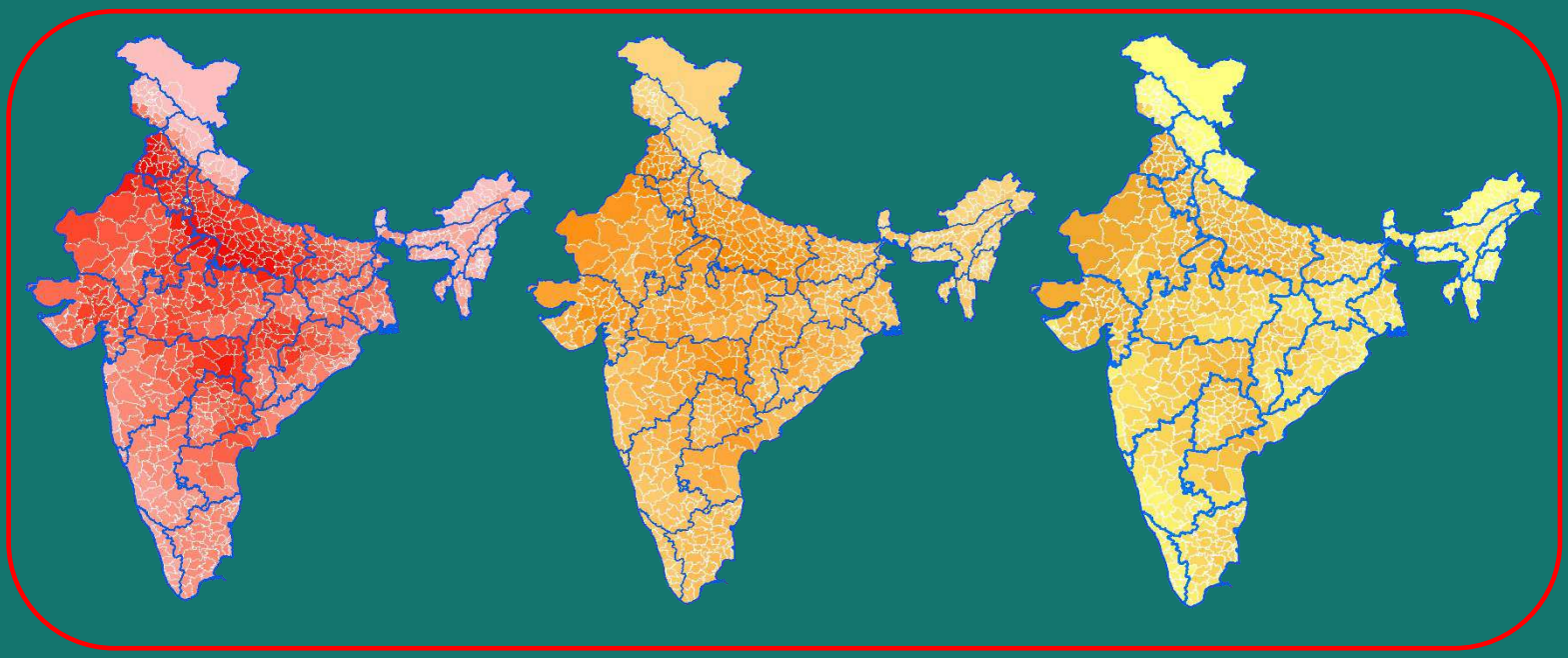
District Wise Heat Threshold Determination for Uttar Pradesh and India



UTTAR PRADESH STATE DISASTER MANAGEMENT AUTHORITY (UP SDMA)

PICUP Bhawan, B-2 Ground Floor, Vibhuti Khand, Gomti Nagar, Lucknow, Uttar Pradesh 226010

GOVERNMENT OF UTTAR PRADESH

2024

District Wise Heat Threshold Determination for Uttar Pradesh and India

July 2024

Direction

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GOVERNMENT OF UTTAR PRADESH

PICUP Bhawan, B-2 Ground floor, Vibhuti Khand, Gomti Nagar, Lucknow,

Uttar Pradesh 226010, https://upsdma.up.nic.in

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Message

Determining heat thresholds is a cornerstone to shape effective policies for safeguarding public health, optimising agriculture and undertaking resilient urban planning. It is with great satisfaction that UP SDMA presents this research report 'District Wise Heat Threshold Determination for Uttar Pradesh and India' which provides a comprehensive assessment of heat thresholds in Uttar Pradesh.

Extreme heat events are linked with increased morbidity and mortality. They also impact livelihood, agriculture, education and day to day life in general. Threshold based early warnings can be highly effective in prevention of heat related illnesses. This Study determines local thresholds for each district of the State, and as an extension for the entire country as well.

The Study is an invaluable information resource on district-level heat thresholds for yellow, orange and red alerts that have hithertofore remain unexplored, more so where surface measurements are sparse. These can help us to build greater resilience by comprehending heat events well in time and preparing better for the effects of extreme heat events. The Study also introduces a concept of 'Century Alert', which corresponds to the 99th percentile that represents an unprecedented level of heat intensity.

The Study is a work in progress. A correlation with epidemiological findings in the districts will help to strengthen and improve the heat threshold data. Availability of granular meteorological data in the future will also serve to refine it further. I urge stakeholders at all levels to utilise this research work primarily to improve our heat wave adaptation and mitigation strategies. I am sanguine that the research will inspire policy development and heat wave planning not only in Uttar Pradesh but across the country.

The dedicated efforts of the Study team in conducting this research are indeed worthy of applause and acknowledgement.

Acknowledgement

Our interactions with UP SDMA have been invaluable in steering the course of our work right from the time the Study on heat wave thresholds was commissioned. We express our heartfelt gratitude to UP SDMA for the unwavering support and encouragement throughout the duration of this Study.

The expertise and dedication of Dr. Sk Ajim, Research Assistant, have greatly enriched our research outcomes. Our special thanks are due to Dr Sk Ajim, Research Assistant, for his diligent efforts and contributions to this Study.

We would like to convey our gratitude to Mr Shashank Dwivedi and Mr Mh Asif, Research Scholars from the Department of Geography, PPN PG College, CSJM University, for their invaluable assistance in data mining and analysis. We also express our thanks to Dr. Maninder Singh Arora, Associate Professor in the Department of Mathematics, PPN PG College, Kanpur, for his extensive support in data management and analysis. His expertise has been instrumental in ensuring the accuracy and reliability of our research outcomes.

Our appreciation extends to all individuals, institutions and organisations who have contributed to this Study in various capacities. Their collective efforts have been instrumental in the successful completion of this project. We also extend our appreciation to all individuals, institutions and organisations who have contributed to this Study in various capacities. These collective efforts have been instrumental in the successful completion of this project.

The Authors

Preface

As the global climate continues to evolve, the frequency and intensity of extreme weather events, including heat waves, are on the rise. In response to this escalating challenge, it becomes imperative for policymakers, researchers and stakeholders to gain a comprehensive understanding of heat wave vulnerabilities and develop effective adaptation strategies. With this goal in mind, the present report, titled "District Wise Heat Threshold Determination for Uttar Pradesh and India," aims to provide a thorough analysis of heat wave thresholds at the district level.

This report represents a collaborative effort between the Uttar Pradesh State Disaster Management Authority and a Team of researchers and experts in the field of disaster management and climate science. Drawing upon a wealth of data and scientific methodologies, the endeavour is to elucidate the spatial variability of heat thresholds across India and extrapolate the findings to inform heat wave resilience efforts at the national level. Through meticulous data collection, statistical analysis and stakeholder engagement, the endeavour has been to produce a resource that not only identifies heat thresholds but also serves as a guiding framework for policymakers and practitioners. By delineating the district threshold for yellow, orange and red alerts, it seeks to empower decision-makers with the knowledge needed to implement targeted interventions and preparedness measures tailored to each alert level by delineating the distinct thresholds for yellow, orange, and red alerts.

Furthermore, this report underscores the importance of proactive heat wave management and the integration of heat thresholds into disaster risk reduction strategies. By leveraging findings, this report aspires to foster a culture of resilience and adaptive governance that prioritises the protection of vulnerable populations, the preservation of livelihoods and the sustainable development of our communities. The insights gleaned from this study can provide a cornerstone for evidence-based policymaking and pave the way for a more resilient and climate-resilient future for Uttar Pradesh and India.

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List of Abbreviations

API	Application Programming Interface
CC	Climate Change
HI	Heat Index
HTTP	Hypertext Transfer Protocol
HW	Heat Waves
HWT	Heat Wave Threshold
IITM	Indian Institute of Tropical Meteorology
IMD	India Meteorological Department
IPCC	Intergovernmental Panel on Climate Change
NASA	National Aeronautics and Space Administration
NDMA	National Disaster Management Authority
POWER	Prediction of Worldwide Energy Resources
SDGs	Sustainable Development Goals
SHW	Severe Heat Wave
UP	Uttar Pradesh
UP SDMA	Uttar Pradesh State Disaster Management Authority
WHO	World Health Organization
WMO	World Meteorological Organization

CHAPTER 1
INTRODUCTION AND OVERVIEW

1. Introduction and Overview

1.1 Background

Heat waves, characterised by prolonged periods of excessively high temperatures, represent a formidable challenge to communities, ecosystems and public health (Ainsworth et al., 2020). A heatwave can be defined as an event or phenomenon characterised by prolonged high temperatures. A heat threshold is the specific temperature metric used to declare the occurrence of a heatwave. In the context of Uttar Pradesh, India's most populous state, the impact of heat waves is particularly significant due to its diverse geography, large population and economic importance. This study aims to explore the district level dynamics of heat threshold in Uttar Pradesh and India, shedding light on the underlying factors, trends and consequences. By understanding the intricacies of heat wave occurrences, policymakers, researchers and communities can develop targeted strategies to enhance resilience and reduce the vulnerabilities associated with extreme heat events. Uttar Pradesh is home to a massive and growing population with densely populated urban centres. The phenomenon of urban heat islands, where urban areas experience higher temperatures than their rural surroundings, amplifies the impact of heat waves in cities (Jiang et al., 2019). The burgeoning urbanization in the state necessitates a comprehensive understanding of heat wave dynamics in both urban and rural settings to address the diverse vulnerabilities of the population (Wang, 2022).

Over the years, Uttar Pradesh has witnessed an observable increase in average temperatures, a trend aligned with global climate change patterns. Rising temperatures exacerbate the occurrence and severity of heat waves, posing substantial challenges to agriculture, water resources and public health (Sun et al., 2019). Recognising the influence of climate change on heat waves is essential for developing effective mitigation and adaptation strategies.

1.2 Geographical Details of Uttar Pradesh

Uttar Pradesh, better known as the "Heartland of India," is bordered by Haryana, Himachal Pradesh, Uttarakhand, Bihar, Jharkhand, Chhattisgarh, Madhya Pradesh and Rajasthan. Centrally located, spans 243,286 km^2, making it India's fourth-largest state and most populous. The state is dominated by the fertile Gangetic Plain, nourished by rivers like the Ganges,

Heat waves are a complex interplay of climate change, urban heat islands and dense populations, demanding targeted resilience and adaptation

Uttar Pradesh hosts a vast and expanding population, with its urban centers becoming increasingly densely populated. As heat waves become more frequent and intense, these densely populated areas face heightened risks, making the impact of extreme temperatures even more challenging to manage.

Yamuna and Ghaghara, supporting its agriculture and culture. The northern region features the Himalayan foothills, known as the Shivalik Range, with cities like Dehradun nearby. Like Bundelkhand, the south has plateaus and uplands, with historical sites like Chitrakoot. Uttar Pradesh's diverse geography has shaped its rich history, witnessing empires from Mauryas to British rule, leaving architectural marvels and cultural traditions. Major urban centres include the historic Lucknow, Kanpur, Agra, Varanasi, Prayagraj and Ghaziabad. The climate varies from subtropical, with hot summers and cool winters, to cooler in the north and hotter in the south. Winter lasts from October to February, summer from March to mid-June and the rainy season from June to September.

Climate change affects Uttar Pradesh, its farming, water, weather and health

Table 1: Uttar Pradesh at a Glance.

Total Geographical Area	**241 lakh ha.**
Population (2021)	24.34 crores
Division	18
Districts	75
Tehsil	351
Blocks	826
Gram Panchayat	57702
Revenue Village	106774
No. of Farmers	2.88 crores
Work Force in Agriculture	3.90 crores
Per Capita income of the State (2022-23)	83636 INR

Source: Agriculture Department, Govt. of Uttar Pradesh (2024).

1.3 Uttar Pradesh and Heat Wave

Uttar Pradesh's diverse geography and substantial population make it increasingly vulnerable to the adverse effects of heat waves. The state often experiences scorching temperatures exceeding 40°C during peak summer. This eventually leads to various social, economic and health impacts (Mall et al., 2017). Heat waves present significant health risks, especially in densely populated urban areas (Campbell et al., 2018). Vulnerable populations such as the elderly, children and those with pre-existing health conditions are particularly susceptible to heat-related illnesses (Benmarhnia et al., 2015; Rony & Alamgir, 2023). Adequate healthcare infrastructure and awareness campaigns are essential to mitigate these risks. The urban heat island effect is exacerbated by rapid urbanisation in major cities. The concentration of concrete structures and limited green spaces increases temperatures in urban areas, intensifying the impact of heat waves (Karimi et al., 2023).

Uttar Pradesh faces changing agricultural landscapes due to climate change. Extreme weather events like heatwaves and floods strain infrastructure and health. Urban growth creates heat islands and biodiversity faces threats. Collaborative efforts and government initiatives aim to build resilience and tackle these challenges.

Therefore, urban planning prioritising green infrastructure is essential to counteract this effect (Tian et al., 2021).

Heat waves also contribute to increased evaporation rates, leading to water scarcity in both rural and urban areas of Uttar Pradesh. This challenges agriculture and drinking water availability, making efficient water management strategies vital during heightened temperatures. From March to June, the state experiences escalating temperatures. In April, daily maximum temperatures frequently exceed 40°C, while by the end of May and early June, temperatures often soar above 46°C, particularly in regions like Bundelkhand. In summary, Uttar Pradesh's geography and human activities, such as rapid urbanisation, intensify the impacts of heat waves.

Uttar Pradesh: India's heartland, spanning diverse landscapes from the Gangetic Plain to the Himalayan foothills, rich in history and culture.

1.4 Heat Wave Impacts

Heat waves can result in a surge in mortality rates, particularly among those ill-equipped to handle extreme temperatures (Huynen et al., 2001). The elderly, homeless individuals and those lacking access to cooling facilities are especially at risk. Rising mortality rates can be attributed to heat-related illnesses, worsening of pre-existing health conditions and increased strain on public health systems (Margolis et al., 2021).

Uttar Pradesh holds the largest proportion of the workforce in India, comprising 19.3% of the total labour force as of 2022. Following Uttar Pradesh are Bihar (11.5%), Madhya Pradesh (10.3%) and West Bengal (9.4%). The labour force in Uttar Pradesh is predominantly youthful, with a median age of 29 years. The primary employment sector for this workforce is agriculture (55%), trailed by the services sector (30%) and the industrial sector (15%). Based on projections from the International Labour Organization (ILO, 2019) report, it can be deduced that between 2001 and 2020, Uttar Pradesh experienced an annual average loss of 50.271 billion labour hours due to heat waves. This loss is equivalent to approximately 1.38 million full-time jobs for a year. The overall economic cost of these heat waves amounted to Rs. 88,780 crore, roughly equivalent to $1.1 billion USD.

Uttar Pradesh's geographical diversity, from the Gangetic Plain to the Himalayan foothills and plateaus, coupled with its major rivers and varied climate, makes it vulnerable to a range of natural disasters, further it is even more intensified by human activities.

Additionally, heat waves intensify evaporation rates, leading to water shortages in both rural and urban areas. This shortage impacts agricultural irrigation, household water supply and industrial operations (Belleza et al., 2023). Water scarcity further challenges farmers, worsening their livelihoods and overall economic stability. Occupations that require outdoor work, such as construction and agriculture, face significant challenges during heat waves (Orlov et al., 2019). Workers in

these fields are more susceptible to heat stress, impacting their health and productivity. Furthermore, small businesses dependent on outdoor activities may suffer disruptions, resulting in economic setbacks. The impact of heat waves on life and livelihoods in Uttar Pradesh presents a multifaceted challenge. Addressing it requires a holistic approach that includes public health initiatives, agricultural resilience building, water management strategies and protective measures for vulnerable populations. Proactive steps, community involvement and sustainable practices are essential to enhance resilience and safeguard the well-being of Uttar Pradesh's residents amid escalating heat wave incidents.

Uttar Pradesh: Battling heat waves with a blend of geography, population and urban challenges. Green planning and healthcare are key.

1.5 Impact of Heat Wave in Uttar Pradesh

The impact of heat wave in Uttar Pradesh, is becoming increasingly pronounced, posing multifaceted challenges across various sectors. As global temperatures rise and weather patterns become more erratic, Uttar Pradesh faces, India's most populous state, a range of environmental, social and economic consequences (Tripathi, 2017). Here, we explore the key areas affected by climate change in the state and the efforts being made to address these challenges.

- Agricultural Challenges: Uttar Pradesh, primarily an agrarian state, is grappling with significant changes to its farming landscape due to climate change. Fluctuating temperature s and rainfall patterns are impacting crop yields, water resources and the spread of pests and diseases (Newton et al., 2011). Unpredictable rainfall and extended dry periods cause water shortages, affecting both staple and cash crops.
- Water Scarcity and Management: Climate change is intensifying water scarcity issues in Uttar Pradesh. Shifts in rainfall, increased evaporation from rising temperatures and the melting of Himalayan glaciers are affecting river and groundwater levels (Singh and Kumar, 2018). This affects agriculture, urban water supply and industrial needs. Implementing sustainable water management and advancing water-efficient technologies are crucial to address these water challenges.
- Extreme Weather Events: The state is witnessing more frequent and severe extreme weather events s uch as heatwaves, cyclones and heavy rainfall leading to floods. These events devastate infrastructure, agriculture and communities, especially those in vulnerable areas like low-lying regions and river basins (Srivastava et al., 2021). Early

According to an IMD study, Jhansi recorded the highest temperature in Uttar Pradesh in May 2023 at 46.5 degrees Celsius. This was followed by Agra at 46.0°C, Prayagraj at 45.7°C and Kanpur at 45.0°C. These maximum temperatures were notably 6.2 degrees Celsius above the average.

warning systems, preparedness measures and robust infrastructure are vital to mitigate these impacts.

- Health Concerns: Climate change poses health risks in Uttar Pradesh, with rising temperatures leading to more heat-related illnesses and changing rainfall patterns potentially increasing vector-borne diseases. Vulnerable groups, including children and the elderly, are at higher risk. Strengthening healthcare services, implementing heat action plans and raising public awareness are key to tackling these health issues.
- Urban Heat Islands: Rapid urban growth in cities like Lucknow, Kanpur and Allahabad has given rise to urban heat islands, where cities experience higher temperatures than rural areas (Kumar et al., 2020). This intensifies the effects of heatwaves, impacting public health, energy use and urban comfort. Prioritizing green spaces, sustainable infrastructure and climate-smart urban planning can help alleviate this issue (Elliott et al., 2020).
- Biodiversity Loss: Climate change is altering ecosystems and habitats in Uttar Pradesh, leading to biodiversity loss. Fluctuating temperatures and rainfall disrupt the state's flora and fauna, upsetting the ecological balance (Upadhyay, 2020). Conservation efforts, habitat restoration and protected area creation are crucial to safeguarding the state's diverse wildlife and endangered species.

A united effort involving government action, community participation and sustainable practices across all sectors is essential to tackle these challenges. The government of Uttar Pradesh has taken steps to address climate change by developing action plans, promoting renewable energy, initiating afforestation and integrating climate resilience into policies. Emphasising community involvement and awareness-building is key to enhancing local resilience to climate change impacts.

1.6 Impact of Heat Waves on the Agriculture Sector

Uttar Pradesh, primarily agrarian, grapples with significant heat wave challenges (Sharma et al., 2020). High temperatures can stress crops, reducing yields and agricultural productivity (Fahad et al., 2017). Livestock also suffer, leading to decreased milk production and related issues. Such challenges risk farmers' livelihoods and food security. The intensified heat waves affect agricultural practices, productivity and farmers' lives (Swaminathan & Rengalakshmi, 2016).

Harvesting Heat: Uttar Pradesh's agricultural contest with rising temperatures.

Uttar Pradesh's agrarian heartland faces rising temperatures, stressing crops and livestock, disrupting water supplies and straining farmers' livelihoods and food security. As heat waves intensify, innovative strategies and resilient practices become vital for sustainable agriculture.

The ICAR–CRIDA, 2022 study (Bal S K et al., 2022) indicated that several Uttar Pradesh districts also experienced problems with late-sown mustard and wheat. In Baghpat and Kushinagar, 9 to 21% in Gorakhpur, 15 to 20% in Gonda and 32 to 34% in Jhansi, heat waves caused a reduction in wheat yield. The yield of cowpeas and mustard was decreased by 9 to 11% and 14 to 18%, respectively, in the Uttar Pradesh districts of Gorakhpur and Kushinagar. A 5°C temperature increase in March compared to normal in Uttar Pradesh has caused a decline in mango flowering and a lot of Jhumka (clustering) problems in mangoes due to inadequate pollination. Citrus orchards in the Vidarbha region have experienced a drop in fruit production in a few locations due to the recent temperature rise. The Bundelkhand region frequently experiences terminal heat stress. In order to lessen the effects of climatic stresses, resilient technologies are being demonstrated as part of the NICRA in the following locations: Baghpat, Jhansi, Hamirpur, Chitrakoot, Pratapgarh, Kaushambi, Bahraich, Gonda, Maharajganj, Gorakhpur, Kushinagar and Sonbhadra. In comparison to farmers' practices at various locations in Uttar Pradesh, feeding livestock with green fodder, concentrates and mineral mixture @50 g/day, along with providing shade, has minimised the impact of heat stress on animals and reduced the loss of milk yield. Some of the important heat wave impacts in Uttar Pradesh are as follows;

- Crop Stress: High temperatures during heat waves stress crops, hampering processes like photosynthesis and water uptake, reducing yields. Key crops like wheat, rice, sugarcane and pulses, vital to Uttar Pradesh's agriculture, are especially at risk.
- Water Scarcity: Heat waves elevate evaporation rates, causing water shortages in both surface and groundwater sources. This scarcity hinders irrigation, crucial for crop growth, leaving farmers struggling to secure sufficient water.
- Crop Growth Disruptions: Heat waves can alter crop growth cycles, affecting germination, flowering and maturation due to accelerated soil moisture loss and water scarcity, resulting in uneven growth and decreased yields.
- Crop Vulnerability: Heat stress reduces crop resilience, making them prone to diseases and pests. This increases the need for pest management and protection measures, adding to farmers' challenges.
- Livestock Impact: Beyond crops, heat waves harm livestock by causing heat stress and reducing feed intake and milk

Heat waves in Uttar Pradesh: Threatening crops, water and livelihoods. Resilience through innovation and sustainable farming is crucial.

Uttar Pradesh's agrarian heartland faces rising temperatures, stressing crops and livestock, disrupting water supplies and straining farmers' livelihoods and food security. As heat waves intensify, innovative strategies and resilient practices become vital for sustainable agriculture.

production. This hits dairy farmers' income and disrupts the agricultural value chain.

- Changing Cropping Patterns: Farmers might need to adjust traditional crop choices due to climate shifts. Heat-resistant or short-duration crops might become more viable, demanding strategic planning and adaptation.
- Economic Stress: Lower yields and higher costs for irrigation and pest control during heat waves strain farmers economically, leading to debt, financial insecurity and struggles to meet basic needs.

The effects of heat waves on Uttar Pradesh's agriculture highlight the need for adaptive and resilient strategies. Sustainable water management, heat-resistant crop development and community-driven initiatives are crucial to mitigate heat wave challenges and ensure agriculture's long-term sustainability in the state

1.7 Importance of Heat Threshold Determination for Uttar Pradesh

Determining heat thresholds in Uttar Pradesh is vital for addressing the state's challenges of extreme heat events. Defining these thresholds involves setting specific meteorological criteria signalling the start of a heat wave. The significance of this process spans multiple areas:

- Public Health and Safety: Establishing heat thresholds is essential for safeguarding public health. With defined temperature criteria, authorities can issue timely warnings, enabling citizens to take precautions like staying hydrated, minimising outdoor activities during peak heat and seeking shelter when necessary.
- Vulnerability Assessment: Heat thresholds offer insights into regional vulnerability within Uttar Pradesh. By setting thresholds for each district, assessments can target vulnerabilities considering factors like population density, age demographics and healthcare access, aiding in crafting region-specific protective strategies.
- Agricultural Planning and Management: Given agriculture's importance to Uttar Pradesh's economy, it's crucial to understand temperature impacts. Heat thresholds guide farmers in adjusting planting times, selecting heat-resistant crops and adopting water management strategies, helping to reduce crop losses and ensure food security.
- Water Resource Management: Heat waves escalate evaporation and water scarcity. Understanding these thresholds assists in managing water resources by enabling

Setting heat thresholds in Uttar Pradesh: A roadmap to resilience, safety and sustainable growth amid rising temperatures.

Defining heat wave thresholds in Uttar Pradesh is a compass for public safety, regional vulnerability, agricultural planning and water management. It guides urban resilience, informs policy formulation and boosts community awareness. This proactive approach is essential for a climate-resilient future, safeguarding well-being amid escalating heat wave challenges.

efficient irrigation, conservation efforts and contingency planning to sustain water supply during extreme heat.

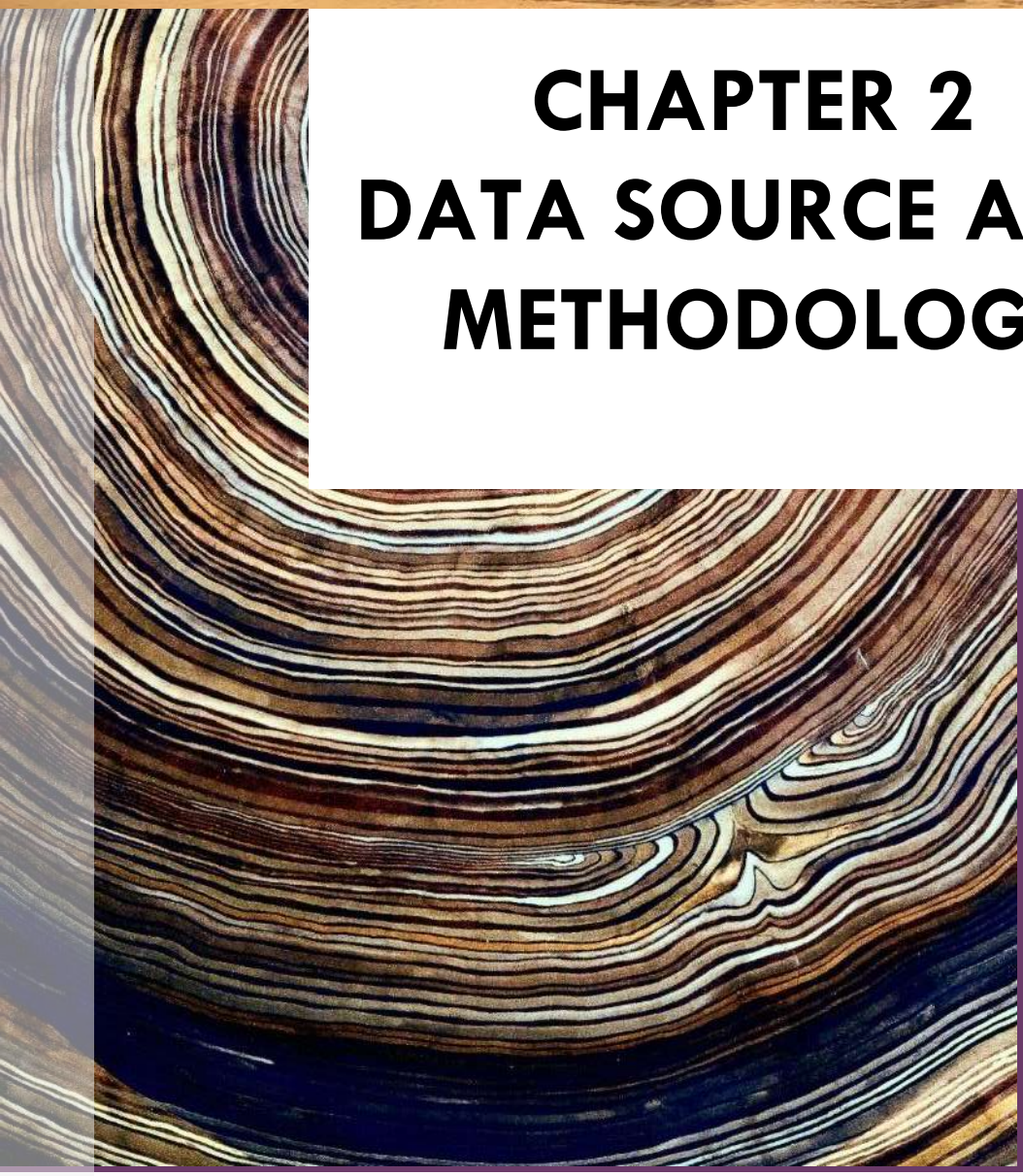
- Urban Planning and Infrastructure: The urban heat island effect, intensified by heat waves, emphasises the role of heat wave thresholds in urban planning. District-specific thresholds inform the design of resilient infrastructure, green spaces and cooling strategies, mitigating heat wave impacts on urban areas and promoting sustainable development.
- Policy Formulation and Response Planning: Accurate heat wave thresholds form the basis for evidence-driven policy and planning. Government agencies can craft comprehensive heat action plans, allocate resources efficiently and implement targeted measures tailored to each district's climate conditions.
- Community Awareness and Education: Transparent communication on heat wave warning criteria enhances public awareness and understanding. Tailored education campaigns stress the importance of readiness and resilience-building measures.

