UTTAR PRADESH
STATE DISASTER MANAGEMENT AUTHORITY

Shri Yogi Adityanath

Hon'ble Chief Minister of Uttar Pradesh

LUCKNOW CITY HEAT ACTION PLAN 2025

लेफ्टिनेंट जनरल योगेन्द्र डिमरी
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Lt Gen Yogendra Dimri
PVSM, AVSM, VSM (Retd)
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MESSAGE

Occurrence of extreme heat events is increasingly frequent which presents significant problems for economies, the environment and people. New global heat records are set every month; the 14 months prior to July 2024 being the warmest on record. Climate change has caused heat waves to increase in frequency and duration over land in nearly every region of the world.

The urban heat island effect due to accelerated urbanization contributes to the increasing concern of extreme heat in cities, which are warming at a rate that is twice the global average. This phenomenon is a consequence of absorption and amplification of heat by dense concentrations of buildings and paved surfaces, particularly in areas with minimal tree cover or green spaces. The problem of excessive heat has worsened in recent years as it has a major impact on labour, public health and the functioning of society in general. To obviate the effects of excessive heat, stronger emergency response systems, greater public awareness and localized heat action plans are urgently needed.

Uttar Pradesh State Disaster Management Authority (UP SDMA) has been implementing the State and District level heat action plans for mitigating the negative impact of extreme heat on population, livelihood and economy. In 2024-25, the State Government has taken a proactive decision to develop and implement City level heat action plans for all Nagar Nigams and major cities in the State. In the first phase amongst others, UP SDMA has developed the City Heat Action Plan for Lucknow.

I am thankful to Municipal Commissioner Lucknow and his Nodal Officer who have been very proactive and extremely forthcoming in extending support to UP SDMA and Indian Institute of Public Health, Gandhinagar. I compliment Team UP SDMA, Shri Ram Kewal, ACEO, Dr Kaneez Fatima, Project Director and Smt Priyanka Dwivedi, Project Expert and other officials for their diligent efforts in the development of Lucknow City Heat Action Plan.

My gratitude to Dr Mahaveer Golechha, Professor and Head, Indian Institute of Public Health, Gandhinagar and Lead - City Heat Action Plan for meticulously developing this Lucknow City Heat Action Plan. His technical expertise has helped the city administration to understand the various strategies for effective implementation of city heat action plan.

The City Heat Action Plan is indispensable for safeguarding vulnerable populations from heat-related ailments and fatalities. It is a work in progress and akin to the State and District level heat action plans, will undergo monitoring and action taken review to strengthen the plan each year. I am sanguine that the implementation of City Heat Action Plan will adequately empower us to confront future heat challenges by combining emergency response activities with long-term cooling interventions.

(Lt Gen Yogendra Dimri)

पी० गुरू प्रसाद
प्रमुख सचिव,
P. Guruprasad
Principal Secretary, Revenue

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MESSAGE

A significant global issue, extreme heat is becoming more widely acknowledged, and it is being exacerbated by climate change. The frequency, intensity, and duration of heat waves are increasing, resulting in severe health hazards, environmental challenges, and socio-economic impacts. Extreme heat is primarily caused by human-induced climate change. The combustion of fossil fuels results in the emission of greenhouse gases, such as carbon dioxide, which trap heat in the atmosphere. In order to address this challenge, it is necessary to coordinate efforts across a variety of sectors in order to implement effective adaptation and mitigation strategies.

For the state of Uttar Pradesh, extreme heat is a multifaceted crisis fuelled by climate change, posing significant threats to public health and economic stability. Urgent action is required to build resilience against these increasingly frequent and severe heat events. To better address heat-related health issues, we need to invest in preparedness, early warning system, long term mitigation and climate resilient health systems.

Heat Action Plans are indispensable for safeguarding vulnerable populations from heat-related ailments and fatalities. They seek to prevent heat related illnesses and other health issues associated with extreme temperatures by providing structured responses to heat waves. These strategies include early warning systems that notify communities of imminent heat waves, thereby enabling the implementation of opportune preventive measures. This is essential to guarantee that high-risk populations receive the necessary information and assistance during extreme weather events.

I am happy to learn that the Uttar Pradesh State Disaster Management Authority is leading the efforts for mitigating the negative impact of extreme heat on population, economy and livelihood through state and district heat action plans. Furthermore, this work has been extended to cities as well.

By implementing a comprehensive heat strategy, the state will significantly mitigate the harmful impact of high heat on the people, improve the adaptive capacity of its infrastructure, and develop a culture of preparedness and resilience among its citizens.

(P. Guruprasad)

सुषमा खर्कवाल
महापौर
Sushma Kharkwal
MAYOR

नगर निगम, लखनऊ
NAGAR NIGAM, LUCKNOW

पत्रांक 515/महापौर/25 दिनांक 07/03/25

सन्देश

वैश्विक स्तर पर गर्मी की स्थिति एक महत्वपूर्ण चिंता का विषय है, क्योंकि जलवायु परिवर्तन के कारण विश्व स्तर पर अत्यधिक गर्मी की घटनाओं में वृद्धि हो रही है। ग्रीनहाउस गैस उत्सर्जन जैसी मानवीय गतिविधियों के कारण बढ़ते वैश्विक तापमान से लगातार, गंभीर और लंबे समय तक चलने वाली हीटवेव आ रही हैं। ये गर्म लहरें सार्वजनिक स्वास्थ्य, आर्थिक स्थिरता, कृषि उत्पादन और पर्यावरण की अखंडता के लिए गंभीर खतरे पैदा करती हैं। पिछले कुछ वर्षों में, भारत में हीटवेव की संख्या में वृद्धि हुई है, जिसका कई राज्यों, जिलों, शहरों और कस्बों में कमजोर आबादी के स्वास्थ्य और जीवन शैली पर नकारात्मक प्रभाव पड़ा है।

वर्तमान में, वैश्विक आबादी का 50% से अधिक शहरी क्षेत्रों में रहती है, और यह अनुमान है कि 2050 तक यह आंकड़ा लगभग 68% तक बढ़ जाएगा। इसके अतिरिक्त, भारतीय शहर पहले से ही जलवायु परिवर्तन के प्रभावों का सामना कर रहे हैं, जिसके कारण शहरी वातावरण को समायोजित करने के लिए नई योजना और डिजाइन रणनीतियों का विकास आवश्यक हो गया है। शहरी ताप द्वीप (UHI) प्रभाव के कारण शहरों में रहने वाले लोग आसपास के क्षेत्रों में रहने वाले लोगों की तुलना में रात और दिन के समय अधिक तापमान से प्रभावित होते हैं।

मैं उत्तर प्रदेश राज्य आपदा प्रबंधन प्राधिकरण, उत्तर प्रदेश सरकार, लेफ्टिनेंट जनरल योगेंद्र डिमरी, पीवीएसएम, एवीएसएम, वीएसएम, (सेवानिवृत्त), उपाध्यक्ष, डॉ. कनीज फातिमा, परियोजना निदेशक और अन्य अधिकारियों को सिटी हीट एक्शन प्लान के विकास के पहले चरण के लिए लखनऊ शहर का चयन करने के लिए धन्यवाद देना चाहती हूँ। मैं नगर आयुक्त, अपर नगर आयुक्त, नोडल अधिकारी–सिटी हीट एक्शन प्लान, पर्यावरण अभियंता, और अन्य नगर निगम अधिकारियों और सलाहकारों को हीट एक्शन प्लान के विकास के लिए यूपीएसडीएमए और आईआईपीएच–गांधीनगर को आवश्यक सहयोग प्रदान करने के लिए आभार व्यक्त करती हूँ। मैं डॉ. महावीर गोलेछा, प्रोफेसर और लीड–सिटी हीट एक्शन प्लान, भारतीय लोक स्वास्थ्य संस्थान–गांधीनगर को लखनऊ सिटी हीट एक्शन प्लान के विकास में उनके योगदान के लिए धन्यवाद देना चाहती हूँ। उनके तकनीकी सहयोग से लखनऊ शहर को एक प्रभावी हीट एक्शन प्लान विकसित करने में मदद मिली है।

इस हीट एक्शन प्लान को अपनाकर हम न केवल अत्यधिक गर्मी के प्रभावों को कम कर सकते हैं, बल्कि ऐसे समुदायों का निर्माण भी कर सकते हैं जो भविष्य में आने वाली किसी भी चुनौती का सामना करने में सक्षम हों। आइए हम सब मिलकर इस महत्वपूर्ण कार्य के लिए खुद को प्रतिबद्ध करें, यह जानते हुए कि हमारे समुदायों की सुरक्षा और संरक्षा हमारे सामूहिक संकल्प पर निर्भर करती है। मुझे विश्वास है कि यह योजना लखनऊ शहर में गर्मी से होने वाली बीमारियों की रोकथाम और प्रबंधन के लिए एक शहरव्यापी रणनीति बनाने में सभी हितधारकों की मदद करेगी।

भवदीया

(सुषमा खर्कवाल)
महापौर

कार्यालयः नगर निगम, त्रिलोक नाथ रोड, लालबाग, लखनऊ
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Message

As climate change intensifies, extreme heat events are becoming increasingly frequent, posing a critical global challenge. The rise in heatwave frequency, intensity, and duration, largely driven by human-induced climate changes like greenhouse gas emissions, presents severe risks to public health, economic stability, agricultural productivity, and environmental integrity. In recent years, India has experienced a surge in heatwaves, negatively impacting vulnerable populations across numerous states, districts, cities, and towns.

Currently, over 50% of the global population resides in urban areas, a figure projected to reach approximately 68% by 2050. This rapid urbanization places significant strain on urban environments. Furthermore, Indian cities are already grappling with the effects of climate change, necessitating the development of innovative planning and design strategies to adapt to evolving urban landscapes.

I extend my sincere gratitude to the Uttar Pradesh State Disaster Management Authority, the Government of Uttar Pradesh, Lt Gen Yogendra Dimri, PVSM, AVSM, VSM (Retd), Vice-Chairperson, Dr. Kaneez Fatima, Project Director, and all other officials for selecting Lucknow for the initial phase of the City Heat Action Plan Development. I also wish to thank the Additional Commissioner, the Nodal Officer-City Heat Action Plan, the Environment Engineer, and other Municipal Corporation Officials and Consultants for their invaluable support to the UPSDMA and IIPH-Gandhinagar in developing this crucial heat action plan.

My appreciation goes to Dr. Mahaveer Golechha, Professor and Lead-City Heat Action Plan at the Indian Institute of Public Health-Gandhinagar, for his significant contribution to the Lucknow City Heat Action Plan. His technical expertise has been instrumental in creating an effective strategy.

This plan provides a roadmap for building resilient communities capable of addressing the heat-related challenges of the 21st century. It outlines actionable strategies to safeguard our population's well-being. I am confident that this plan will empower all stakeholders to implement a citywide strategy that incorporates preventive, mitigative, and adaptive measures for the prevention and management of heat-related illnesses.

Sincerely,

Shri Indrajeet Singh (IAS)
Municipal Commissioner, Lucknow

Lucknow City Heat Action Plan

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ABBREVIATIONS

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

Chapter 1: Background and Context

1.1 Climate Change and Extreme Heat

The global situation of heat is a pressing and increasingly urgent issue as climate change intensifies high heat occurrences globally. Increasing global temperatures, predominantly attributable to anthropogenic activities like greenhouse gas emissions, are resulting in increasingly frequent, severe, and extended heatwaves. These hot episodes provide considerable threats to public health, economic stability, agricultural output, and environmental integrity.

Increased variability in temperature distribution is one of the most direct global impacts of climate change, with extreme temperature events occurring more frequently at either extremity of the temperature distribution (IPCC, 2023). The frequency of heatwaves has increased in recent years, which is consistent with the evidence of anthropogenic climate change (IPCC, 2023). According to research, temperature extremes are a significant contributor to weather-related mortality on a global scale. The burden of disease associated with extreme heat is particularly pronounced in Low and Middle-Income Countries, such as India, where extreme environmental exposures intersect with unplanned urbanization, poor-quality housing, declining urban green cover, and other vulnerabilities in the world's most populous country. A national assessment of climate change conducted by the Indian government anticipates that India will experience an increase in extreme heat events and temperatures throughout the 21st century (de Bont et al., 2024).

Extreme heat exposure can result in illness and mortality through a variety of biological mechanisms. It is crucial to note that heat exposure triggers physiological mechanisms, including ischemia, heat cytotoxicity, inflammatory response, disseminated intravascular coagulation, and rhabdomyolysis, as well as vital organs that can be critically impacted, including the brain, heart, intestines, kidneys, liver, lungs, and pancreas. Exposure to extreme heat can result in heat-related morbidity and mortality, such as a variety of heat-related ailments ranging from heat exhaustion to heat stroke. The indirect effects of extreme heat exposure are equally challenging from a public health perspective. These effects emerge when heat exposure stresses underlying physiological systems and leads to other specific manifestations, such as renal insufficiency, acute cerebrovascular and cardiovascular disease, and exacerbations of pulmonary disease. All-cause mortality is a health endpoint that can demonstrate the direct and indirect effects of extreme heat exposure (de Bont et al., 2024).

Extreme weather was intensified and "misery to millions of people" was caused as a result of climate breakdown, which caused the annual global temperature to rise above the globally agreed 1.5°C target for the first time last year. According to statistics from the EU's Copernicus Climate Change Service (C3S), the average temperature in 2024 was 1.6°C higher than preindustrial levels. This is an increase of 0.1°C above 2023, another record-breaking year, and it signifies temperatures that modern people have never before encountered. Burning fossil fuels is the main driver of global warming, and until these fuels are replaced, the damage to people's lives and livelihoods will keep getting worse. A single year above 1.5°C does not indicate that the aim has been missed, but it does demonstrate that the climate emergency is continuing to deepen, as the Paris Agreement target is measured over a decade or two. Among records dating back to 1850, each of the last ten years has ranked among the top ten hottest. According to the C3S statistics, the hottest day ever recorded occurred on July 22, and a record 44% of the world was subject to strong to extreme heat stress on July 10, 2024. El Niño, a natural climate event, increased temperatures in the first half of 2024, but even after El Niño faded, temperatures stayed exceptionally high in the second half of the year. Concerning acceleration of global warming, some experts think an unforeseen element has kicked in; yet, an uncommon year-to-year natural variation could possibly be the cause. It was already obvious that the climate crisis was amplifying extreme weather; the globe is seeing heatwaves, droughts, and wildfires of unprecedented severity and frequency. There have to be ambitious reductions in emissions because the harm to people and ecosystems increases with each fraction of a degree, be it 1.4°C, 1.5°C, or 1.6°C.

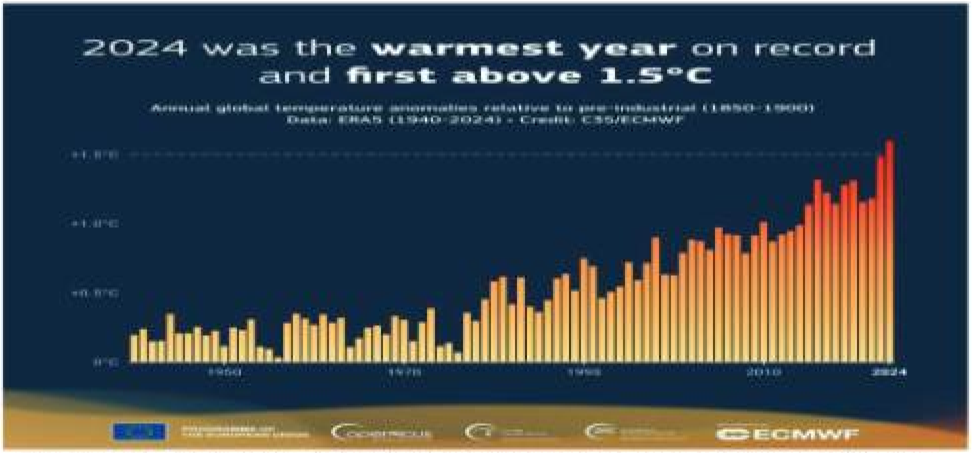


Figure 1: Annual global Temperature anomalies relative to pre-industrial (1850-1900) (ERAS- c3S/ECMWF)

An extended stretch of abnormally hot weather, sometimes with considerable humidity, is called a heatwave. Due in part to the fact that there is no one best indicator from a public health standpoint and that a heatwave is measured in relation to local meteorological norms and seasonally appropriate temperatures, definitions differ by region in both public health and policy literature. When a station's maximum temperature hits at least 40 °C or higher for plains and at least 30 °C or higher for hilly areas, any day in India could be considered for a heatwave declaration, according to the Indian Meteorology Department (IMD). Decisions about heatwaves are based on two factors: either an absolute temperature threshold or a deviation from the typical temperature. When the maximum temperature exceeds the 30-year average historical maximum temperature by greater than 4.5 ◦C, it is considered a heatwave. Regardless of the typical historical maximum temperature, a heatwave is proclaimed if the actual maximum temperature is higher than 45 °C (IMD, 2023).

