January 1981 to October 2023.

No	District	Heat-Health Temperature Warning			Heat-Health Humidity Warning		
		Yellow Alert	Orange Alert	Red Alert	Yellow Alert	Orange Alert	Red Alert
1	AGRA	39	42.3	45.3	60.2	71.8	83.6

Table 3: Final Heat Threshold of Agra district based on Temperature records from January 1981 to October 2023.

SL. No.	Heat Threshold Level	Heat Threshold Temperature	Alert Status
1	Yellow Alert	≥ 39.0° C	Heat Alert
2	Orange Alert	≥ 42.3° C	Severe Heat Alert
3	Red Alert	≥ 45.3° C	Extreme Heat Alert

Note: The work is in the development phase. Threshold values and methodology can change in final report.

* * *


₹ 66.40 करोड़ की लागत से 1.5 एकड़ में निर्मित
उत्तर प्रदेश राज्य आपदा प्रबंधन प्राधिकरण के भवन का शिलान्यास
राज्य आपदा प्रबंधन योजना का लोकार्पण
विभिन्न आपदाओं से बचाव हेतु लघु फिल्म एवं रेडियो जिंगल की लॉन्चिंग
आपदाओं के दौरान उल्लेखनीय प्रदर्शन करने वाले एनडीआरएफ एवं एसडीआरएफ के अधिकारियों/जवानों को प्रशस्ति-पत्र वितरण
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सुदृढ़ीकरण

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