Determining heat thresholds in Uttar Pradesh is pivotal for protecting public health, optimising agriculture, managing water resources, bolstering urban resilience and shaping effective policies. This proactive approach is crucial for building a climate-resilient state and ensuring residents' well-being amid rising heat wave occurrences.

Heat thresholds in Uttar Pradesh - Key to health, agriculture, water and resilient urban planning.

Determining heat thresholds is a cornerstone for safeguarding public health, optimizing agriculture and shaping effective policies in Uttar Pradesh.

CHAPTER 2
DATA SOURCE AND METHODOLOGY



2. Data Source and Methodology

The Intergovernmental Panel on Climate Change (IPCC) defines heatwaves "a period of abnormally hot weather, often defined with reference to a relative temperature threshold, lasting from two days to months." According to the World Meteorological Organization (WMO), a heat wave occurs when the daily maximum temperature for more than five consecutive days surpasses the average maximum temperature by 5 °C (9 °F). Hence, a heatwave is commonly described as "a period of unusually hot and usually humid weather."

2.1 Heat Wave in India

According to the Indian Meteorological Department (IMD), a heat wave occurs when the temperature in a location exceeds 40°C in the plains, 37°C in coastal areas and 30°C in the hills. A heat wave is declared by the IMD when a location has a temperature that is 4.5°C to 6.4°C higher than the normal temperature for the region on that day (Azhar et al., 2017). The IMD classifies a 'severe' heat wave when the temperature exceeds 6.4°C above average.

Another criterion used by the IMD to designate a heat wave is absolute measured temperatures. When the temperature exceeds 45°C, the Department announces a heat wave; when it exceeds 47°C, the Department declares a 'severe' heat wave (Kumar et al., 2022). If the above criteria are met at least in 2 stations in a Meteorological sub-division for at least two consecutive days, it is declared on the second day.

Heat waves are most common in India between March and July, with intense heat waves occurring predominantly between April and June. Heat waves typically impact northwest India's plains, the central and eastern regions and the northern section of Peninsular India. Extreme temperatures have become increasingly common in recent years across India, especially in areas that have not previously experienced heat waves, such as Himachal Pradesh and Kerala (Devi et al., 2023). Record-breaking heat events are already posing a serious health risk to vulnerable people in India and throughout the world.

When the mercury rises above 40°C in the plains, 37°C in coastal areas and 30°C in the hills. As per IMD if threshold temperature is recorded in two stations within a meteorological subdivision for a minimum of two consecutive days, the declaration is made on the second day.

2.2 Criterion for Declaring Heat Wave according to Departure from Normal

The IMD Criteria for declaring Heat Wave (HW) on the basis of departure from normal by 4.5°C to 6.4°C and a Severe Heat Wave (SHW) on a departure from normal greater than 6.4°C, establishes a range from 4.5°C to 6.4°C that aligns closely with percentile thresholds like the 80th, 88th and 95th percentiles. The methodology establishes thresholds derived from statistical analysis of

temperature data, aiding in identifying extreme heat events. The NDMA (2019) advisory recommends issuing colour-coded signals for heatwave alerts. The alignment of IMD's "departure from normal" concept with the WMO-WHO guidelines for percentile-based thresholds establishes an effective basis and aligns closely with percentile thresholds like the 80th, 88th and 95th percentiles for determining Yellow, Orange and Red alerts based on temperature thresholds.

Colour Code	Action	Alert Level
Yellow Alert	Be Updated	Heat Alert
Orange Alert	Be Prepared	Severe Heat Alert
Red Alert	Take Action	Extreme Heat Alert

Fig. 2.1: Colour code signals for heat wave alerts were suggested by NDMA (2019).

2.3 Heat Index in India

The Heat Index (HI) is a measure that takes both temperature and humidity into account to compute the perceived or "feel like" temperature for humans (Lu & Romps, 2023). It gives a better understanding of the effect of humidity on high temperatures and how it relates to human suffering during hot weather. The IMD has released the Heat Index experimentally. It tries to give broad guidelines for places with higher perceived temperatures that are causing people pain.

Categorisation of Heat Levels ('feel like' temperature for humans)

The Heat Index, a parameter piloted by the IMD, (Heat Wave Guidance, 2023) combines temperature and humidity to calculate the "feels like" temperature experienced by individuals. In India, heat categories are generally determined using the Heat Index, which factors in both temperature and humidity to gauge the perceived heat. Though classifications might differ slightly by source or region, a typical breakdown of the experimental Heat Index as per IMD is:-

- **Green**: Experimental heat Index below 40°C - Generally comfortable conditions with minimal risk of heat-related illnesses.
- **Yellow**: Experimental heat Index in range 40°C - 50°C - Increased discomfort, especially for sensitive individuals. Precautions such as staying hydrated and seeking shade are recommended.
- **Orange**: Experimental heat Index in range 50°C - 60°C - Elevated risk of heat-related illnesses, particularly for vulnerable populations. Caution is advised and outdoor activities should be limited.
- **Red**: Experimental heat Index above 60°C - Dangerous conditions with a high risk of heat-related illnesses, including heat exhaustion and heatstroke. Urgent measures, such as staying

The Heat Index (HI) factors in temperature and humidity to calculate the "feel-like" temperature, providing insights into the combined impact of heat and humidity on human comfort.

indoors in air-conditioned spaces and staying hydrated, are crucial to prevent heat-related emergencies.

2.4 Data Source for Heat Wave Determination

For estimating the district-level heatwave threshold across the country, data from 1982 – 2023 were collected from NASA POWER data access. Accessing NASA POWER data involves using the NASA POWER API or accessing the data directly from the NASA POWER website (https://power.larc. nasa.gov/data-access-viewer/).

Initially, the NASA POWER website (https://power.larc.nasa.gov/) was visited and registered for an API key. The API documentation for information on available endpoints, parameters and data formats were referred. The documentation can typically be found on the NASA POWER website. To make HTTP requests to the relevant API endpoints, the registered API was used in programming languages R for this purpose. Example of cURL as follows:

curl -X GET
"https://power.larc.nasa.gov/api/temporal/daily/point?parameters=
T2M,T2M_MAX,T2M_MIN,QV2M,RH2M,PRECTOTCORR
=re&longitude=78.0&latitude= 27.17&format=CSV" -H
"Authorization: API_KEY"

Utilising NASA POWER data access offers several advantages, making it a valuable resource for researchers, scientists and professionals in various fields. The data is available at various temporal resolutions, including hourly, daily and monthly. This flexibility allows users to choose the level of detail needed for their specific analyses, accommodating different research objectives and time scales. NASA POWER follows an open data policy, providing free and open access to its datasets.

NASA POWER datasets are derived from satellite observations, ground-based measurements and models. The data undergoes rigorous quality control processes, ensuring high accuracy and reliability. Researchers can have confidence in the quality of the data for their analyses.

NASA POWER datasets are derived from satellite observations, ground-based measurements, and models. The data undergoes rigorous quality control processes, ensuring high accuracy and reliability.

2.5 Methodology for Calculating Heat Wave Threshold

Weather data - daily maximum and minimum temperature and humidity were collected from NASA POWER data access for the summer months of March to June (1982-2023) to construct criteria for all districts of UP.

2.6 Maximum Temperature Threshold Based on 80th, 88th and 95th percentile

Percentile-based technique established by the World Meteorological Organization and World Health Organization (WMO-WHO), has been employed to estimate maximum temperature thresholds for summer heat early warning systems. This is useful in cities where only temperature data are available. WMO-WHO guidelines for developing a heat health warning system recommended that in situations where no mortality or morbidity data are available and only meteorological data are available, percentile-based thresholds at the 90th and 95th percentile values be used to trigger early warning systems (McGregor et al., 2015). A study by Azhar et al., (2014) estimated the 75th, 85th and 95th percentile values for the common seasonal threshold using the percentile-based technique. Another study by Honda et al., (2007) revealed increased mortality risk at the 80th and 85th percentiles of maximum temperature. The extant practice defines heat events as departures from the normal unless the temperature exceeds a laid down limit and provides information on extreme temperature events. This Study adopts the percentile-based thresholds technique to determine the heat thresholds corresponding to the colour-coded heat alerts identified by NDMA. The 80th, 88th and 95th percentiles as maximum temperature values for yellow, orange and red alerts respectively, ensure adequate phasing to comprehend heat events as well as prepare better to respond to the effects of extreme heat. This allows the district administration and authorities sufficient time to transition from alert mode to action mode between a yellow alert and a red alert.

The study employed a percentile-based technique established by the World Meteorological Organization and World Health Organization (WMO-WHO) to estimate maximum temperature thresholds for summer heat early warning systems

The mathematical formulation for determining maximum temperature thresholds based on percentiles involves statistical analysis of temperature data. The percentile indicates the relative standing of a particular temperature within a dataset. Here's a general formula for calculating temperature thresholds based on the 80th, 88th and 95th percentiles:

Let's denote:

- X as the dataset of maximum daily temperatures.
- P as the percentile value (e.g., 80th, 88th, 95th).
- The formula to calculate the temperature threshold at a specific percentile is given by the following steps:
- Sort the Data: Arrange the dataset X in ascending order.
- Identify the Position:
- Determine the position of the desired percentile within the sorted dataset using the formula:

$$Position = \frac{P}{100} \times (n + 1)$$

where n is the total number of observations in the dataset.

Interpolation:

If the position is not an integer, interpolate between the two nearest data points to find the temperature threshold. For example, if the position is k, where k is not an integer, the interpolated threshold (TP) can be calculated as:

$$T_P = T_{\lfloor k \rfloor} + (X_{\lceil k \rceil} - X_{\lfloor k \rfloor}) \times (k - \lfloor k \rfloor)$$

where $X_{\lfloor k \rfloor}$is the value at the floor position,$X_{\lceil k \rceil}$ is the value at the ceiling position.

The calculated value T Represents the temperature threshold corresponding to the desired percentile P.

The formula for calculating the temperature threshold at a specific percentile involves sorting the dataset, determining the position of the percentile and interpolating to find the temperature threshold. This process allows for the establishment of heat wave thresholds based on statistical analysis of historical temperature data.

For temperature warning, humidity warning and a combined heatwave index, R code was utilised based on both daily maximum temperature and humidity data using percentiles (e.g., 80th, 88th and 95th percentiles). This combined index can help determine heatwave conditions by integrating temperature and humidity.

The methodology for calculating heat thresholds involves a systematic approach to defining specific temperature criteria that indicate the onset of a heat wave. This process typically considers historical climate data, regional climatic conditions and the impact of extreme heat on various sectors. While specific methodologies may vary, the following steps provide a general framework for calculating and implementing heat thresholds:

Data Collection: Historical meteorological data was collected, including daily maximum and minimum temperatures and humidity. The data was collected for an extended period, ideally spanning several decades, to capture long-term temperature trends.

Identification of Extreme Events: Periods characterised by unusually high temperatures that can be considered as heat waves were identified. This may involve reviewing historical records and identifying instances where daily temperatures exceeded certain predefined thresholds.

Statistical Analysis: Conduct of statistical analyses, such as calculating the mean, median and standard deviation of daily temperatures during normal conditions and identification of the threshold beyond which temperatures can be considered extreme. This threshold is often determined by statistical measures, such as defining

Research conducted by Honda et al. (2007) highlighted a heightened risk of mortality at the 80th and 85th percentiles of maximum temperature. In response, the study set threshold values based on the 80th, 88th, and 95th percentiles of maximum temperature and designating them as criteria for yellow, orange, and red heat-health warnings for the districts in Uttar Pradesh.

temperatures exceeding a certain percentile (e.g., 90th or 95th percentile) as extreme.

Validation and Calibration: The calculated thresholds were validated by comparing them with historical heat wave events. The thresholds were adjusted as needed to improve accuracy and alignment with observed extreme temperature events. Any changes in climate patterns or urbanisation that may impact temperature trends were duly considered.

Development of District-Wise or Region-Specific Thresholds: There was a need to recognise that temperature thresholds may vary across districts or regions even within Uttar Pradesh due to differences in climate and geography. District-wise or region-specific heat wave thresholds were developed to account for local variations.

Integration with Early Warning Systems: The calculated thresholds need to be integrated with the early warning systems. These define the criteria that trigger heat wave warnings and advisories for different levels of severity. Collaboration with relevant authorities to establish effective communication channels for disseminating warnings to the public is essential.

Public Awareness and Outreach: Conduct public awareness campaigns to inform the community about the established heat wave thresholds, the significance of early warnings and the recommended preventive measures.

The methodology for calculating heat wave thresholds in Uttar Pradesh can provide a scientifically grounded and region-specific foundation for proactive heat wave management and resilience-building efforts. Collaboration between disaster management and climate experts, meteorologists and local authorities is essential for ensuring the accuracy and relevance of the calculated thresholds.

As extreme temperatures have become increasingly common in recent years across India. This meticulous methodology offers Uttar Pradesh a robust, scientifically-backed blueprint for proactive heat wave management and resilience enhancement.

CHAPTER 3
ANALYSIS AND RESULTS

3. Analysis & Results

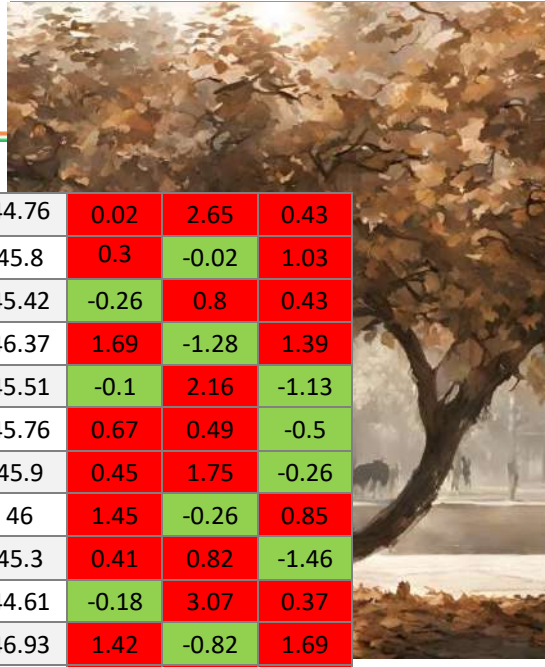
To conduct a District Wise Heat Threshold Determination for Uttar Pradesh, a comprehensive analysis of historical temperature data, statistical methods and regional characteristics was considered based on percentile values of temperature trends from 1982 to 2023. It is crucial to establish these thresholds based on the long-term temperature patterns specific to each district.

3.1 Historical Temperature Data Analysis

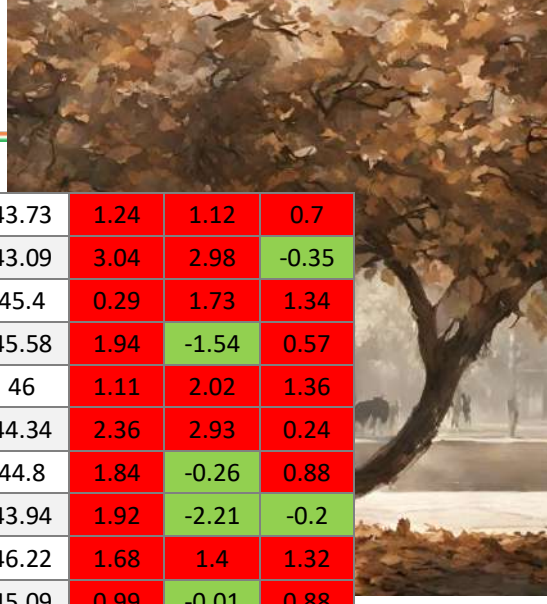
Analysing historical temperature data for Uttar Pradesh involved examining temperature trends, variability and extremes over an extended period. Our findings, using trend analysis of maximum temperature between April and June, show how often and how much temperatures have changed from the historical average. ***From 1982 to 2023, the maximum temperature over Uttar Pradesh has dramatically increased (Table 3.1).***

Table 3.1: District-wise maximum temperature recorded for the months of April, May and June of 1982 and 2023.

District Name	1982			2023			Difference* (1982-2023)		
	April	May	June	April	May	June	April	May	June
AGRA	42.72	45.39	46.75	43.17	46.63	44.87	0.45	1.24	-1.88
ALIGARH	42	42.92	45.38	41.64	45.8	44.84	-0.36	2.88	-0.54
AMBEDKAR NAGAR	41.75	45.32	45	43.44	44.87	46.12	1.69	-0.45	1.12
AMETHI	42.14	45.44	44.54	43.22	45.23	46.5	1.08	-0.21	1.96
AMROHA	40.33	41.76	43.38	41.38	43.62	44.95	1.05	1.86	1.57
AURAIYA	43.01	45.89	45.76	43.53	46.04	45.31	0.52	0.15	-0.45
AYODHYA	41.78	44.93	44.76	43.37	45.02	46.25	1.59	0.09	1.49
AZAMGARH	41.78	44.93	44.76	43.37	45.02	46.25	1.59	0.09	1.49
BAGHPAT	40.07	41.67	44.07	41.08	44.46	44.58	1.01	2.79	0.51
BAHRAICH	40.14	43.58	43.55	41.95	42.76	44.9	1.81	-0.82	1.35
BALLIA	42.33	45.29	44.74	44.56	43.88	46.91	2.23	-1.41	2.17
BALRAMPUR	39.94	44.04	44.75	41.94	42.62	44.44	2	-1.42	-0.31
BANDA	42.92	45.61	45.33	43.84	45.87	46.11	0.92	0.26	0.78
BARABANKI	41.42	45.01	44.6	43.01	44.91	46.3	1.59	-0.1	1.7
BAREILLY	41.21	42.56	44.37	42.15	43.94	45.56	0.94	1.38	1.19
BASTI	41.14	44.72	45.12	42.79	44.33	45.45	1.65	-0.39	0.33
BHADOHI	43.62	45.6	44.62	43.83	45.38	46.36	0.21	-0.22	1.74
BIJNOR	38.74	40.81	43.18	40.58	43.82	43.95	1.84	3.01	0.77
BUDAUN	42.2	43.08	45.01	42.03	45.31	45.55	-0.17	2.23	0.54



BULANDSHAHR	41.52	42.42	44.33	41.54	45.07	44.76	0.02	2.65	0.43
CHANDAULI	43.08	44.89	44.77	43.38	44.87	45.8	0.3	-0.02	1.03
CHITRAKOOT	43.37	44.94	44.99	43.11	45.74	45.42	-0.26	0.8	0.43
DEORIA	42.25	45.24	44.98	43.94	43.96	46.37	1.69	-1.28	1.39
ETAH	42.65	43.9	46.64	42.55	46.06	45.51	-0.1	2.16	-1.13
ETAWAH	42.72	45.39	46.26	43.39	45.88	45.76	0.67	0.49	-0.5
FARRUKHABAD	42.39	43.84	46.16	42.84	45.59	45.9	0.45	1.75	-0.26
FATEHPUR	42.19	45.67	45.15	43.64	45.41	46	1.45	-0.26	0.85
FIROZABAD	42.92	45.56	46.76	43.33	46.38	45.3	0.41	0.82	-1.46
GAUTAM BUDDHA NAGAR	41.44	41.98	44.24	41.26	45.05	44.61	-0.18	3.07	0.37
GHAZIPUR	42.84	45.67	45.24	44.26	44.85	46.93	1.42	-0.82	1.69
GHAZIABAD	40.07	41.67	44.07	41.08	44.46	44.58	1.01	2.79	0.51
GONDA	40.94	44.43	44.24	42.55	44.48	45.8	1.61	0.05	1.56
GORAKHPUR	41.94	45.29	45.05	43.66	44.68	46.32	1.72	-0.61	1.27
HAMIRPUR	34.33	38.39	42.3	37.6	41.98	40.01	3.27	3.59	-2.29
HAPUR	41.52	42.42	44.33	41.54	45.07	44.76	0.02	2.65	0.43
HARDOI	41.65	43.63	45.25	43.01	45.41	46.19	1.36	1.78	0.94
HATHRAS	42.36	43.87	46.8	42.58	46.43	44.97	0.22	2.56	-1.83
JALAUN	43.55	45.8	45.9	43.61	46.08	45.3	0.06	0.28	-0.6
JAUNPUR	43.62	45.6	44.62	43.83	45.38	46.36	0.21	-0.22	1.74
JHANSI	43.37	45.3	45.63	43.37	45.9	44.87	0.00	0.6	-0.76
KANNAUJ	41.98	44.97	45.31	43.53	45.55	46.14	1.55	0.58	0.83
KANPUR NAGAR	42.11	45.73	45.09	43.58	45.58	45.67	1.47	-0.15	0.58
KANPUR DEHAT	42.11	45.73	45.09	43.58	45.58	45.67	1.47	-0.15	0.58
KASGANJ	42.2	43.08	45.01	42.03	45.31	45.55	-0.17	2.23	0.54
KAUSHAMBI	43.11	45.59	45.07	43.81	45.99	46.37	0.7	0.4	1.3
LAKHIMPUR KHERI	40.84	43.31	44.47	42.44	44.43	45.86	1.6	1.12	1.39
KUSHINAGAR	40.89	45.02	44.9	43.01	42.62	45.44	2.12	-2.4	0.54
LALITPUR	41.89	43.98	45.47	41.59	44.87	43.22	-0.3	0.89	-2.25
LUCKNOW	41.61	44.87	44.94	43.48	45.33	46.36	1.87	0.46	1.42
MAHARAJGANJ	40.89	45.02	44.9	43.01	42.62	45.44	2.12	-2.4	0.54
MAHOBA	43.25	45.53	45.62	43.64	45.93	45.53	0.39	0.4	-0.09
MAINPURI	42.72	45.39	46.26	43.39	45.88	45.76	0.67	0.49	-0.5
MATHURA	42.39	43.55	46.37	42.12	46.46	44.84	-0.27	2.91	-1.53
MAU	42.56	45.57	45.21	44.33	44.57	46.85	1.77	-1	1.64
MEERUT	40.41	41.84	43.87	41.29	44.49	44.76	0.88	2.65	0.89
MIRZAPUR	43.32	45.16	44.73	43.49	45.33	45.72	0.17	0.17	0.99
MORADABAD	40.33	41.76	43.38	41.38	43.62	44.95	1.05	1.86	1.57
MUZAFFARNAGAR	38.74	40.81	43.18	40.58	43.82	43.95	1.84	3.01	0.77
PILIBHIT	40.73	42.47	44.17	41.97	43.38	44.75	1.24	0.91	0.58
PRATAPGARH	42.14	45.44	44.54	43.22	45.23	46.5	1.08	-0.21	1.96
PRAYAGRAJ	43.32	45.65	44.73	43.45	45.83	46.56	0.13	0.18	1.83
RAEBARELI	42.23	45.53	45.1	43.56	45.37	46.37	1.33	-0.16	1.27



RAMPUR	39.62	41.23	43.03	40.86	42.35	43.73	1.24	1.12	0.7
SAHARANPUR	37.08	40.51	43.44	40.12	43.49	43.09	3.04	2.98	-0.35
SAMBHAL	41.55	42. 39	44.06	41.84	44.12	45.4	0.29	1.73	1.34
SANT KABIR NAGAR	40.96	45.06	45.01	42.9	43.52	45.58	1.94	-1.54	0.57
SHAHJAHANPUR	41.23	43.05	44.64	42.34	45.07	46	1.11	2.02	1.36
SHAMLI	38.52	41.42	44.1	40.88	44.35	44.34	2.36	2.93	0.24
SHRAVASTI	40.36	43.83	43.92	42.2	43.57	44.8	1.84	-0.26	0.88
SIDDHARTH NAGAR	39.79	44.13	44.14	41.71	41.92	43.94	1.92	-2.21	-0.2
SITAPUR	41.08	43.62	44.9	42.76	45.02	46.22	1.68	1.4	1.32
SONBHADRA	41.97	44.58	44.21	42.96	44.57	45.09	0.99	-0.01	0.88
SULTANPUR	41.78	44.93	44.76	43.37	45.02	46.25	1.59	0.09	1.49
UNNAO	41.87	45.3	44.8	43.51	45.15	46.19	1.64	-0.15	1.39
VARANASI	43.4	45.42	45.38	43.9	45.27	46.71	0.5	-0.15	1.33

Note: a minus (-) value indicates decreased temperature and a plus (+) value indicates increased temperature. *Difference signifies the difference in maximum recorded temperatures in the month in 1982 and 2023.

Although some districts show a decrease in temperature but overall temperature in April, May and June has continuously increased for the majority of districts of Uttar Pradesh (*Table 3.1*). The districts of Saharanpur, Bijnor, Muzaffarnagar, Shamli, Hamirpur, Shahjahanpur, Amroha, Moradabad, Meerut and Sitapur experienced the highest mean maximum temperatures during the months of April, May and June in Uttar Pradesh. These districts are particularly susceptible to extreme heat conditions. Although the above-average temperature increase may seem relatively small at just 1.4 degrees Celsius, the impact of this rise can be exponential, especially when considering the cumulative effect over time and across various sectors.

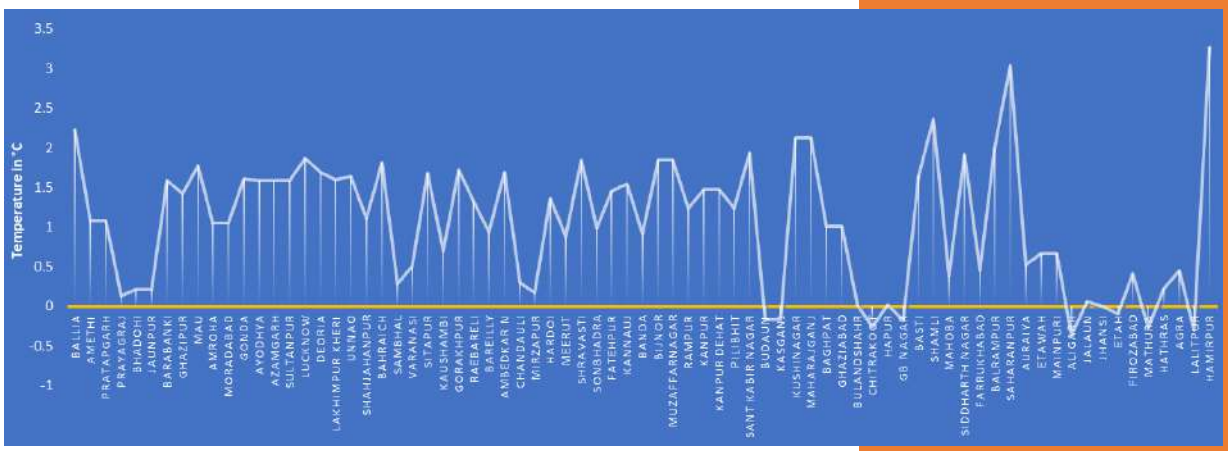


Figure 3.1: Increase/decrease of maximum temperature for the month of April, 1982 and April, 2023.