Heatwave in India: Heatwaves in India have a profound and widespread impact across various sectors, significantly affecting agriculture, water resources, and the economy. In agriculture, heatwaves lead to reduced crop yields, diminished water availability, and lower soil moisture content, which collectively decrease agricultural productivity. This is particularly concerning for crops like wheat, rice, and pulses that are vital for India's food security and are highly susceptible to heat stress (Mishra et al., 2020). In terms of water resources, heatwaves worsen water scarcity by increasing evaporation rates and depleting water availability in reservoirs, rivers, and groundwater sources. This situation is further aggravated in urban areas where high demand often surpasses supply, causing severe water crises (Mall et al., 2023). Economically, the consequences of heatwaves are considerable, especially in labor-intensive sectors such as agriculture, construction, and manufacturing, where productivity declines sharply due to heat stress (Kjellstrom et al., 2020). Together, these impacts highlight the urgent need for comprehensive strategies to address the multifaceted challenges posed by heatwaves in India.

India has had multiple heatwaves, the frequency of which has grown in recent decades. Most notably, in May 1998, India witnessed a severe heatwave lasting two weeks, which was considered the worst in the previous 50 years. The next year, a similar record-breaking event happened in northwestern and central India. In April 1999, India witnessed record-breaking heat, with temperatures reaching 40°C or more for over 14 days. Another heatwave in 2003 is claimed to have killed over 3,000 people in Andhra Pradesh. In May 2010, a heatwave in Ahmedabad (Gujarat), which killed roughly 1300 people, prompted the development of many heat action plans aimed at mitigating the effects of high heat nationally. Extreme heatwaves have been seen across India in recent years, including in 2016, 2018, 2019, and 2023, however few studies have assessed the health impact of these extreme events across numerous Indian cities, and those studies focus on older years of data. In 2024, a major heat wave occurred during India's General Election, resulting in significant mortality and illness. Different communities' demographics and socioeconomic features may influence their vulnerability and adaptive capacity to heatwave events, emphasizing the significance of community-specific assessments and solutions (de Bont et al., 2024).

Urban Heat: Cities all over the world are at risk of warming because of global climate change and the urban heat island (UHI) effect. Extreme heat events have gotten stronger, lasted longer, and happened more often. This has caused record-breaking high temperatures and more deaths and illnesses linked to heat. Today, more than half of the world's people live in cities. By 2050, that number will have grown to about 68%. Just this fact alone makes our cities hard to live in. Also, cities all over the world are already being affected by climate change, which is leading to new ways of planning and designing cities to fit this new urban environment. Especially, the expected rise in temperatures and number of high heat events are having an effect on plans for urban planning. The number of towns that will be hit by extreme temperatures will almost triple in the next few decades. By 2050, the average high temperature in more than 970 towns will be 35°C (95°F) in the summer. This rise in high heat puts a lot of stress on city services like transportation, energy, and water. This has very bad effects on people's health and well-being as a whole (Huang et al., 2025).

People who live in cities are more likely to be exposed to higher temperatures at night and during the day than people who live in the surrounding areas. This is because of something called the Urban Heat Island (UHI) effect. This is because roofs, buildings, and paved surfaces absorb more heat, hot air gets trapped between buildings, and there aren't as many trees. Other things that trap heat and make it rise, like burning fuel and using air conditioning, can make cities 1 to 30°C hotter on average each year. UHI intensity goes up because of things like pollution, climate change, growth, lifestyle, and the way cities are built. More energy use in the summer, more air pollution, and more greenhouse gas releases are all caused by higher temperatures in cities. Higher temperatures are bad for people's health and comfort, and warmer storm water flow hurts the quality of water (Huang et al., 2025).

Uttar Pradesh and Extreme Heat: The state of Uttar Pradesh is located in the centre of the Indo-Gangetic plain. Uttar Pradesh's climate ranges from temperate in the east to extremely dry in the west to semi-arid in the Bundelkhand and Agra zone. As a result, it is quite challenging to classify it within a certain climatic context. Nevertheless, the winters are frigid and the summers are extremely scorching. Typically, heat waves start in the northwest of India or across northern Pakistan and spread to the neighbouring states, including Uttar Pradesh. In the event of development, a heat wave could also form locally across the area**. State experience heat wave condition from March to June.** In April the land area becomes hot with daytime maximum temperatures often reaching above 40°C. At many locations, the difference between the highest and lowest temperatures throughout this season is found to be greater than 15°C. By the end of May and the beginning of June, maximum temperatures quickly increase and surpass 46°C, resulting in extremely hot summers, especially over the SW U.P. (Bundelkhand). When high pressure (3000-7600 metres) in the atmosphere strengthens and stays over a region for several days to several weeks, heat waves result. The air sinks toward the surface when there is a lot of pressure. This falling air covers the atmosphere like a dome. Instead of allowing heat to rise, its cap aids in its retention as per IMD report, in many cities temperature has surpassed 45°C and even crossed 49°C.

City Heat Action Plan in Uttar Pradesh: The National Disaster Management Authority has recommended development and implementation of City Heat Action Plans in the state of Uttar Pradesh. The cities are now becoming hotspot for heat related illnesses due to extreme heat and compounding effect of Urban heat Island. The city of Lucknow has significant slum population and they are the most vulnerable for climate sensitive diseases including heat related illnesses. Therefore, the city needs long term adaptation and mitigation planning for resilience against extreme heat to protect its population.

1.2. City Information Lucknow

1.2.1 Geographic and demographic overview

The capital of Uttar Pradesh, Lucknow is located on the banks of Gomti river which strategically divides the city into 2 halves. Lucknow is the perfect blend of culture and modernization with its rich history still lingering and contributing to the city's exquisite architecture. People all around the world come to experience the city not just as a tourist spot but an epicentre of heritage and culture. It is surrounded by several districts—Barabanki to the east, Unnao to the west, Raebareli to the south, and Sitapur and Hardoi to the north—Lucknow covers an area of approximately 631 square kilometres (244 square miles) after including 88 nearby villages in December 2019. The city sits about 123 meters (404 feet) above sea level, placing it within a seismic zone III, with a moderate earthquake risk. This geography has a vibrant agricultural sector, with crops like wheat, sugarcane, and various fruits being cultivated in the surrounding rural areas. Lucknow is the 11th most populous city and the 12th most populous urban area in India. Below are some facts and figures related to the city of Lucknow:

Table 1: Lucknow City Information

Details	Information
Latitude	26.50° N
Longitude	80.50° E
Altitude	123 m (404 ft)
Total area	631 km² (244 sq mi)
Population (as per census 2011)	2,817,105
Average Rainfall	1010 mm (40 in)
Average temperature	25°C (max), 6-8°C (min)

City's location:

Located in the middle of the vast Gangetic Plain, Lucknow is surrounded by numerous rural towns and villages, including scenic orchard towns of Malibabad , the historic Kakori, and the vibrant Mohanlalganj, Gosainganj, Chinhat, and Itaunja. The cities that border Lucknow are: Barabanki to the east, Unnao to the west, Raebareli to the south, and Sitapur and Hardoi to the north. The chief geographic feature of the city is the Gomti River, which elegantly divides the city into two regions: more developed Trans-Gomti and emerging Cis-Gomti. Defense areas of Lucknow Cantonment support urbanization and development but also poses a threat and restrict land usage and construction. As discussed earlier, Lucknow's geography supports agriculture and development, the city often faces issues with uncontrollable growth, urban sprawl, and waterlogging. There is certainly a need for improvement of connectivity for better access during hazardous situations.

Geography: The wonderful city of Lucknow is situated on the banks of the Gomti River, covering a stretch of 30 kilometres. Even though Gomti is an essential source of water for Lucknow, contributing majorly to the region's agriculture and ecosystem, it often faces challenges related to water pollution and urbanization that in turn affects the health and the river's utility. The area is known for a variety of soil types like sandy loam, silty clay and clay loam, which are fertile for growing crops like mangoes and rice. The fertility and variety of the soil makes it an agricultural hotspot. The alluvial soil here ranges from grey to ash grey in colour. This variation is mainly because of the composition of the soil, which includes minute particles of silt, sand, and clay making it even more fertile.

Transportation: Lucknow offers a variety of public transportation options, which include metro rails, taxis, city buses, cycle rickshaws auto rickshaws, and CNG-powered low-floor buses (with and without AC). The city is located strategically at the intersection of two major national highways – NH 30 linking Shahjahanpur and Allahabad and NH 27, connecting Kanpur and Porbandar. Lucknow also has an extensive rail network with the main hub at Lucknow railway station in Charbagh. Lucknow also has an international airport Chaudhary Charan Singh International Airport, which is recognized for all-weather operations. Lucknow metro, launched at September 6, 2017, is India's fastest-built metro project and the city also promotes cycling with bike tracks constructed specifically for the same.

Demographic overview: The capital of Uttar Pradesh has a diverse demographic profile. According to Census 2011, the total population was **2,817,105** with a sex ratio of 928 females for every 1000 males. The child population (aged 0-6) is around **293,697,** with a child sex ratio of 904 girls for every 1000 boys. The literacy rate of Lucknow is 82.50%. All of these reflect the city's cultural diversity and developmental trends, contributing to a successful urban centre in northern India. Main languages spoken are Hindi and Urdu.

Numerous causes are contributing to the growing population density. Many people have moved from rural to urban areas due to urbanization in search of better employment options, however this has increased the population of urban areas. Today, Lucknow serves as a commercial and educational center that draws people looking to raise their level of living. Families find Lucknow to be a more desirable place to reside thanks to its infrastructure, which includes healthcare and transportation. Additionally, the city is home to numerous educational establishments that draw students from other areas. Because urbanized areas offer better living conditions and more basic facilities, social reasons also play a part in the government's promotion of housing and urban development.

Table 2: Literacy rate with population distribution (Census 2011)

Male	**Population**	**1,460,970**
	Literacy Rate	**86.04%**
Female	**Population**	**1,356,135**
	Literacy rate	**78.70%**

1.2.2 Climate Context

The hot summers, dry, chilly winters, and intense monsoon season characterize Lucknow's climate. Recent trends indicate that extreme heat events are becoming more common and ordinary temperatures are growing. The severe weather, which varies from scorching heat to dry, icy winters, causes many problems for the residents of Lucknow. The comprehensive facts regarding Lucknow's climate, historical patterns, and preventative actions to address the problem of steadily increasing humidity and warmth are highlighted in this section.

Climate data for Lucknow (Chaudhary Charan Singh International Airport) 1991–2020, extremes 1952–present													[hide]
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °C (°F)	31.6 (88.9)	35.9 (96.6)	41.1 (106.0)	45.0 (113.0)	46.5 (115.7)	47.7 (117.9)	44.2 (111.6)	40.4 (104.7)	40.1 (104.2)	38.7 (101.7)	38.0 (100.4)	29.9 (85.8)	47.7 (117.9)
Mean daily maximum °C (°F)	21.4 (70.5)	26.2 (79.2)	32.2 (90.0)	38.2 (100.8)	39.9 (103.8)	38.3 (100.9)	34.2 (93.6)	33.4 (92.1)	33.4 (92.1)	32.8 (91.0)	29.0 (84.2)	23.6 (74.5)	31.9 (89.4)
Daily mean °C (°F)	14.0 (57.2)	18.4 (65.1)	23.8 (74.8)	29.6 (85.3)	32.6 (90.7)	32.5 (90.5)	30.0 (86.0)	29.5 (85.1)	28.9 (84.0)	26.0 (78.8)	20.9 (69.6)	15.9 (60.6)	25.2 (77.3)
Mean daily minimum °C (°F)	7.8 (46.0)	11.0 (51.8)	15.4 (59.7)	21.0 (69.8)	24.8 (76.6)	26.7 (80.1)	26.0 (78.8)	25.6 (78.1)	24.4 (75.9)	19.5 (67.1)	13.3 (55.9)	8.9 (48.0)	18.7 (65.7)
Record low °C (°F)	−1.0 (30.2)	0.0 (32.0)	5.4 (41.7)	10.9 (51.6)	17.0 (62.6)	19.2 (66.6)	21.5 (70.7)	21.2 (70.2)	17.2 (63.0)	10.0 (50.0)	3.9 (39.0)	0.5 (32.9)	−1.0 (30.2)
Average rainfall mm (inches)	21.6 (0.85)	14.0 (0.55)	11.0 (0.43)	5.5 (0.22)	24.5 (0.96)	107.4 (4.23)	236.5 (9.30)	241.6 (9.51)	162.1 (6.38)	27.9 (1.10)	2.5 (0.10)	4.7 (0.19)	861.4 (33.91)
Average rainy days	1.7	1.4	1.1	0.7	2.0	5.1	11.8	10.6	7.2	1.4	0.4	0.5	43.8
Average relative humidity (%) (at 17:30 IST)	61	49	35	26	32	49	73	77	73	62	59	63	55
Average dew point °C (°F)	9 (48)	12 (54)	13 (55)	14 (57)	19 (66)	23 (73)	26 (79)	26 (79)	25 (77)	19 (66)	14 (57)	10 (50)	18 (63)
Average ultraviolet index	5	7	9	11	12	12	12	12	10	8	6	5	9

Figure 2: Climate data for Lucknow (Source: IMD, Weather Atlas, Tokyo Climate Center)

Table 3: Climatic information of Lucknow

Parameters	Information
Climate	Humid subtropical climate
Latitude	26.85° N
Longitude	80.93° E
Average Temperature	25.3°C (annual average)
Average rainfall	1010 mm (40 in) annually
Relative humidity	Approximately 68.6% (annual average)
Prominent wind direction	Predominantly from the southwest during monsoon; varies throughout the year

The capital of Uttar Pradesh is mainly characterized by extremes of weather due to its significant distance from the sea. Due to this, continental air dominates for most of the year. During monsoon, specifically from June to September, oceanic air enters which results in humidity, cloudiness, and rainfall at last. Around 75% of yearly rainfall occurs within these 4 months. The climate of Lucknow can further be divided into 4 seasons:

1. Winter evenings can occasionally dip to 3–4°C during cold spells brought on the Himalayan winds during the cold season, which runs from December to February. Even though afternoons frequently see sunshine, morning fog and mist are typical.
2. Hot Weather Season (March to Mid-June): Summers are extremely hot, with potential peaks getting as high as 46°C and averages between 38 and 39°C. For a few days, heatwaves can raise the daily maximum temperature by 4–6°C.
3. Monsoon Season (June to September): The weather changes as the monsoons arrive because of the heavy rainfall and humidity they bring.
4. Post-Monsoon Transition: This time frame connects the monsoon and winter seasons and lasts from October to November.

Winters in Lucknow are generally mild but can get very cold sometimes and create a contrasting picture with the scorching heat during summers.

1.3 Impact of Extreme Heat in City (Temp, Heatwave days)

Lucknow, the capital of Uttar Pradesh, experienced a steady rise in maximum temperatures from 1982 to 2024. The temperature increased from 44.87°C (1982) to 46°C (2023), a difference of +1.13°C. June also witnessed a significant increase, with temperatures rising from 44.94°C (1982) to 46.36°C (2023), a difference of +1.42°C. The rising trend across all summer months indicates the growing impact of extreme heat on urban areas like Lucknow. The city is particularly vulnerable due to the urban heat island effect, which amplifies temperatures in densely populated areas.

Temperatures have been rising ever since especially in summers. This results in frequent heatwaves and severe health risks during the months of summer. A maximum temperature of **46°C**, which is **5.6°C above normal** was recorded in May 2024 after a previous high of **43.2°C.** Heatwaves cause significant health risks to vulnerable populations like the elderly and young children. Heavy sweating, weakness, and dizziness are some symptoms of heat exhaustion. While heat stroke can cause confusion and loss of consciousness. Heatwaves heavily affect daily life, increasing hospital administrations due to heat-induced diseases. During heatwaves, Relative humidity can range between 45% and 65%. Higher humidity adds to the distress caused by higher temperatures and increased health risks. Humidity slows down the evaporation of sweat, which makes it harder for the body to cool down which gives rise to numerous above-stated issues.