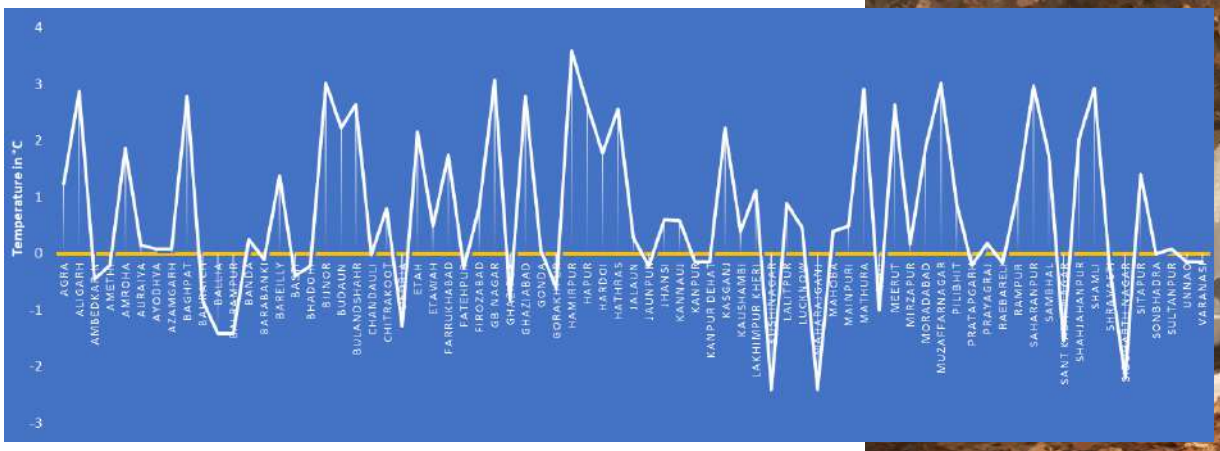


Figure 3.2: Increase/decrease of maximum temperature for the months of May, 1982 and May, 2023.

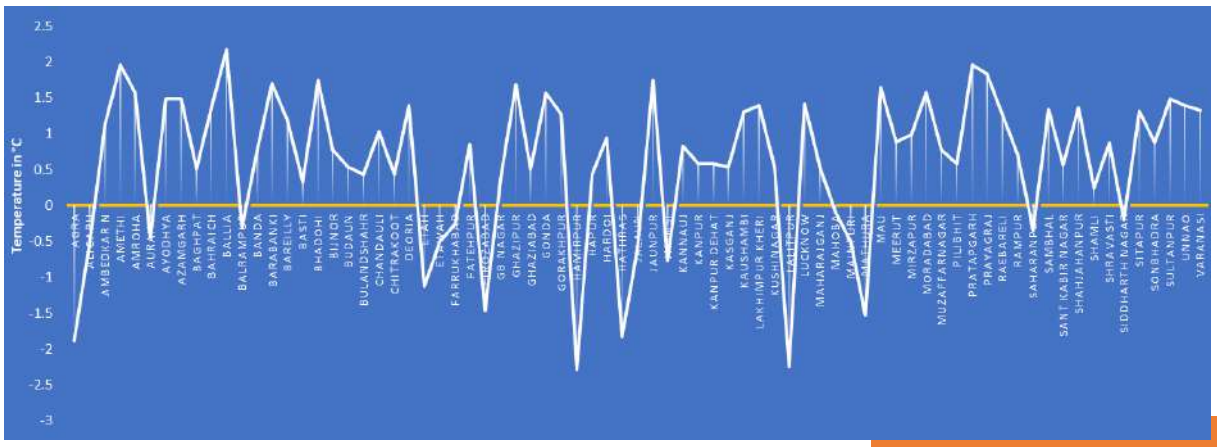


Figure 3.3: Increase/decrease of maximum temperature for the month of June, 1982 to June, 2023.

3.2 Heat Wave Threshold for Districts

Heat alert aims to inform residents, emergency services and other stakeholders about the impending heatwave conditions. Issuing a heat alert is a proactive measure to protect public health and safety during extreme heat events. It involves a coordinated effort between meteorological agencies, health organizations, emergency services and the public. *Table 3.2* shows the 80th, 88th and 95thpercentiles of annual maximum temperature to calculate thresholds. The yellow alert is indicated by 80th percentiles, orange alert by 88th percentiles and red alert by 95th percentiles.

Table 3.2: District wise Heat threshold for Uttar Pradesh.

SL NO	District	Heat Threshold		
		Yellow Alert	Orange Alert	Red Alert
1	AGRA	40.54	43.08	**45.26**
2	ALIGARH	40.03	42.55	**44.78**

Heat alert aims to inform residents, emergency services and other stakeholders about the impending heatwave conditions.

3	AMBEDKAR NAGAR	39.67	42.20	44.36
4	AMETHI	39.87	42.43	44.55
5	AMROHA	39.33	42.00	44.33
6	AURAIYA	40.44	43.01	45.11
7	AYODHYA	39.67	42.20	44.36
8	AZAMGARH	39.98	42.58	44.71
9	BAGHPAT	39.61	42.01	44.43
10	BAHRAICH	38.81	41.26	43.44
11	BALLIA	39.18	41.62	43.83
12	BALRAMPUR	38.45	40.72	42.94
13	BANDA	40.58	43.30	45.31
14	BARABANKI	39.68	42.24	44.38
15	BAREILLY	39.34	42.00	44.25
16	BASTI	39.27	41.73	43.93
17	BHADOHI	40.28	42.98	45.02
18	BIJNOR	36.47	39.08	41.48
19	BUDAUN	39.92	42.52	44.72
20	BULANDSHAHR	39.74	42.29	44.63
21	CHANDAULI	39.52	42.26	44.38
22	CHITRAKOOT	39.86	42.64	44.66
23	DEORIA	39.08	41.50	43.67
24	ETAH	40.22	42.80	44.93
25	ETAWAH	40.50	43.05	45.15
26	FARRUKHABAD	40.01	42.59	44.75
27	FATEHPUR	40.37	43.03	45.10
28	FIROZABAD	40.50	43.05	45.15
29	GAUTAM BUDH NAGAR	39.96	42.40	44.69
30	GAZIPUR	39.71	42.31	44.48
31	GHAZIABAD	39.55	42.11	44.48
32	GONDA	39.36	41.82	43.94
33	GORAKHPUR	39.38	41.85	44.08
34	HAMIRPUR	40.51	43.21	45.27
35	HAPUR	39.33	42.00	44.33
36	HARDOI	39.73	42.35	44.49
37	HATHRAS	40.30	42.87	45.05
38	JALAUN	40.55	43.23	45.34
39	JAUNPUR	39.98	42.58	44.71
40	JHANSI	40.40	43.05	45.14
41	KANNAUJ	40.10	42.63	44.74
42	KANPUR NAGAR	40.51	43.21	45.27
43	KANPUR DEHAT	40.26	42.86	44.96
44	KASGANJ	39.65	42.29	44.50
45	KAUSHAMBI	40.52	43.23	45.24
46	LAKHIMPUR KHERI	39.30	41.87	44.11
47	KUSHINAGAR	38.75	41.08	43.30
48	LALITPUR	39.07	41.66	43.80

It should be noted that when the threshold temperature is recorded for at least two consecutive days, a heat wave alert shall be declared on the second day.

49	LUCKNOW	39.94	42.55	**44.65**
50	MAHARAJGANJ	38.49	40.84	**43.05**
51	MAHOBA	40.48	43.21	**45.30**
52	MAINPURI	40.26	42.80	**44.92**
53	MATHURA	40.40	42.95	**45.12**
54	MAU	39.39	41.89	**44.14**
55	MEERUT	39.33	42.00	**44.33**
56	MIRZAPUR	39.88	42.65	**44.69**
57	MORADABAD	39.02	41.69	**43.97**
58	MUZAFFAR NAGAR	38.47	41.19	**43.65**
59	PILIBHIT	38.82	41.50	**43.91**
60	PRATAPGARH	40.14	42.77	**44.88**
61	PRAYAGRAJ	40.53	43.15	**45.21**
62	RAIBEARELI	40.24	42.88	**45.02**
63	RAMPUR	39.34	42.00	**44.25**
64	SAHARANPUR	38.19	41.01	**43.65**
65	SAMBHAL	39.59	42.21	**44.41**
66	SANT KABIR NAGAR	38.94	41.30	**43.51**
67	SHAHJAHANPUR	39.50	42.05	**44.30**
68	SHAMLI	39.16	41.81	**44.29**
69	SHRAWASTI	39.05	41.39	**43.49**
70	SIDDHARTH NAGAR	37.83	40.05	**42.25**
71	SITAPUR	39.51	42.08	**44.26**
72	SONBHADRA	39.02	41.80	**43.95**
73	SULTANPUR	39.87	42.43	**44.55**
74	UNNAO	40.12	42.73	**44.82**
75	VARANASI	40.12	42.72	**44.83**

In Uttar Pradesh, the significance of heat alerts cannot be overstated, especially considering the varying thresholds that dictate these alerts. As temperatures soar across the State, the calculated heat thresholds range from 36.47°C to 40.58°C for Yellow Alert, 39.08°C to 43.30°C for Orange Alert and 41.48°C to 45.34°C for Red Alert in different districts of Uttar Pradesh. These thresholds serve as crucial indicators, delineating the severity of heat conditions and prompting appropriate responses from authorities and the public alike. With such diverse thresholds, ranging from moderate to extreme, it becomes imperative for Uttar Pradesh to implement robust heat wave mitigation and adaptation strategies tailored to each alert level.

The calculated heat thresholds range from 36.47°C to 40.58°C for Yellow Alert, 39.08°C to 43.30°C for Orange Alert and 41.48°C to 45.34°C for Red Alert.

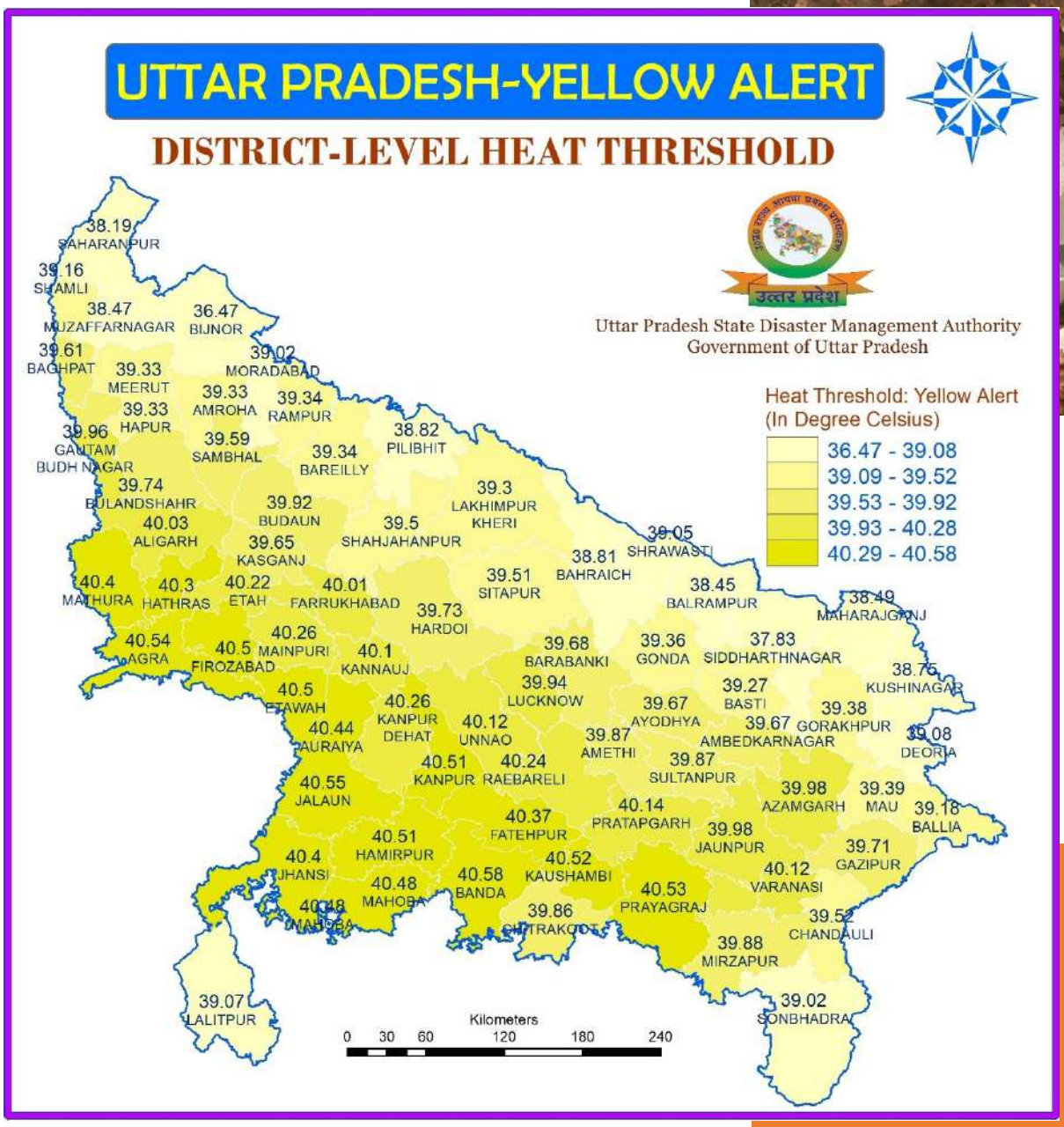


Figure 3.4: District wise heat threshold at 80th percentile (Yellow Alert).

3.2.1 Heat Threshold (Yellow Alert)

In Uttar Pradesh, Banda, Jalaun and Agra are among the top districts experiencing the highest yellow alert temperatures, indicative of elevated heat levels. These districts, along with Prayagraj, Kaushambi and Hamirpur, face significant heat challenges, impacting daily life and agricultural activities. With Kanpur Nagar, Etawah and Firozabad also on the list, it underscores the widespread nature of heat vulnerability in the region. The yellow alert signifies a cautionary phase, urging residents and authorities to take preventive measures against

Banda, Jalaun and Agra are among the top districts experiencing the highest yellow alert temperatures.

heat-related illnesses and agricultural stress. Given Uttar Pradesh's diverse landscape and population density, understanding heat thresholds in these districts is crucial for effective heat wave management and adaptation strategies.

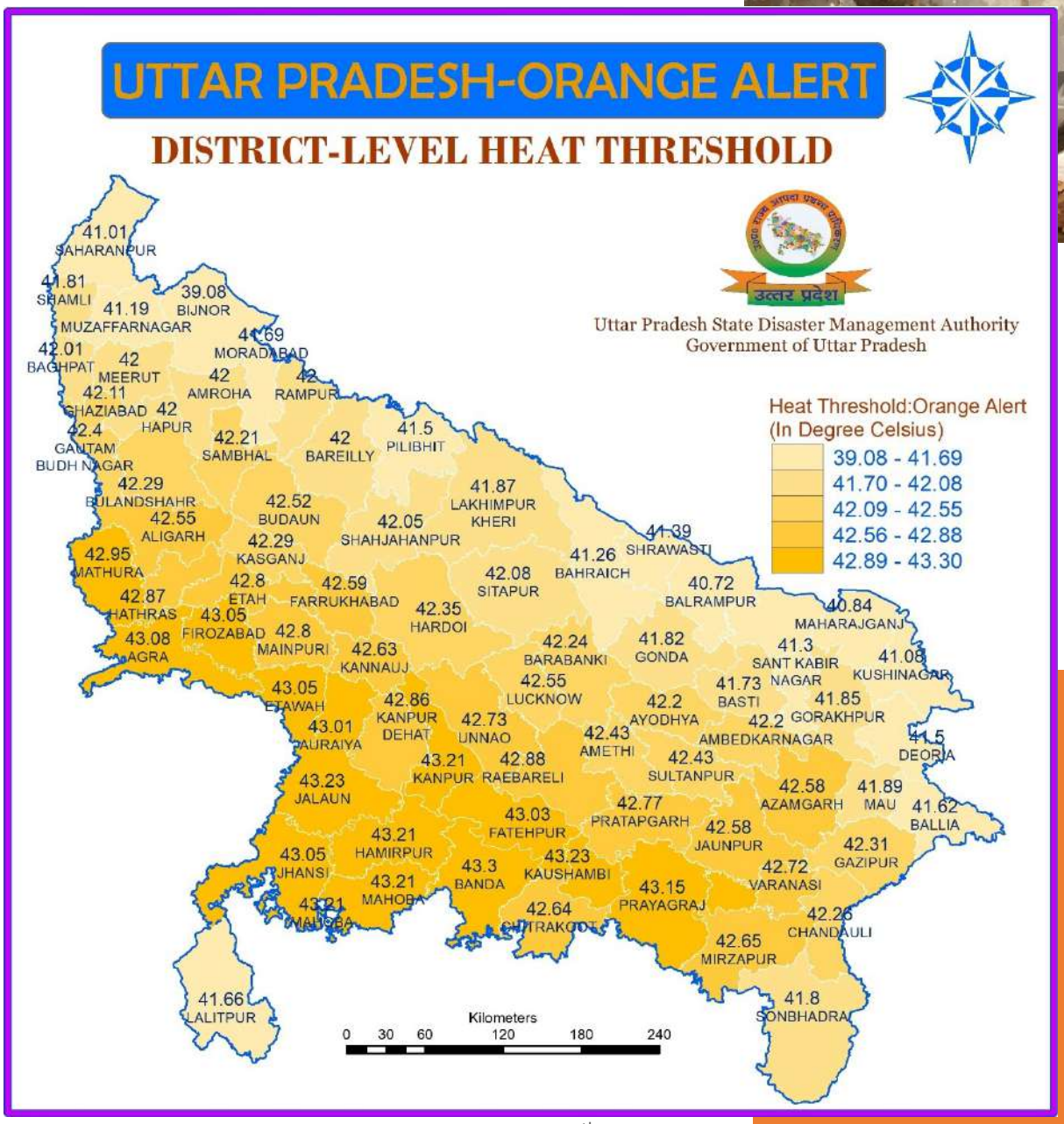
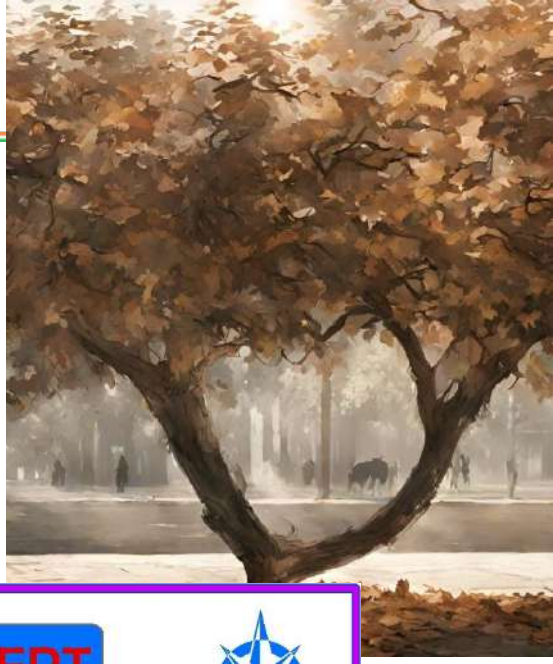


Figure 3.5: District wise heat threshold at 88th percentile (Orange Alert).

3.2.2 Heat Threshold (Orange Alert)

Districts like Banda, Jalaun and Kaushambi top the list with the highest orange alert temperatures, indicating heightened heat levels that pose significant risks to public health and agricultural activities. With Hamirpur, Kanpur Nagar, Mahoba, Prayagraj and Agra also experiencing extreme heat, it underscores the

Banda, Jalaun and Kaushambi top the list with the highest orange alert temperatures while Jalaun, Banda and Mahoba lead the list with red alert



widespread vulnerability to heat waves across the state. The orange alert serves as a critical warning, urging residents and authorities to take immediate action to protect themselves from heat-related illnesses and mitigate the impact on crops and livestock. Additionally, districts like Etawah, Firozabad, Jhansi and Fathepur facing high orange alert temperatures highlight the urgent need for proactive heat wave management and adaptation strategies.

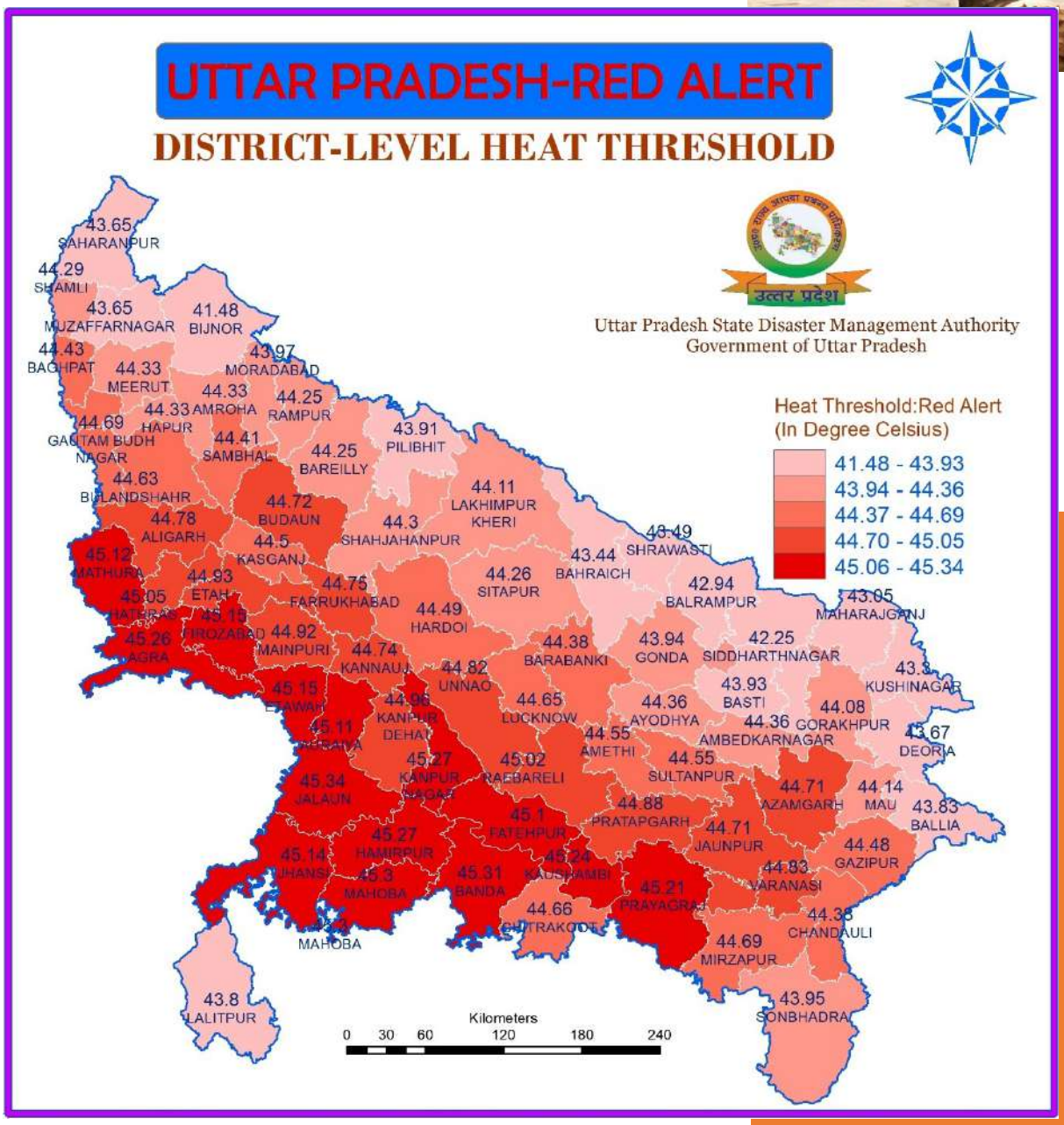


Figure 3.6 District wise heat threshold at 95th percentile (Red Alert).

3.2.3 Heat Threshold (Red Alert)

Several districts experienced exceptionally high-temperature threshold, warranting red alert classifications to signify the severity of the heat waves. Banda, Jalaun and Mahoba lead the list with temperatures soaring as high as 45.31°C, 45.34°C and 45.30°C, respectively. These extreme temperatures pose significant health risks and necessitate immediate interventions to protect vulnerable populations from heat-related illnesses. Districts like Agra, Hamirpur, Kanpur Nagar and Kaushambi are also grappling with intense heat. Besides there are another seven districts with temperatures hovering above 45°C. The red alert underscores the urgency for local authorities to implement heat wave management strategies, including the establishment of cooling centers, distribution of emergency supplies and dissemination of public health advisories. Additionally, efforts to mitigate the impact on agriculture, such as promoting water conservation and heat-resistant crop varieties, are crucial to safeguarding livelihoods in these districts. Collaborative action is essential to ensure the well-being and safety of communities amid these extreme heat conditions in Uttar Pradesh.

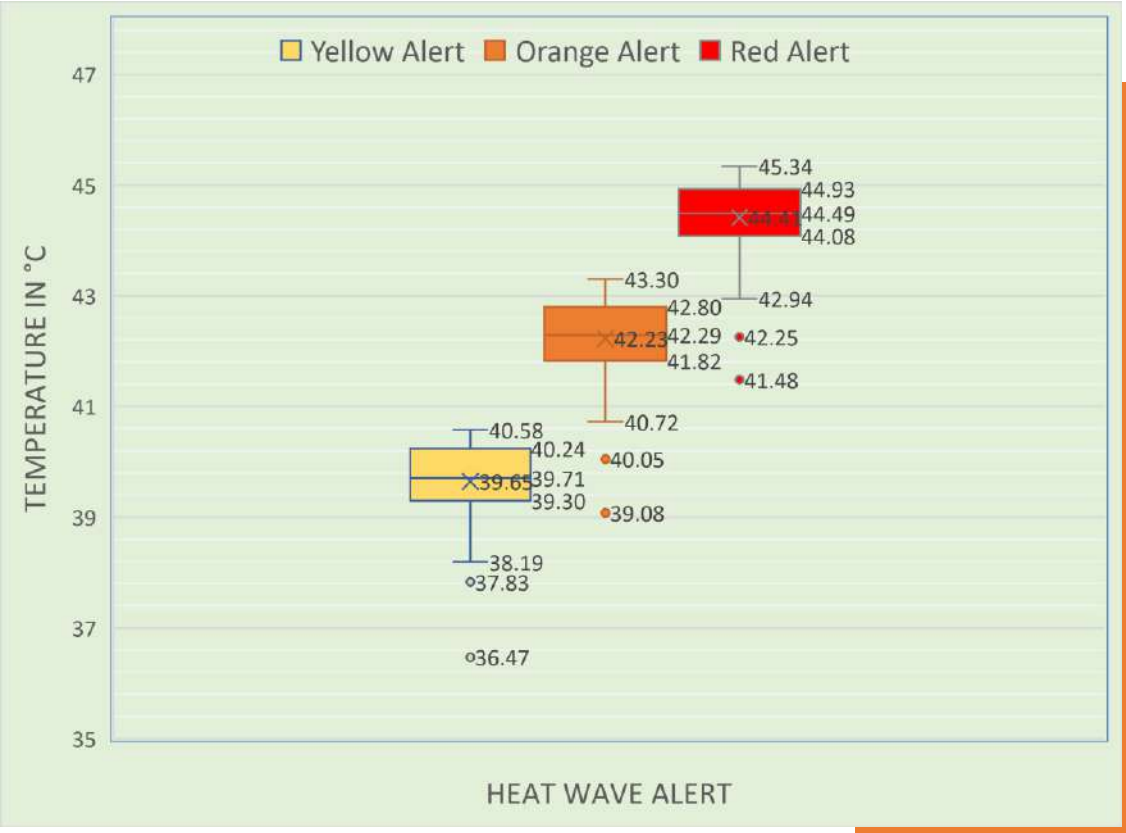


Fig. 3.7 Box-and-whisker plots of yellow, orange and red alerts.

Box-and-whisker plots are used to display the distribution and variability of a heat threshold dataset. In the context of heat thresholds for yellow, orange and red alerts, a box plot can provide valuable insights into the range and distribution of temperature values associated with each alert level. It includes statistics like interquartile range (IQR), various percentile, Median, Outliers etc.

3.3 Conclusion

The establishment of heat thresholds for yellow, orange and red alerts in Uttar Pradesh represents a significant step towards enhancing the state's resilience to extreme heat events. Through rigorous data collection, statistical analysis and collaboration with experts, we have developed scientifically grounded criteria to define heat thresholds tailored to the specific climatic conditions of each district. This initiative provides vital information for early warning systems, allowing authorities to issue timely alerts and implement targeted measures to mitigate the adverse effects of heat waves on public health, agriculture, water resources and infrastructure. By proactively addressing heat-related risks, Uttar Pradesh can better protect its population and minimize economic losses and foster climate resilience.