Lucknow is home to approximately 787 slums and more than 10 lakh people residing in those areas in overcrowded situations. Census 2011 states that 27% of the population live in slum areas without basic amenities like proper roofing and clean water to drink in the hot humid weather conditions.

Lucknow is one of those cities that is rapidly urbanizing but amidst all these developments a threat is posed to the climatic conditions due to industrialization. Implementation of targeted intervention is necessary at this very moment to help diminish the effects of heat and provide a sustainable living condition. A study by Mishra et al in 2023 examined Land Use and Land Cover (LULC) changes in Lucknow from 1992 to 2022. The findings stated that in 1992, 37.57% was barren land while built-up area and vegetation were 23.27% and 43.95% respectively. Whereas in 2022, the built-up area constituted 50.77% of the total area. This shows that there has been rapid urbanization. Barren land in 2022 was reduced to 11.70% and vegetation dropped to 13.42%. This signifies the conversion of a substantial proportion of land was converted for urban purposes. The green cover also dropped from 34.95% in 1992 to 22.72% in 2022. Water bodies were also not exempted, it showed a slight decline from 1.43% to 1.36%, emphasizing the need of water resource management at the earliest.

Table 4: Year-wise statistics of mean maximum temperature, humidity, heat index (HI) and days with maximum temperature >40° C for the Lucknow city

Year	Maximum Temperature mean ± SD	Highest recorded value of temperature	Relative humidity mean ± SD	Highest recorded value of Relative humidity (%)	Heat Index (Mean±SD)	Highest Heat Index	Maximum Temperature >40° C (days)
2014	36.70± 4.78	46.3	59.69± 19.02	100	123.68±25.39	202.45	42

2015	35.81± 5.28	45.7	65.48± 16.28	100	123.44±21.96	195.25	38
2016	36.92± 3.82	44.4	61.18± 20.47	100	124.69±17.28	192.50	41
2017	36.67± 4.63	45.3	62.03± 17.80	100	125.28±20.37	177.31	45
2018	36.75± 3.58	44.8	61.37± 16.66	100	125.13±19.49	176.72	32
2019	36.97± 4.84	44.9	60.04± 18.49	100	124.98±21.62	169.30	50
2020	34.59± 4.00	44.1	72.28± 14.49	100	123.55±21.25	175.37	10
2021	35.68± 3.27	41.9	64.66± 18.72	100	122.55±18.99	168.31	12
2022	38.10± 3.79	45.1	63.57± 15.21	100	137.11±24.03	213.43	54
2023	35.56± 3.85	43.2	51.83±23.03	98	112.83±21.32	177.10	29
2024	37.42± 4.76	46	58.31± 18.17	98	126.39±22.80	177.72	47

The analysis of year-wise statistics for Lucknow city, as presented in Table 4, highlights notable trends in maximum temperature, humidity, heat index (HI), and the frequency of extreme heat days. From 2014 to 2024, the mean maximum temperature ranged between 34.59 ± 4.00°C (2020) and 38.10 ± 3.79°C (2022), with the highest recorded temperature peaking at 46.3°C in 2014 and again at 46.0°C in 2024. Relative humidity showed fluctuations, with mean values ranging from 51.83 ± 23.03% (2023) to 72.28 ± 14.49% (2020), and the highest recorded relative humidity consistently reaching 100% except in 2023 and 2024 (98%).

The heat index (HI), reflecting the combined effect of temperature and humidity, demonstrated substantial variability, with mean values peaking at 137.11 ± 24.03 in 2022, coinciding with the highest recorded HI of 213.43. The number of days with maximum temperatures exceeding 40°C also varied widely, from just 9 days in 2020 to 52 days in 2022. These findings underline the variability in thermal and humidity conditions over the years, with 2022 standing out as the most severe year in terms of heat stress indicators. This data offers critical insights for understanding trends in extreme heat and their potential implications for public health and urban planning.

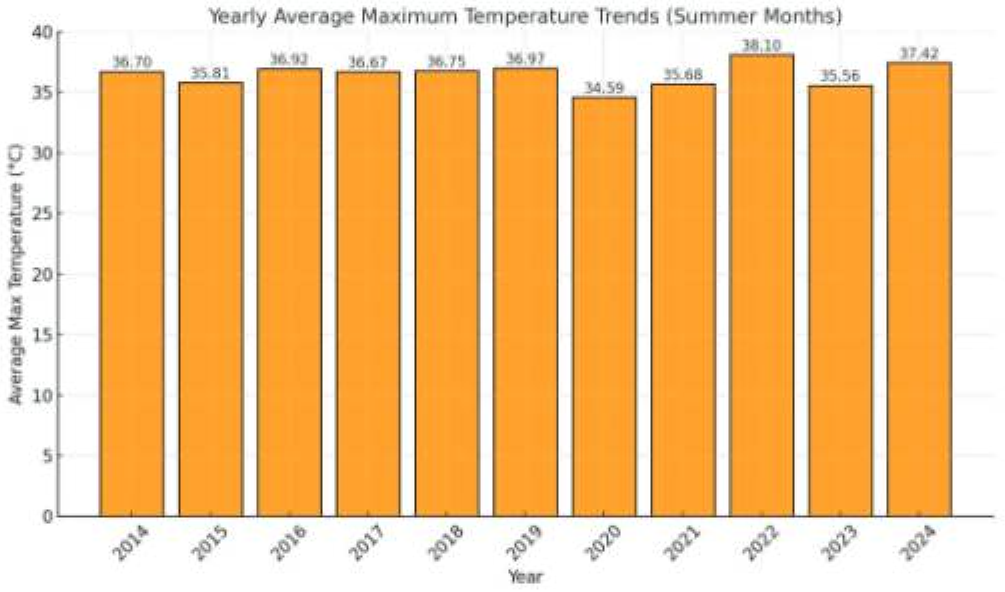


Figure 3: Yearly average Maximum temperature trends (March to June) for the last decade (2014-2024)

The Figure 3 illustrates the yearly average maximum temperature trends for the summer months (March to June) in Lucknow city over a decade (2014–2024). The average maximum temperature fluctuates slightly across the years, with a noticeable dip in 2020 (34.59°C), marking the lowest value during the period, followed by a significant rise to the highest average of 38.10°C in 2022. Temperatures remain relatively consistent in most other years, hovering around 36–37°C, with minor variations. The values highlight both inter annual variability and an overall resilience in temperature levels, underscoring the prevalence of intense summer heat in the region. These trends are indicative of potential implications for urban planning and heat adaptation strategies in the city.

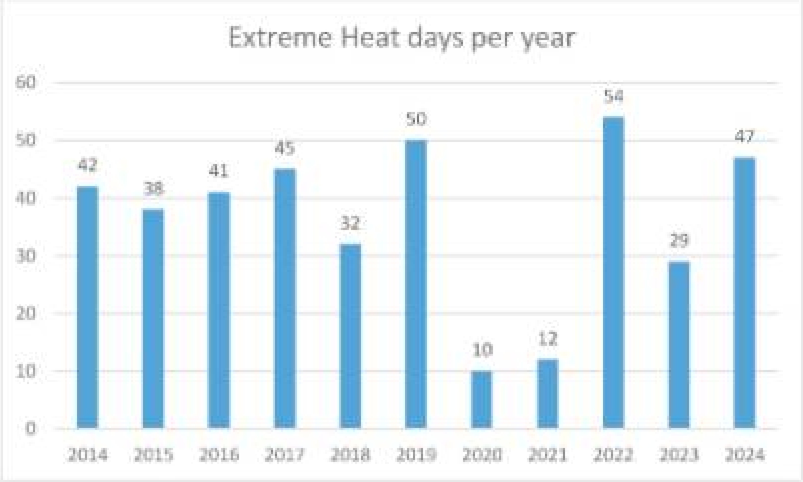


Figure 4: Trends of Extreme Heat Days (Temperature above 40°C) per years (2014-2024).

Figure 4 depicts the trend of extreme heat days per year in Lucknow from 2014 to 2024, showing significant year-to-year variation. The number of extreme heat days peaked in 2022 with 54 days, while 2020 witnessed the lowest count, demonstrating a dip in extreme heat events during that year. The overall trend highlights an increasing pattern of extreme heat days in recent years.

Table 5: Distribution of Absolute Heatwave days and Severe Heat wave days

Year	Absolute Heatwave Days (>40°C)	Absolute Severe Heatwave Days (>45°C)	95th Percentile Heatwave Days -43.2	98th Percentile Severe Heatwave Days – 44.3
2014	42	3	10	6
2015	38	2	13	5
2016	41	0	3	1
2017	45	1	6	3
2018	32	0	2	1
2019	50	0	9	3
2020	10	0	2	0
2021	12	0	0	0
2022	54	1	7	1
2023	29	0	1	0
2024	47	6	16	10
Absolute Heatwave Days- Maximum temperature above 40 °C, Absolute Severe Heatwave Days - Maximum temperature above 45 °C				

Table 5 provides a year-wise distribution of heatwave and severe heatwave days in terms of absolute and percentile-based criteria. From 2014 to 2024, the number of "Absolute Heatwave Days" (days with maximum temperatures above 40°C) ranged from a low of 10 days in 2020 to a high of 54 days in 2022, with notable peaks in 2019 and 2024. "Absolute Severe Heatwave Days" (maximum temperature above 45°C) were rare but spiked significantly in 2024 with 6 days, compared to zero or minimal occurrences in other years. Heatwave days based on the 95th percentile threshold (43.2°C) and severe heatwave days (44.3°C) showed lower counts overall, with the highest occurrences in 2024 at 16 and 10 days, respectively. A general fluctuation in extreme heat events is observed over the decade, with certain years like 2024 and 2019 standing out for their intense heatwave activity, while years like 2020 and 2021 experienced comparatively milder conditions.

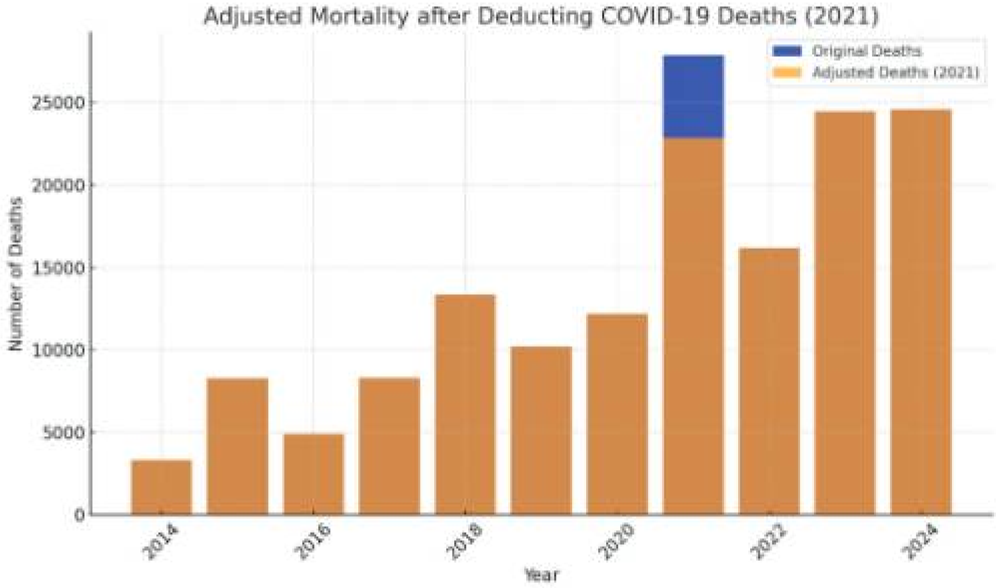


Figure 5: Adjusted excess mortality for 2021 due to COVID-19

The above graph illustrates the adjustment in all-cause mortality for 2021 (March, April, May, and June) by deducting 5,000 COVID-19 excess deaths. The orange bars represent the adjusted mortality data, showing a significant reduction in deaths for 2021 compared to the original count (blue bars). This adjustment highlights the impact of COVID-19 on mortality rates in that year and provides a more accurate representation of deaths attributable to other factors, including heatwaves and severe heat events. The adjusted data indicates that after accounting for COVID-19, mortality in 2021 aligns more closely with the general trend observed in other years. This adjustment is crucial for isolating the effect of heat-related mortality from pandemic-driven excess deaths (Figure 5).

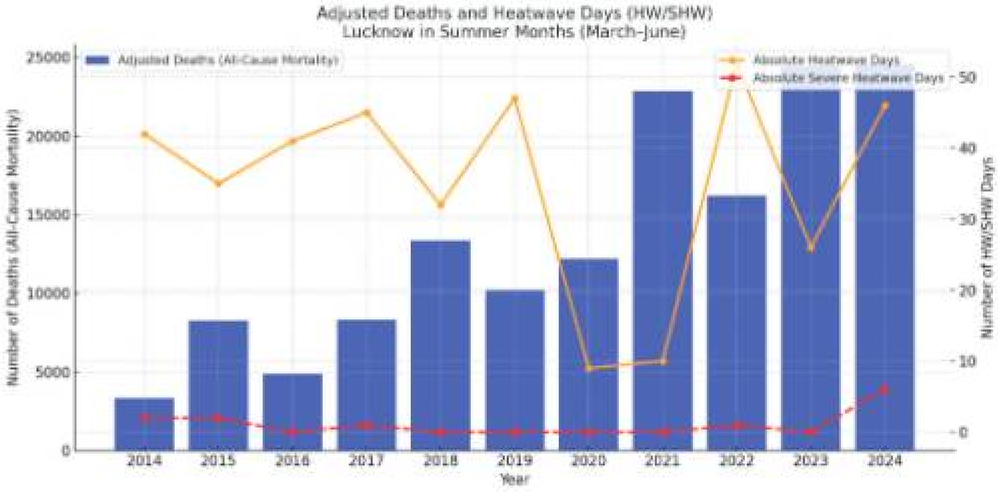
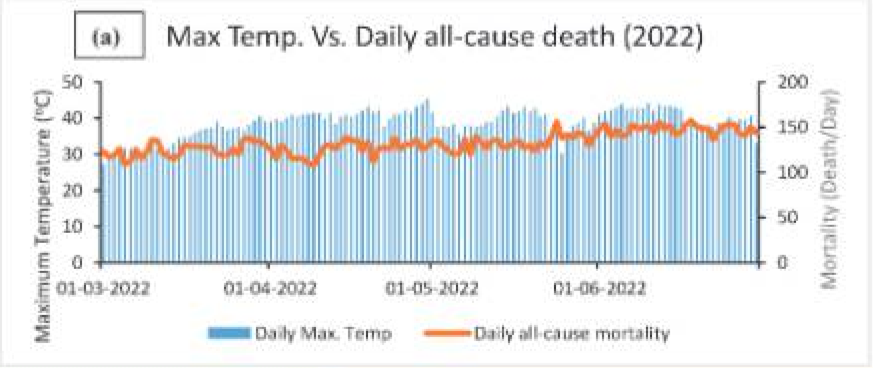


Figure 6: Distribution of HW/SHW and all-cause mortality for the last decade during summer months

Figure 6 displays the adjusted all-cause mortality (blue clustered columns) and the number of heatwave (HW) and severe heatwave (SHW) days (orange and red lines, respectively) for Lucknow during the summer months (March–June) from 2014 to 2024. The primary axis shows the number of deaths, while the secondary axis captures the HW and SHW days.

The chart highlights the variability in HW and SHW days, with peaks in 2022 (52 HW days) and 2024 (46 HW days, 6 SHW days). Meanwhile, the mortality trend (blue bars) shows a general increase over time, which aligns with the rise in heatwave frequency and intensity. This visualization effectively combines two key metrics to emphasize the impact of extreme heat events on mortality. The data underscores the growing impact of heatwaves on public health, emphasizing the need for targeted mitigation and adaptation strategies to protect vulnerable populations from the adverse effects of extreme heat.

Temperature and Mortality analysis



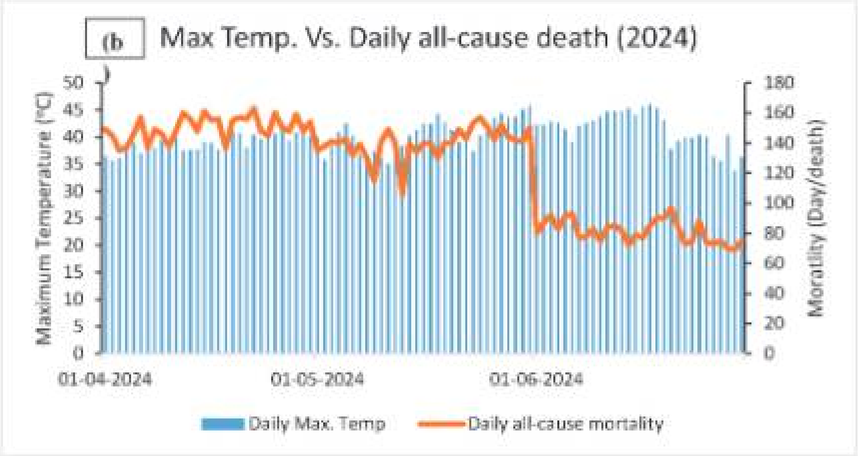


Figure 7: Maximum Temperature vs. daily all-cause deaths (a) 2022 (b) 2024

Figure 7 (a) and (b) depict a comparison between maximum daily temperatures (°C) and daily all-cause mortality for the years 2022 and 2024. In both cases, the blue bars represent the maximum daily temperature, while the orange line corresponds to daily mortality counts.

In 2022 (Figure 7(a), the temperature generally increased and stayed consistently high (above 35°C) during the warmer months, with a corresponding rise in daily mortality counts peaking around mid-year. Mortality shows moderate fluctuation, peaking on certain days where the temperature was consistently high.

In 2024 (Figure 7(b), the temperature exhibits a similar pattern of increase and fluctuation, but with slightly more variability. A notable observation is a sharp dip in daily mortality during June, despite sustained high temperatures. This suggests possible interventions or other factors influencing mortality during this period. Overall, both graphs highlight a strong relationship between rising temperatures and mortality, though the patterns of mortality differ slightly between the two years.

1.4 Rationale of Lucknow City Heat Action Plan

Extreme heat is having a catastrophic impact on infrastructure, livelihoods, and human lives, which is why the Heat Action Plan is crucial. Everyone is impacted by the extensive effects, which range from power outages to heat-related ailments. The city can lessen the effects of extreme heat and create more resilient communities that can withstand any problems in the future by adopting this Heat Action Plan (HAP). The HAP takes a holistic approach to addressing the various aspects of heat-related risks, including community involvement, infrastructure resilience, public health, policy frameworks, and innovative research.

The City Municipal Corporation must create a thorough heat response plan in order to protect its citizens from the growing risks associated with extreme heat events. The vulnerability of particular population groups, the increased demand on healthcare facilities, the strain on infrastructure systems, and the increased danger of environmental degradation and urban heat island effects within the metropolitan region are some of the factors that exacerbate this difficulty. These issues are acknowledged by the Heat Action Plan (HAP), which provides a thorough framework for addressing heat-related risks, boosting resilience, and encouraging sustainable activities.

Building resilience into health systems can help reduce the burden of heat waves on public health by 1) improving preparedness by enhancing forecasting expertise and investing in vulnerability assessments to inform risk management and communicate practical recommendations, especially to the most vulnerable populations, for reducing heat risks, and 2) improving heat interventions by emphasising inter-sectoral collaboration and implementing responsible.

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

1.5 Purpose and key strategies of Uttar Pradesh State Heat Action Plan

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

Key Components of City Heat Action Plan:

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

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

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

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

1.6 Objectives of the Lucknow City Heat Action Plan

The City Heat Action Plan is a strategic and proactive roadmap that is intended to address the intricate and changing challenges that heatwaves present in urban areas. By emphasizing resilience, promoting adaptive strategies, nurturing collaboration among diverse stakeholders, and ensuring public health and well-being, the HAP endeavors to navigate the changing climate landscape with foresight and resilience. The Municipal Corporation's objective is to substantially reduce heat-related mortality and morbidity, improve the adaptive capacity of its infrastructure, and cultivate a culture of preparedness and resilience among its residents by implementing this comprehensive plan.

1. To develop and implement various strategies for extreme heat events
2. To develop and implement an early warning system in partnership with IMD for alerting those populations at risk and carrying out activities by the line departments
3. To take appropriate measures for the Prevention and Mitigation against Heat Related Illnesses
4. To build capacity of City inter-department officials for efficient and coordinated implementation of City heat action plan

5. To make more and appropriate use of adaptation and mitigation strategies for reducing heat waves and its impact on human health, livelihood and economy
6. To identify vulnerable population and heat hotspots in the city
7. To reduce the heat related illnesses
8. To enhance resilience of communities against extreme heat events
9. To make City of Lucknow more resilient against extreme heat wave

Chapter 2: Early warning System and Heat Health Communication

2.1 Introduction

Early warning systems (EWS) for disaster prevention are essential for alleviating the effects of natural disasters and other emergencies. Their objective is to deliver prompt and precise knowledge regarding forthcoming events, enabling people, communities, and governments to implement preventive measures and mitigate losses of life and property. Effective Early Warning Systems encompass a sequence of actions, including monitoring, forecasting, distribution, and response. Effective Early Warning Systems (EWS) encompass not only the issuance of alerts but also the establishment of preparedness and response mechanisms at the community level. This encompasses the instruction of communities regarding evacuation protocols, the formulation of emergency response strategies, the establishment of communication frameworks, and the distribution of emergency provisions. The involvement of local leaders and the promotion of community engagement are essential for the effective execution of initiatives.

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

The early warning system is also involving notification of heat wave events, and communication of prevention responses. After several devastating heat wave events in 2010 and 2016, many cities and states across the country-implemented early warning system as a risk reduction strategy (Lowe et al, 2011). Early warning systems can enhance the preparedness of decision-makers and enhance preparedness against the disaster. Early warning systems for natural hazards is based both on sound scientific and technical knowledge. Accurate and timely alert systems are essential part of early warning system. The City Administration should collaborate with IMD Regional Office Lucknow for developing and implementing an effective early warning system for the city. The nodal officer will utlize the information for issuing a early warning alert during extreme heat days.

2.2 Heat Wave Definition (NDMA, 2019, UPSDMA, 2025)

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

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

Criteria for Heat Wave (IMD)

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

a) Based on Departure from Normal

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

b) Based on Actual Maximum Temperature

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

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

2.3 City Heat Index and Threshold Determination

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.

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

To develop heatwave thresholds for the city of Lucknow, weather data—daily maximum and minimum temperatures and humidity—were obtained from the Indian Meteorological Department (IMD) for summer months (March to June) (Golechha et al., 2021). Percentile-based thresholds, as recommended by WMO and WHO for developing heat health warning systems, were used. Specifically, the 80^{th}, 88^{th} 95th and 98^{th} percentiles were calculated for (1) a common seasonal threshold for the entire summer (March–June) and (2) individual thresholds for each summer month (March, April, May, and June) for Lucknow city. A multi-step methodological approach to investigate the relationship between temperature, heat index, and all-cause mortality, with an emphasis on identifying significant temperature thresholds. Initially, a quadratic regression model was applied to analyze the temperature-mortality relationship. The methodologies employed align with established practices in environmental epidemiology for assessing the impact of temperature on mortality. The use of Distributed Lag Non-Linear Models (DLNMs) is a standard approach to capture both non-linear and delayed effects of temperature on health outcomes.

Maximum temperature was used as the primary independent variable, with percentile-based thresholds (80^{th}, 88^{th} 95^{th} and 98^{th}) calculated to categorize heat alerts. These thresholds were selected to represent varying levels of heat severity, ranging from moderate to extreme conditions (Table 6). The model incorporated a quadratic term to account for non-linear relationships, and the predicted mortality curve was plotted alongside observed data to identify key temperature thresholds.

In the advanced modeling phase, lagged temperature variables were introduced to evaluate the delayed effects of heat exposure on mortality. Lagged maximum temperatures for 1-day, 2-day, and 3-day periods were included in the model alongside the quadratic temperature term to assess cumulative and delayed impacts of heat. The model was then subjected to residual diagnostics, including residual plots and Q-Q plots, to evaluate model performance and assumptions such as normality and linearity.

For sensitivity analysis, percentile-based thresholds were systematically varied to test the robustness of the identified temperature-mortality relationships. Models were constructed for each threshold level (90th, 95th, and 98th percentiles), and their fit was evaluated using R-squared values and p-values to assess the consistency and strength of the associations across varying levels of heat intensity.

For examination of dose-response relationship between maximum temperature on total daily deaths by statistical software package R-version 3.5.3. This structured methodology allowed for a comprehensive examination of the relationship between temperature and mortality, incorporating both immediate and lagged effects, as well as exploring the impact of varying thresholds to assess the robustness and applicability of the findings.

Heat threshold and early warning system for the City of Lucknow

Table 6: Month-wise and seasonal Thresholds for Heat wave warning for Lucknow

	Moderate level (80% percentile) Yellow alert	**High level (88% percentile) Orange alert**	**Very hight level (Heat alert day) (95% percentile) Red alert**	**Extreme high level (Extreme heat alert day) (98% percentile Extreme Red alert**
April	40.80° C	41.45° C	42.30° C	43.04° C
May	42.00° C	43.00° C	43.90° C	44.40° C
June	41.92° C	42.70° C	44.32° C	45.30° C
Common seasonal threshold for entire summer (March to June) months				
	80% percentile	**88% percentile**	**95% percentile**	**98% percentile**
	41.00° C	42.00° C	43.70° C	44.32° C

Table 6 presents heat wave warning thresholds for Lucknow, categorized into four levels based on percentile values: Moderate (80th percentile - Yellow alert), High (88th percentile - Orange alert), Very High (95th percentile - Heat Alert Day with Red alert), and Extreme High (98th percentile - Extreme Heat Alert Day with Extreme Red alert). These thresholds represent varying levels of heat wave severity and serve as a framework for public health measures and interventions.

- **April**: In April, the heat wave thresholds start with a Yellow Alert at 40.80°C, escalate to an Orange Alert at 41.45°C, with a Red Alert triggered at 42.30°C (95th percentile) and an Extreme Red Alert at 43.04°C (98th percentile).
- **May**: In May, the thresholds increase further, with a Yellow Alert beginning at 42.00°C, an Orange Alert at 43.00°C, a Red Alert at 43.90°C (95th percentile), and an Extreme Red Alert at 44.40°C (98th percentile).
- **June**: in June, a Yellow Alert is triggered at 41.92°C, an Orange Alert at 42.70°C, a Red Alert at 44.32°C (95th percentile), and an Extreme Red Alert at 45.30°C (98th percentile).

For the entire summer (March to June), the common thresholds are defined as follows: a Yellow Alert is triggered at 41.00°C (80th percentile), an Orange Alert at 42.00°C (88th percentile), a Red Alert at 43.20°C (95th percentile), and an Extreme Red Alert at 44.32°C (98th percentile). These thresholds serve as crucial benchmarks for identifying heat wave days and implementing timely interventions to reduce health risks and protect vulnerable populations.

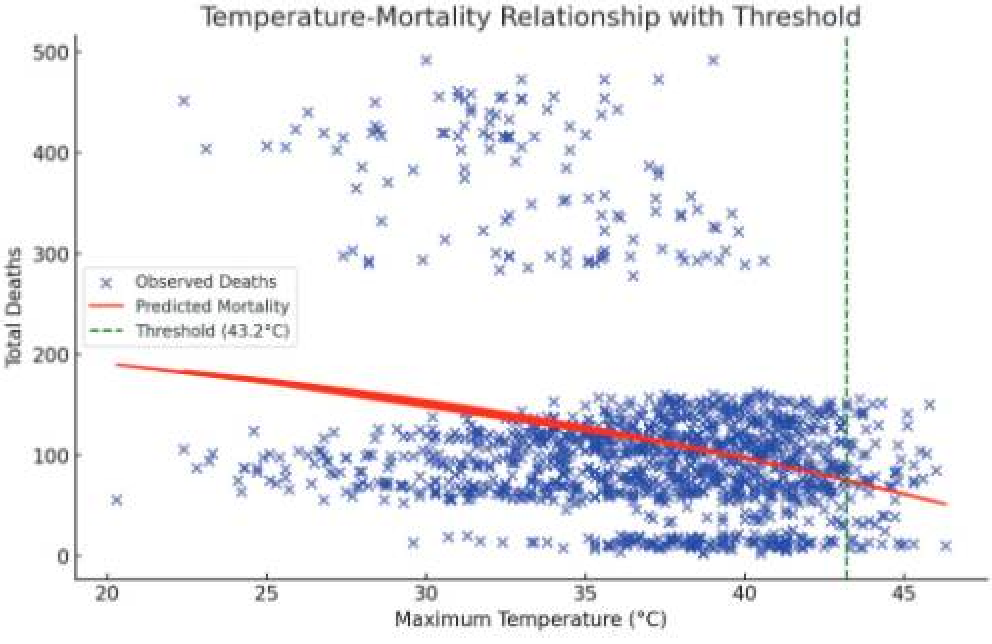


Figure 8: Temperature- mortality relationship with threshold (95th percentile)

Table 7: Sensitivity analysis for Threshold percentiles

	Threshold Temp (°C)	Model R-squared	P-value
80th Percentile	41.0	0.0047	0.2546
88th Percentile	42.0	0.0203	0.4882
95th Percentile	43.2	0.0153	0.4618
98th Percentile	44.362	0.1557	0.0787

The sensitivity analysis evaluated the robustness of the temperature-mortality relationship across varying thresholds: the 80th (41.0°C), 88th (42.0°C), 95th (43.2°C), and 98th (44.362°C) percentiles of maximum temperature. These results suggest that while extreme heat (e.g., 98th percentile) may pose a higher risk, temperature alone does not strongly predict mortality, emphasizing the need to consider additional factors such as humidity, healthcare access, or population vulnerability in future analyses (Table 7). Overall, the results suggest that lagged temperature effects are weak in this dataset, and other unmeasured factors may play significant roles. However, percentile-based thresholds offer a flexible approach to assessing heat-related mortality risks, with higher percentiles showing more consistent patterns of impact. This highlights the utility of percentile-based methods in understanding and categorizing the severity of heat effects on public health.

2.4 Heat Alert Warning Systems in City of Lucknow

Early warning systems can enhance the preparedness of decision-makers and their readiness to harness favourable weather conditions. Early warning systems for natural hazards is based both on sound scientific and technical knowledge. Accurate and timely alert systems are essential. Collaboration with India Meteorological Department (IMD) is needed to develop heat warning systems (HWS), trigger a warning, determine the threshold for action and communicate the risks. The IMD provides warnings based on heat index (based on temperature and humidity). It disseminates information to Relief Commissioner (RC), District Magistrates, Municipal Commissioners and all other concerned authorities including Doordarshan, All India Radio (AIR) by email. Immediately upon receipt of such a warning, the City Heat Action Plan Nodal Officer will make necessary arrangements for disseminating the warning through all forms of media (Figure 10). Simultaneously, departments of Health and Family Welfare, Education, Labour,Transport, and other related departments remain alert and put necessary emergency measures in place. During a Heat Wave condition, Nodal Officer issues directives to all the concerned governmental organizations for a prompt action.

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

The operational system of weather forecasts and warning is summarized in the chart below (*Figure 9*).