The establishment of heat thresholds for yellow, orange and red alerts in Uttar Pradesh represents a significant step towards enhancing the state's resilience to extreme heat events.

CHAPTER 4
INDIA-DISTRICT WISE HEAT WAVE THRESHOLD

4. District-Level Heat Thresholds for India

The report categorises heat alerts into Yellow, Orange and Red for more precise and localised heatwave alerts across all heat-affected districts in India. Thus, enabling district administration in Indigenous monitoring and decimation of heat alerts.

4.1 Data Source for Heat Threshold Determination

For this initiative, two primary climatic parameters—temperature (for temperature threshold) and humidity (for Heatwave Index, see Annexure-1) were considered. Historical data spanning 42 years (1982–2023) were sourced from NASA POWER.

When the mercury rises above 40°C in the plains, 37°C in coastal areas and 30°C in the hills.

4.2 Methodology for Calculating Heat Threshold

Daily maximum and minimum temperature and humidity data for all months from 1982 to 2023 were collected to construct criteria for all districts of India. The percentile-based technique, endorsed by WMO-WHO, was employed to establish the thresholds. Specifically, the 80th, 88th and 95th percentile values were used to determine the Yellow, Orange and Red alert criteria. One of the criteria of IMD to issues heat alerts is when temperatures exceed 40°C in the plains, 37°C in coastal areas and 30°C in the hills. This report classifies the 80th, 88th and 95th percentiles for all districts as various levels of Heat alert. For some colder and coastal districts, IMD values may vary significantly. People's vulnerability to heat can increase even at comparatively low temperatures, if the usual temperature of the area is much lower. Therefore, these thresholds may not be applicable to colder districts, which must develop their own thresholds by correlating local temperatures with mortality data to establish accurate thresholds.

The percentile approach for heat thresholds is endorsed by the WMO-WHO and aligns with IMS's departure from normal. In the present report, the 80th, 88th and 95th percentiles define the criteria for yellow, orange and red alerts, respectively.

The methodology involves statistical analysis of temperature data and the general formula used to calculate the percentile-based thresholds is detailed in Chapter 2. The calculated thresholds were validated against historical heatwave events to ensure accuracy and relevance.

Alert Categories;

- **Yellow Alert**: 80th percentile value
- **Orange Alert**: 88th percentile value
- **Red Alert**: 95th percentile value

The district-level Heat Alert System aims to provide timely warnings to help communities, local governments and healthcare providers prepare and mitigate the adverse effects of heatwaves.

This system can serve as a blueprint for other regions or states within India, with adjustments made to account for local climatic variations. Continuous validation and calibration of the thresholds will be essential to ensure the system's effectiveness and adaptability to changing climate patterns. It should be noted that when the threshold temperature is recorded for at least two consecutive days, a heat wave alert shall be declared on the second day.

4.3 Heat Threshold: Yellow Alert

Several districts in North and North Western India have recorded some of the highest temperatures, triggering yellow heat alerts. Leading the list is Fazilka in Punjab with a threshold of 42.19°C, followed closely by Ganganagar in Rajasthan at 41.72°C, known for its severe weather. Faridkot (41.51°C), Sri Muktsar Sahib (41.47°C) and Bathinda (40.97°C) also represent Punjab's significant summer heat. Rajasthan's Jaisalmer, with a threshold of 40.96°C, is notable for its desert climate. Sirsa in Haryana, experiencing temperatures up to 40.91°C, marks the state's extreme conditions. Moga (40.89°C) and Firozpur (40.66°C) in Punjab, along with Hanumangarh in Rajasthan (40.79°C), round out the list, illustrating the widespread impact of heat waves across these states.

4.4 Heat Threshold: Orange Alert

India with the highest orange alert heat wave threshold temperatures showcase regions experiencing severe heat conditions. Fazilka in Punjab leads with a threshold of 43.94°C, followed by Faridkot (43.45°C) and Sri Muktsar Sahib (43.33°C), indicating significant heat wave conditions in Punjab. Uttar Pradesh has multiple districts on this list, including Banda (43.30°C), Jalaun (43.23°C), Kaushambi (43.23°C), Hamirpur (43.21°C), Kanpur (43.21°C) and Mahoba (43.21°C), reflecting widespread intense heat across the state. Ganganagar in Rajasthan, shows an orange alert threshold of 43.26°C, underlining its extreme summer temperatures. These districts represent some of the hottest areas in their respective states, facing critical heat wave situations.

Northern and North-Western Indian districts appear to be the most vulnerable to heat waves.

4.5 Heat Threshold: Red Alert

Leading this list is Fazilka in Punjab, with a threshold of 45.87°C, followed by Faridkot at 45.55°C, indicating severe heat waves in Punjab. Uttar Pradesh dominates the list with Jalaun (45.34°C), Banda (45.31°C), Mahoba (45.30°C), Hamirpur (45.27°C), Kanpur (45.27°C) and Agra (45.26°C), reflecting widespread and intense heat conditions across the state. Moga in Punjab also appears with a threshold of 45.27°C and Sri Muktsar Sahib in Punjab records

45.24°C. These districts represent some of the hottest and most critically affected areas by heat waves in India, facing extreme summer temperatures that necessitate red alert warnings.

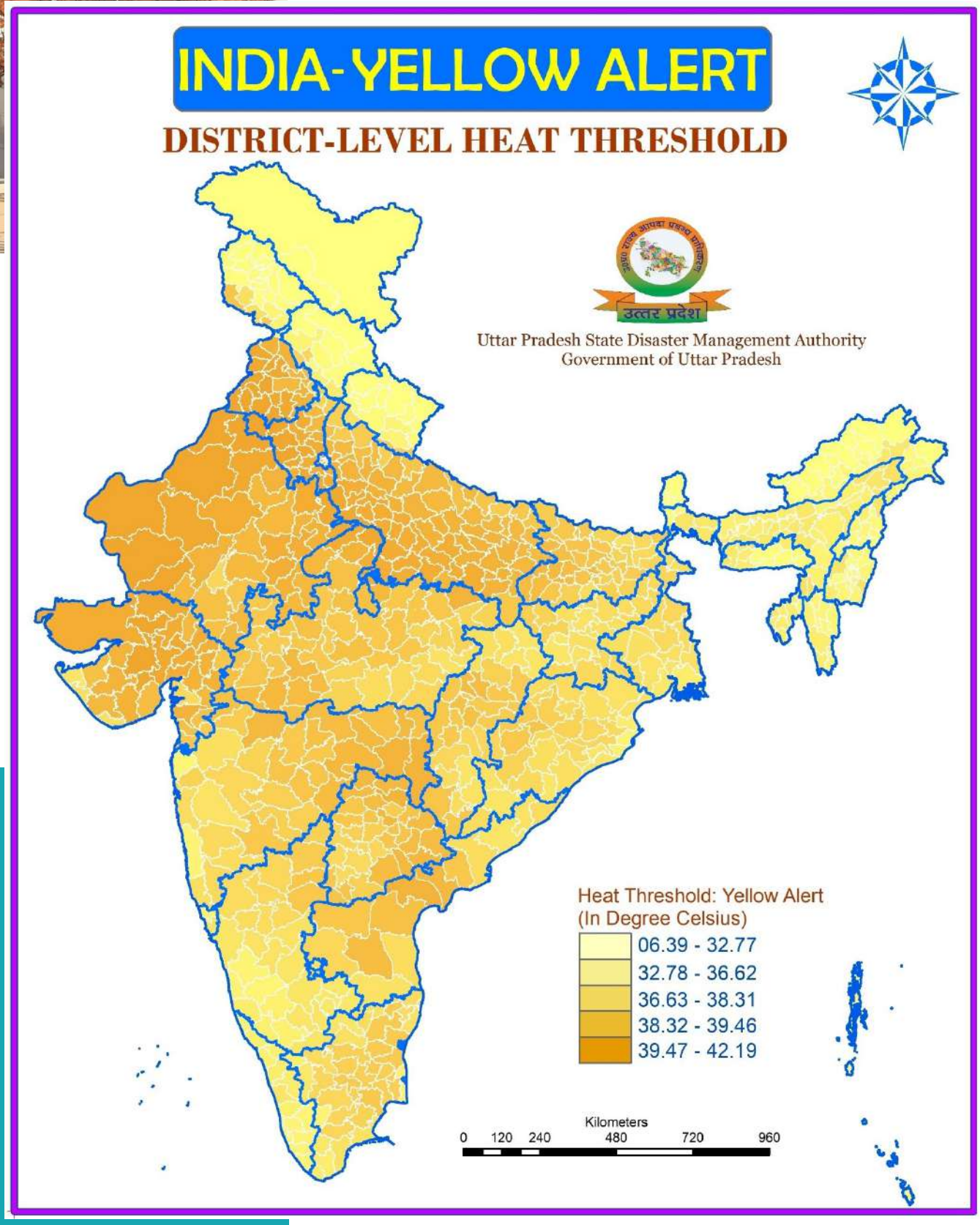


Figure 4.1: Pan India district wise Yellow alert.

Note: Thresholds are only applicable and relevant for districts affected by heat waves.

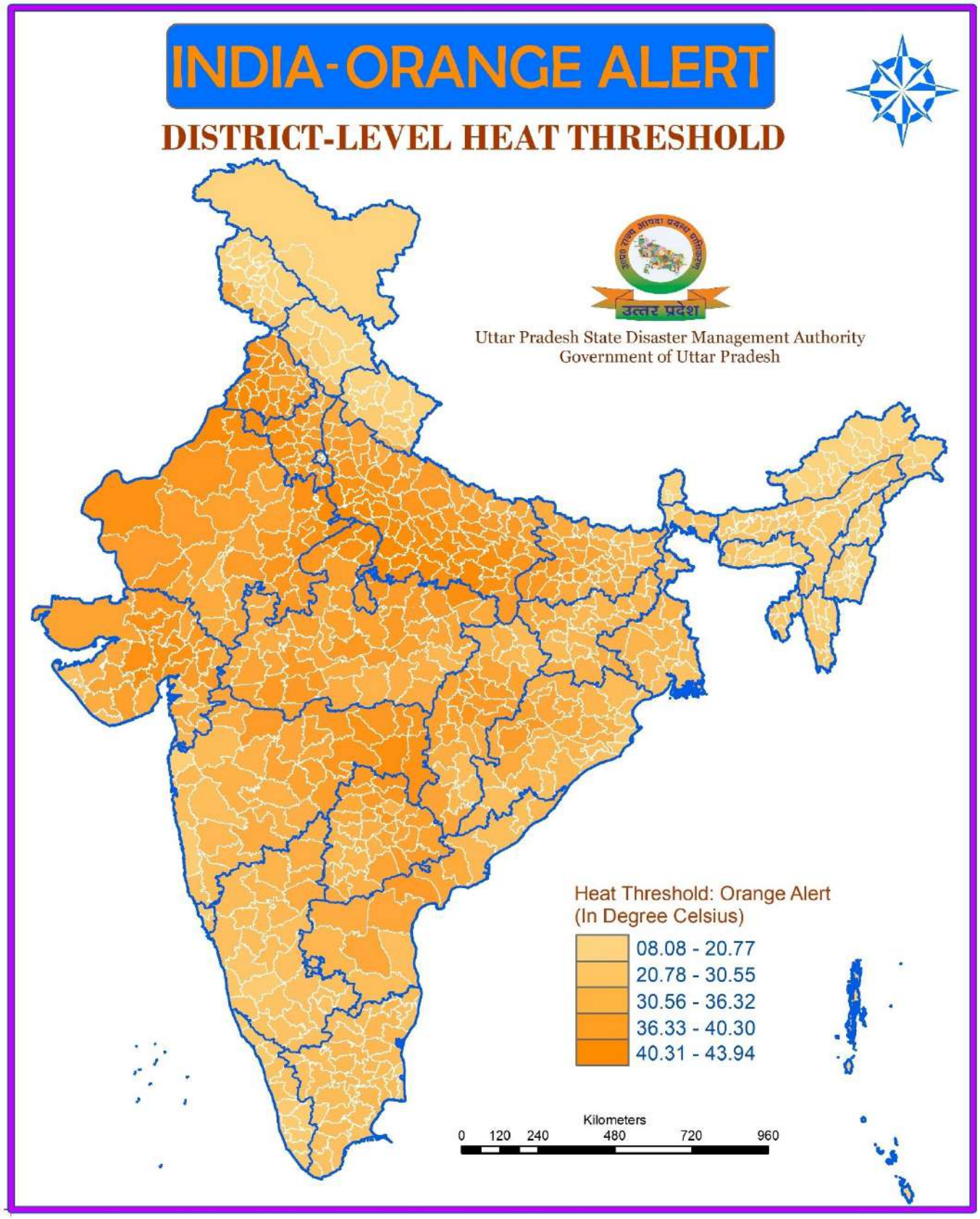


Figure 4.2: Pan India district wise Orange alert.

Note: Thresholds are only applicable and relevant for districts affected by heat waves.

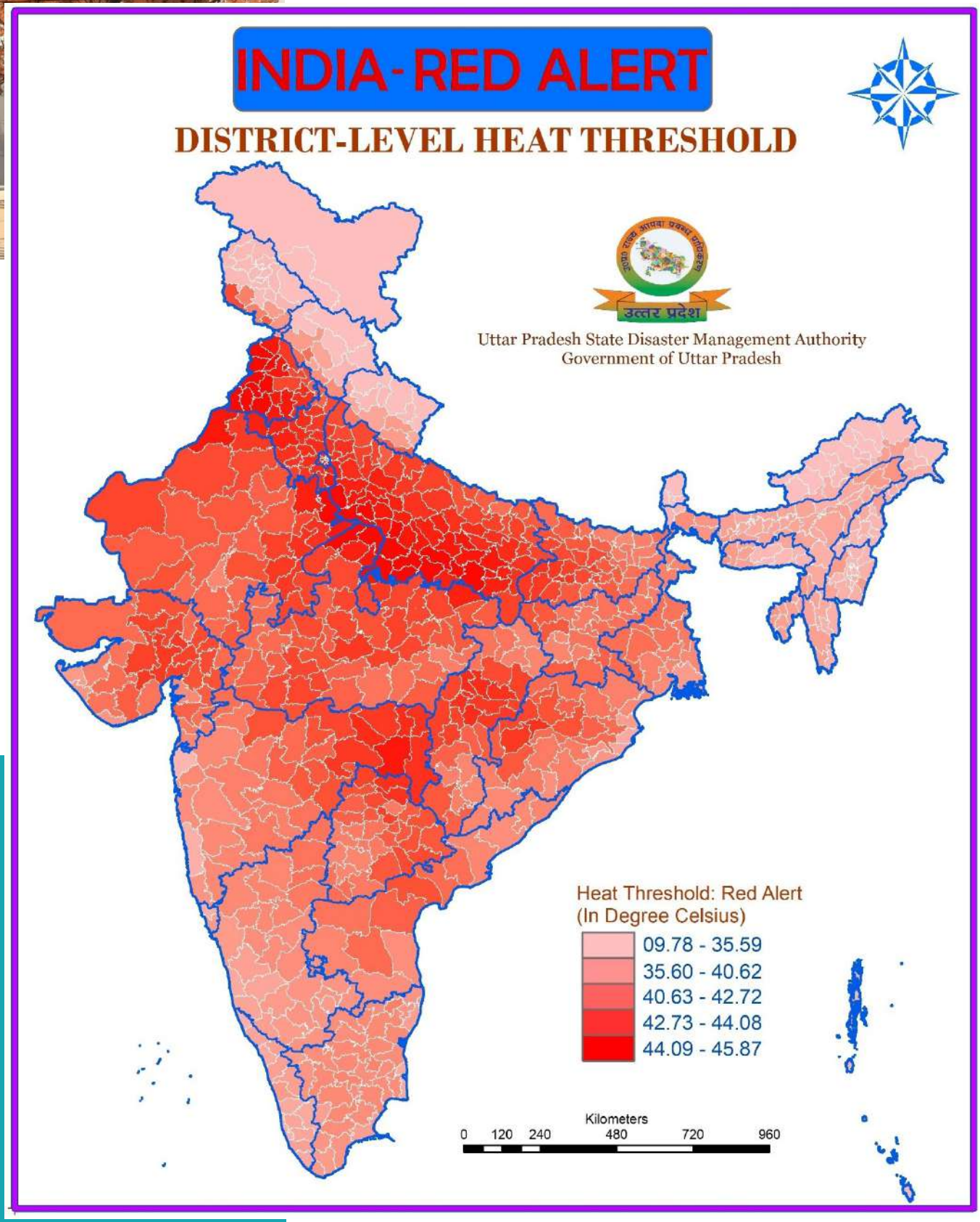


Figure 4.3: Pan India district wise Red alert.

Note: Thresholds are only applicable and relevant for districts affected by heat waves.

Kaushambi in Uttar Pradesh, with a threshold of 45.24°C and Bhind in Madhya Pradesh (45.24°C), highlights the severe heat conditions beyond the initially mentioned regions. Firozpur in Punjab, with a threshold of 45.23°C and Prayagraj in Uttar Pradesh, recording 45.21°C, further emphasise the critical heat stress these areas face.

The red heat alerts in Uttar Pradesh highlight the state's vulnerability to heat waves. With several districts recording temperatures well above 45°C, it underscores the region's susceptibility to extreme heat events. Factors such as climate, urbanisation and local geography contribute to this heightened vulnerability. The combination of high temperatures and humidity levels in Uttar Pradesh can exacerbate the impact of heat waves on the population. It is essential to prioritise heat wave preparedness and mitigation measures, including public awareness campaigns, provision of cooling centres and ensuring uninterrupted water supply during these extreme events. Addressing these vulnerabilities is crucial to safeguarding the health and well-being of Uttar Pradesh's residents during periods of intense heat.

4.6 District Wise Temperature Threshold: Yellow, Orange and Red Alert

The comprehensive list of temperature thresholds for yellow, orange and red alerts across all districts of India provides a crucial tool for preparedness and response to extreme heat events. Utilising data spanning from 1982 to 2023 offers a comprehensive view of long-term temperature trends and variations across India. This extended time frame captures multiple cycles of weather patterns, allowing for the identification of consistent and evolving heat wave patterns. Analysing such extensive historical data provides insights into how temperatures have changed over the decades, highlighting any increasing trends or shifts in heat wave occurrences.

This data-driven approach enables authorities, communities and individuals to anticipate and act upon escalating heat conditions promptly. Understanding these thresholds helps in early warning dissemination, ensuring that timely alerts reach the most vulnerable populations. It also aids in resource allocation, enabling better planning for interventions. Moreover, this standardised classification across districts facilitates a unified understanding and response strategy at both regional and national levels. By recognising the importance of these temperature thresholds, India can enhance its resilience against heat waves, minimise health risks and reduce socio-economic impacts associated with extreme heat events.

This data-driven approach enables prompt action on escalating heat conditions. Early warnings help authorities and communities reach vulnerable populations in time. Understanding these thresholds ensures timely alerts and better preparedness.

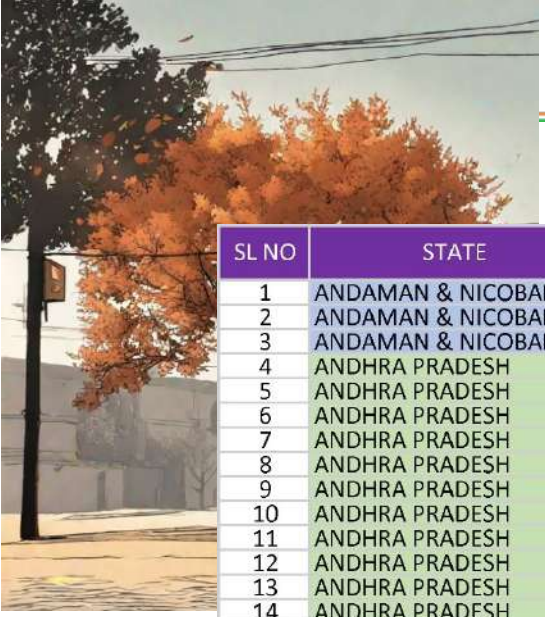
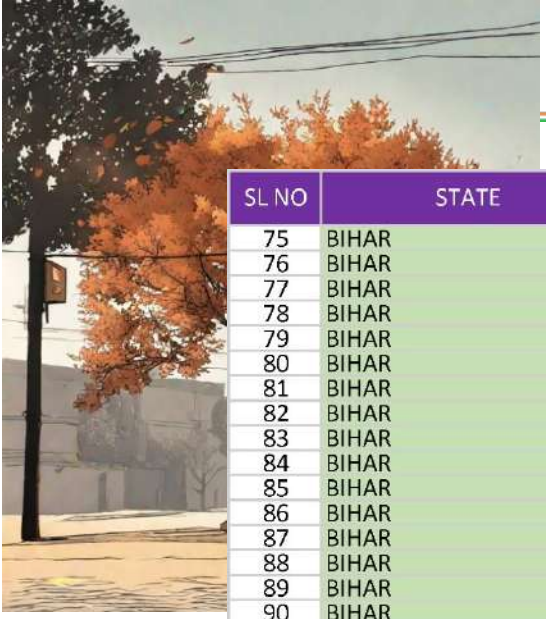
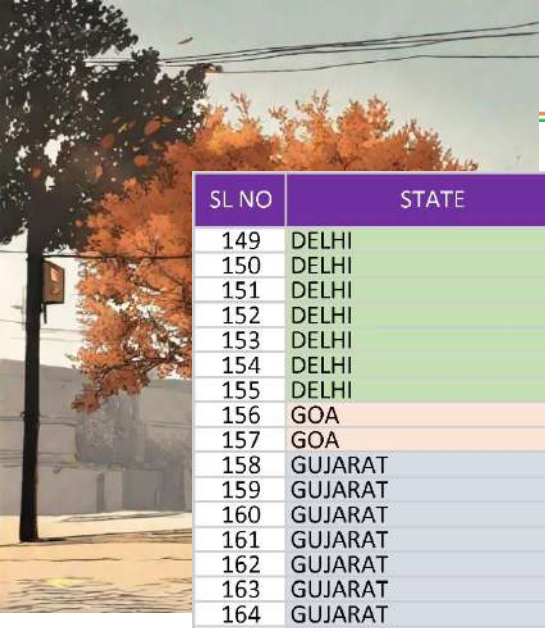


Table 4.1: District-wise Heat threshold for Yellow, Orange and Red Alert. (Only applicable to districts affected by heat waves)

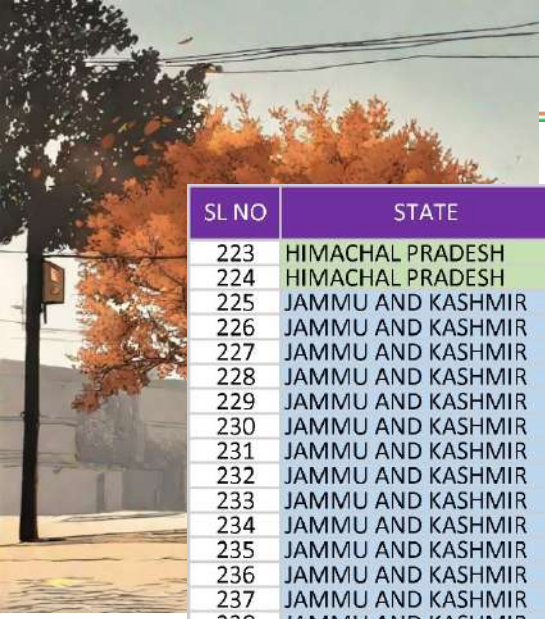
SL NO	STATE	District	Heat Threshold		
			Yellow Alert	Orange Alert	Red Alert
1	ANDAMAN & NICOBAR	NICOBAR	28.82	29.09	29.49
2	ANDAMAN & NICOBAR	NORTH & MIDDLE ANDAMAN	29.71	30.51	31.49
3	ANDAMAN & NICOBAR	SOUTH ANDAMAN	29.07	29.42	30.04
4	ANDHRA PRADESH	ANANTAPUR	37.20	39.10	40.66
5	ANDHRA PRADESH	CHITTOOR	35.13	37.03	38.73
6	ANDHRA PRADESH	EAST GODAVARI	36.66	38.74	40.47
7	ANDHRA PRADESH	GUNTUR	39.48	41.51	43.48
8	ANDHRA PRADESH	KRISHNA	38.83	40.69	42.55
9	ANDHRA PRADESH	KURNOOL	38.32	40.40	42.09
10	ANDHRA PRADESH	POTTI SRIRAMULU NELLORE	35.62	36.74	38.40
11	ANDHRA PRADESH	PRAKASAM	38.53	40.75	42.76
12	ANDHRA PRADESH	SRIKAKULAM	36.65	38.51	40.31
13	ANDHRA PRADESH	VISAKHAPATNAM	35.13	36.94	38.53
14	ANDHRA PRADESH	VIZIANAGARAM	35.81	38.14	40.15
15	ANDHRA PRADESH	WEST GODAVARI	38.43	40.39	42.13
16	ANDHRA PRADESH	Y S R KADAPA	38.63	40.82	42.51
17	ARUNACHAL PRADESH	ANJAW	19.75	20.77	21.79
18	ARUNACHAL PRADESH	CHANGLANG	30.14	31.15	32.64
19	ARUNACHAL PRADESH	DIBANG VALLEY	22.90	23.98	25.09
20	ARUNACHAL PRADESH	EAST KAMENG	23.35	24.19	25.23
21	ARUNACHAL PRADESH	EAST SIANG	33.40	34.50	35.87
22	ARUNACHAL PRADESH	KAMLE	30.23	31.19	32.52
23	ARUNACHAL PRADESH	KRA DAADI	23.87	24.87	25.97
24	ARUNACHAL PRADESH	KURUNG KUMEY	17.68	18.53	19.41
25	ARUNACHAL PRADESH	LEPA RADA	30.24	31.37	32.72
26	ARUNACHAL PRADESH	LOHIT	27.37	28.20	29.31
27	ARUNACHAL PRADESH	LONGDING	31.01	32.05	33.44
28	ARUNACHAL PRADESH	LOWER DIBANG VALLEY	33.40	34.50	35.87
29	ARUNACHAL PRADESH	LOWER SIANG	27.12	28.17	29.40
30	ARUNACHAL PRADESH	LOWER SUBANSIRI	26.51	27.39	28.48
31	ARUNACHAL PRADESH	NAMSAI	30.14	31.15	32.64
32	ARUNACHAL PRADESH	PAKKE KESSANG	30.55	31.44	32.69
33	ARUNACHAL PRADESH	PAPUMPARE	30.67	31.51	32.76
34	ARUNACHAL PRADESH	SHI YOMI	21.75	22.94	24.24
35	ARUNACHAL PRADESH	SIANG	21.75	22.94	24.24
36	ARUNACHAL PRADESH	TAWANG	17.79	18.76	19.69
37	ARUNACHAL PRADESH	TIRAP	31.01	32.05	33.44
38	ARUNACHAL PRADESH	UPPER SIANG	22.12	23.38	24.78
39	ARUNACHAL PRADESH	UPPER SUBANSIRI	17.64	18.62	19.65
40	ARUNACHAL PRADESH	WEST KAMENG	19.06	19.81	20.58
41	ARUNACHAL PRADESH	WEST SIANG	27.12	28.17	29.40
42	ASSAM	BAKSA	32.78	33.69	35.12
43	ASSAM	BARPETA	32.84	33.62	34.82
44	ASSAM	BISWANATH	30.55	31.44	32.69
45	ASSAM	BONGAIGAON	32.48	33.30	34.65
46	ASSAM	CACHAR	32.14	33.19	34.61
47	ASSAM	CHARAIDEO	33.34	34.49	36.05
48	ASSAM	CHIRANG	32.48	33.30	34.65
49	ASSAM	DARRANG	32.78	33.69	35.12
50	ASSAM	DHEMAJI	33.98	35.23	36.91
51	ASSAM	DHUBRI	33.60	34.92	37.02
52	ASSAM	DIBRUGARH	33.98	35.23	36.91
53	ASSAM	DIMA HASAO	31.12	32.08	33.53
54	ASSAM	GOALPARA	33.27	34.22	35.79
55	ASSAM	GOLAGHAT	33.36	34.35	35.76
56	ASSAM	HAILAKANDI	34.68	35.81	37.37
57	ASSAM	HOJAI	32.14	33.19	34.61
58	ASSAM	JORHAT	32.19	33.15	34.44
59	ASSAM	KAMRUP METRO	33.08	33.98	35.19
60	ASSAM	KAMRUP RURAL	33.33	34.13	35.47
61	ASSAM	KARBI ANGLONG	32.80	33.78	35.16
62	ASSAM	KARIMGANJ	34.68	35.81	37.37
63	ASSAM	KOKRAJHAR	32.67	33.86	35.92
64	ASSAM	LAKHIMPUR	32.61	33.55	34.91
65	ASSAM	MAJULI	32.61	33.55	34.91
66	ASSAM	MARIGAON	33.16	34.15	35.62
67	ASSAM	NAGAON	33.16	34.15	35.62
68	ASSAM	NALBARI	32.84	33.62	34.82
69	ASSAM	SIBSAGAR	32.61	33.55	34.91
70	ASSAM	SONITPUR	33.16	34.15	35.62
71	ASSAM	SOUTH SALMARA MANCACHAR	33.60	34.92	37.02
72	ASSAM	TINSUKIA	34.77	36.07	37.71
73	ASSAM	UDALGURI	32.78	33.69	35.12
74	ASSAM	WEST KARBI ANGLONG	33.34	34.24	35.59