Figure 9: Temperature Forecast: Specific Range, Time duration and area

2.5 Declaring Heat wave for the City of Lucknow During 2025 and colour code signals

For declaring the heat wave, the above criteria should be met for at least at two stations in a Meteorological sub-division for at least two consecutive days. A heat wave will be declared on the second day. The early warning would be communicated to line department from City **Heat Action Plan Nodal Officer through Heat Wave Early Warning Communication System (*Figure10*).**

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

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

Yellow alert	Hot day advisory	41.1- 43-degree C
Orange alert	Heat alert day	43.1- 44.9-degree C
Red alert	Extreme heat alert day	≥ 45-degree C

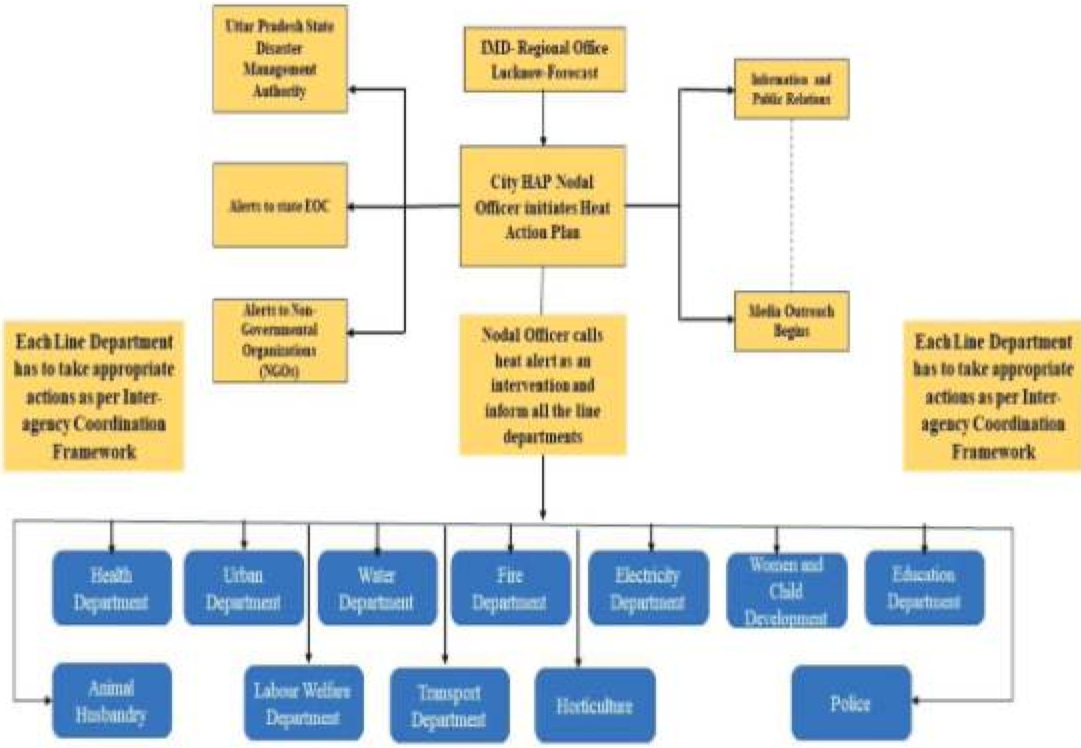


Figure 10: Heat Health Communication System

Chapter 3: Inter-department Coordination Framework and Roles and Responsibilities of Line Department at City Level

3.1 Introduction and inter-departmental coordination framework

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

3.2 Phases of Heat Action Plan Implementation

The Heat Action Plan shall be implemented in 3 Phases annually

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

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

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

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

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

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

3.3 Roles and Responsibilities of the Departments

3.3.1 City Heat Action Plan Nodal Officer

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

- Facilitate the Constitution of a heat wave action plan committee/task force: Prevention and Mitigation of Impacts of Heat Wave, with Municipal Commissioner as a Chairman and Nodal Officer as Member Secretary, representatives of all departments to be member of this committee.

- Committee should meet at-least 3 times in year, once in pre-heat, during-heat and post-heat season.
- Establish heat mortality tracking system and update datasets
- To review preparedness instructions to all concerned departments for the heat season
- Develop and Implement City Heat Action Plan- Capacity Building initiative at City level
- Preparation of a list of high risk areas in the City vulnerable to heat waves for more focus in planning to mitigate adverse effects of Heat wave
- Convene meetings at City level with the concerned Departments/ Agencies/ NGOs involved in response mechanism to Heat waves to review the action plan periodically
- Develop and Distribute pamphlets and posters with tips to prevent heat stress in local language to hospitals, schools, and professional associations

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

- Led the implementation of City Heat Action Plan
- Monitoring of implementation of various activities of City Heat Action Plan
- Establishing incident and emergency management teams
- Monitoring City heat action plan implementation
- Organizing meeting with concerned departments during heat season
- Awareness relating to prevention and management of heat related illnesses
- Advertisements on safety tips through local newspapers, radio and television channels.
- Issue of timely information and warnings to all key Departments / Agencies, State Emergency Operation Center (SEOC), DEOC etc.
- Communicate locations of emergency facilities and cooling centers/shaded areas with each Department / Organization.
- Inform power supply Companies to prioritize maintaining power to critical facilities (such as hospitals) during extreme heat events
- Notify all the stakeholders when the heat alert is issued and over.
- Ex-Gratia Relief- After declaring heat wave as State Specific disaster vide notification no- 303/1-11-2016-4(G)/ 2016 dated 27 June 2016, ex-gratia relief of Rs. 4.00 Lakh is given to the family of each deceased due to heat stroke from State Disaster Response Fund (SDRF). A person needs hospitalization due to heat wave is also eligible to get relief from SDRF as per norms.

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

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

3.3.2 Medical and Health Department

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

- Designing and initiating targeted training programs, capacity building efforts and communication on heat illness for medical staff at public health facilities/ including nursing staff, paramedics, field staff and link workers (ANMs, ASHA Workers, etc.), while paying special attention to the susceptibility of particular wards.
- Up-dation of admissions and emergency case records in Hospitals to track heat-related morbidity and mortality and to create simple, user-friendly means to track daily heat-related data.
- Adopt heat-focused examination procedures at local hospitals and urban health centers.
- Developing of SMS facility to reach the field level staff during emergency periods.
- Checking of inventories of medical supplies including ORS powder in PHCs and other Local Hospitals.
- Purchase and distribute reusable soft plastic ice packs for the CHCs, 108 emergency centers, ambulances and hospitals.
- **To provide following services through 108 Emergency Service**
    - Ensure adequate supply of IV fluids.
    - Prepare handouts for paramedics about heat related illness.
    - Create displays on ambulances to build public awareness during major local events.
    - Identifying routes to high risk areas and to reach vulnerable sections of population in shortest time possible by utilizing the list of high-risk areas.

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

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

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

- Perform an epidemiological case review of heat-related mortalities during the summer.
- Conduct and gather epidemiological outcomes from the data on heat risk factors, illness and death, based on average daily temperatures.

- Measure mortality and morbidity rates based on data before and after the Plan's interventions.
- Provide data to key Agency / Department.
- Incorporate data and findings into future versions of the Heat Action Plan.
- Participate in annual evaluation of Heat Action Plan review the revised Heat Action Plan.
- To ensure 108 Emergency Service

3.3.3 India Meteorological Department (Uttar Pradesh Regional Office)

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

- Issue prior Warnings with details of temperature to city nodal officer
- Establish system of early warning and forecasting in collaboration with City Heat Action Plan Nodal Officer

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

- Provide daily/ weekly forecasts
- Communicate Heat wave alerts/warnings promptly
- Update heat wave details regularly in their website
- Determine city heat health threshold

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

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

3.3.4 Education Department

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

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

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

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

- Ensure school buses are parked in sheds, sprinkle water on the roof of the buses, before commuting.
- Scheduling of examinations before starting of Heat period normally and also avoid examination during orange and red alert
- Hostels operated by Social Welfare, Minority, and by Private Institutions to ensure proper measures are adopted to provide sufficient water and arrangements to keep the environment in the hostels cool. Ensure sufficient power supply is available, access to health facility is available, fans/cooler's are installed.

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

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

3.3.5 Labour and Employment Department

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

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

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

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

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

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

3.3.6 Urban Development Department

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

- High Risk Area mapping and identification of vulnerable groups particularly destitute, homeless, beggar homes and old age homes to concentrate on mitigation efforts during heat alert period.
- Identification of areas to provide shelters and drinking water during heat alert period.

- Special care in restricting outdoor activities and functions during heat period.
- Identification of NGOs / Rotary Clubs / Lions Clubs and Corporate houses (under Corporate Social Responsibility) to provide shelters, drinking water, medical supplies and temporary homes during heat days.
- Ensure adequate drinking water supply.

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

- Disseminate SMS text messages to warn residents of high risk areas and vulnerable sections of population during a heat alert.
- Activate "cooling centers," such as public buildings, malls, temples, schools.
- Expand access to shaded areas for outdoor workers, slum communities, and other vulnerable sections of population.
- All non-essential uses of water (other than drinking, keeping cool) may be suspended, if necessary.
- Distribution of fresh drinking water to the public by opening water centers at people congregation points like market places, labour addas, etc.
- Actively involve NGOs and Corporate houses in providing shelter and drinking water facilities to vulnerable population

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

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

3.3.7 Animal Husbandry Department

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

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

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

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

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

- Participate in annual evaluation of heat action plan.

3.3.8 Transport Department

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

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

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

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

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

- Participate in annual evaluation of heat action plan.

3.3.9 Women and Child Development Department

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

- Women, children and infants are most vulnerable to heatwave seasons. WCD has to take essential precautionary measures to ensure that essential nutritional services will not get effected during the time of heatwaves.
- Setting up of nutritional resource centres at Anganwadi centres to supplement nutritional deficiency in children.
- Pre heatwave necessary precautionary methods such as provision of proper stock of ORS, buttermilk and other rehydration methods may be arranged well in advance
- Create surveillance mechanism on tracking children, lactating mothers and women through ICDS and Anganwadi centres in the city.
- Capacity building of Anganwadi Sevikas, Asha workers, ANM nurses and ICDS workers to identify symptoms in women and children and to report it when necessary.

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

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

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

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

3.3.10 Police Department

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

- Review the department action plan with concerned officials and others stakeholders.
- Conduct joint capacity building and awareness building activities to the police staff posted in vulnerable wards on topics such as importance of periodic hydration, working in shade and effects of pollution combined with heatwave.
- Shifting of work hours of Traffic personnel in the early morning and late evening along with convenient shifts throughout the day with enough rest.
- Prepare SOP for managing heatwave related health causalities.
- Address the thick material of police uniforms that trap heat addition to the body heat.
- Update the guidelines for police personnel on duty and creating awareness at all levels.

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

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

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

- Participate in annual evaluation of heat action plan.

3.3.11 Fire Department

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

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

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

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

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

- Participate in annual evaluation of heat action plan

3.3.12 Vidyut Vitran (Power) Electricity Department

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

- Ensure infrastructure is ready for high demand and carry out maintenance work
- Prepare for load management during peak heat
- Inform public about energy conservation during heatwaves
- Promote the use of energy-efficient appliances and support initiatives for cooling centers
- Replace and upgrade all the damaged transformers and replace loose wires
- Awareness generation to run the AC at more than 25degree centigrade

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

- Track and manage power demand in real-time
- Execute load management and emergency plans
- Maintain and enhance the reliability of electrical supply, especially during peak heat periods
- Continuously monitor power infrastructure for issues
- Provide regular updates on energy conservation

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

- Analyze data collected about power related issues during the heat season
- Assess effectiveness of load management and emergency plans
- Revise programs based on lessons learned
- Gather feedback on power supply measures

3.3.13 Water Department

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

- Develop a guideline for management of water supply issues during heat season with well-defined roles and responsibilities

- Develop a plan for releasing water in canals during summer
- Identify and map vulnerable areas for ensuring additional water supply during extreme heat events
- Promote water conservation and efficient water use among citizens
- Restoration of water bodies and activities for increasing ground water

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

- Ensure additional and adequate water supply during heatwaves in vulnerable areas
- Ensure adequate supply of drinking water at bus depot, vulnerable areas and prominent places
- Provide regular updates on water safety and availability

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

- Analyze data collected during the heat season
- Conduct meeting to review implementation of Heat Wave mitigation measures by the department
- Assess the effectiveness of emergency water supply plans
- Gather feedback on water supply measures
- Revise programs based on lessons learned

3.3.14 NGOs, SHGs, Community Groups and Other social organisations

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

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

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

- Take all precautions to avoid Heat related illness
- Awareness and community outreach on prevention and management of heat related illnesses
- Keep cool and hydrated during the heat season by drinking water, staying out of the sun, and wearing light clothing
- Check on vulnerable neighbours, particularly during a heat alert
- Limit heavy work in direct sun or indoors, if poorly ventilated, especially during a heat alert

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

- Participate in annual evaluation of heat action plan.

3.3.15 Information and Public Relations (I and PR) Department

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

- Identification of areas to post warnings and information during heat season.
- Securing advertisement / scrolling slots for announcements regarding Heat waves.
- Designing information and awareness material in the form of pamphlets, posters etc. on Heat waves in local language for distribution to the general public, especially focusing on identified high risk areas in the City.

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

- Create awareness among public through advertisements in regional languages
- Display hoardings at important places
- Create awareness through TV and Radio spots and jingles
- Circulate heat wave warnings i.e. text alerts or WhatsApp messages in collaboration with private sector telecom companies in addition to traditional media.
- Send warnings in bulk to the public via centralized email databases during heat waves.
- Explore other means of communication like Facebook, Twitter and Whats App.
- Collect all news items/reports on Heatwaves daily and report to Government. Conducting regular press conferences at city level on the risks and dangers of heat related illness.

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

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

3.3.16 Horticulture Department

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

- Develop a guideline for management of water supply in gardens
- Develop a plan for releasing water for gardens in city
- Ensure maintenance work of garden before summer season
- Promote water conservation and efficient water use among citizens

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

- Ensure additional and adequate water supply during heatwaves
- Ensure gardens are open all day during peak heat wave days
- Ensure availability of water and ORS in gardens
- Ensure IEC banner and pamphlets in gardens about Do's and Don't of heat wave

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

- Analyze data collected during the heat season
- Conduct meeting to review implementation of Heat Wave mitigation measures by the department

Chapter 4: Prevention and Management of Heat Related Illnesses

4.1 Introduction

Heat Waves have the highest impact on morbidity and mortality and the impact of extreme summer heat on human health may be exacerbated by an increase in humidity. The frequency, severity, intensity and duration of heat wave and related mortality is going to increase further due to rapid global climate change. Thermoregulation is the process that enables our body to maintain a normal core temperature. The hypothalamus regulates body temperature. It causes us to shed heat and maintain a normal core temperature by activating receptors in your skin and other organs. Our body uses sweat evaporation to release heat when it becomes really warm (make the heat go away). If the heat entering person body is more than the rate of heat leaving the body, the core temperature will rise and the person will be at risk for a heat-related illness.

The risk of heat-related illnesses is determined by heat exposure (ambient and internally produced heat from exertion), individual vulnerability (influenced by age, pregnant status, and concurrent disorders), and socio-cultural variables (including environmental exposure, poverty, lack of social cohesion, lack of access to health care, and limited worker protections). Geographical location, employment (e.g., farming, construction, driving deliveries), social isolation, and time spent outdoors or in hot spots, such as urban heat islands and places with less greenery, all affect how much each person is exposed to heat-related dangers.

Heat-related illnesses range from mild to life-threatening, and heat exposure exacerbates many common health conditions, including cardiac, respiratory, and kidney diseases. Heat related illnesses can be best prevented if the vulnerable populations/ communities are made aware of prevention tips basic Do's and Don'ts through effective use of various media. Physicians and pharmacists must have knowledge of effective prevention and first-aid treatment of heat related illnesses. It is also crucial to have an awareness of potential side-effects of prescription drugs during hot weather, to ensure the mitigation of heat illnesses.

4.2 Vulnerable Population:

Heat waves and hot weather can be deadly and make pre-existing medical issues worse. All age groups and a variety of conditions can have an impact on one's health, but some people are more susceptible than others are to heat-related illnesses and even mortality. Children, elderly individuals, homeless people, persons with pre-existing ailments, outdoor and indoor laborers, emergency responders, members of low-income communities, pregnant women, athletes, and others are among the groups most at risk from heat (*Figure 11*).

Figure 11: Vulnerable Population-Extreme Heat

4.3 Health Facilities Preparedness Measures for Managing Heat related Illness

Director/In-charge of public health facilities should ensure the following measures:

- A detailed action plan to tackle Heat related illnesses well in advance of hotter months.
- Operational framework-preparing specific health adaptation plan, development of guidelines and response plan for climate sensitive diseases.
- Need for updating Heat Health Action Plan and issuing Advisory for Hospital Preparedness, Surveillance and weekly monitoring including Capacity Building.
- Standard Operating Procedures to tackle all levels of Heat related illnesses. Capacity Building measures for doctors, nurses and other staffs should be undertaken.
- Cases with expected heat stroke should be rapidly assessed using standard treatment protocols.
- Identify RRT (Rapid Response Team) to respond to any exigency call outside the hospital.
- Ensure adequate arrangements of staff, beds, IV Fluids, ORS, essential medicines and equipment's to cater to management of volume depletion and electrolyte imbalance.
- Primary Health Centers must refer the patients to higher facility only after ensuring adequate stabilization and basic definitive care (cooling and hydration).
- Hospitals must ensure proper networking with nearby facilities and medical centers to share the patient load which exceed their search capacities.

4.4 Case Definitions of various Heat related illnesses

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

4.5 Symptoms and First Aid for various Heat Related Illnesses

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

4.6 Clinical evaluation or differential diagnosis

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

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

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

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

The clinical evaluation or differential diagnosis is given in the below chart (*Figure 12*)

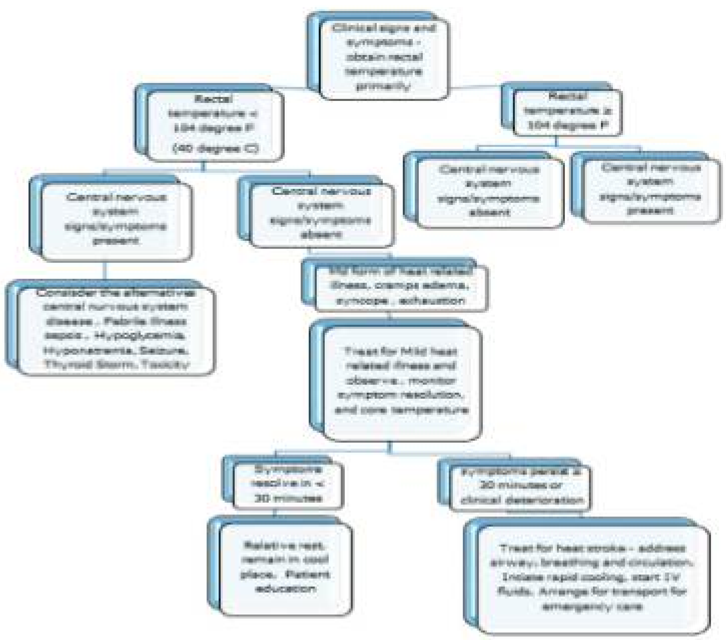


Figure 12: Algorithm for the initial evaluation of a patient with suspected heat related illness

4.7 Heat Illness Treatment Protocol (NDMA, 2019)

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

1. Initial assessment and primary survey of patient (airway, breathing, circulation, disability, exposure), vital signs including temperature.
2. Consider heat illness in differential diagnosis if:
   a. Presented with suggestive symptoms and signs
   b. Patient has one or more of the following risk factors:
      - Extremes of age (infants, elderly)
      - Debilitation/physical reconditioning, overweight or obese
      - Lack of acclimatization to environmental heat (recent arrival, early in summer season)
      - Any significant underlying chronic disease, including psychiatric, cardiovascular, neurologic, hematologic, obesity, pulmonary, renal, and respiratory diseases
      - Taking one or more of the following:
        - Sympathomimetic drugs, Anticholinergic drugs, Barbiturates
        - Diuretics, Alcohol, Beta blockers
3. Remove from environmental heat exposure and stop physical activity
4. Initiate passive cooling procedures
   - Cool wet towels or ice packs to axillae, groin, and around neck; if patient is stable, may take a cool shower, but evaluate risk of such activity against gain and availability of other cooling measures
   - Spray cool water or blot cool water on to the skin
   - Use fan to blow cool air onto moist skin
5. If temperature lower than 40°C, repeat assessment every 5 minutes; if improving, attempt to orally hydrate (clear liquids, ORS can be used but not necessary; cool liquids better than cold). If temperature is 40°C or above, initiate IV rehydration and immediately transport to emergency department for stabilization.

4.8 Heat Stroke Treatment (Sorensen and Hess, 2022)

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

Heat stroke, treatment need to be started with maintaining the airway, breathing, and circulation, immediately followed by rapid cooling. The delay in cooling can be associated with worse outcomes. Initial management should always be focused on rapidly reducing the core body temperature to 38° to 39°C, ideally within 30 minutes after presentation. The most effective cooling methods are cold-water immersion and ice-water immersion. A combination of evaporative and conductive cooling techniques, such as the infusion of cold fluids, the application of ice packs to the neck, groin, and axillae, and fanning, are used as treatment if resource availability, ongoing cardiopulmonary resuscitation, airway compromise, or other factors prevent cold-water immersion (*Figure 13*).

Antipyretic medications should not be used since they make heat stroke patients worse and can exacerbate coagulopathy and end-organ damage. Dantrolene is not often used to treat heat stroke; however, it has been linked to a shorter cooling time without an improvement in recovery rates. Agitation, pain, and shivering can be managed with benzodiazepines. Successfully cooled patients who make it through the hyperthermic-neurologic phase are at a high risk of progressing to the late hepatic-renal and hematologic-enzymatic stages. The most effective care for these patients should be provided by a multidisciplinary team in an Intensive Care Unit.

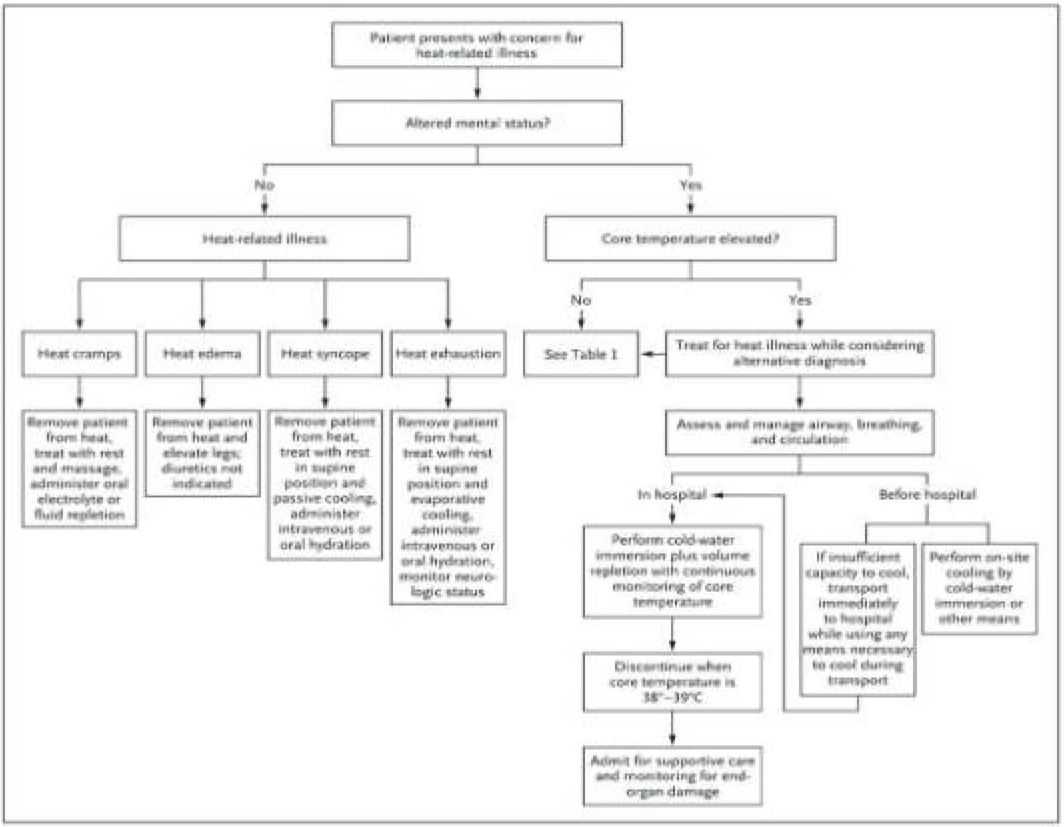


Figure 13: Heat Stroke Treatment Protocol

Chapter 5: Information, Education and Communication (IEC)

5.1 Role of IEC in prevention of heat related illnesses

Information Education and Communication (IEC) employs a crucial framework across multiple industries to raise awareness, improve understanding, and encourage behavioral change among target audiences. IEC is crucial for attaining improved health outcomes in all public health initiatives. This method is acknowledged as an effective and economical strategy for tackling larger health determinants, mitigating risk factors, cultivating trust and commitment, promoting community engagement, and empowering the formulation and execution of health projects.

IEC is an important tool in health promotion for creating supportive environment and strengthening community action. The IEC in health programmes aims to increase awareness, change attitude and bring about behaviour change. IEC provides a platform for the discussion of important health issues to foster an understanding of concepts, underlying principles, and benefits of health initiatives.

IEC is essential to community development because it empowers people and encourages involvement. It acts as a basis for raising awareness of the health and climate change issues, which in turn sparks long-lasting change in local communities. IEC enhances community members' quality of life, encourages holistic development, and educates them about heat health prevention measures by fostering social capital.

Recognising importance of IEC, IEC pamphlet has been developed under Lucknow City Heat Action Plan Action Plan for creating awareness regarding prevention and management of heat related illnesses. It is important to note that these are preventable deaths. Informing the public on the preventive actions to be taken, reporting early to health facility, timely diagnosis and treatment, would reduce the deaths attributable to heat waves. IEC can play an important role in preventing mortality and morbidity due to heat related illnesses. The IEC- posters can be used in crowded places Bus Station, Railway Station, Schools, Cinemas and for larger awareness. Health advisories can also be circulated through social media- Facebook, WhatsApp, Mass emails etc.

IEC's significance is derived from its capacity to educate, inform, and empower communities in a variety of sectors, such as health, economic development, and social change. IEC promotes positive behaviors, facilitates informed decision-making, and ultimately contributes to the general welfare of society by employing effective communication strategies.

5.2 Role of Nodal Officer in IEC activities

The Nodal Officer should work closely with Public Relation and media department to run a campaign for community awareness and public education regarding prevention and management of heat related illnesses. Furthermore, during red alert days special drive can be implemented for alerting the high risk and vulnerable population.

To increase public awareness and prevent heat-related illnesses, Nodal Officer can implement the following strategies:

Education Campaigns for disseminating the risk due to extreme heat, symptoms for identifying heat related illnesses and preventive measures.

Community Engagement: Organizing training and workshops to educate vulnerable and high risk groups, such as outdoor workers, slum population, daily wage labourers, children, pregnant women etc. about staying safe during heat waves.

Utilize Technology: Utilize mobile applications and social media to distribute alerts and notifications regarding safety precautions and heat warnings.

5.3 IEC material for community awareness and sensitization


लू / तापघात जानलेवा हो सकता है।
अरे ! बहुत तेज गर्मी है, चलो पानी पी लेते है।
गर्मी के दिनों में बार-बार पानी पीये।
Lucknow City Heat Action Plan


बुजुर्ग गर्मी के प्रति अत्यन्त संवेदनशील समूह है।
हम बुजुर्गों की अच्छी देखभाल करेंगे और उन्हें गर्मी से बचाएंगे ।
तीव्र गर्मी के दिनों में उन्हें बार-बार पानी एंव शीतल पेय पदार्थ पिलायें। दोपहर के समय बाहर न जानें दें।
Lucknow City Heat Action Plan


Lucknow City Heat Action Plan
बच्चे गर्मी के प्रति अत्यन्त संवेदनशील होते हैं।
तीव्र गर्मी से बच्चों के स्वास्थ्य पर नकारात्मक प्रभाव पड़ता है।
बच्चों को अत्यधिक गर्मी से बचाये!
बच्चों को पसीना कम आता है।
बच्चों का शरीर गर्मी के प्रति अनुकूलन में अधिक समय लेता है।
बच्चों का शरीर अधिक गर्मी उत्पन्न करता है।
बच्चों को कम प्यास लगती है।
बच्चों के शरीर की सतह क्षेत्र अधिक होने के कारण शरीर जल्दी गर्मी सोखता है।
बच्चों की प्रतिरोधक क्षमता कम होती है।
बच्चों को गर्मी से बचाने के उपाय:
• धूप में बाहर जाने से बचें, खासकर दिन के सबसे गर्म समय (दोपहर 12 से 4 बजे)।
• खूब पानी पिएँ और हल्के, ढीले कपड़े पहनें।
• ठंडी और हवादार जगहों पर समय बिताएँ।
• प्यास न होने पर भी बार - बार पानी पियें।


Lucknow City Heat Action Plan
अत्यधिक गर्मी गर्भवती महिलाओं के स्वास्थ्य के लिए गंभीर खतरा बन सकती है।
समय पर सावधानी वरतें और उन्हें सुरक्षित रखें!
गर्मी के कारण गर्भावस्था के दौरान जटिलताएं:
• भ्रूण की वृद्धि के कारण शरीर की गर्मी बढ़ती है।
• शिशु पर प्रभाव:
जन्म के समय कम वजन।
जन्मजात हृदय दोष।
समय से पहले प्रसव।
• पसीना अधिक आने से निर्जलीकरण होती है अतः श्रम समय से पहले शुरू हो सकता है।
• अत्यधिक गर्मी से उच्च रक्तचाप, गर्भावधि मधुमेह का खतरा।
गर्भवती महिलाओं को गर्मी से बचाने के उपाय:
• धूप में बाहर जाने से बचें, खासकर दिन के सबसे गर्म समय (दोपहर 12 से 4 बजे)।
• खूब पानी पिएँ और हल्के, ढीले कपड़े पहनें।
• ठंडी और हवादार जगहों पर समय बिताएँ।
• प्यास न होने पर भी बार - बार पानी पियें।
• समय - समय पर नजदीकी स्वास्थ्य केन्द्र पर जाँच करवाएँ।


Lucknow City Heat Action Plan
कार्यस्थल पर स्वयं को सुरक्षित और स्वस्थ रखें
प्यास न होने पर भी बार - बार पानी पीयें। चाय, कॉफी, शराब और सॉफ्ट ड्रिंक का सेवन न करें।
काम के दौरान बीच - बीच में विश्राम करें।
हल्का और ताजा भोजन खाएं। मसालेदार और तैलयुक्त भोजन का सेवन न करें।
बाहर जाते समय अपना सिर ढक कर रखें।


LUCKNOW CITY HEAT ACTION PLAN

5.4 Do's and Don't

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

DO's

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

DONT's

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

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

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

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

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

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

Chapter 6: Financial Provisions for Heatwave related disasters in Uttar Pradesh

6.1 Heat wave and disaster management

Heat waves are extreme weather events that have recently raised concerns about disaster management in India because of their severe and broad effects on the environment and human health. Over the past few years, summer heat waves have had an increasing impact on the nation's morbidity and mortality rates. Given the current situation, in addition to developing strategies for future risk avoidance and heat wave conditions management, an efficient response is crucial for preserving people's lives and health. Particularly in the past ten years or more, extreme weather conditions have grown increasingly evident and have affected people's lives worldwide. As a result, coping techniques for communities now depend heavily on methods and means for comprehending and managing intense heat episodes.

A disaster is a catastrophic event that can be caused by either natural or man-made factors. Significant numbers of people are killed, property is damaged, the environment is harmed, or all three occur as a result of this incident. According to the Disaster Management Act of 2005, for example, a notified disaster is one that has been formally acknowledged by the government.

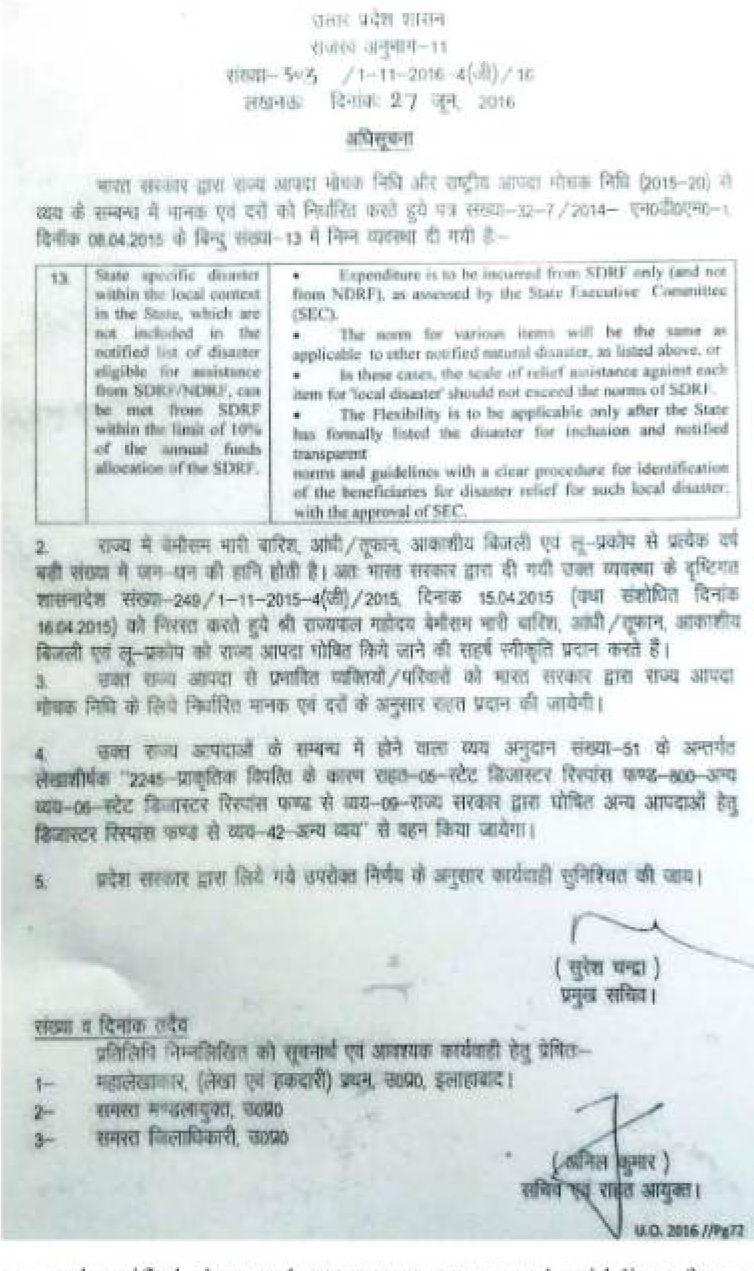
A National Disaster Management Authority (NDMA) and State Disaster Management Authorities (SDMAs) are established by the National Disaster Management Act. At the state and federal levels, respectively, they are in charge of disaster management. The Ministry of Home Affairs is designated by the Act as the nodal ministry in charge of the country's overall disaster management. Monetary mechanisms, such as creating funds for emergencies and disaster assistance, are also included in the Act.