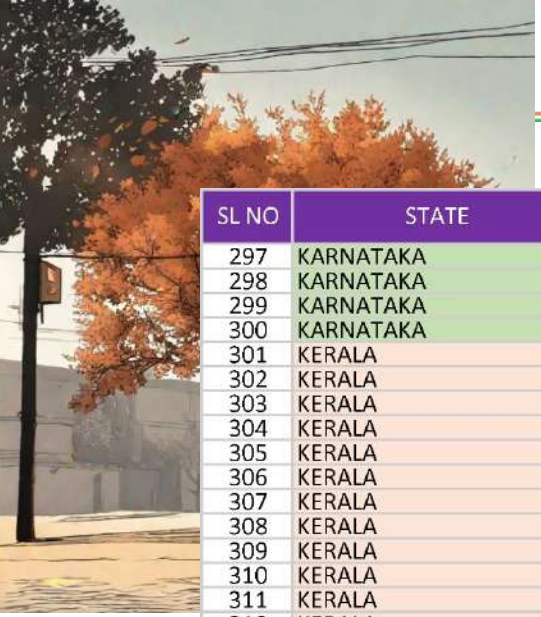
SL NO	STATE	District	Heat Threshold		
			Yellow Alert	Orange Alert	Red Alert
75	BIHAR	ARARIA	36.72	38.78	41.01
76	BIHAR	ARWAL	39.48	42.08	44.35
77	BIHAR	AURANGABAD	38.83	41.63	43.87
78	BIHAR	BANKA	37.61	40.01	42.39
79	BIHAR	BEGUSARAI	38.31	40.66	42.95
80	BIHAR	BHAGALPUR	36.97	39.24	41.57
81	BIHAR	BHOJPUR	39.48	42.01	44.28
82	BIHAR	BUXAR	39.71	42.31	44.48
83	BIHAR	DARBHANGA	38.16	40.35	42.65
84	BIHAR	GAYA	38.01	40.79	43.14
85	BIHAR	GOPALGANJ	38.75	41.08	43.30
86	BIHAR	JAHANABAD	39.19	41.79	44.12
87	BIHAR	JAMUI	36.83	39.44	42.08
88	BIHAR	KAIMUR	39.71	42.31	44.48
89	BIHAR	KATIHAR	37.07	39.18	41.41
90	BIHAR	KHAGARIA	38.31	40.66	42.95
91	BIHAR	KISHANGANJ	37.89	40.09	42.41
92	BIHAR	LAKHISARAI	37.98	40.49	42.88
93	BIHAR	MADHEPURA	37.38	39.50	41.73
94	BIHAR	MADHUBANI	37.29	39.20	41.29
95	BIHAR	MUNGER	37.61	40.01	42.39
96	BIHAR	MUZAFFARPUR	38.66	40.98	43.21
97	BIHAR	NALANDA	39.19	41.79	44.12
98	BIHAR	NAWADA	36.92	39.70	42.33
99	BIHAR	PASHCHIMI CHAMPARAN	38.02	40.27	42.47
100	BIHAR	PATNA	39.19	41.76	44.04
101	BIHAR	PURBI CHAMPARAN	37.14	39.27	41.36
102	BIHAR	PURNIA	36.72	38.78	41.01
103	BIHAR	ROHTAS	39.37	42.02	44.21
104	BIHAR	SAHARSA	37.89	40.09	42.41
105	BIHAR	SAMASTIPUR	38.89	41.37	43.63
106	BIHAR	SARAN	38.95	41.32	43.57
107	BIHAR	SHEIKHPURA	38.50	41.12	43.51
108	BIHAR	SHEOHAR	38.45	40.67	42.90
109	BIHAR	SITAMARHI	38.03	40.19	42.35
110	BIHAR	SIWAN	38.75	41.08	43.30
111	BIHAR	SUPAUL	36.03	37.87	39.87
112	BIHAR	VAISHALI	38.66	40.98	43.21
113	CHANDIGARH	CHANDIGARH	37.56	40.12	42.71
114	CHHATTISGARH	BALOD	37.87	40.60	42.85
115	CHHATTISGARH	BALODA BAZAR	38.87	41.89	44.21
116	CHHATTISGARH	BALRAMPUR	35.63	38.62	40.92
117	CHHATTISGARH	BASTAR	36.10	38.51	40.62
118	CHHATTISGARH	BEMETARA	39.33	42.16	44.37
119	CHHATTISGARH	BIJAPUR	38.82	41.08	43.11
120	CHHATTISGARH	BILASPUR	38.27	41.07	43.33
121	CHHATTISGARH	DAKSHIN BASTAR DANTEWADA	36.77	39.10	41.15
122	CHHATTISGARH	DHAMTARI	37.75	40.51	42.77
123	CHHATTISGARH	DURG	38.80	41.65	43.93
124	CHHATTISGARH	GARIYABAND	38.81	41.73	44.01
125	CHHATTISGARH	GAURELA-PENDRA-MARWAHI	37.00	39.83	42.04
126	CHHATTISGARH	JANJGIR - CHAMPA	38.94	41.97	44.37
127	CHHATTISGARH	JASHPUR	35.32	38.33	40.70
128	CHHATTISGARH	KABIRDHAM	38.73	41.53	43.71
129	CHHATTISGARH	KONDAGAON	35.70	38.25	40.51
130	CHHATTISGARH	KORBA	38.32	41.30	43.66
131	CHHATTISGARH	KOREA	36.79	39.65	41.83
132	CHHATTISGARH	MAHASAMUND	38.45	41.38	43.66
133	CHHATTISGARH	MUNGELI	39.46	42.39	44.60
134	CHHATTISGARH	NARAINPUR	36.70	39.11	41.20
135	CHHATTISGARH	RAIGARH	38.58	41.57	44.04
136	CHHATTISGARH	RAIPUR	39.42	42.40	44.60
137	CHHATTISGARH	RAJ NANDGAON	38.95	41.69	43.91
138	CHHATTISGARH	SUKMA	38.51	40.76	42.62
139	CHHATTISGARH	SURAJPUR	36.95	39.84	42.02
140	CHHATTISGARH	SURGUJA	36.29	39.21	41.48
141	CHHATTISGARH	UTTAR BASTAR KANKER	37.87	40.60	42.85
142	DADRA & NAGAR HAVELI &	DADRA & NAGAR HAVELI	37.71	39.26	41.03
143	DADRA & NAGAR HAVELI &	DAMAN	37.53	39.06	40.87
144	DADRA & NAGAR HAVELI &	DIU	30.05	30.55	31.33
145	DELHI	CENTRAL	39.96	42.40	44.69
146	DELHI	EAST	39.96	42.40	44.69
147	DELHI	NEW DELHI	39.96	42.40	44.69
148	DELHI	NORTH	40.00	42.26	44.59



SL NO	STATE	District	Heat Threshold		
			Yellow Alert	Orange Alert	Red Alert
149	DELHI	NORTH EAST	39.96	42.40	44.69
150	DELHI	NORTH WEST	40.01	42.32	44.53
151	DELHI	SHAHADRA	39.96	42.40	44.69
152	DELHI	SOUTH	40.01	42.32	44.53
153	DELHI	SOUTH EAST	39.96	42.40	44.69
154	DELHI	SOUTH WEST	40.01	42.32	44.53
155	DELHI	WEST	40.01	42.32	44.53
156	GOA	NORTH GOA	31.76	32.40	33.22
157	GOA	SOUTH GOA	34.30	35.50	36.65
158	GUJARAT	AHMADABAD	39.58	41.60	43.34
159	GUJARAT	AMRELI	39.40	41.30	43.01
160	GUJARAT	ANAND	40.15	42.24	44.11
161	GUJARAT	ARAVALLI	39.87	41.73	43.51
162	GUJARAT	BANAS KANTHA	40.19	41.83	43.44
163	GUJARAT	BHARUCH	36.39	38.12	39.80
164	GUJARAT	BHAVNAGAR	38.61	40.43	42.11
165	GUJARAT	BOTAD	40.54	42.69	44.33
166	GUJARAT	CHHOTA UDEPUR	39.60	41.64	43.45
167	GUJARAT	DAHOD	38.49	40.63	42.51
168	GUJARAT	DANGS	37.69	39.46	41.10
169	GUJARAT	DEVBHUMI DWARKA	34.33	35.19	36.36
170	GUJARAT	GANDHINAGAR	40.45	42.49	44.21
171	GUJARAT	GIR SOMNATH	35.39	36.72	38.24
172	GUJARAT	JAMNAGAR	38.10	39.52	41.07
173	GUJARAT	JUNAGADH	38.51	40.22	41.92
174	GUJARAT	KACHCHH	39.53	41.00	42.56
175	GUJARAT	KHEDA	40.23	42.27	44.08
176	GUJARAT	MAHESANA	39.48	41.51	43.39
177	GUJARAT	MAHISAGAR	39.59	41.65	43.52
178	GUJARAT	MORBI	38.98	40.52	42.07
179	GUJARAT	NARMADA	39.08	41.10	42.88
180	GUJARAT	NAVSARI	38.24	39.87	41.70
181	GUJARAT	PANCH MAHALS	39.59	41.65	43.52
182	GUJARAT	PATAN	40.37	42.26	43.94
183	GUJARAT	PORBANDAR	35.54	36.77	38.26
184	GUJARAT	RAJKOT	39.16	40.91	42.50
185	GUJARAT	SABAR KANTHA	38.92	40.74	42.51
186	GUJARAT	SURAT	39.06	40.80	42.67
187	GUJARAT	SURENDRANAGAR	40.45	42.48	44.10
188	GUJARAT	TAPI	38.63	40.48	42.22
189	GUJARAT	VADODARA	39.60	41.54	43.37
190	GUJARAT	VALSAD	37.71	39.26	41.03
191	HARYANA	AMBALA	37.56	40.12	42.71
192	HARYANA	BHIWANI	40.48	42.44	44.40
193	HARYANA	CHARKHI DADRI	40.13	42.28	44.38
194	HARYANA	FARIDABAD	39.96	42.40	44.69
195	HARYANA	FATEHABAD	40.65	42.72	44.78
196	HARYANA	GURUGRAM	40.01	42.32	44.53
197	HARYANA	HISAR	40.20	42.33	44.65
198	HARYANA	JHAJJAR	40.01	42.32	44.53
199	HARYANA	JIND	40.28	42.37	44.58
200	HARYANA	KAITHAL	40.20	42.33	44.65
201	HARYANA	KARNAL	39.11	41.64	44.20
202	HARYANA	KURUKSHETRA	39.11	41.64	44.20
203	HARYANA	MAHENDRAGARH	39.59	41.83	43.95
204	HARYANA	MEWAT	39.88	42.29	44.52
205	HARYANA	PALWAL	40.19	42.69	44.89
206	HARYANA	PANCHKULA	37.56	40.12	42.71
207	HARYANA	PANIPAT	37.56	40.12	42.71
208	HARYANA	REWARI	37.56	40.12	42.71
209	HARYANA	ROHTAK	37.56	40.12	42.71
210	HARYANA	SIRSA	40.91	42.80	44.76
211	HARYANA	SONIPAT	40.00	42.26	44.59
212	HARYANA	YAMUNANAGAR	38.19	41.01	43.65
213	HIMACHAL PRADESH	BILASPUR	30.62	33.08	35.63
214	HIMACHAL PRADESH	CHAMBA	17.08	18.38	20.02
215	HIMACHAL PRADESH	HAMIRPUR	23.38	25.06	27.25
216	HIMACHAL PRADESH	KANGRA	31.91	34.22	36.78
217	HIMACHAL PRADESH	KINNAUR	11.00	12.63	14.11
218	HIMACHAL PRADESH	KULLU	11.35	12.40	13.55
219	HIMACHAL PRADESH	LAHUL & SPITI	6.39	8.08	9.78
220	HIMACHAL PRADESH	MANDI	30.62	33.08	35.63
221	HIMACHAL PRADESH	SHIMLA	26.11	28.36	30.90
222	HIMACHAL PRADESH	SIRMAUR	34.04	36.80	39.41

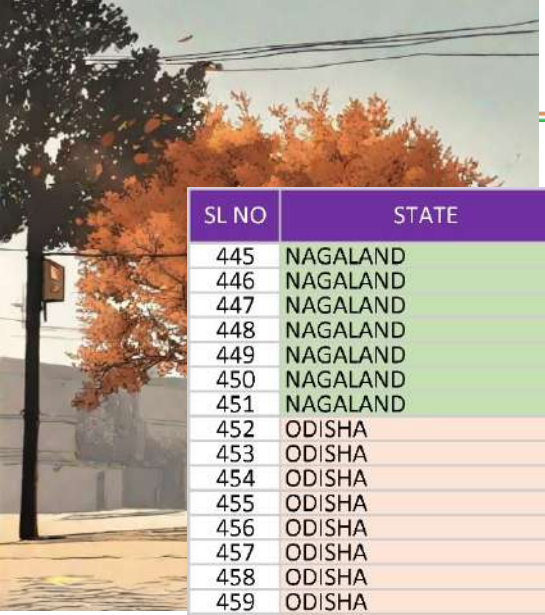


SL NO	STATE	District	Heat Threshold		
			Yellow Alert	Orange Alert	Red Alert
223	HIMACHAL PRADESH	SOLAN	33.58	36.07	38.67
224	HIMACHAL PRADESH	UNA	37.22	39.69	42.22
225	JAMMU AND KASHMIR	ANANTNAG	24.38	25.99	27.98
226	JAMMU AND KASHMIR	BADGAM	25.60	27.23	29.22
227	JAMMU AND KASHMIR	BANDIPURA	24.15	26.03	28.17
228	JAMMU AND KASHMIR	BARAMULA	25.60	27.23	29.22
229	JAMMU AND KASHMIR	DODA	25.73	27.61	30.12
230	JAMMU AND KASHMIR	GANDERBAL	23.58	25.13	26.95
231	JAMMU AND KASHMIR	JAMMU	36.12	38.35	41.22
232	JAMMU AND KASHMIR	KATHUA	32.69	35.01	37.70
233	JAMMU AND KASHMIR	KISHTWAR	20.54	22.07	23.94
234	JAMMU AND KASHMIR	KULGAM	24.38	25.99	27.98
235	JAMMU AND KASHMIR	KUPWARA	24.15	26.03	28.17
236	JAMMU AND KASHMIR	MIRPUR	38.43	40.81	43.53
237	JAMMU AND KASHMIR	MUZAFFARABAD	25.37	27.23	29.52
238	JAMMU AND KASHMIR	PULWAMA	23.58	25.13	26.95
239	JAMMU AND KASHMIR	PUNCH	25.60	27.23	29.22
240	JAMMU AND KASHMIR	RAJAURI	36.12	38.35	41.22
241	JAMMU AND KASHMIR	RAMBAN	24.38	25.99	27.98
242	JAMMU AND KASHMIR	RIASI	24.38	25.99	27.98
243	JAMMU AND KASHMIR	SAMBA	37.69	40.16	42.94
244	JAMMU AND KASHMIR	SHUPIYAN	24.38	25.99	27.98
245	JAMMU AND KASHMIR	SRINAGAR	23.58	25.13	26.95
246	JAMMU AND KASHMIR	UDHAMPUR	31.87	34.00	36.78
247	JHARKHAND	BOKARO	37.00	39.79	42.33
248	JHARKHAND	CHATRA	36.79	39.70	42.04
249	JHARKHAND	DEOGHAR	37.00	39.50	41.99
250	JHARKHAND	DHANBAD	36.78	39.61	42.19
251	JHARKHAND	DUMKA	36.95	39.38	41.83
252	JHARKHAND	EAST SINGHBHUM	37.40	40.04	42.57
253	JHARKHAND	GARHWA	38.12	41.05	43.30
254	JHARKHAND	GIRIDIH	36.83	39.44	42.08
255	JHARKHAND	GODDA	36.97	39.24	41.57
256	JHARKHAND	GUMLA	35.51	38.46	40.88
257	JHARKHAND	HAZARIBAGH	36.35	39.29	41.83
258	JHARKHAND	JAMTARA	36.94	39.56	42.06
259	JHARKHAND	KHUNTI	36.15	38.93	41.42
260	JHARKHAND	KODARMA	36.92	39.70	42.33
261	JHARKHAND	LATEHAR	37.97	40.87	43.12
262	JHARKHAND	LOHARDAGA	35.44	38.35	40.70
263	JHARKHAND	PAKUR	36.95	39.38	41.83
264	JHARKHAND	PALAMU	38.83	41.63	43.87
265	JHARKHAND	RAMGARH	36.60	39.47	41.91
266	JHARKHAND	RANCHI	36.60	39.47	41.91
267	JHARKHAND	SAHIBGANJ	36.97	39.24	41.57
268	JHARKHAND	SARAIKELA-KHARSAWAN	37.37	40.12	42.69
269	JHARKHAND	SIMDEGA	37.51	40.37	42.87
270	JHARKHAND	WEST SINGHBHUM	37.35	40.03	42.51
271	KARNATAKA	BAGALKOT	36.96	38.84	40.37
272	KARNATAKA	BALLARI	35.76	37.57	39.09
273	KARNATAKA	BELAGAVI	36.44	38.30	39.79
274	KARNATAKA	BENGALURU RURAL	34.26	36.08	37.69
275	KARNATAKA	BENGALURU URBAN	33.88	35.69	37.36
276	KARNATAKA	BIDAR	37.75	39.96	41.90
277	KARNATAKA	CHAMARAJANAGAR	34.54	36.31	37.98
278	KARNATAKA	CHIK BALLAPUR	34.15	36.09	37.71
279	KARNATAKA	CHIKKAMAGALURU	31.60	33.75	35.44
280	KARNATAKA	CHITRADURGA	35.04	36.90	38.50
281	KARNATAKA	DAKSHINA KANNADA	32.99	34.07	35.08
282	KARNATAKA	DAVANGERE	35.65	37.48	39.01
283	KARNATAKA	DHARWAD	36.26	38.00	39.57
284	KARNATAKA	GADAG	36.49	38.32	39.84
285	KARNATAKA	HASSAN	33.05	34.83	36.54
286	KARNATAKA	HAVERI	35.79	37.73	39.26
287	KARNATAKA	KALABURAGI	37.83	40.05	41.92
288	KARNATAKA	KODAGU	33.12	34.76	36.18
289	KARNATAKA	KOLAR	33.88	35.74	37.44
290	KARNATAKA	KOPPAL	36.84	38.68	40.30
291	KARNATAKA	MANDYA	34.60	36.40	38.05
292	KARNATAKA	MYSURU	33.20	34.90	36.63
293	KARNATAKA	RAICHUR	38.01	39.99	41.69
294	KARNATAKA	RAMANAGARAM	34.46	36.30	38.00
295	KARNATAKA	SHIVAMOGGA	32.74	34.51	36.02
296	KARNATAKA	TUMAKURU	34.56	36.32	37.94

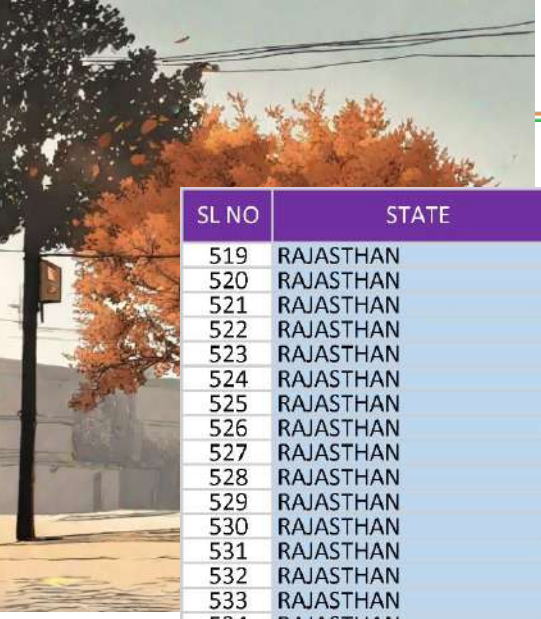


SL NO	STATE	District	Heat Threshold		
			Yellow Alert	Orange Alert	Red Alert
297	KARNATAKA	UDUPI	32.25	33.67	34.91
298	KARNATAKA	UTTARA KANNADA	34.30	35.50	36.65
299	KARNATAKA	VIJAYAPURA	37.25	39.14	40.71
300	KARNATAKA	YADGIR	38.11	40.11	41.90
301	KERALA	ALAPPUZHA	30.69	31.32	32.15
302	KERALA	ERNAKULAM	32.38	33.40	34.60
303	KERALA	IDUKKI	30.76	32.55	34.28
304	KERALA	KANNUR	32.77	34.07	35.29
305	KERALA	KASARAGOD	31.91	32.69	33.54
306	KERALA	KOLLAM	32.55	34.14	35.87
307	KERALA	KOTTAYAM	31.99	33.77	35.52
308	KERALA	KOZHIKODE	32.24	33.13	34.12
309	KERALA	MALAPPURAM	33.49	34.91	36.35
310	KERALA	PALAKKAD	33.49	34.91	36.35
311	KERALA	PATTANAMTHITTA	31.99	33.77	35.52
312	KERALA	THIRUVANANTHAPURAM	31.78	32.89	34.10
313	KERALA	TRISSUR	34.06	35.47	36.82
314	KERALA	WAYANAD	32.72	34.28	35.80
315	LADAKH	KARGIL	15.20	17.63	19.69
316	LADAKH	LEH	14.70	17.23	19.25
317	LAKSHADWEEP	LAKSHADWEEP	28.81	29.15	29.58
318	MADHYA PRADESH	AGAR MALWA	38.59	40.98	43.03
319	MADHYA PRADESH	ALIRAJPUR	38.65	40.74	42.55
320	MADHYA PRADESH	ANUPPUR	38.27	41.07	43.33
321	MADHYA PRADESH	ASHOKNAGAR	39.05	41.62	43.71
322	MADHYA PRADESH	BALAGHAT	37.89	40.73	42.86
323	MADHYA PRADESH	BARWANI	38.91	41.15	42.90
324	MADHYA PRADESH	BETUL	37.93	40.58	42.59
325	MADHYA PRADESH	BHIND	40.62	43.16	45.24
326	MADHYA PRADESH	BHOPAL	38.24	40.79	42.87
327	MADHYA PRADESH	BURHANPUR	39.15	41.56	43.39
328	MADHYA PRADESH	CHHATARPUR	39.00	41.72	43.81
329	MADHYA PRADESH	CHHINDWARA	37.26	40.01	42.01
330	MADHYA PRADESH	DAMOH	39.01	41.80	43.96
331	MADHYA PRADESH	DATIA	40.51	43.12	45.21
332	MADHYA PRADESH	DEWAS	39.33	41.75	43.71
333	MADHYA PRADESH	DHAR	38.69	40.86	42.68
334	MADHYA PRADESH	DINDORI	36.35	39.20	41.38
335	MADHYA PRADESH	EAST NIMAR	39.33	41.85	43.77
336	MADHYA PRADESH	GUNA	38.47	40.90	42.97
337	MADHYA PRADESH	GWALIOR	40.05	42.58	44.67
338	MADHYA PRADESH	HARDA	39.53	42.14	44.18
339	MADHYA PRADESH	HOSHANGABAD	38.08	40.74	42.82
340	MADHYA PRADESH	INDORE	38.72	40.99	42.88
341	MADHYA PRADESH	JABALPUR	38.83	41.66	43.81
342	MADHYA PRADESH	JHABUA	37.93	40.12	42.01
343	MADHYA PRADESH	KATNI	38.80	41.70	43.79
344	MADHYA PRADESH	MANDLA	37.54	40.36	42.50
345	MADHYA PRADESH	MANDSAUR	38.19	40.40	42.45
346	MADHYA PRADESH	MORENA	40.55	43.05	45.17
347	MADHYA PRADESH	NARSHIMAPURA	39.09	41.79	43.96
348	MADHYA PRADESH	NIMACH	38.07	40.33	42.28
349	MADHYA PRADESH	NIVARI	40.26	42.88	44.98
350	MADHYA PRADESH	PANNA	38.95	41.80	43.88
351	MADHYA PRADESH	RAISEN	39.34	42.08	44.24
352	MADHYA PRADESH	RAJGARH	39.06	41.49	43.56
353	MADHYA PRADESH	RATLAM	38.11	40.35	42.32
354	MADHYA PRADESH	REWA	40.02	42.79	44.80
355	MADHYA PRADESH	SAGAR	38.61	41.27	43.47
356	MADHYA PRADESH	SATNA	38.97	41.83	43.89
357	MADHYA PRADESH	SEHORE	38.71	41.29	43.29
358	MADHYA PRADESH	SEONI	37.58	40.30	42.35
359	MADHYA PRADESH	SHAHDOL	38.10	41.00	43.14
360	MADHYA PRADESH	SHAJAPUR	38.64	41.13	43.22
361	MADHYA PRADESH	SHEOPUR	39.59	42.03	44.06
362	MADHYA PRADESH	SHIVPURI	39.04	41.53	43.58
363	MADHYA PRADESH	SIDHI	38.28	41.19	43.26
364	MADHYA PRADESH	SINGRAULI	38.12	40.94	42.99
365	MADHYA PRADESH	TIKAMGARH	39.59	42.16	44.25
366	MADHYA PRADESH	UJJAIN	38.23	40.51	42.48
367	MADHYA PRADESH	UMARIA	38.80	41.66	43.80
368	MADHYA PRADESH	VIDISHA	38.91	41.58	43.73
369	MADHYA PRADESH	WEST NIMAR	39.38	41.70	43.51
370	MAHARASHTRA	AHAMADNAGAR	37.36	39.50	41.04

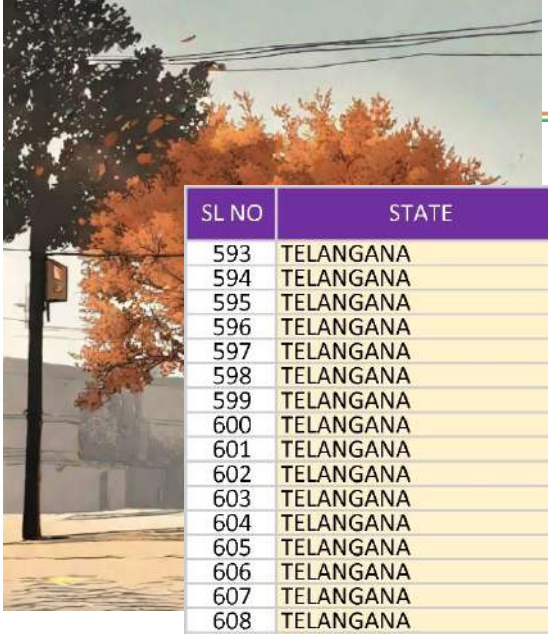
SL NO	STATE	District	Heat Threshold		
			Yellow Alert	Orange Alert	Red Alert
371	MAHARASHTRA	AKOLA	39.05	41.47	43.23
372	MAHARASHTRA	AMARAVATI	39.38	41.90	43.81
373	MAHARASHTRA	AURANGABAD	37.59	39.90	41.50
374	MAHARASHTRA	BHANDARA	39.62	42.41	44.55
375	MAHARASHTRA	BID	37.69	39.90	41.55
376	MAHARASHTRA	BULDHANA	38.37	40.71	42.42
377	MAHARASHTRA	CHANDRAPUR	40.15	42.82	44.90
378	MAHARASHTRA	DHULE	37.99	39.98	41.59
379	MAHARASHTRA	GADCHIROLI	39.87	42.33	44.44
380	MAHARASHTRA	GONDIA	39.51	42.33	44.46
381	MAHARASHTRA	HINGOLI	38.98	41.48	43.28
382	MAHARASHTRA	JALGAON	39.26	41.59	43.33
383	MAHARASHTRA	JALNA	38.65	41.01	42.72
384	MAHARASHTRA	KOLHAPUR	36.58	38.37	39.98
385	MAHARASHTRA	LATUR	37.84	40.12	41.94
386	MAHARASHTRA	MUMBAI CITY	37.12	38.61	40.20
387	MAHARASHTRA	NAGPUR	39.28	42.13	44.17
388	MAHARASHTRA	NANDED	39.06	41.50	43.36
389	MAHARASHTRA	NANDURBAR	38.65	40.73	42.40
390	MAHARASHTRA	NASHIK	36.24	38.01	39.68
391	MAHARASHTRA	PALGHAR	29.80	30.26	30.88
392	MAHARASHTRA	PARBHANI	38.89	41.27	43.02
393	MAHARASHTRA	PUNE	35.60	37.52	39.25
394	MAHARASHTRA	RATNAGIRI	30.88	31.42	32.30
395	MAHARASHTRA	RAYGAD	36.26	37.63	39.12
396	MAHARASHTRA	SANGLI	36.73	38.59	40.21
397	MAHARASHTRA	SATARA	36.64	38.37	40.13
398	MAHARASHTRA	SINDHUDURG	35.39	36.52	37.74
399	MAHARASHTRA	SOLAPUR	38.07	40.14	41.78
400	MAHARASHTRA	SUB URBAN MUMBAI	37.12	38.61	40.20
401	MAHARASHTRA	THANE	36.33	38.15	39.83
402	MAHARASHTRA	USMANABAD	37.54	39.71	41.46
403	MAHARASHTRA	WARDHA	39.76	42.49	44.56
404	MAHARASHTRA	WASHIM	38.44	40.89	42.60
405	MAHARASHTRA	YAVATMAL	39.69	42.30	44.23
406	MANIPUR	BISHNUPUR	30.55	31.58	32.86
407	MANIPUR	CHANDEL	31.20	32.19	33.43
408	MANIPUR	CHURACHANDPUR	30.55	31.58	32.86
409	MANIPUR	IMPHAL EAST	29.28	30.23	31.50
410	MANIPUR	IMPHAL WEST	29.28	30.23	31.50
411	MANIPUR	JIRIBAM	32.14	33.19	34.61
412	MANIPUR	KAKCHING	30.55	31.58	32.86
413	MANIPUR	KAMJONG	29.95	30.95	32.18
414	MANIPUR	KANGPOKPI	29.28	30.23	31.50
415	MANIPUR	NONEI	29.28	30.23	31.50
416	MANIPUR	PHERZAWL	32.94	34.01	35.39
417	MANIPUR	SENAPATI	29.90	30.84	32.14
418	MANIPUR	TAMENGLONG	29.28	30.23	31.50
419	MANIPUR	TENGNOUPAL	34.37	35.40	36.76
420	MANIPUR	THOUBAL	30.55	31.58	32.86
421	MANIPUR	UKHRUL	28.37	29.26	30.43
422	MEGHALAYA	EAST GARO HILLS	32.92	34.12	35.76
423	MEGHALAYA	EAST JAINTIA HILLS	28.79	29.58	30.67
424	MEGHALAYA	EAST KHASI HILLS	25.72	26.43	27.37
425	MEGHALAYA	NORTH GARO HILLS	33.27	34.22	35.79
426	MEGHALAYA	RI-BHOI	33.08	33.98	35.19
427	MEGHALAYA	SOUTH GARO HILLS	32.92	34.12	35.76
428	MEGHALAYA	SOUTH WEST GARO HILLS	34.05	35.56	37.45
429	MEGHALAYA	SOUTH WEST KHASI HILLS	26.73	27.37	28.35
430	MEGHALAYA	WEST GARO HILLS	33.60	34.92	37.02
431	MEGHALAYA	WEST JAINTIA HILLS	28.79	29.58	30.67
432	MEGHALAYA	WEST KHASI HILLS	26.73	27.37	28.35
433	MIZORAM	AIZAWL	30.88	32.32	34.12
434	MIZORAM	CHAMPHAI	29.97	30.98	32.25
435	MIZORAM	KOLASIB	31.77	33.07	34.92
436	MIZORAM	LAWNGTLAI	33.21	34.52	36.12
437	MIZORAM	LUNGLEI	32.99	34.23	35.82
438	MIZORAM	MAMIT	31.77	33.07	34.92
439	MIZORAM	SAIHA	30.77	31.83	33.16
440	MIZORAM	SERCHHIP	29.97	30.98	32.25
441	NAGALAND	DIMAPUR	32.80	33.78	35.16
442	NAGALAND	KIPHIRE	27.36	28.37	29.56
443	NAGALAND	KOHIMA	28.37	29.26	30.43
444	NAGALAND	LONGLENG	29.37	30.33	31.65



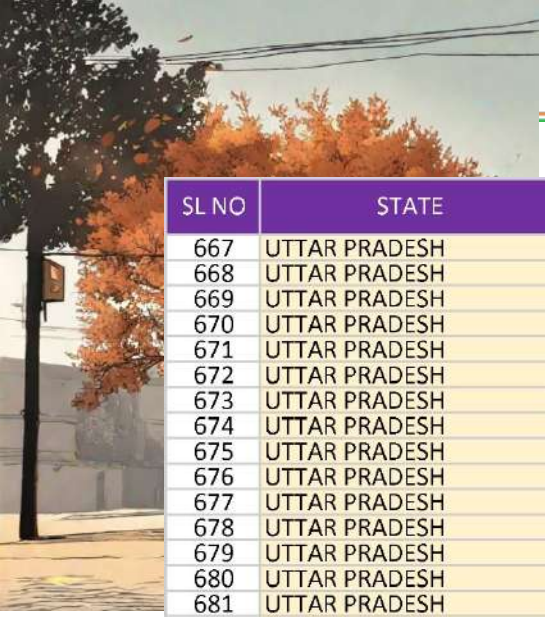
SL NO	STATE	District	Heat Threshold		
			Yellow Alert	Orange Alert	Red Alert
445	NAGALAND	MOKOKCHUNG	32.19	33.15	34.44
446	NAGALAND	MON	33.34	34.49	36.05
447	NAGALAND	PAREN	29.90	30.84	32.14
448	NAGALAND	PHEK	28.37	29.26	30.43
449	NAGALAND	TUENSANG	27.36	28.37	29.56
450	NAGALAND	WOKHA	30.16	31.11	32.30
451	NAGALAND	ZUNHEBOTO	30.16	31.11	32.30
452	ODISHA	ANUGUL	38.15	40.94	43.34
453	ODISHA	BALASORE (BALESHWAR)	35.57	37.78	39.93
454	ODISHA	BARAGARH	38.66	41.52	43.83
455	ODISHA	BAUDH (BAUDA)	37.41	40.06	42.43
456	ODISHA	BHADRAK	33.54	35.22	36.98
457	ODISHA	BOLANGIR (BALANGIR)	39.00	41.82	44.20
458	ODISHA	CUTTACK	37.54	40.17	42.52
459	ODISHA	DEOGARH	37.71	40.37	42.82
460	ODISHA	DHENKANAL	37.60	40.38	42.80
461	ODISHA	GAJAPATI	35.01	36.83	38.58
462	ODISHA	GANJAM	36.62	39.00	41.15
463	ODISHA	JAGATSINGHPUR	32.63	33.86	35.15
464	ODISHA	JAJAPUR	37.46	40.12	42.51
465	ODISHA	JHARSUGUDA	37.94	40.78	43.12
466	ODISHA	KALAHANDI	38.19	40.85	43.10
467	ODISHA	KANDHAMAL	36.89	39.55	41.76
468	ODISHA	KENDRAPARHA	31.73	32.76	33.94
469	ODISHA	KEONJHAR (KENDUJHAR)	36.83	39.51	41.94
470	ODISHA	KHORDHA	34.63	36.39	38.15
471	ODISHA	KORAPUT	35.05	37.51	39.50
472	ODISHA	MALKANGIRI	36.69	38.83	40.59
473	ODISHA	MAYURBHANJ	35.96	38.55	41.03
474	ODISHA	NABARANGAPUR	36.42	38.98	41.16
475	ODISHA	NAYAGARH	36.94	39.33	41.54
476	ODISHA	NUAPARHA	37.91	40.70	42.95
477	ODISHA	PURI	34.63	36.39	38.15
478	ODISHA	RAYAGARHA	36.94	39.33	41.54
479	ODISHA	SAMBALPUR	38.35	41.09	43.49
480	ODISHA	SUBARNAPUR	39.26	42.04	44.40
481	ODISHA	SUNDARGARH	37.36	40.01	42.51
482	PUDUCHERRY	KARAIKAL	32.57	33.11	33.72
483	PUDUCHERRY	MAHE	32.24	33.13	34.12
484	PUDUCHERRY	PUDUCHERRY	32.95	33.61	34.39
485	PUDUCHERRY	YANAM	30.01	30.49	31.20
486	PUNJAB	AMRITSAR	39.70	42.16	44.86
487	PUNJAB	BARNALA	40.56	42.68	44.87
488	PUNJAB	BATHINDA	40.97	42.98	45.06
489	PUNJAB	FARIDKOT	41.51	43.45	45.55
490	PUNJAB	FATEHGARH SAHIB	39.65	42.00	44.53
491	PUNJAB	FAZILKA	42.19	43.94	45.87
492	PUNJAB	FIROZPUR	40.66	42.85	45.23
493	PUNJAB	GURDASPUR	39.70	42.16	44.86
494	PUNJAB	HOSHIARPUR	39.42	41.80	44.33
495	PUNJAB	JALANDHAR	40.12	42.39	44.86
496	PUNJAB	KAPURTHALA	39.42	41.80	44.33
497	PUNJAB	LUDHIANA	38.89	41.33	43.83
498	PUNJAB	MANSA	40.56	42.68	44.87
499	PUNJAB	MOGA	40.89	42.98	45.27
500	PUNJAB	PATHUNKOT	32.69	35.01	37.70
501	PUNJAB	PATIALA	37.56	40.12	42.71
502	PUNJAB	RUPNAGAR	38.89	41.33	43.83
503	PUNJAB	SANGRUR	40.37	42.54	44.94
504	PUNJAB	SAS NAGAR (SAHIBZADA AJIT SINGH	37.56	40.12	42.71
505	PUNJAB	SHAHID BHAGAT SINGH NAGAR	38.89	41.33	43.83
506	PUNJAB	SRI MUKTSAR SAHIB	41.47	43.33	45.24
507	PUNJAB	TARN TARAN	40.25	42.58	45.10
508	RAJASTHAN	AJMER	39.03	40.90	42.65
509	RAJASTHAN	ALWAR	40.11	42.57	44.71
510	RAJASTHAN	BANSWARA	38.99	41.16	43.11
511	RAJASTHAN	BARAN	39.37	41.77	43.79
512	RAJASTHAN	BARMER	40.12	41.33	42.87
513	RAJASTHAN	BHARATPUR	40.44	42.94	45.07
514	RAJASTHAN	BHILWARA	39.37	41.52	43.42
515	RAJASTHAN	BIKANER	40.55	42.01	43.69
516	RAJASTHAN	BUNDI	39.97	42.23	44.17
517	RAJASTHAN	CHITTAURGARH	38.54	40.73	42.57
518	RAJASTHAN	CHURU	40.02	41.83	43.65



SL NO	STATE	District	Heat Threshold		
			Yellow Alert	Orange Alert	Red Alert
519	RAJASTHAN	DAUSA	39.44	41.76	43.74
520	RAJASTHAN	DHAULPUR	40.38	42.86	44.98
521	RAJASTHAN	DUNGARPUR	38.61	40.62	42.51
522	RAJASTHAN	GANGANAGAR	41.72	43.26	45.01
523	RAJASTHAN	HANUMANGARH	40.79	42.47	44.26
524	RAJASTHAN	JAIPUR	39.05	41.15	43.06
525	RAJASTHAN	JAISALMER	40.96	42.29	43.80
526	RAJASTHAN	JALOR	40.38	41.83	43.43
527	RAJASTHAN	JHALAWAR	39.40	41.75	43.80
528	RAJASTHAN	JHUNJHUNUN	39.34	41.35	43.28
529	RAJASTHAN	JODHPUR	39.90	41.45	43.12
530	RAJASTHAN	KARAULI	39.91	42.37	44.42
531	RAJASTHAN	KOTA	39.94	42.27	44.29
532	RAJASTHAN	NAGAUR	39.62	41.27	43.04
533	RAJASTHAN	PALI	39.37	41.14	42.83
534	RAJASTHAN	PRATAPGARH	39.04	41.15	43.15
535	RAJASTHAN	RAJ SAMAND	37.17	39.15	40.91
536	RAJASTHAN	SAWAI MADHOPUR	40.08	42.47	44.47
537	RAJASTHAN	SIKAR	38.96	40.83	42.73
538	RAJASTHAN	SIROHI	39.03	40.79	42.49
539	RAJASTHAN	TONK	39.89	42.11	44.01
540	RAJASTHAN	UDAIPUR	38.01	39.83	41.62
541	SIKKIM	EAST	17.26	18.01	18.90
542	SIKKIM	NORTH	12.27	13.26	14.32
543	SIKKIM	SOUTH	14.89	15.55	16.31
544	SIKKIM	WEST	14.89	15.55	16.31
545	TAMIL NADU	ARIYALUR	36.84	37.89	39.14
546	TAMIL NADU	CHENGALPATTU	34.44	35.23	36.29
547	TAMIL NADU	CHENNAI	35.65	36.66	37.90
548	TAMIL NADU	COIMBATORE	33.77	35.63	37.54
549	TAMIL NADU	CUDDALORE	37.05	38.12	39.41
550	TAMIL NADU	DHARMAPURI	35.81	37.55	39.33
551	TAMIL NADU	DINDIGUL	36.62	38.03	39.74
552	TAMIL NADU	ERODE	36.15	37.66	39.34
553	TAMIL NADU	KALLAKKURICHI	36.23	37.89	39.65
554	TAMIL NADU	KANCHIPURAM	35.65	36.66	37.90
555	TAMIL NADU	KANYAKUMARI	33.30	35.14	37.02
556	TAMIL NADU	KARUR	37.14	38.63	40.35
557	TAMIL NADU	KRISHNAGIRI	34.83	36.73	38.46
558	TAMIL NADU	MADURAI	36.57	37.85	39.47
559	TAMIL NADU	NAGAPATTINAM	32.57	33.11	33.72
560	TAMIL NADU	NAMAKKAL	36.94	38.42	40.15
561	TAMIL NADU	NILGIRIS	32.93	34.63	36.40
562	TAMIL NADU	PERAMBALUR	37.32	38.69	40.27
563	TAMIL NADU	PUDUKKOTTAI	37.33	38.46	39.90
564	TAMIL NADU	RAMANATHAPURAM	34.53	35.30	36.23
565	TAMIL NADU	RANIPPETTAI	37.45	39.13	40.98
566	TAMIL NADU	SALEM	36.94	38.42	40.15
567	TAMIL NADU	SIVAGANGA	36.51	37.45	38.60
568	TAMIL NADU	TENI	32.35	34.08	36.05
569	TAMIL NADU	TENKASI	34.15	36.13	38.23
570	TAMIL NADU	THANJAVUR	36.84	37.89	39.14
571	TAMIL NADU	THIRUVARUR	36.84	37.89	39.14
572	TAMIL NADU	TIRUCHIRAPALLI	36.84	37.89	39.14
573	TAMIL NADU	TIRUNELVELI	33.30	35.14	37.02
574	TAMIL NADU	TIRUPPATTUR	36.15	37.89	39.66
575	TAMIL NADU	TIRUPPUR	36.46	38.12	39.96
576	TAMIL NADU	TIRUVALLUR	35.65	36.66	37.90
577	TAMIL NADU	TIRUVANNAMALAI	37.12	38.32	39.75
578	TAMIL NADU	TUTICORIN	35.12	36.15	37.46
579	TAMIL NADU	VELLORE	35.56	37.41	39.12
580	TAMIL NADU	VILLUPURAM	37.40	38.87	40.55
581	TAMIL NADU	VIRUDHUNAGAR	36.61	37.83	39.41
582	TELANGANA	ADILABAD	39.44	41.99	43.91
583	TELANGANA	BHADRADRI KOTHAGUDEM	39.02	41.19	43.14
584	TELANGANA	HYDERABAD	37.23	39.35	41.26
585	TELANGANA	JAGTIAL	39.25	41.74	43.65
586	TELANGANA	JANGAON	38.83	41.14	43.20
587	TELANGANA	JAYASHANKAR BHUPALAPALLY	38.66	40.88	42.94
588	TELANGANA	JOGULAMBA GADWAL	38.42	40.47	42.22
589	TELANGANA	KAMAREDDY	37.65	39.85	41.74
590	TELANGANA	KARIMNAGAR	39.62	42.01	44.02
591	TELANGANA	KHAMMAM	39.07	41.15	43.05
592	TELANGANA	KUMURAM BHEEM	39.77	42.33	44.35



SL NO	STATE	District	Heat Threshold		
			Yellow Alert	Orange Alert	Red Alert
593	TELANGANA	MAHABUBABAD	39.05	41.17	43.24
594	TELANGANA	MAHABUBNAGAR	36.98	39.05	40.92
595	TELANGANA	MANCHERIAL	39.85	42.33	44.34
596	TELANGANA	MEDAK	37.65	39.85	41.74
597	TELANGANA	MEDCHAL-MALKAJGIRI	37.36	39.54	41.54
598	TELANGANA	MULUGU	39.11	41.33	43.39
599	TELANGANA	NAGARKURNOOL	37.64	39.77	41.64
600	TELANGANA	NALGONDA	38.90	41.10	43.15
601	TELANGANA	NARAYANPET	37.94	40.02	41.83
602	TELANGANA	NIRMAL	39.07	41.52	43.40
603	TELANGANA	NIZAMABAD	38.40	40.75	42.64
604	TELANGANA	PEDDAPALLI	37.69	39.73	41.59
605	TELANGANA	RANGAREDDY	36.98	39.05	40.92
606	TELANGANA	RANJANNA SIRCILLA	38.74	41.16	43.07
607	TELANGANA	SANGAREDDY	37.23	39.35	41.26
608	TELANGANA	SIDDIPET	37.80	40.03	42.00
609	TELANGANA	SURYAPET	39.40	41.55	43.55
610	TELANGANA	VIKARABAD	36.98	39.05	40.92
611	TELANGANA	WANAPARTHY	37.69	39.73	41.59
612	TELANGANA	WARANGAL (RURAL)	38.83	41.14	43.20
613	TELANGANA	WARANGAL (URBAN)	38.83	41.14	43.20
614	TELANGANA	YADADRI BHUVANAGIRI	38.66	40.88	42.94
615	TRIPURA	DHALAI	32.94	34.29	36.28
616	TRIPURA	GOMATI	32.89	34.24	36.16
617	TRIPURA	KHOWAI	32.94	34.29	36.28
618	TRIPURA	NORTH TRIPURA	31.77	33.07	34.92
619	TRIPURA	SEPAHIJALA	33.05	34.83	37.14
620	TRIPURA	SOUTH TRIPURA	32.55	34.07	36.01
621	TRIPURA	UNOKOTI	32.94	34.29	36.28
622	TRIPURA	WEST TRIPURA	33.53	35.16	37.43
623	UTTAR PRADESH	AGRA	40.54	43.08	45.26
624	UTTAR PRADESH	ALIGARH	40.03	42.55	44.78
625	UTTAR PRADESH	AMBEDKARNAGAR	39.67	42.20	44.36
626	UTTAR PRADESH	AMETHI	39.87	42.43	44.55
627	UTTAR PRADESH	AMROHA	39.33	42.00	44.33
628	UTTAR PRADESH	AURAIYA	40.44	43.01	45.11
629	UTTAR PRADESH	AYODHYA	39.67	42.20	44.36
630	UTTAR PRADESH	AZAMGARH	39.98	42.58	44.71
631	UTTAR PRADESH	BAGHPAT	39.61	42.01	44.43
632	UTTAR PRADESH	BAHRAICH	38.81	41.26	43.44
633	UTTAR PRADESH	BALLIA	39.18	41.62	43.83
634	UTTAR PRADESH	BALRAMPUR	38.45	40.72	42.94
635	UTTAR PRADESH	BANDA	40.58	43.30	45.31
636	UTTAR PRADESH	BARABANKI	39.68	42.24	44.38
637	UTTAR PRADESH	BAREILLY	39.34	42.00	44.25
638	UTTAR PRADESH	BASTI	39.27	41.73	43.93
639	UTTAR PRADESH	BHADOHI	40.28	42.98	45.02
640	UTTAR PRADESH	BIJNOR	36.47	39.08	41.48
641	UTTAR PRADESH	BUDAUN	39.92	42.52	44.72
642	UTTAR PRADESH	BULANDSHAHR	39.74	42.29	44.63
643	UTTAR PRADESH	CHANDAULI	39.52	42.26	44.38
644	UTTAR PRADESH	CHITRAKOOT	39.86	42.64	44.66
645	UTTAR PRADESH	DEORIA	39.08	41.50	43.67
646	UTTAR PRADESH	ETAH	40.22	42.80	44.93
647	UTTAR PRADESH	ETAWAH	40.50	43.05	45.15
648	UTTAR PRADESH	FARRUKHABAD	40.01	42.59	44.75
649	UTTAR PRADESH	FATEHPUR	40.37	43.03	45.10
650	UTTAR PRADESH	FIROZABAD	40.50	43.05	45.15
651	UTTAR PRADESH	GAUTAMBUDHNAGAR	39.96	42.40	44.69
652	UTTAR PRADESH	GAZIPUR	39.71	42.31	44.48
653	UTTAR PRADESH	GHAZIABAD	39.55	42.11	44.48
654	UTTAR PRADESH	GONDA	39.36	41.82	43.94
655	UTTAR PRADESH	GORAKHPUR	39.38	41.85	44.08
656	UTTAR PRADESH	HAMIRPUR	40.51	43.21	45.27
657	UTTAR PRADESH	HAPUR	39.33	42.00	44.33
658	UTTAR PRADESH	HARDOI	39.73	42.35	44.49
659	UTTAR PRADESH	HATHRAS	40.30	42.87	45.05
660	UTTAR PRADESH	JALAUN	40.55	43.23	45.34
661	UTTAR PRADESH	JAUNPUR	39.98	42.58	44.71
662	UTTAR PRADESH	JHANSI	40.40	43.05	45.14
663	UTTAR PRADESH	KANNAUJ	40.10	42.63	44.74
664	UTTAR PRADESH	KANPUR	40.51	43.21	45.27
665	UTTAR PRADESH	KANPUR DEHAT	40.26	42.86	44.96
666	UTTAR PRADESH	KASGANJ	39.65	42.29	44.50



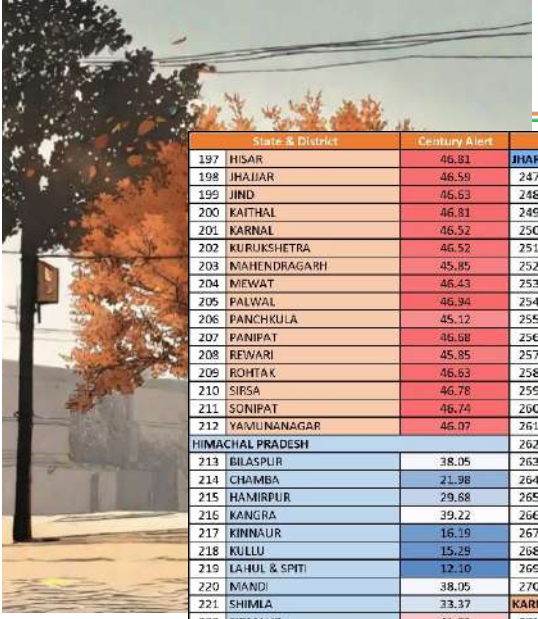
SL NO	STATE	District	Heat Threshold		
			Yellow Alert	Orange Alert	Red Alert
667	UTTAR PRADESH	KAUSHAMBI	40.52	43.23	45.24
668	UTTAR PRADESH	KHERI	39.30	41.87	44.11
669	UTTAR PRADESH	KUSHINAGAR	38.75	41.08	43.30
670	UTTAR PRADESH	LALITPUR	39.07	41.66	43.80
671	UTTAR PRADESH	LUCKNOW	39.94	42.55	44.65
672	UTTAR PRADESH	MAHARAJGANJ	38.49	40.84	43.05
673	UTTAR PRADESH	MAHOBA	40.48	43.21	45.30
674	UTTAR PRADESH	MAINPURI	40.26	42.80	44.92
675	UTTAR PRADESH	MATHURA	40.40	42.95	45.12
676	UTTAR PRADESH	MAU	39.39	41.89	44.14
677	UTTAR PRADESH	MEERUT	39.33	42.00	44.33
678	UTTAR PRADESH	MIRZAPUR	39.88	42.65	44.69
679	UTTAR PRADESH	MORADABAD	39.02	41.69	43.97
680	UTTAR PRADESH	MUZAFFARNAGAR	38.47	41.19	43.65
681	UTTAR PRADESH	PILIBHIT	38.82	41.50	43.91
682	UTTAR PRADESH	PRATAPGARH	40.14	42.77	44.88
683	UTTAR PRADESH	PRAYAGRAJ	40.53	43.15	45.21
684	UTTAR PRADESH	RAIBEARELI	40.24	42.88	45.02
685	UTTAR PRADESH	RAMPUR	39.34	42.00	44.25
686	UTTAR PRADESH	SAHARANPUR	38.19	41.01	43.65
687	UTTAR PRADESH	SAMBHAL	39.59	42.21	44.41
688	UTTAR PRADESH	SANTKABIRNAGAR	38.94	41.30	43.51
689	UTTAR PRADESH	SHAHJAHANPUR	39.50	42.05	44.30
690	UTTAR PRADESH	SHAMLI	39.16	41.81	44.29
691	UTTAR PRADESH	SHRAWASTI	39.05	41.39	43.49
692	UTTAR PRADESH	SIDDHARTHNAGAR	37.83	40.05	42.25
693	UTTAR PRADESH	SITAPUR	39.51	42.08	44.26
694	UTTAR PRADESH	SONBHADRA	39.02	41.80	43.95
695	UTTAR PRADESH	SULTANPUR	39.87	42.43	44.55
696	UTTAR PRADESH	UNNAO	40.12	42.73	44.82
697	UTTAR PRADESH	VARANASI	40.12	42.72	44.83
698	UTTARAKHAND	ALMORA	31.96	34.40	36.73
699	UTTARAKHAND	BAGESHWAR	23.62	25.21	27.38
700	UTTARAKHAND	CHAMOLI	17.72	18.83	20.38
701	UTTARAKHAND	CHAMPAWAT	29.22	31.66	34.00
702	UTTARAKHAND	DEHRADUN	29.47	32.07	34.72
703	UTTARAKHAND	HARIDWAR	35.96	38.76	41.32
704	UTTARAKHAND	NAINITAL	31.96	34.40	36.73
705	UTTARAKHAND	PAURI GARHWAL	30.23	32.87	35.44
706	UTTARAKHAND	PITHORAGARH	17.75	18.84	20.23
707	UTTARAKHAND	RUDRAPRAYAG	24.00	26.08	28.55
708	UTTARAKHAND	TEHRI GARHWAL	24.00	26.08	28.55
709	UTTARAKHAND	UDHAM SINGH NAGAR	37.94	40.60	42.94
710	UTTARAKHAND	UTTARKASHI	12.66	13.69	14.87
711	WEST BENGAL	ALIPUR DUAR	33.55	35.33	37.48
712	WEST BENGAL	BANKURA	36.80	39.63	42.19
713	WEST BENGAL	BIRBHUM	37.08	39.64	42.15
714	WEST BENGAL	DAKSHIN DINAJPUR	36.01	38.06	40.55
715	WEST BENGAL	DARJILING	27.00	28.28	29.94
716	WEST BENGAL	HAORA	35.87	38.25	40.51
717	WEST BENGAL	HUGLI	36.53	39.18	41.48
718	WEST BENGAL	JALPAIGURI	34.33	36.40	38.66
719	WEST BENGAL	JHARGRAM	37.00	39.87	42.44
720	WEST BENGAL	KALIMPONG	27.24	28.26	29.67
721	WEST BENGAL	KOCH BIHAR	33.55	35.33	37.48
722	WEST BENGAL	KOLKATA	35.87	38.25	40.51
723	WEST BENGAL	MALDAH	36.87	38.92	41.23
724	WEST BENGAL	MURSHIDABAD	37.19	39.59	41.97
725	WEST BENGAL	NADIA	36.51	39.07	41.56
726	WEST BENGAL	NORTH TWENTY-FOUR PARGANAS	35.50	37.77	40.04
727	WEST BENGAL	PASCHIM BARDDHAMAN	36.96	39.72	42.29
728	WEST BENGAL	PASCHIM MEDINIPUR	35.98	38.82	41.30
729	WEST BENGAL	PURBA BARDDHAMAN	36.96	39.55	41.88
730	WEST BENGAL	PURBA MEDINIPUR	34.66	36.79	38.91
731	WEST BENGAL	PURULIYA	36.80	39.63	42.19
732	WEST BENGAL	SOUTH TWENTY-FOUR PARGANAS	33.19	34.76	36.39
733	WEST BENGAL	UTTAR DINAJPUR	35.89	37.98	40.29

4.7 The Century Alert

Heat waves have become increasingly common and severe in recent years, posing significant challenges to public health, infrastructure and ecosystems. To address this pressing issue, meteorological agencies worldwide have developed alert systems to warn individuals and authorities about impending heat-related dangers. Traditionally, these systems have relied on thresholds based on percentiles of temperature data, such as the 80th, 88th and 95th percentiles, corresponding to yellow, orange and red heat alerts, respectively. However, as extreme heat events become more frequent and intense, there is a need for a higher level of alert to signal the most severe heat waves. In response to this need, the study proposes the introduction of the “Century Alert," which corresponds to the 99th percentile of temperature data. The Century Alert is a new category of heat alert designed to warn the public and authorities about exceptionally severe heat waves. It is based on the 99th percentile of temperature data, meaning that temperatures associated with the Century Alert occur approximately 2.05 days each year on average.