India has experienced unprecedented heatwaves this year, killing hundreds of people, but there is currently no plan to classify it as a notified disaster, making it eligible for financial assistance under the Disaster Management Act of 2005, the government informed Parliament on July 25, 2024. The 15th Finance Commission considered adding further calamities to the existing notified list, but decided not to include heatwaves. "The Commission stated in paragraph 8.143 of its report that the list of notified disasters eligible for funding from the State Disaster Mitigation Fund and the National Disaster Mitigation Fund adequately meets the needs of the state, and thus did not see much merit in the request to broaden its scope. The current list of calamities eligible for National Disaster Response Fund/State Disaster Response Fund (SDRF) aid comprises 12: cyclone, drought, earthquake, fire, flood, tsunami, hailstorm, landslide, avalanche, cloud burst, pest assault, and frost and cold wave.

However, the 15th Finance Commission enables governments to use up to 10% of SDRF money for "local disasters" like lightning or heatwaves, which they can inform themselves. Several disaster management authorities derive their authority from this act, and they determine whether natural disasters are eligible for state compensation. The legislation also establishes special funds, both at the state and national levels, that can be used in the event of a disaster.

Some states have classified heatwaves as local disasters. Uttar Pradesh is one of the states that has declared heatwave a local calamity. Haryana, Uttar Pradesh, Odisha, Kerala, Tamil Nadu, and Rajasthan are the other states that have declared heatwaves as local disasters.

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



उत्तर प्रदेश शासन
राजस्व अनुभाग–11
संख्या– 5०3 /1–11–2016–4(जी)/16
लखनऊ: दिनांक: 27 जून, 2016

अधिसूचना

भारत सरकार द्वारा राज्य आपदा मोचक निधि और राष्ट्रीय आपदा मोचक निधि (2015–20) से व्यय के सम्बन्ध में मानक एवं दरों को निर्धारित करते हुये पत्र संख्या–32–7/2014– एन0डी0एम0–1 दिनांक 08.04.2015 के बिन्दु संख्या–13 में निम्न व्यवस्था दी गयी है–

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

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

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

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

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

(सुरेश चन्द्रा)
प्रमुख सचिव।

संख्या व दिनांक तदैव
प्रतिलिपि निम्नलिखित को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित–
1– महालेखाकार, (लेखा एवं हकदारी) प्रथम, उ0प्र0, इलाहाबाद।
2– समस्त मण्डलायुक्त, उ0प्र0
3– समस्त जिलाधिकारी, उ0प्र0

(अनिल कुमार)
सचिव एवं राहत आयुक्त।

U.O. 2016 //Pg72

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

All the concerned departments and District Magistrates have been instructed to take required precautionary measures for mitigating the heat-wave situation. The City Heat Action Plan Nodal Officer and Municipal Commissioner should inform the District Administration about any mortality or calamity due to heatwave.

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

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

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

Chapter 7: Short-term, Long-term measures and best practices for enhancing resilience against extreme heat in cities

7.1 Short term measures for enhancing resilience against extreme heat in cities

Short-term urban heat mitigation strategies emphasize immediate, readily implemented measures that enhance comfort and lower temperatures in urban areas. These measures typically address the urban heat island effect, a phenomenon in which urban areas are substantially warmer than their surrounding rural areas. The City Administration has the option of implementing numerous short-term measures. Climate, urban design, and available resources are among the numerous factors that influence the efficacy of each measure. A comprehensive strategy should prioritize interventions with the greatest impact and take into account the specific context. For example, it is imperative to concentrate on vulnerable populations and regions that experience the most severe heat stress. Furthermore, although these measures offer immediate respite, they should be viewed as a component of a more comprehensive, long-term urban heat mitigation strategy that encompasses more significant modifications to urban infrastructure and design.

Installing temporary shade structures: Plazas, parks, and bus stations are all good places to use awnings, umbrellas, and temporary shade canopies. These offer quick protection from the sunlight to the population.

Implementing temporary green roofs or walls: Smaller-scale green walls and roofs using readily available materials can be installed on buildings quickly, providing localized cooling and increasing shade.

Creating wind corridors: Strategically removing obstructions and widening streets can increase airflow and reduce temperatures.

Using fans and misting systems: Public spaces can implement fans or misting systems to provide immediate cooling relief during heat waves.

Public awareness campaigns: Instructing residents on heat-related hazards and basic mitigation techniques, such as maintaining hydration and locating cool environments, can markedly enhance community resilience.

Community cooling centers: Opening libraries, community centers, and other public buildings as cooling centers during heat waves provides essential refuge for vulnerable populations.

Public transportation improvements: Ensure public transportation is functioning effectively during extreme heat, providing access to cooling spaces.

Free water distribution: Provide free access to water at public locations, particularly for vulnerable communities. Nodal Officer can identify the high risk areas for opening additional water distribution points.

Public shade structures: Install temporary shade structures in high-traffic areas to provide immediate relief from direct sunlight.

Vulnerable populations: Prioritize actions that protect the most vulnerable, including the elderly, infants, children, individuals with chronic illnesses, and people experiencing homelessness.

These approaches offer prompt relief during heat waves while also establishing the foundation for more comprehensive long-term plans that tackle the fundamental structural factors contributing to heat vulnerability. The adopted solutions will differ based on context and available resources, emphasizing equity and access for marginalized communities.

7.2 Long term measures for enhancing resilience against extreme heat in cities

Adapting to and mitigating the effects of excessive heat requires a multifaceted strategy that includes large-scale urban planning and infrastructure upgrades, community-level projects, and individual acts. Urban heat mitigation techniques are complex and call for a coordinated strategy that includes community involvement, infrastructure upgrades, building design, and urban planning. Extreme heat events are on the rise, but there are things you can do now—in your own home, workplace, or neighbourhood—to reduce your current and future risks. Here are some ways through which we can reduce the impact of Heat Wave to some extent. In this chapter, long-term measures and best practices are mentioned and City Administration can implement these for enhancing resilience against extreme heat.

7.2.1 Cool roof (NDMA, 2021)

Numerous cooling solutions have been proposed and discussed to mitigate the worsening heat stress in urban areas. These solutions can be classified into three categories: gray, green, and blue strategies, according to their cooling techniques, which are engineering-based (e.g., cool roofs, shading facilities, and advanced building façade materials), vegetation-based (e.g., green roof, lawn, urban parks, street trees), and water-based (e.g., waterbodies, misting, irrigation, sprinkling), respectively.

Cool roofs (reflective roofs) are been widely used for reducing the negative impact of extreme heat in urban areas. Cool roofs are specially designed roofing systems that reflect more sunlight and absorb less heat than traditional roofs. They provide several benefits, especially in regions experiencing extreme heat. There are many advantages of cool roofs and cooling technologies.

Energy Savings: Cool roofs significantly reduce the energy required for cooling buildings. By reflecting sunlight, they lower indoor temperatures, which decreases reliance on air conditioning systems. This can lead to substantial savings on energy bills, particularly in hot climates where cooling demands are high.

Health Benefits: Cool roofs help mitigate heat-related health issues by reducing the risk of heat exhaustion and other heat-induced illnesses. Implementing cool roof technology across urban areas could potentially offset a significant percentage of heat-related mortality associated with urban heat islands.

Improved Indoor Comfort: By maintaining cooler indoor temperatures, cool roofs enhance occupant comfort. Studies indicate that cool roofs can lower maximum indoor temperatures by approximately 1.2 to 3.3°C (2.2 to 5.9°F) in non-air-conditioned homes, making living spaces more pleasant during extreme heat.

Reduction of Urban Heat Island Effect: Cool roofs contribute to lowering ambient temperatures in urban areas, which helps combat the urban heat island effect—a phenomenon where cities become significantly warmer than their rural surroundings due to human activities and infrastructure. This reduction can improve overall air quality and contribute to climate change mitigation

Cool roofs provide a range of benefits that enhance energy efficiency, improve comfort and health, extend roof life, reduce urban heat effects, and contribute positively to environmental sustainability—all crucial factors in combating the challenges posed by extreme heat conditions.

According to research, planting shade trees and installing highly reflecting pavement and roofs around the city will, on average, lower a city's ambient air temperature by 2 to 4 degrees Celsius during the summer (*Figure 14*).

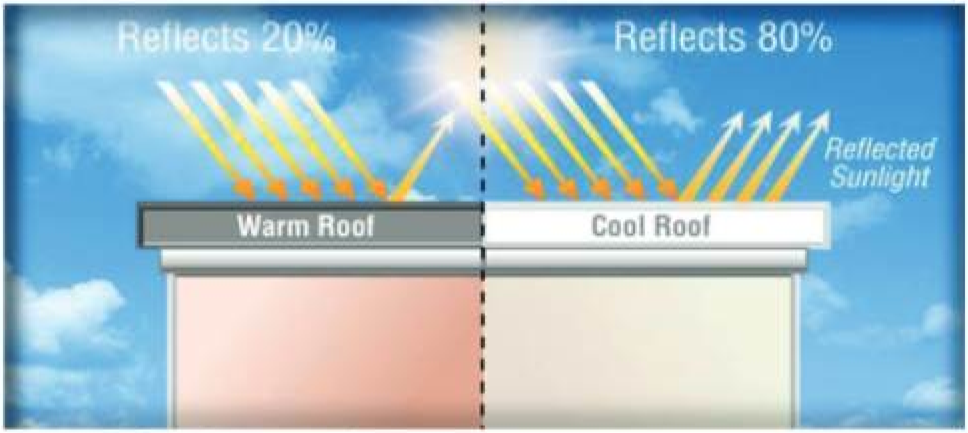


Figure 14: Cool Roof Demonstration

Source: Heat Island Group, Lawrence Berkley National Lab

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

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

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

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

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

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

7.2.2 Green Infrastructure for reducing impact of Urban Heat Island

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

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

Urban Green Infrastructure (UGI), which is defined as "a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services, is acknowledged as one of the most crucial strategies to mitigate UHI and to promote a resilient environment in cities. Green Infrastructure is in fact known to be an effective strategy to reduce heat intensity. With urban forests being the most effective, the cooling capability of UGI can vary significantly and varied across plant species including grass, shrubs, and trees. Trees, green roofs, and vegetation can help reduce urban heat island effects by shading building surfaces, deflecting radiation from the sun, and releasing moisture into the atmosphere.

Urban Forests and Green Spaces: The strategic planting of trees, with careful consideration of species selection to maximize shelter and evapotranspiration, is of paramount importance. Parks, green corridors, and lesser green spaces strategically distributed throughout the urban environment can substantially mitigate temperatures and enhance air quality.

Green roofs and walls: These vegetated surfaces contribute to the reduction of building temperatures, enhance insulation, and facilitate the management of stormwater discharge. Green roofs, in particular, provide significant cooling benefits.

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

7.2.4 Urban Agriculture and Community Gardens: The incorporation of agricultural spaces within urban environments not only facilitates food production but also enhances cooling through the processes of evapotranspiration and the provision of shade.

7.2.5 Building design and materials: Designing buildings to maximize natural ventilation, minimize solar heat gain, and use cool roofing materials considerably reduces building heat load and energy usage for cooling. This can include both passive design measures, such as building orientation and shading devices, and active solutions, such as enhanced insulation and energy-efficient air conditioning.

7.2.6 Urban planning and design: Strategies include optimizing roadway layouts to enhance air circulation, adding shade trees into streetscapes, and developing urban parks and green areas to provide relief from the heat. The microclimate is substantially influenced by building density and arrangement. This includes assessing building layout in relation to prevailing winds and solar trajectories.

7.2.7 Water management: Stormwater management systems that are effective and make use of green infrastructure to collect and filter rainfall can contribute to a reduction in surface temperatures and an improvement in urban microclimates. Rain gardens and bios wales are two examples of features that may fall under this category.

7.2.8 Improved energy efficiency: Reducing energy consumption through building retrofits and energy-efficient technologies helps lower overall energy demand and the heat generated by power plants.

7.2.9 Regulations and incentives: Government initiatives that promote the use of energy-efficient buildings and green infrastructure can quicken the rate of adaption. This covers building codes, tax benefits, and subsidies.

7.2.10 Research and monitoring investment: To better understand the effects of urban heat and assess the efficacy of adaptation measures, more research is required. Programs for data collecting and monitoring are essential for informing policy choices.

The successful adaptation of urban heat involves a multi-pronged approach that combines the enhancement of infrastructure, the engagement of the community, and the implementation of good governance. The particular procedures that are put into place will differ from one location to another depending on the resources available and the weather conditions. It is of the utmost importance to incorporate both short-term and long-term strategies in order to achieve complete and efficient adaptation.

7.3 Best Practices for adaptation and mitigation

Urban Forestry and Green Spaces: Urban greening and tree canopy provide natural cooling, cleaner air, and urban biodiversity throughout the whole city. Urban forests cool the temperature through evapotranspiration and shade, which can reduce heat waves in the longer run. There are many initiatives which focuses on increasing the green cover of the city to fight the climatic monster of Heat waves.

- **Mexico City, Mexico** – The "Azoteas Verdes" program promotes the installation of green rooftops to reduce UHI effects, reduce energy consumption, and enhance stormwater management.
- **Riyadh, Saudi Arabia** – The "Green Riyadh" project includes the planting of 7.5 million trees, of which drought-resistant plants are planted for ensuring the sustainability of urban greening efforts.
- **Mumbai – Urban Forestry and Miyawaki Forests**: Three Miyawaki-style urban forests have been created in Ghatkopar, Mahim, and Goregaon as Mumbai tries to counter heat stress by means of dense native forests. These green spaces bring the temperature down, soak up polluting gases as well as dust particles; many kinds of animal can live here better. Moreover, urban forestry projects have filled highly-congested areas with trees, giving both pedestrians and residents protection from the sun while lowering temperatures.

Green Roofs and Vertical Forests: Green roofs are vegetated roof systems that can be extensive (lightweight, requiring minimal maintenance) or intensive (heavier, supporting a wider variety of plants, including trees and shrubs). They offer significant cooling benefits by absorbing sunlight, reducing rooftop temperatures, and lowering overall urban temperatures. Vertical forests refer to high-rise buildings with integrated plant life, including trees, shrubs, and climbing plants. These structures improve air quality, enhance urban biodiversity, and regulate building temperatures by providing natural insulation.

Water-Centric Cooling Strategies: Water bodies play a critical role in moderating urban temperatures by evaporative cooling. They absorb heat and release water vapor into the atmosphere, creating localized microclimates that enhance the comfort of urban life, reduce the Urban Heat Island (UHI) effect, and improve air quality. Urban areas all over the world are increasingly implementing water-based cooling techniques, such as canals, lakes, wetlands, and stormwater management systems, to counteract rising temperatures and increase climate resilience.

Copenhagen, Denmark – Climate-Resilient Water Parks

Water bodies are utilised by water parks such as Tasinge Plads for cooling and flood management. Stormwater management features: Green retention ponds.

Impact: Localized cooling of 2–4°C.

Cool pavements: Sidewalk and road temperatures are lowered by high albedo surfaces, that reflect more sunlight.

Tokyo, Japan – Cool Pavements and High-Albedo Materials

Tokyo installed over hundres kilometres of cool pavements. Coatings of high-albedo on sidewalks and pavements.

Impact: Surface temperatures decreased by up to 8°C.

Blue-Green Hybrid Solutions: Blue-green hybrid systems produce multi-purpose urban cooling systems through the combination of water (blue) and plant (green) infrastructure. Blue-green hybrid systems increase cities' resilience to climate change and enhance flood resilience, biodiversity protection, and heat mitigation. Cities can mitigate heat stress, save ecosystems, and increase the general urban capacity to adapt through the integration of lakes, green corridors, wetlands, and riparian forests.

São Paulo, Brazil – Riparian Forest Restoration

Shielding and reforestation of riverbanks in order to improve cooling and flood control. Rehabilitated more than 1000 hectares of riparian zones to mitigate the urban heat island effect.

Impact: Lowered urban temperatures by 2–3 °C. Highly water-retentive soil with less drought susceptibility.

Bengaluru – Blue-Green Hybrid Solutions and Lake Restoration: Bengaluru has been actively restoring its urban lakes and integrating them with green corridors to enhance evaporative cooling and biodiversity. Projects like Kaikondrahalli and Jakkur Lakes have helped lower temperatures in nearby areas by 2–3°C, while also improving groundwater recharge and stormwater management.

Hyderabad – Lake Restoration and Water-Based Cooling: Hyderabad has focused on restoring urban water bodies like Hussain Sagar and Durgam Cheruvu, which contribute to natural cooling by evaporative processes. These efforts have led to a temperature reduction of 2–3°C in surrounding areas. Additionally, Hyderabad has implemented smart stormwater management techniques to improve water retention and reduce urban flooding risks.

Chapter 8: Brief description of important actions by Key Stakeholders (Ready Reckoner)

8.1 City Heat Action Plan Nodal Officer

Action	Status
To lead and coordinate the Heat Action Plan (HAP) for Municipal Corporation	
To conduct regular meetings of line department officials and monitor various activities of City Heat Action Plan	
To act as the primary point of contact for all heat-related activities and issue the various alerts- Red, Orange and Yellow	
To monitor the effectiveness of the HAP and make necessary adjustments	
Develop and implement emergency response plans specific to heatwaves	
Conduct capacity building and training of various stakeholders	

8.2 Medical and Health Department (Nagar Swasthya Adhikari and CMO)

Action	Status
Develop and prepare a Standard Operating Procedure (SOP) for various activities under City Heat Action Plan- Prevention, management and Treatment	
Conduct capacity building and training of various stakeholders- Medical Officers, Paramedical Professionals, ASHA Workers	
Coordinate with healthcare facilities to ensure preparedness for heat-related illnesses prevention and management	
To conduct awareness and sensitization activities regarding do's and don'ts of heat related illnesses prevention	
Distribute resources and guidelines to prevent heat strokes	
Ensure EMS is operational and responsive	
Provide data on heat-related health incidents for monitoring and evaluation	

8.3 IMD (UP Regional Office Lucknow)

Action	Status
Provide regular forecast about Maximum Temperature to Nodal Officers for activating an Early Warning System	
Conduct capacity building and training of various stakeholders- regarding heat wave, climate change, climate profile	

8.4 Education Department

Action	Status
Ensure availability of drinking water, ORS and Cool room during summer months	
Conduct capacity building and training of teachers, students on prevention and management of heat related illnesses, identifying heat related illnesses and first aid protocol	
Provide data on heat-related health incidents for monitoring and evaluation	
Distribute resources and guidelines to prevent heat strokes	
Run ongoing campaigns on heat safety	

8.5 Women and Child Department (ICDS)

Action	Status
Ensure availability of drinking water, ORS and Cool room during summer months at Anganwadi Centres	
Conduct capacity building and training of Anganwadi Workers on prevention and management of heat related illnesses, identifying heat related illnesses and first aid protocol	
Provide data on heat-related health incidents for monitoring and evaluation	
Distribute resources and guidelines to prevent heat strokes	

8.6 Urban Development

Action	Status
Incorporate heat-mitigation strategies in urban planning	
Conduct continuous monitoring of urban heat areas	
Develop green spaces and ensure proper zoning regulations to reduce urban heat islands	
Promote cool roof and other cooling technologies for mitigating the extreme heat	
Establish cooling centres in high risk areas	

8.7 Horticulture Department

Action	Status
Keep open garden throughout to day for public	
Ensure availability of drinking water in all the gardens	
Develop a ORS corner in gardens	
Develop and maintain green spaces to reduce the urban heat island effect	
Promote tree plantation and maintenance	

8.8 City Transport Department

Action	Status
Ensure availability of water and ORS at Bus Stops	
Awareness and Sensitization pamphlets about heat related illnesses at Bus Stops	
Capacity building and training of bus drivers in first aid and managing heat related illnesses	
Ensure availability of ORS in buses and also open ORS corner at major bus stops	
Use reflective paints on buses to reduce inside temperature	

8.9 Police Department

Action	Status
Ensure availability of water and ORS at Traffic Booths	
Awareness and Sensitization pamphlets about heat related illnesses at traffic booths	
Capacity building and training of police personnel in first aid and managing heat related illnesses	
Monitor the heat related illnesses cases and report to nodal officer	
Use reflective paints on traffic booths to reduce inside temperature	

8.10 Fire Department

Action	Status
Provide emergency response services for heat-related incidents and ensure public safety during heatwaves	
Conduct ongoing community education about heat safety.	
Capacity building and training of fire brigade personnel in first aid and managing heat related illnesses	
Monitor the heat related illnesses cases and report to nodal officer	

8.11 Animal Husbandry Department

Action	Status
Ensure availability of water at Gaushala and other locations	
Conduct ongoing community education about heat safety for animals	
Use reflective paint over shades in Gaushalas for reducing the impact of heat on animals	
Monitor the heat related illnesses cases and report to nodal officer	

8.12 Labour and Employment Department

Action	Status
Ensure availability of water and ORS at various sites- Building, NAREGA sites and Industries	
Ensure implementation of work hour adjustments for outdoor labourers	
Provide regular updates and training to supervisors	
Execute safety plans for workers and continuous management of heat stress	
Monitor the heat related illnesses cases and report to nodal officer	

8.13 Information and Public Relations Department

Action	Status
Develop and Disseminate Public Awareness Campaigns to inform the public about heat-related risks and protective measures	
Conduct press briefing during extreme heat wave days and ensure coverage of red alerts days in newspapers and local media for mass awareness	
Ensure heat alerts and warnings are promptly communicated to the public, and provide consistent updates on weather conditions and recommended actions	
Coordinate with Media and Stakeholders to ensure timely and accurate dissemination of heat-related information	
Evaluate Communication Efforts and Update Strategies.	

Annexures

Annexure-1

Format A

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

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

Annexure-2

HOSPITAL PREPAREDNESS CHART-PRE HEAT SEASON

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

HOSPITAL PREPAREDNESS CHART- HEAT SEASON								
INFRASTRUCTURE AND LOGISTICS			LOGISTICS CAPACITY BUILDING			IEC/AWARENESS		
PHC	CHC	DH/MC	PHC (MOs, nursing staff,	CHC (MOs, nursing staff,	DH/MC (MOs, nursing staff,	PHC	CHC	DH/MC

			paramedics, ASHA, ANM)	**paramedics, ASHA, ANM, MPHW)**	**paramedics, MPHW)**			
• Ensure adequate medical supplies available • Identify surge capacities and mark the beds dedicated to treat the heat stroke victims and enhance emergency department preparedness to handle more patients			• Ensure reporting of HRI cases on daily basis • Adopt HRI treatment and prevention protocols • Expedite recording of cause of death due to heat related illnesses			• Ensure IEC dissemination • Target the vulnerable area/communities followed by other areas. • Plan activities as per the Heat Wave alert issued by IMD		
			• Referral of patients to the higher facility only after ensuring adequate stabilization and basic definitive care (cooling and hydration)	• Prepare weekly reports of health impact for nodal officer • Conduct case review during heat season	• Prepare weekly reports of health impact for nodal officer • Conduct case review during heat season			
• Increase ASHA/ANM /MPHW outreach in at-risk villages during a heat alert, if feasible.	• Increase ASHA/ANM/ MP HW outreach in at risk PHC during a heat alert, if feasible. • Ensure dedicated bed availability • Ensure ambulance availability	• Increase MPHW outreach in at-risk blocks during a heat alert, if feasible • Ensure dedicated bed availability						

		• Ensure ambulance availability • Dedicated heat corners • Increase staffing at DH/MCs to attend to the influx of patients during a heat alert, if feasible. • Have DNO-CC/SNO- CC visit CHCs to confirm proper preparation has been made for heat related illness and conduct case audits during heat season.	

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

Annexure 3: Additional data analysis Lucknow City Extreme Heat

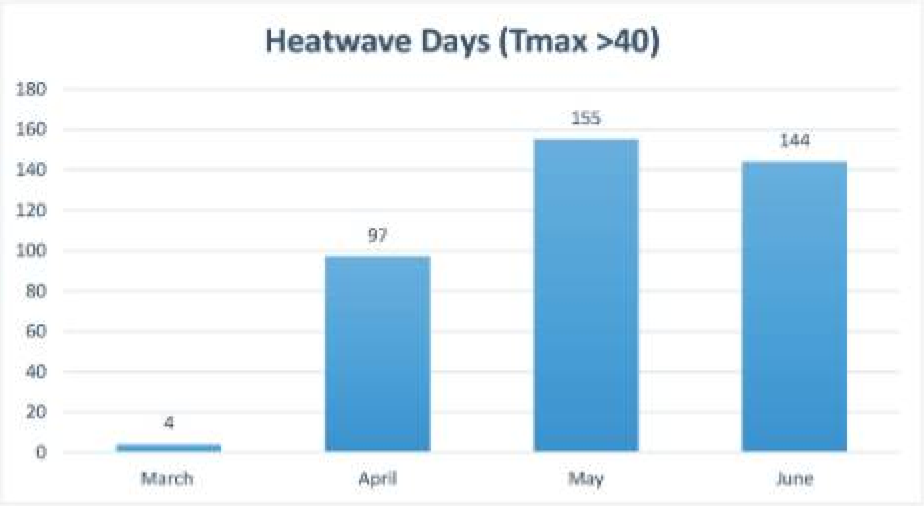


Figure A1: Monthly distribution of Heatwave days for 2014-2014.

Above figure illustrates the distribution of heatwave days (Tmax > 40°C) across the months of March, April, May, and June. Heatwave days are minimal in March, with only 4 occurrences, but increase significantly in April (97 days). May experiences the highest number of heatwave days at 155, followed by June with 144. This trend highlights a sharp rise in heatwave days as the summer season progresses, peaking in May, before slightly declining in June.

Table: Variation of Maximum and Minimum Temperatures for summer season (2014-2024)

Month (2014-2024)	Tmax (°C)	Deviation from Mean Tmax (°C)	Avg Increase in Mean Tmax (°C)	Tmin (°C)	Deviation from Mean Tmin (°C)	Avg Increase in Mean Tmin (°C)
March	32.07	-4.96		16.33	-6.35	1.4
April	37.99	0.95		21.73	-0.94	
May	39.15	2.12		25.12	2.45	
June	38.92	1.89	1.1	27.51	4.84	

Tmax- Maximum Temperature, Tmin – Minimum Temperature. Source: National Data Centre, IMD

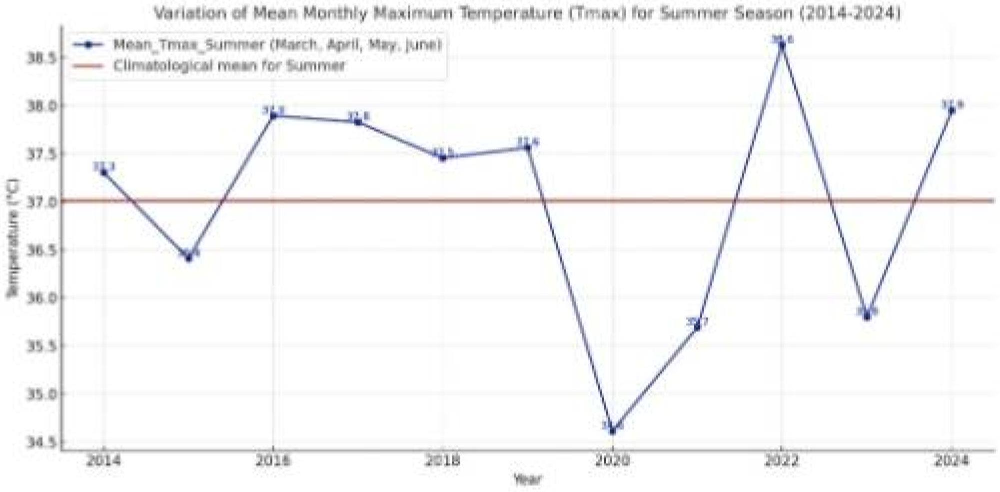


Figure A2: Variation of average monthly Tmax for summer months

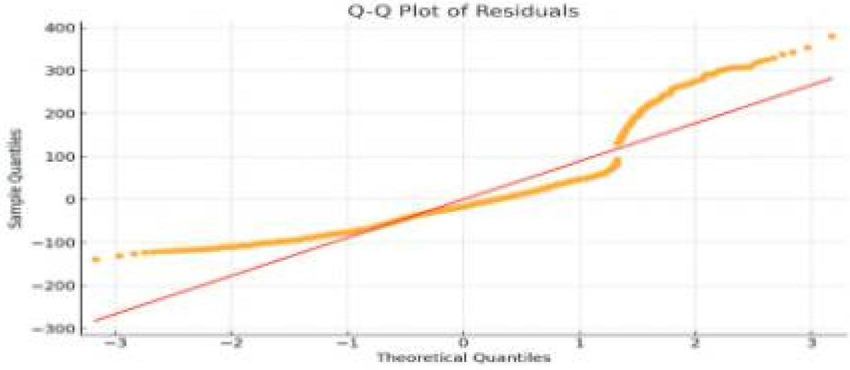


Figure A3: Q-Q plot of residuals

The advanced modeling incorporated lagged maximum temperatures (1-day, 2-day, and 3-day lags) alongside a quadratic temperature term to examine the influence of past temperatures on current mortality. The model explained approximately 9.4% of the variability in mortality data ($R^2 = 0.094$), though the lagged temperature variables were not statistically significant (p-values > 0.05). This suggests weak immediate associations between past temperatures and mortality, potentially indicating the influence of unaccounted factors such as demographic characteristics or healthcare access. Residual analysis revealed patterns that may suggest the presence of additional confounders or non-linear relationships. The Q-Q plot further indicated deviations from normality, suggesting the residuals were not perfectly normally distributed (Q-Q Plot Figure A3).

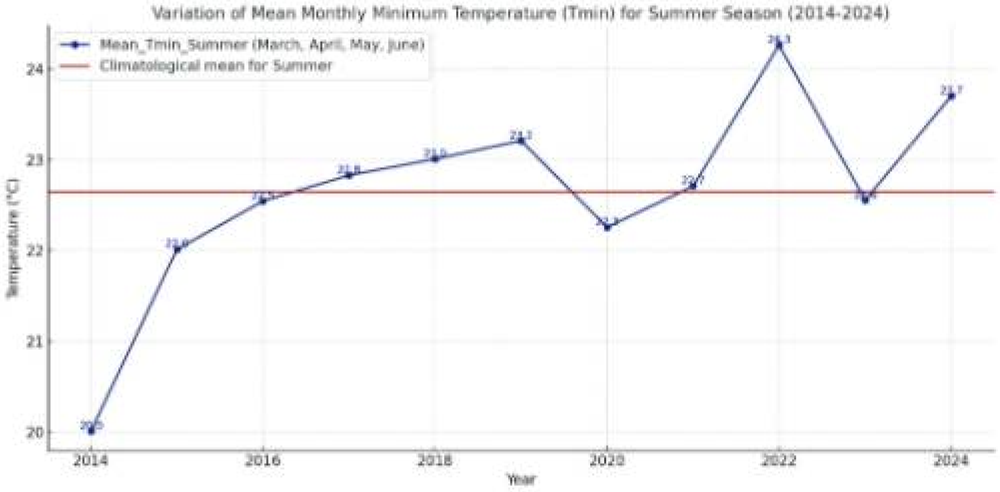


Figure A4: Variation of average monthly Tmin for summer months

Above figures illustrate the variation in mean monthly maximum (Tmax) and minimum (Tmin) temperatures for the summer season (March to June) from 2014 to 2024. The Tmax graph shows inter-annual fluctuations, with some years (e.g., 2022) significantly exceeding the climatological mean, represented by the red baseline, while others (e.g., 2020) fall below it. Similarly, the Tmin graph highlights notable year-wise variations, with peaks (e.g., 2022) and troughs (e.g., 2020), deviating from the climatological mean. These graphs underline the variability in summer temperatures over the decade, showcasing trends and anomalies useful for understanding climatic patterns and informing planning.

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