Table 4.2: District-wise Century alert heat threshold (In ° Celsius). (Only applicable to districts affected by heat waves)

State & District	Century Alert	State & District	Century Alert	State & District	Century Alert	State & District	Century Alert
ANDAMAN & NICOBAR		49 DARRANG	37.33	100 PATNA	46.01	148 NORTH	46.74
1 NICOBAR	30.19	50 DHEMAJI	39.05	101 PURBI CHAMPARAN	43.51	149 NORTH EAST	46.85
2 NORTH & MIDDLE ANDAMAN	32.48	51 DHUBRI	39.38	102 PURNIA	43.29	150 NORTH WEST	46.59
3 SOUTH ANDAMAN	30.90	52 DIBRUGARH	39.05	103 ROHTAS	46.10	151 SHAHADRA	46.85
ANDHRA PRADESH		53 DIMA HASAO	35.62	104 SAHARSA	44.60	152 SOUTH	46.59
4 ANANTAPUR	41.98	54 GOALPARA	38.21	105 SAMASTIPUR	45.66	153 SOUTH EAST	46.85
5 CHITTOOR	40.25	55 GOLAGHAT	37.76	106 SARAN	45.51	154 SOUTH WEST	46.59
6 EAST GODAVARI	42.36	56 HAILAKANDI	39.47	107 SHEIKHPURA	45.52	155 WEST	46.59
7 GUNTUR	45.79	57 HOJAI	36.43	108 SHEOHAR	45.05	GOA	
8 KRISHNA	45.19	58 JORHAT	36.31	109 SITAMARHI	44.45	156 NORTH GOA	34.35
9 KURNOOL	43.60	59 KAMRUP METRO	36.91	110 SIWAN	45.34	157 SOUTH GOA	37.91
10 POTTI SRIRAMULU NELLORE	41.15	60 KAMRUP RURAL	37.76	111 SUPAUL	41.95	GUJARAT	
11 PRAKASAM	44.87	61 KARBI ANGLONG	36.98	112 VAISHALI	45.27	158 AHMADABAD	44.87
12 SRIKAKULAM	42.37	62 KARIMGANJ	39.47	CHANDIGARH		159 AMRELI	44.59
13 VISAKHAPATNAM	40.36	63 KOKRAJHAR	38.33	113 CHANDIGARH	45.12	160 ANAND	45.67
14 VIZIANAGARAM	42.08	64 LAKHIMPUR	37.08	CHHATTISGARH		161 ARAVALLI	45.29
15 WEST GODAVARI	44.38	65 MAJULI	37.08	114 BALOD	44.69	162 BANAS KANTHA	45.25
16 Y S R KADAPA	43.89	66 MARIGAON	37.62	115 BALODA BAZAR	46.21	163 BHARUCH	41.40
ARUNACHAL PRADESH		67 NAGAON	37.62	116 BALRAMPUR	42.76	164 BHAVNAGAR	43.59
17 ANJAW	23.02	68 NALBARI	37.19	117 BASTAR	42.60	165 BOTAD	45.87
18 CHANGLANG	34.93	69 SIBSAGAR	37.08	118 BEMETARA	46.30	166 CHHOTA UDEPUR	45.06
19 DIBANG VALLEY	27.01	70 SONITPUR	37.62	119 BIJAPUR	44.97	167 DAHOD	44.20
20 EAST KAMENG	26.68	71 SOUTH SALMARA MANCACHAR	39.38	120 BILASPUR	45.31	168 DANGS	42.73
21 EAST SIANG	38.35	72 TINSUKIA	39.64	121 DAKSHIN BASTAR DANTEWADA	43.04	169 DEVBHUMI DWARKA	37.94
22 KAMLE	34.26	73 UDALGURI	37.33	122 DHAMTARI	44.57	170 GANDHINAGAR	45.87
23 KRA DAADI	27.36	74 WEST KARBI ANGLONG	37.44	123 DURG	45.79	171 GIR SOMNATH	40.09
24 KURUNG KUMEY	20.50	BIHAR		124 GARIYABAND	45.87	172 JAMNAGAR	42.75
25 LEPA RADA	34.39	75 ARARIA	43.29	125 GAURELA-PENDRA-MARWAHI	43.97	173 JUNAGADH	43.70
26 LOHIT	30.93	76 ARWAL	46.30	126 JANJGIR - CHAMPA	46.43	174 KACHCHH	44.44
27 LONGDING	35.23	77 AURANGABAD	45.77	127 JASHPUR	42.65	175 KHEDA	45.71
28 LOWER DIBANG VALLEY	38.35	78 BANKA	44.62	128 KABIRDHAM	45.67	176 MAHESANA	45.22
29 LOWER SIANG	30.89	79 BEGUSARAI	44.96	129 KONDAGAON	42.44	177 MAHISAGAR	45.16
30 LOWER SUBANSIRI	29.90	80 BHAGALPUR	43.81	130 KORBA	45.65	178 MORBI	43.81
31 NAMSAI	34.93	81 BHOJPUR	46.23	131 KOREA	43.75	179 NARMADA	44.51
32 PAKKE KESSANG	34.45	82 BUXAR	46.44	132 MAHASAMUND	45.55	180 NAVSARI	43.74
33 PAPUMPARE	34.69	83 DARBHANGA	44.75	133 MUNGELI	46.58	181 PANCH MAHALS	45.16
34 SHI YOMI	25.68	84 GAYA	45.09	134 NARAINPUR	43.06	182 PATAN	45.66
35 SIANG	25.68	85 GOPALGANJ	45.34	135 RAIGARH	46.08	183 PORBANDAR	40.11
36 TAWANG	20.80	86 JAHANABAD	46.12	136 RAIPUR	46.51	184 RAJKOT	44.09
37 TIRAP	35.23	87 JAMUI	44.09	137 RAJ NANDGAON	45.77	185 SABAR KANTHA	44.34
38 UPPER SIANG	26.56	88 KAIMUR	46.44	138 SUKMA	44.61	186 SURAT	44.49
39 UPPER SUBANSIRI	20.87	89 KATIHAR	43.71	139 SURAJPUR	43.86	187 SURENDRANAGAR	45.75
40 WEST KAMENG	21.50	90 KHAGARIA	44.96	140 SURGUJA	43.45	188 TAPI	43.82
41 WEST SIANG	30.89	91 KISHANGANJ	44.60	141 UTTAR BASTAR KANKER	44.69	189 VADODARA	45.04
ASSAM		92 LAKHISARAI	44.94	DADRA & NAGAR HAVELI & DAMAN & DIU		190 VALSAD	43.12
42 BAKSA	37.33	93 MADHEPURA	43.99	142 DADRA & NAGAR HAVELI	43.12	HARYANA	
43 BARPETA	37.19	94 MADHUBANI	43.44	143 DAMAN	42.98	191 AMBALA	45.12
44 BISWANATH	34.45	95 MUNGER	44.62	144 DIU	32.68	192 BHIWANI	46.40
45 BONGAIGAON	37.02	96 MUZAFFARPUR	45.27	DELHI		193 CHARKHI DADRI	46.27
46 CACHAR	36.43	97 NALANDA	46.12	145 CENTRAL	46.85	194 FARIDABAD	46.85
47 CHARAIDEO	38.05	98 NAWADA	44.35	146 EAST	46.85	195 FATEHABAD	46.88
48 CHIRANG	37.02	99 PASHCHIMI CHAMPARAN	44.59	147 NEW DELHI	46.85	196 GURUGRAM	46.59



	State & District	Century Alert
197	HISAR	46.81
198	JHAJJAR	46.59
199	JIND	46.63
200	KAITHAL	46.81
201	KARNAL	46.52
202	KURUKSHETRA	46.52
203	MAHENDRAGARH	45.85
204	MEWAT	46.43
205	PALWAL	46.94
206	PANCHKULA	45.12
207	PANIPAT	46.68
208	REWARI	45.85
209	ROHTAK	46.63
210	SIRSA	46.78
211	SONIPAT	46.74
212	YAMUNANAGAR	46.07
HIMACHAL PRADESH		
213	BILASPUR	38.05
214	CHAMBA	21.98
215	HAMIRPUR	29.68
216	KANGRA	39.22
217	KINNAUR	16.19
218	KULLU	15.29
219	LAHUL & SPITI	12.10
220	MANDI	38.05
221	SHIMLA	33.37
222	SIRMAUR	41.91
223	SOLAN	41.02
224	UNA	44.58
JAMMU AND KASHMIR		
225	ANANTNAG	30.33
226	BADGAM	31.66
227	BANDIPURA	30.70
228	BARAMULA	31.66
229	DODA	32.67
230	GANDERBAL	29.03
231	JAMMU	43.71
232	KATHUA	40.20
233	KISHTWAR	26.26
234	KULGAM	30.33
235	KUPWARA	30.70
236	MIRPUR	45.99
237	MUZAFFARABAD	32.00
238	PULWAMA	29.03
239	PUNCH	31.66
240	RAJAURI	43.71
241	RAMBAN	30.33
242	RIASI	30.33
243	SAMBA	45.38
244	SHUPIYAN	30.33
245	SRINAGAR	29.03
246	UDHAMPUR	39.30

	State & District	Century Alert
JHARKHAND		
247	BOKARO	44.58
248	CHATRA	43.90
249	DEOGHAR	44.20
250	DHANBAD	44.37
251	DUMKA	44.22
252	EAST SINGHBHUM	44.92
253	GARHWA	45.11
254	GIRIDIH	44.09
255	GODDA	43.81
256	GUMLA	42.84
257	HAZARIBAGH	43.85
258	JAMTARA	44.44
259	KHUNTI	43.37
260	KODARMA	44.35
261	LATEHAR	44.92
262	LOHARDAGA	42.56
263	PAKUR	44.22
264	PALAMU	45.77
265	RAMGARH	43.98
266	RANCHI	43.98
267	SAHIBGANJ	43.81
268	SARAIKELA-KHARSAWAN	45.03
269	SIMDEGA	44.99
270	WEST SINGHBHUM	44.79
KARNATAKA		
271	BAGALKOT	41.75
272	BALLARI	40.39
273	BELAGAVI	41.17
274	BENGALURU RURAL	39.02
275	BENGALURU URBAN	38.73
276	BIDAR	43.50
277	CHAMARAJANAGAR	39.45
278	CHIK BALLAPUR	39.11
279	CHIKKAMAGALURU	37.09
280	CHITRADURGA	39.80
281	DAKSHINA KANNADA	36.15
282	DAVANGERE	40.27
283	DHARWAD	40.90
284	GADAG	41.25
285	HASSAN	37.96
286	HAVERI	40.59
287	KALABURAGI	43.58
288	KODAGU	37.55
289	KOLAR	38.98
290	KOPPAL	41.69
291	MANDYA	39.47
292	MYSURU	38.15
293	RAICHUR	43.19
294	RAMANAGARAM	39.37
295	SHIVAMOGGA	37.49
296	TUMAKURU	39.19

	State & District	Century Alert
297	UDUPI	36.24
298	UTTARA KANNADA	37.91
299	VIJAYAPURA	42.18
300	YADGIR	43.51
KERALA		
301	ALAPPUZHA	33.13
302	ERNAKULAM	35.83
303	IDUKKI	36.19
304	KANNUR	36.43
305	KASARAGOD	34.48
306	KOLLAM	37.51
307	KOTTAYAM	37.35
308	KOZHIKODE	35.11
309	MALAPPURAM	37.67
310	PALAKKAD	37.67
311	PATTANAMTHITTA	37.35
312	THIRUVANANTHAPURAM	35.28
313	TRISSUR	38.12
314	WAYANAD	37.26
LADAKH		
315	KARGIL	22.01
316	LEH	21.32
LAKSHADWEEP		
317	LAKSHADWEEP	30.15
MADHYA PRADESH		
318	AGAR MALWA	44.84
319	ALIRAJPUR	44.15
320	ANUPPUR	45.31
321	ASHOKNAGAR	45.58
322	BALAGHAT	44.68
323	BARWANI	44.48
324	BETUL	44.40
325	BHIND	47.15
326	BHOPAL	44.80
327	BURHANPUR	45.09
328	CHHATARPUR	45.68
329	CHHINDWARA	43.75
330	DAMOH	45.79
331	DATIA	47.11
332	DEWAS	45.51
333	DHAR	44.33
334	DINDORI	43.33
335	EAST NIMAR	45.59
336	GUNA	44.87
337	GWALIOR	46.54
338	HARDA	46.05
339	HOSHANGABAD	44.64
340	INDORE	44.64
341	JABALPUR	45.62
342	JHABUA	43.76
343	KATNI	45.63
344	MANDLA	44.31

	State & District	Century Alert
345	MANDSAUR	44.37
346	MORENA	47.05
347	NARSHIMAPURA	45.83
348	NIMACH	44.26
349	NIVARI	46.81
350	PANNA	45.75
351	RAISEN	46.14
352	RAJGARH	45.48
353	RATLAM	44.14
354	REWA	46.64
355	SAGAR	45.31
356	SATNA	45.79
357	SEHORE	45.14
358	SEONI	44.16
359	SHAHDOL	45.00
360	SHAJAPUR	45.09
361	SHEOPUR	46.00
362	SHIVPURI	45.48
363	SIDHI	45.11
364	SINGRAULI	44.83
365	TIKAMGARH	46.02
366	UJJAIN	44.33
367	UMARIA	45.65
368	VIDISHA	45.59
369	WEST NIMAR	45.20
MAHARASHTRA		
370	AHAMADNAGAR	42.46
371	AKOLA	44.80
372	AMARAVATI	45.53
373	AURANGABAD	42.86
374	BHANDARA	46.38
375	BID	42.98
376	BULDHANA	43.91
377	CHANDRAPUR	46.68
378	DHULE	43.08
379	GADCHIROLI	46.23
380	GONDIA	46.21
381	HINGOLI	44.85
382	JALGAON	44.93
383	JALNA	44.15
384	KOLHAPUR	41.33
385	LATUR	43.49
386	MUMBAI CITY	42.48
387	NAGPUR	45.94
388	NANDED	44.98
389	NANDURBAR	43.99
390	NASHIK	41.23
391	PALGHAR	31.95
392	PARBHANI	44.49
393	PUNE	40.76
394	RATNAGIRI	34.06
395	RAYGAD	41.32

	State & District	Century Alert
396	SANGLI	41.59
397	SATARA	41.65
398	SINDHUDURG	39.24
399	SOLAPUR	43.33
400	SUB URBAN MUMBAI	42.48
401	THANE	41.39
402	USMANABAD	43.07
403	WARDHA	46.21
404	WASHIM	44.07
405	YAVATMAL	45.89
MANIPUR		
406	BISHNUPUR	34.60
407	CHANDEL	35.00
408	CHURACHANDPUR	34.60
409	IMPHAL EAST	33.34
410	IMPHAL WEST	33.34
411	JIRIBAM	36.43
412	KAKCHING	34.60
413	KAMJONG	33.96
414	KANGPOKPI	33.34
415	NONEI	33.34
416	PHERZAWL	37.17
417	SENAPATI	33.77
418	TAMENGLONG	33.34
419	TENGNOUPAL	38.56
420	THOUBAL	34.60
421	UKHRUL	31.91
MEGHALAYA		
422	EAST GARO HILLS	37.94
423	EAST JAINTIA HILLS	32.18
424	EAST KHASI HILLS	28.56
425	NORTH GARO HILLS	38.21
426	RI-BHOI	36.91
427	SOUTH GARO HILLS	37.94
428	SOUTH WEST GARO HILLS	39.76
429	SOUTH WEST KHASI HILLS	29.76
430	WEST GARO HILLS	39.38
431	WEST JAINTIA HILLS	32.18
432	WEST KHASI HILLS	29.76
MIZORAM		
433	AIZAWL	36.25
434	CHAMPHAI	33.95
435	KOLASIB	37.13
436	LAWNGTLAI	37.74
437	LUNGLEI	37.59
438	MAMIT	37.13
439	SAIHA	34.77
440	SERCHHIP	33.95
NAGALAND		
441	DIMAPUR	36.98
442	KIPHIRE	31.30
443	KOHIMA	31.91

	State & District	Century Alert
444	LONGLENG	33.26
445	MOKOKCHUNG	36.31
446	MON	38.05
447	PAREN	33.77
448	PHEK	31.91
449	TUENSANG	31.30
450	WOKHA	33.76
451	ZUNHEBOTO	33.76
ODISHA		
452	ANUGUL	45.47
453	BALASORE (BALESHWAR)	42.35
454	BARAGARH	45.82
455	BAUDH (BAUDA)	44.42
456	BHADRAK	39.23
457	BOLANGIR (BALANGIR)	46.17
458	CUTTACK	45.09
459	DEOGARH	44.89
460	DHENKANAL	45.16
461	GAJAPATI	40.50
462	GANJAM	43.25
463	JAGATSINGHPUR	36.76
464	JAJAPUR	45.91
465	JHARSUGUDA	45.13
466	KALAHANDI	45.10
467	KANDHAMAL	43.73
468	KENDRAPARHA	35.61
469	KEONJHAR (KENDUJHAR)	44.25
470	KHORDHA	40.22
471	KORAPUT	41.45
472	MALKANGIRI	42.39
473	MAYURBHANJ	43.36
474	NABARANGAPUR	43.20
475	NAYAGARH	43.77
476	NUAPARHA	44.86
477	PURI	40.22
478	RAYAGARHA	43.77
479	SAMBALPUR	45.51
480	SUBARNAPUR	46.45
481	SUNDARGARH	44.61
PUDUCHERRY		
482	KARAIKAL	34.64
483	MAHE	35.11
484	PUDUCHERRY	35.73
485	YANAM	32.52
PUNJAB		
486	AMRITSAR	47.22
487	BARNALA	47.02
488	BATHINDA	47.14
489	FARIDKOT	47.68
490	FATEHGARH SAHIB	46.76
491	FAZILKA	47.90
492	FIROZPUR	47.44

	State & District	Century Alert
493	GURDASPUR	47.22
494	HOSHIARPUR	46.65
495	JALANDHAR	47.14
496	KAPURTHALA	46.65
497	LUDHIANA	46.15
498	MANSA	47.02
499	MOGA	47.44
500	PATHUNKOT	40.20
501	PATIALA	45.12
502	RUPNAGAR	46.15
503	SANGRUR	47.10
504	SAS NAGAR (SAHIBZADA AJIT S	45.12
505	SHAHID BHAGAT SINGH NAGA	46.15
506	SRI MUKTSAR SAHIB	47.29
507	TARN TARAN	47.38
RAJASTHAN		
508	AJMER	44.57
509	ALWAR	46.65
510	BANSWARA	44.92
511	BARAN	45.76
512	BARMER	44.83
513	BHARATPUR	47.01
514	BHILWARA	45.30
515	BIKANER	45.57
516	BUNDI	46.08
517	CHITTAURGARH	44.50
518	CHURU	45.51
519	DAUSA	45.67
520	DHAULPUR	46.89
521	DUNGARPUR	44.43
522	GANGANAGAR	46.92
523	HANUMANGARH	46.13
524	JAIPUR	44.98
525	JAISALMER	45.76
526	JALOR	45.30
527	JHALAWAR	45.73
528	JHUNJHUNUN	45.11
529	JODHPUR	45.10
530	KARAULI	46.30
531	KOTA	46.28
532	NAGAUR	44.98
533	PALI	44.71
534	PRATAPGARH	45.11
535	RAJ SAMAND	42.76
536	SAWAI MADHOPUR	46.35
537	SIKAR	44.57
538	SIROHI	44.32
539	TONK	45.94
540	UDAIPUR	43.44
SIKKIM		
541	EAST	20.05
542	NORTH	15.82

	State & District	Century Alert
543	SOUTH	17.25
544	WEST	17.25
TAMIL NADU		
545	ARIYALUR	40.76
546	CHENGALPATTU	38.12
547	CHENNAI	40.25
548	COIMBATORE	39.09
549	CUDDALORE	41.23
550	DHARMAPURI	40.74
551	DINDIGUL	41.19
552	ERODE	40.76
553	KALLAKKURICHI	41.20
554	KANCHIPURAM	40.25
555	KANYAKUMARI	38.65
556	KARUR	41.64
557	KRISHNAGIRI	39.97
558	MADURAI	41.02
559	NAGAPATTINAM	34.64
560	NAMAKKAL	41.53
561	NILGIRIS	38.01
562	PERAMBALUR	41.71
563	PUDUKKOTTAI	41.38
564	RAMANATHAPURAM	37.37
565	RANIPPETTAI	42.83
566	SALEM	41.53
567	SIVAGANGA	40.00
568	TENI	37.69
569	TENKASI	40.11
570	THANJAVUR	40.76
571	THIRUVARUR	40.76
572	TIRUCHIRAPALLI	40.76
573	TIRUNELVELI	38.65
574	TIRUPPATTUR	41.26
575	TIRUPPUR	41.26
576	TIRUVALLUR	40.25
577	TIRUVANNAMALAI	41.76
578	TUTICORIN	38.99
579	VELLORE	40.76
580	VILLUPURAM	42.62
581	VIRUDHUNAGAR	41.07
TELANGANA		
582	ADILABAD	45.64
583	BHADRADRI KOTHAGUDEM	45.16
584	HYDERABAD	42.98
585	JAGTIAL	45.32
586	JANGAON	44.94
587	JAYASHANKAR BHUPALAPALLY	44.87
588	JOGULAMBA GADWAL	43.87
589	KAMAREDDY	43.30
590	KARIMNAGAR	45.72
591	KHAMMAM	45.26
592	KUMURAM BHEEM	46.05

	State & District	Century Alert		State & District	Century Alert		State & District	Century Alert
593	MAHABUBABAD	45.27	643	CHANDAULI	46.21	695	SULTANPUR	46.57
594	MAHABUBNAGAR	42.78	644	CHITRAKOOT	46.51	696	UNNAO	46.83
595	MANCHERIAL	46.00	645	DEORIA	45.74	697	VARANASI	46.81
596	MEDAK	43.30	646	ETAH	46.87	UTTARAKHAND		
597	MEDCHAL-MALKAJGIRI	43.33	647	ETAWAH	47.03	698	ALMORA	38.94
598	MULUGU	45.34	648	FARRUKHABAD	46.74	699	BAGESHWAR	29.43
599	NAGARKURNOOL	43.44	649	FATEHPUR	47.06	700	CHAMOLI	22.37
600	NALGONDA	45.07	650	FIROZABAD	47.03	701	CHAMPAWAT	36.24
601	NARAYANPET	43.55	651	GAUTAMBUDH NAGAR	46.85	702	DEHRADUN	37.13
602	NIRMAL	45.03	652	GAZIPUR	46.44	703	HARIDWAR	43.68
603	NIZAMABAD	44.21	653	GHAZIABAD	46.78	704	NAINITAL	38.94
604	PEDDAPALLI	43.41	654	GONDA	46.04	705	PAURI GARHWAL	37.78
605	RANGAREDDY	42.78	655	GORAKHPUR	46.12	706	PITHORAGARH	21.81
606	RANJANNA SIRCILLA	44.70	656	HAMIRPUR	47.19	707	RUDRAPRAYAG	30.98
607	SANGAREDDY	42.98	657	HAPUR	46.63	708	TEHRI GARHWAL	30.98
608	SIDDIPET	43.70	658	HARDOI	46.57	709	UDHAM SINGH NAGAR	45.08
609	SURYAPET	45.64	659	HATHRAS	46.93	710	UTTARKASHI	16.66
610	VIKARABAD	42.78	660	JALAUN	47.24	WEST BENGAL		
611	WANAPARTHY	43.41	661	JAUNPUR	46.72	711	ALIPUR DUAR	39.64
612	WARANGAL (RURAL)	44.94	662	JHANSI	47.03	712	BANKURA	44.88
613	WARANGAL (URBAN)	44.94	663	KANNAUJ	46.74	713	BIRBHUM	44.72
614	YADADRI BHUVANAGIRI	44.87	664	KANPUR	47.19	714	DAKSHIN DINAJPUR	42.93
TRIPURA			665	KANPUR DEHAT	46.91	715	DARJILING	31.65
615	DHALAI	38.54	666	KASGANJ	46.52	716	HAORA	42.95
616	GOMATI	38.55	667	KAUSHAMBI	47.17	717	HUGLI	44.08
617	KHOWAI	38.54	668	KHERI	46.20	718	JALPAIGURI	40.77
618	NORTH TRIPURA	37.13	669	KUSHINAGAR	45.34	719	JHARGRAM	45.11
619	SEPAHIJALA	39.66	670	LALITPUR	45.60	720	KALIMPONG	31.37
620	SOUTH TRIPURA	38.48	671	LUCKNOW	46.67	721	KOCH BIHAR	39.64
621	UNOKOTI	38.54	672	MAHARAJGANJ	45.25	722	KOLKATA	42.95
622	WEST TRIPURA	39.84	673	MAHOBA	47.19	723	MALDAH	43.61
UTTAR PRADESH			674	MAINPURI	46.88	724	MURSHIDABAD	44.50
623	AGRA	47.12	675	MATHURA	47.01	725	NADIA	44.16
624	ALIGARH	46.86	676	MAU	46.14	726	NORTH TWENTY-FOUR PARGAN	42.30
625	AMBEDKAR NAGAR	46.43	677	MEERUT	46.63	727	PASCHIM BARDDHAMAN	44.81
626	AMETHI	46.57	678	MIRZAPUR	46.52	728	PASCHIM MEDINIPUR	44.17
627	AMROHA	46.63	679	MORADABAD	46.14	729	PURBA BARDDHAMAN	44.52
628	AURAIYA	47.04	680	MUZAFFARNAGAR	45.96	730	PURBA MEDINIPUR	41.37
629	AYODHYA	46.43	681	PILIBHIT	45.98	731	PURULIYA	44.88
630	AZAMGARH	46.72	682	PRATAPGARH	46.84	732	SOUTH TWENTY-FOUR PARGAN	38.32
631	BAGHPAT	46.68	683	PRAYAGRAJ	47.09	733	UTTAR DINAJPUR	42.52
632	BAHRAICH	45.58	684	RAIBEARELI	46.98			
633	BALLIA	45.88	685	RAMPUR	46.30			
634	BALRAMPUR	45.11	686	SAHARANPUR	46.07			
635	BANDA	47.24	687	SAMBHAL	46.58			
636	BARABANKI	46.50	688	SANTKABIRNAGAR	45.71			
637	BAREILLY	46.30	689	SHAHJAHANPUR	46.36			
638	BASTI	46.03	690	SHAMLI	46.64			
639	BHADOHI	46.92	691	SHRAWASTI	45.71			
640	BIJNOR	43.63	692	SIDDHARTHNAGAR	44.42			
641	BUDAUN	46.79	693	SITAPUR	46.33			
642	BULANDSHAHR	46.82	694	SONBHADRA	45.80			

Introducing the "Century Alert," a new heat warning based on the 99th percentile of temperature data. It signals exceptionally severe heat waves, occurring about 2.05 days each year.

This must also be taken into account that, as per IMD when the maximum temperature exceeds these thresholds for two consecutive days in two stations within a meteorological subdivision, a heat alert is triggered. This approach accounts for the persistence of extreme heat events, recognising that prolonged exposure to high temperatures significantly increases the risk of heat-related illnesses and fatalities. By requiring consecutive days of extreme temperatures, the IMD methodology ensures that heat alerts are not issued prematurely but rather when there is sustained heat stress in the environment. This threshold represents an extreme level of heat that poses a severe risk to human health, particularly for vulnerable populations such as the elderly, children and individuals with pre-existing medical conditions. As heat waves become more frequent and intense due to climate change, it is essential to have effective heat alert systems in place to protect public health and safety. By identifying

and warning about the most extreme heat events, we can reduce the risk of heat-related illnesses and fatalities and build a more resilient society in the face of climate change.

4.8 Conclusion

Heat thresholds serve as a pivotal milestone for heat wave adaptation planning across India. As one of the world's most populous countries, India is particularly vulnerable to the adverse impacts of extreme heat events due to its diverse climate, large population and varying levels of socio-economic development. Heat thresholds provide a standardised and scientifically backed framework that enables authorities, communities and stakeholders at all levels to prepare, respond and adapt to increasing heat wave risks effectively.

Firstly, heat thresholds act as early warning indicators, signalling the onset and severity of heatwave conditions. Authorities can activate timely and targeted interventions by categorising heat levels into yellow, orange and red alerts based on specific temperature benchmarks. These early warnings facilitate the mobilisation of resources, such as cooling centres, emergency medical services and relief materials, ensuring that response efforts are swift, coordinated and aligned with the severity of the heat wave.

Secondly, establishing heat thresholds fosters the development of tailored heat wave preparedness and response plans at regional, state and national levels. Recognising that the impacts of heat waves vary across different regions due to local climatic conditions, population density and vulnerability factors, heat thresholds enable the customisation of adaptation strategies to address specific challenges and needs. This localised approach ensures that interventions are context-specific, relevant and effective in mitigating heat-related risks and enhancing resilience.

Heat thresholds are crucial benchmarks for planning and adapting to heat waves across India.

Thirdly, heat thresholds encourage proactive planning and investment in heat wave adaptation measures. By providing a clear and quantifiable benchmark for heat wave severity, heat thresholds highlight the urgency and importance of prioritising heat wave preparedness and response in national and state-level policy agendas. This can lead to increased capacity-building, infrastructure development and funding aimed at reducing heat-related vulnerabilities, enhancing public health resilience and protecting the most vulnerable populations.

Furthermore, establishing heat thresholds promotes collaboration, coordination and partnership among various stakeholders involved in heat wave adaptation planning. It encourages a multi-sectoral

approach involving government agencies, non-governmental organisations, academia, community groups and the private sector. This collaborative effort fosters knowledge sharing, innovation and collective action, ensuring that heat wave adaptation strategies are comprehensive, inclusive and sustainable.

Importantly, the data used to establish heat thresholds, such as temperature records from 1982 to 2023, offers valuable insights into historical climate trends and future projections. This long-term data provides a robust foundation for understanding the evolving nature of heat wave risks and informs evidence-based decision-making in heat wave adaptation planning. It enables authorities to anticipate future heat wave scenarios, assess potential impacts and develop adaptive strategies that are resilient to changing climate conditions.

In conclusion, heat thresholds are an essential tool for guiding heat wave adaptation planning in India. They facilitate early warning, promote tailored adaptation strategies, encourage proactive planning and investment, foster stakeholder collaboration and leverage historical and future climate data for informed decision-making. By prioritising the establishment and utilisation of heat thresholds in heat wave adaptation planning, India can build a climate-resilient future, reduce heat-related vulnerabilities and safeguard the health, well-being and livelihoods of its people.

Note: 1. It is important to highlight that this analysis is based on the centroid of each district using GIS methodology. However, significant temperature variations can occur within a district, particularly in hilly terrain. These variations can happen simultaneously, necessitating careful consideration of local topography and microclimatic influences for accurate interpretation of findings.

2. Districts with small geographical areas located near each other may encounter similar alert temperatures.

Utilisation of heat thresholds can build a disaster and climate-resilient future, reduce heat-related vulnerabilities and safeguard the health, well-being and livelihoods of people.

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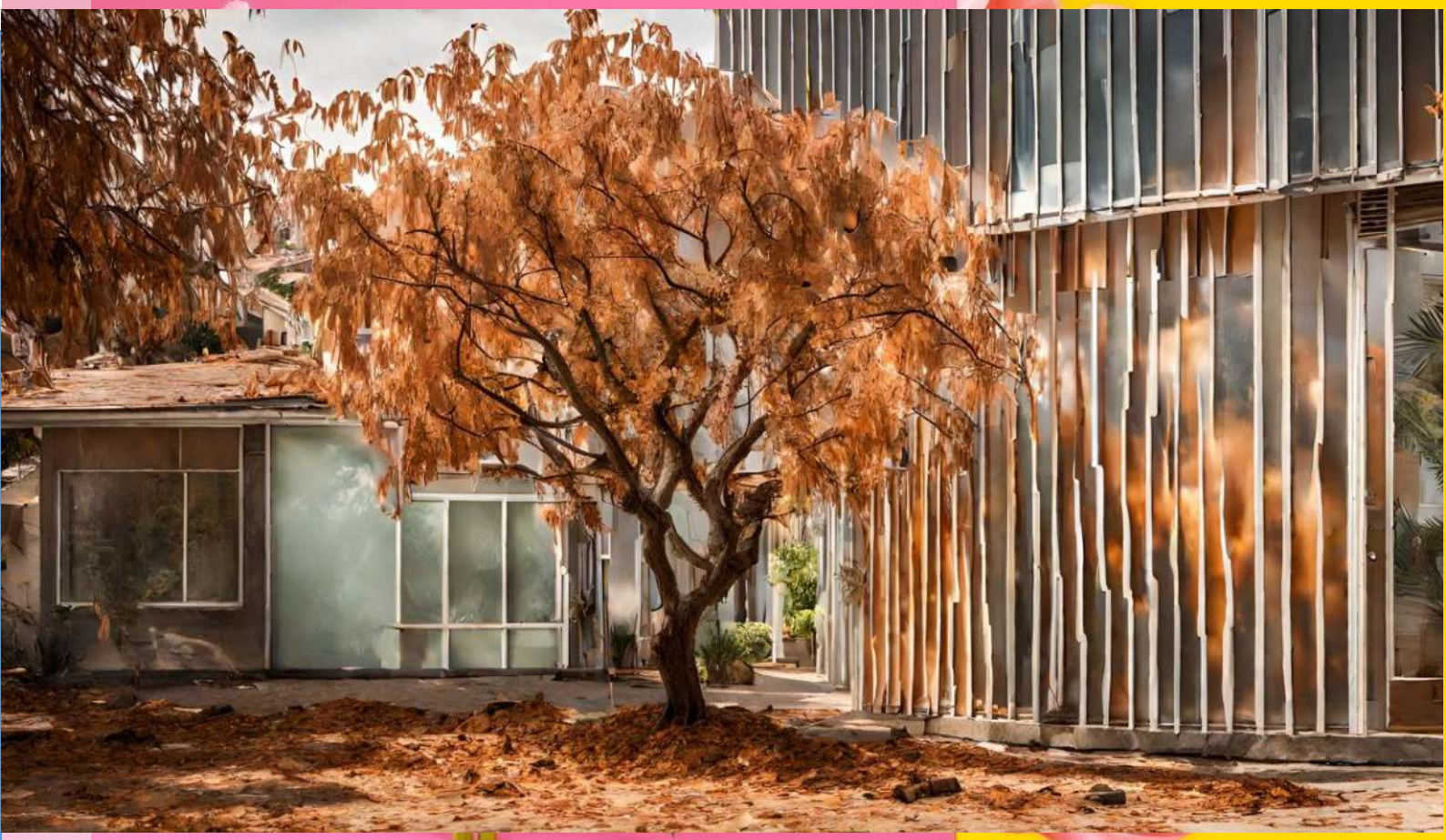

CHAPTER 5
DISCUSSION AND CONCLUSIONS

5. Discussions and Conclusions

5.1 Discussions

Until recently, heat waves were not considered as catastrophic events like floods and landslides in India. As a result, accurate information and data on heat wave-related deaths and illnesses have not been readily available. The establishment of comprehensive district specific heat wave warning thresholds that allow communities to build local heat response plans is critical for climate-sensitive illness prevention and control. Early warning systems are also critical for improving medical and public health practitioners' readiness and response capabilities, as well as promoting stakeholder coordination (Azhar et al., 2014). Notification levels and timing vary, but are often based on projected temperatures and hence followed by heat waves. Because adversely affected persons could die quickly after exposure to severe temperatures (Diaz et al., 2006), timely warnings should precede heatwave occurrences and should not occur on a day when the mortality threshold temperature is surpassed (Mastrangelo et al., 2006). Heat-related mortality, on the other hand, occurred at temperatures below specified limits, indicating that proper protection is essential even when the thresholds are not achieved (Pascal et al., 2013).

The SDGs include specific objectives for poverty (SDG 1), gender equality (SDG 5), sustainability (SDG 11) and climate action (SDG 13). This is also true for health implications, since climate change increases the probability of gender-based health inequities (Sorensen et al., 2018). The WHO recently designated the "health impacts of climate and environmental change" as one of four major health priorities for the next five years, calling for the well-being of women, children and adolescents to be prioritised at the global level. Heat disease is arguably the most serious climate-related illness. Heatwaves and other severe weather events are becoming more frequent and intense as a result of climate change and this trend is expected to continue in the future decades. Heatwaves and rising mean temperatures both pose significant health risks, particularly for communities with inadequate physiological or socioeconomic resources to respond to or adapt to high temperatures (Chersich et al., 2020).

Extreme heat episodes kill more people in the United States than all other weather-related causes combined (Anderson and Bell, 2011). High temperatures have a negative influence on the human body because they interfere with its capacity to disperse heat and thermo-regulate, resulting in heat exhaustion and perhaps heat stroke, a condition

Until recently, heat waves were not considered as catastrophic events like floods and landslides in India. As a result, accurate information and data on heat wave-related deaths and illnesses have not been readily available.

defined by a core temperature of 40.6 degrees Celsius and central nervous system dysfunction (Bouchama and Knochel, 2002). Climatic change is having widespread effects in India, which are expected to intensify under future climatic scenarios (IPCC, 2014). In terms of extreme climatic events, India is already the fifth most susceptible country in the world (Mishra et al., 2017). In India, average annual temperatures are expected to rise between 1.7 and 2.2°C by 2030, with corresponding increases in the severity and length of heatwaves (IPCC, 2014).

Poor access to healthcare and cooling facilities due to personal safety concerns and a lack of personal transportation, culturally prescribed heavy clothing garments that limit evaporative cooling and a lack of awareness of women's vulnerabilities to heat among local, national and global decision-makers and health care personnel are all examples of cultural vulnerabilities (Sorensen et al., 2014). Furthermore, since their capacity to thermoregulate is reduced, pregnant women are more vulnerable to rising ambient temperatures and heat waves (Harlan et al., 2006). Pregnancies are also prone to problems at all stages of gestation. Such difficulties may impair the mother's and/or child's maternal health, fetal health, perinatal health, or postnatal health (Halonen et al., 2011) and are complicated in both aetiology and outcome. Low birth weight was traditionally thought to be caused by prolonged heat exposure and maternal heat stress (Harlan et al., 2006). While there is no clear evidence at this time, there may be a link between unfavourable birth outcomes and severe temperature variations. However, there is very little evidence that temperature extremes have a negative influence on delivery outcomes, such as changes in gestational duration, birth weight, stillbirth and neonatal stress in exceptionally hot temperature exposures.

Heat advisories are based only on maximum temperature departures from their typical values for that time of year. This is because high levels of natural all-cause mortality at the summer weekly, monthly and seasonal timeframes have been linked to anomalous heat at the same timescales in several areas. According to the NDMA (2019) report on preliminary research to identify temperature thresholds for many Indian cities, every one-degree Celsius rise in daily maximum temperature increases the relative risk of fatality.

In this context, the determination of thresholds in this study is a crucial step forward in developing an urban and rural heat wave action plans, which will become the cornerstone of environmental health in Uttar Pradesh and India to alleviate the difficulties. Furthermore, because the 80th, 88th and 95th percentile values of the maximum temperature are quite near with overlapping standard

Climatic change is having widespread effects in India, which are expected to intensify under future climatic scenarios (IPCC, 2014)

deviations, this study gives percentile-based temperature thresholds without standard deviations.

5.2 Conclusions

In conclusion, the heat wave threshold determination in Uttar Pradesh represents a significant step toward enhancing climate resilience and safeguarding public health in the face of rising temperatures. District-wise heat wave thresholds have been established through a meticulous analysis of historical temperature data. These thresholds serve as crucial indicators for early warning systems, enabling proactive measures to mitigate the adverse impacts of heat waves.

Threshold evaluation can aid in the development of a comprehensive, evidence-based, district-wide heat wave alarm system. District-specific criteria may also aid in the prevention of heat-related false alarms and the efficient utilisation of resources. This can also serve as a benchmark against which future heat wave mitigation initiatives can be properly assessed. Significant efforts will be necessary in the near future to gather heat health data that would otherwise be lost so that such data may be utilised to better understand the determinants of heat health in various societies.

The study underscores the importance of recognising regional variability within UP, considering diverse climatic conditions and geographical features. By acknowledging the limitations of data availability and potential sources of uncertainty, this research provides a foundation for continuous improvement in threshold determination methodologies.

The implications of the established thresholds extend beyond meteorological considerations. They carry profound significance for public health, emergency response planning and urban development policies. The integration of these thresholds into early warning systems can empower communities to take preventive actions, fostering a climate-resilient state.

As Uttar Pradesh embraces the challenges posed by climate change, this Study contributes valuable insights to guide evidence-based decision-making. Continued research, community engagement and adaptive strategies will be essential to further refine and optimise heat wave thresholds, ensuring the well-being of the people of Uttar Pradesh in an evolving climate landscape.

5.3 What has this Study Added?

Heat-related temperature thresholds were quantified for all districts of India, including Uttar Pradesh. This heat

The heat wave threshold determination in Uttar Pradesh (UP) represents a significant step toward enhancing climate resilience and safeguarding public health in the face of rising temperatures.

threshold Study has added valuable insights into further understanding and mitigating the impacts of heat waves in India. By establishing specific temperature thresholds for different alert levels (yellow, orange and red), the Study provides a structured framework for early warning systems and adaptation planning. Additionally, it enhances an understanding of the relationship between temperature extremes and their impacts on human health, agriculture, infrastructure and the environment (See the Heat Index for the 75 Districts of Uttar Pradesh computed in Appendix 1). Moreover, the study highlights the importance of long-term data analysis and collaboration between meteorological agencies, researchers, policymakers and local communities in addressing the growing threat of heat waves. Overall, this study contributes to building resilience and preparedness against heat-related risks and promoting sustainable development in India.

5.4 Recommendations

This study considered the district-wide heat wave threshold of Uttar Pradesh and the present findings may help policymakers answer concerns about the severity of the problem and design coping methods. As a result, the following are the recommendations of this work;

- The results of the Study not only serve to identify goals for action among several urban local bodies' actors but also encourage the development of a strategic framework for city-specific Heat Action Plans aimed at preventing and reducing heat-related health concerns. Heat Action Plans are more likely to be effective in bringing about change at the municipal level while also building capacity in the field and raising public knowledge of heat sensitivity and associated coping mechanisms. As a result, district-wise heat action programs must be devised, executed and scientifically assessed using data to estimate their success.
- The second most significant policy effect will be connected to temperature threshold assessment since early identification of district-wise temperature thresholds is critical for activities, particularly drafting heat response plans and alerts.
- The analysis also revealed that there is a substantial association between household vulnerability and adaptive capability in all of the cities. To reduce vulnerability, focus and effort should be devoted to adaptive capability.
- Interior heat exposure may be decreased by implementing medium and short-term remedies, as well as giving advice on how to keep inside temperatures low during high heat.

The present findings may help policymakers answer concerns about the severity of the problem and design coping methods

- Long-term urban planning should include building sites, particularly with regard to airflow, as most dwellings are flanked on three or four sides by tall structures.
- During excessive heat, those with comorbidities, particularly diabetes and hypertension, should be given extra care.
- Implement cooling measures (while keeping affordability in mind) at home and work and urge people to sleep on bare floors (with caution) during intense hot seasons, particularly those without air conditioning.
- Ensure the availability of healthcare facilities within a 5-kilometer radius.
- Ensure high-quality, continuous water supply during the summer.
- Create more green areas in their neighbourhood (if space is available).
- Collaborating with the labour department to change work schedules, particularly for persons who work outdoors (contractors, drivers, etc.).

5.5 Policy Implications from Threshold Assessment

- Heat Wave Preparedness Policies: Governments may use heat threshold assessments to formulate and implement robust heat wave preparedness policies. These policies should include early warning systems, heat shelters and guidelines for vulnerable populations.
- Urban Planning and Infrastructure: Heat threshold assessments can inform urban planning and infrastructure development, encouraging the creation of green spaces, cool roofs and efficient cooling systems to mitigate the urban heat island effect.
- Healthcare Infrastructure: Health authorities can utilise heat threshold assessments to enhance healthcare infrastructure, ensuring that hospitals and clinics are equipped to handle the influx of heat-related illnesses during extreme heat events.
- Agricultural Adaptation Strategies: Agricultural policies can be tailored based on heat threshold assessments to promote the adoption of heat-tolerant crops, improved irrigation techniques and other adaptation strategies to minimise heat-related crop losses.
- Community Engagement and Education: Policies should prioritise community engagement and education initiatives to raise awareness about heat waves, their health impacts and the importance of preventive measures. This could involve public

Assessments of heat thresholds provide valuable insights for urban planning and infrastructure enhancement, promoting the integration of green spaces, implementation of cool roofs and adoption of effective cooling systems to alleviate the urban heat island phenomenon.

outreach campaigns and educational programs in schools and communities.

- Climate Change Mitigation: Heat threshold assessments highlight the urgency of addressing climate change. Policies should aim to reduce greenhouse gas emissions and promote renewable energy sources to mitigate the frequency and intensity of heat waves in the long term.
- Social Safety Nets: Governments may consider implementing social safety nets to support vulnerable populations during heat waves, including providing access to cooling centres, financial assistance for utility bills and social support services.
- Cross-Sector Collaboration: Effective heat wave policies require collaboration across sectors, including government agencies, healthcare providers, community organisations and businesses. Policies should prioritise multi-sectoral collaboration to ensure a coordinated response to heatwave events.
- Mortality Recording Systems: Municipal and higher-level mortality recording systems must be upgraded to examine the impact of the Heat Wave on the community.

Assessments of heat thresholds underscore the critical need to tackle climate change promptly. Policies should prioritize efforts to decrease greenhouse gas emissions and foster the adoption of renewable energy sources to mitigate the long-term impacts of heat waves, including their frequency and intensity.

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ANNEXURE**1**: Heat threshold, Humidity Threshold and Combined Heatwave Index of UP.

SL NO	District	Heat Threshold			Humidity Threshold			Combined Heatwave Index		
		Yellow Alert	Orange Alert	Red Alert	Yellow Alert	Orange Alert	Red Alert	Yellow Index	Orange Index	Red Index
1	AGRA	40.54	43.08	45.26	65.88	75.19	83.31	106.42	118.27	128.57
2	ALAGARH	40.03	42.55	44.78	61.62	73.31	83.81	101.65	115.86	128.59
3	AMBEDKAR NAGAR	39.67	42.20	44.36	74.25	81.69	87.56	113.92	123.89	131.92
4	AMETHI	39.87	42.43	44.55	72.94	81.50	87.44	112.81	123.93	131.99
5	AMROHA	39.33	42.00	44.33	64.12	74.88	84.56	103.45	116.88	128.89
6	AURAIYA	40.44	43.01	45.11	65.00	76.06	84.94	105.44	119.07	130.05
7	AYODHYA	39.67	42.20	44.36	73.14	81.50	87.31	112.81	123.70	131.67
8	AZAMGARH	39.98	42.58	44.71	73.14	81.50	87.31	113.12	124.08	132.02
9	BAGHPAT	39.61	42.01	44.43	61.50	72.69	83.38	101.11	114.70	127.81
10	BAHRAICH	38.81	41.26	43.44	70.06	78.70	86.00	108.87	119.96	129.44
11	BALLIA	39.18	41.62	43.83	76.81	82.81	87.81	115.99	124.43	131.64
12	BALRAMPUR	38.45	40.72	42.94	69.94	78.62	86.50	108.39	119.34	129.44
13	BANDA	40.58	43.30	45.31	71.44	79.88	86.12	112.02	123.18	131.43
14	BARABANKI	39.68	42.24	44.38	71.50	80.19	86.94	111.18	122.43	131.32
15	BAREILLY	39.34	42.00	44.25	68.06	78.31	86.12	107.40	120.31	130.37
16	BASTI	39.27	41.73	43.93	73.12	80.75	87.31	112.39	122.48	131.24
17	BHADOHI	40.28	42.98	45.02	73.62	80.94	87.06	113.90	123.92	132.08
18	BIJNOR	36.47	39.08	41.48	66.81	76.75	84.69	103.28	115.83	126.17
19	BUDAUN	39.92	42.52	44.72	63.44	74.88	84.56	103.36	117.40	129.28
20	BULANDSHAHR	39.74	42.29	44.63	63.00	74.25	84.12	102.74	116.54	128.75
21	CHANDAULI	39.52	42.26	44.38	75.75	82.19	87.56	115.27	124.45	131.94
22	CHITRAKOOT	39.86	42.64	44.66	73.88	81.75	87.50	113.74	124.39	132.16
23	DEORIA	39.08	41.50	43.67	75.44	82.07	87.56	114.52	123.57	131.23
24	ETAH	40.22	42.80	44.93	61.06	72.50	83.56	101.28	115.30	128.49
25	ETAWAH	40.50	43.05	45.15	63.94	75.31	84.62	104.44	118.36	129.77
26	FARRUKHABAD	40.01	42.59	44.75	64.94	76.12	84.88	104.95	118.71	129.63
27	FATEHPUR	40.37	43.03	45.10	70.75	79.88	86.25	111.12	122.91	131.35
28	FIROZABAD	40.50	43.05	45.15	61.46	72.88	83.94	101.96	115.93	129.09
29	GAUTAMBUDH NAGAR	39.96	42.40	44.69	59.50	70.63	82.50	99.46	113.03	127.19
30	GAZIPUR	39.71	42.31	44.48	74.62	81.38	87.19	114.33	123.69	131.67
31	GHAZIABAD	39.55	42.11	44.48	61.50	72.69	83.38	101.05	114.80	127.86
32	GONDA	39.36	41.82	43.94	72.88	80.94	87.25	112.24	122.76	131.19
33	GORAKHPUR	39.38	41.85	44.08	74.44	81.56	87.44	113.82	123.41	131.52
34	HAMIRPUR	40.51	43.21	45.27	68.53	78.31	85.25	109.04	121.52	130.52
35	HAPUR	39.33	42.00	44.33	63.00	74.25	84.12	102.33	116.25	128.45
36	HARDOI	39.73	42.35	44.49	68.88	78.50	86.12	108.61	120.85	130.61
37	HATHRAS	40.30	42.87	45.05	59.62	71.69	83.12	99.92	114.56	128.17
38	JALAUN	40.55	43.23	45.34	67.38	77.56	85.00	107.93	120.79	130.34
39	JAUNPUR	39.98	42.58	44.71	73.62	80.94	87.06	113.60	123.52	131.77
40	JHANSI	40.40	43.05	45.14	69.88	78.94	85.62	110.28	121.99	130.76
41	KANNAUJ	40.10	42.63	44.74	66.94	77.69	85.50	107.04	120.32	130.24

SL NO	District	Heat Threshold			Humidity Threshold			Combined Heatwave Index		
		Yellow Alert	Orange Alert	Red Alert	Yellow Alert	Orange Alert	Red Alert	Yellow Index	Orange Index	Red Index
42	KANPUR	40.51	43.21	45.27	67.25	77.75	85.62	107.76	120.96	130.89
43	KANPUR DEHAT	40.26	42.86	44.96	67.25	77.75	85.62	107.51	120.61	130.58
44	KASGANJ	39.65	42.29	44.50	63.44	74.88	84.56	103.09	117.17	129.06
45	KAUSHAMBI	40.52	43.23	45.24	71.56	80.38	86.69	112.08	123.61	131.93
46	KHERI	39.30	41.87	44.11	70.38	78.88	86.25	109.68	120.75	130.36
47	KUSHINAGAR	38.75	41.08	43.30	75.38	82.12	87.75	114.13	123.20	131.05
48	LALITPUR	39.07	41.66	43.80	75.31	83.19	88.69	114.38	124.85	132.49
49	LUCKNOW	39.94	42.55	44.65	69.94	79.44	86.44	109.88	121.99	131.09
50	MAHARAJGANJ	38.49	40.84	43.05	75.38	82.12	87.75	113.87	122.96	130.80
51	MAHOBA	40.48	43.21	45.30	71.06	79.50	85.88	111.54	122.71	131.18
52	MAINPURI	40.26	42.80	44.92	63.94	75.31	84.62	104.20	118.11	129.54
53	MATHURA	40.40	42.95	45.12	57.19	68.19	80.94	97.59	111.14	126.06
54	MAU	39.39	41.89	44.14	76.62	82.75	87.94	116.01	124.64	132.08
55	MEERUT	39.33	42.00	44.33	65.19	75.56	84.44	104.52	117.56	128.77
56	MIRZAPUR	39.88	42.65	44.69	74.06	81.69	87.25	113.94	124.34	131.94
57	MORADABAD	39.02	41.69	43.97	64.12	74.88	84.56	103.14	116.57	128.53
58	MUZAFFAR NAGAR	38.47	41.19	43.65	66.81	76.75	84.69	105.28	117.94	128.34
59	PILIBHIT	38.82	41.50	43.91	70.81	80.06	86.75	109.63	121.56	130.66
60	PRATAPGARH	40.14	42.77	44.88	72.94	81.50	87.44	113.08	124.27	132.32
61	PRAYAGRAJ	40.53	43.15	45.21	73.00	81.19	87.12	113.53	124.34	132.33
62	RAIBEARELI	40.24	42.88	45.02	72.00	80.94	87.12	112.24	123.82	132.14
63	RAMPUR	39.34	42.00	44.25	66.94	77.94	86.00	106.28	119.94	130.25
64	SAHARANPUR	38.19	41.01	43.65	66.12	76.62	84.62	104.31	117.63	128.27
65	SAMBHAL	39.59	42.21	44.41	64.50	75.31	84.62	104.09	117.52	129.03
66	SANTKABIR NAGAR	38.94	41.30	43.51	73.38	80.88	87.62	112.32	122.18	131.13
67	SHAHJAHANPUR	39.50	42.05	44.30	70.06	79.19	86.19	109.56	121.24	130.49
68	SHAMLI	39.16	41.81	44.29	64.50	75.00	84.12	103.66	116.81	128.41
69	SHRAWASTI	39.05	41.39	43.49	70.44	79.06	86.50	109.49	120.45	129.99
70	SIDDHARTH NAGAR	37.83	40.05	42.25	70.56	79.62	86.56	108.39	119.67	128.81
71	SITAPUR	39.51	42.08	44.26	69.71	78.70	86.19	109.22	120.78	130.45
72	SONBHADRA	39.02	41.80	43.95	76.62	82.88	87.81	115.64	124.68	131.76
73	SULTANPUR	39.87	42.43	44.55	73.14	81.50	87.31	113.01	123.93	131.86
74	UNNAO	40.12	42.73	44.82	69.50	79.50	86.44	109.62	122.23	131.26
75	VARANASI	40.12	42.72	44.83	73.71	80.94	86.75	113.83	123.66	131.58