

Climate Change and Increasing Heatwaves in India: Spatial Patterns, Vulnerability and Adaptation Strategies

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Abstract

Heatwaves have emerged as a major climate-related hazard in India because rising background temperatures interact with high population density, rapid urbanisation, outdoor labour, unequal access to cooling and uneven public-health capacity. This paper examines the changing spatial pattern of heatwaves in India, identifies the principal dimensions of vulnerability, and evaluates adaptation strategies using secondary evidence from the India Meteorological Department (IMD), Ministry of Earth Sciences (MoES), Department of Science and Technology (DST), National Disaster Management Authority (NDMA), National Centre for Disease Control (NCDC), World Meteorological Organization (WMO), and peer-reviewed research published up to 2025. The analysis combines long-term temperature and heatwave climatology with recent evidence on heat-stress exposure, mortality, urban risk and Heat Action Plans. IMD evidence shows that heatwave frequency and duration have increased over many stations during 1961–2020, with persistent hotspots in north-western, central and northern India and parts of Odisha and coastal Andhra Pradesh. India's annual mean land-surface air temperature in 2024 was 0.65°C above the 1991–2020 average, making 2024 the warmest year in the national record since 1901. Vulnerability, however, is geographically differentiated: climatic exposure overlaps with poverty, outdoor employment, water stress, dense built-up environments, age, health conditions and limited adaptive capacity. The paper argues that India needs to move from episodic heatwave response towards year-round, risk-based heat governance integrating impact-based warnings, occupational protection, heat-resilient urban design, public-health surveillance, cool roofs, green-blue infrastructure and locally calibrated Heat Action Plans.

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1. Introduction

Anthropogenic climate change is increasing the probability, intensity and duration of extreme heat across much of the world, and South Asia is among the regions where the consequences are especially serious. India combines a warm tropical and subtropical climate with a large population, dependence on climate-sensitive livelihoods and rapidly expanding cities. Extreme heat therefore operates not only as a meteorological event but also as a public-health, labour, food-security, water, energy and urban-planning problem. The Intergovernmental Panel on Climate Change has concluded that human-induced warming has increased hot extremes in most land regions, while the WMO has reported that Asia is warming faster than the global average (IPCC, 2023; WMO, 2025). For India, the key policy concern is no longer whether extreme heat is increasing, but how its geography is changing and which populations are least able to avoid, absorb and recover from heat exposure.

A heatwave is not defined by one universal temperature threshold because human and ecological responses vary by local climate. IMD uses region-specific criteria. For plains, a heatwave is considered when maximum temperature reaches at least 40°C, while the corresponding threshold for hilly regions is 30°C; heatwave conditions can then be classified by departure from normal, with a departure of 4.5–6.4°C indicating a heatwave and a larger departure indicating a severe heatwave. Actual maximum-temperature thresholds are also used: 45°C for heatwave and 47°C for severe heatwave. Coastal stations use a lower absolute threshold because high humidity can intensify physiological heat stress. These operational criteria, documented by IMD (2023), are essential for warning and disaster management, but they do not capture the whole burden of heat, particularly hot nights, humid heat and repeated sub-threshold exposure.

India has warmed substantially over the historical period. The national climate assessment reported that average temperature increased by about 0.7°C during 1901–2018 (Krishnan et al., 2020). More recent observations show that this long-term signal is continuing. IMD (2025) reported that the annual mean land-surface air temperature in 2024 was 0.65°C above the 1991–2020 average, the highest annual anomaly in the national record since 1901, and that ten of the fifteen warmest years occurred during 2010–2024. Heatwave conditions in 2024 affected much of the east coast in April, north-west India in May, and northern and central India in June. Such sequencing illustrates that heat risk is spatially mobile and seasonally progressive rather than confined to a single fixed region.

The climatological core of Indian heatwaves is well established. IMD's 1961–2020 analysis indicates that more than two heatwave events occur on average over parts of northern India and coastal Andhra Pradesh and Odisha, while some pockets experience more than four events in a season (IMD, 2023). Typical heatwave duration is approximately four to eight days, but duration exceeds eight days in parts of central and north-western India and in sections of Odisha and coastal Andhra Pradesh. Earlier station-based research likewise identified north, north-west,

central and north-east peninsular India as major heatwave regions and found significant increasing trends at many stations. Gridded analyses have confirmed that frequency, total duration and maximum duration have increased most strongly over north-western and central India.

Recent research shows that heat exposure cannot be understood only through conventional heatwave-day counts. A district-scale study using the Universal Thermal Climate Index found increasing heat-stress exposure during 1981–2023, with particularly strong increases in central and eastern districts (Shah et al., 2025). Minimum thermal-stress indicators also rose faster than daily maxima, suggesting reduced physiological recovery. Prolonged warmth, humidity and hot nights can therefore create health risks even when official heatwave thresholds are not crossed.

The existing literature is rich but fragmented. Meteorological studies quantify changing frequency, intensity and duration; public-health studies examine mortality and illness; vulnerability assessments focus on social and livelihood sensitivity; and urban research evaluates Heat Action Plans, cool roofs and early warnings. Less often are these dimensions brought together in one geographical framework that distinguishes hazard, exposure, sensitivity and adaptive capacity. This paper addresses that gap by synthesising evidence up to 2025 to answer three questions: How are heatwave and heat-stress patterns changing across India? Which regions and social groups are most vulnerable, and why? Which adaptation strategies offer a basis for reducing current and future risk? The objective is to develop an integrated, policy-relevant interpretation suitable for climate adaptation and regional planning.

2. Study Area, Data and Methodology

India extends from the Himalayan and trans-Himalayan mountains to the Indo-Gangetic Plain, the Thar Desert, the central highlands, the Deccan Plateau and long Arabian Sea and Bay of Bengal coastlines. This physical diversity produces strong regional differences in temperature, humidity, rainfall, land cover and atmospheric circulation. Pre-monsoon heat is generally most intense from March to June, although coastal and southern regions may experience dangerous humid heat at lower dry-bulb temperatures. The arrival and advance of the southwest monsoon usually moderates maximum temperature, but delayed rainfall, deficient soil moisture, persistent anticyclonic circulation and advection of hot dry air can extend or intensify heatwave conditions. Urban areas introduce an additional local-scale heat island through dense construction, reduced vegetation, anthropogenic heat and limited nocturnal cooling.

The study uses a descriptive, analytical and comparative secondary-data methodology. Government evidence was prioritised wherever numerical claims were required. Principal sources include IMD heatwave climatology and warning criteria, the MoES national climate assessment, parliamentary responses on heatwave impacts and government preparedness, the DST Climate Vulnerability Assessment, NDMA heatwave planning guidance and NCDC heat-

related-illness action documents. These are supplemented by WMO regional climate assessments and peer-reviewed studies to interpret mechanisms, heat-stress metrics, mortality, occupational exposure and adaptation effectiveness. The evidence base is restricted to publications and datasets available through 2025; later publications are excluded from the substantive interpretation even where they report 2025 conditions.

The analytical framework treats heat risk as the interaction of four dimensions. Hazard refers to the intensity, duration, frequency, timing and humidity characteristics of extreme heat. Exposure represents the people, livelihoods, infrastructure and ecosystems located where harmful heat occurs. Sensitivity captures physiological, social and economic characteristics that increase harm, including age, pre-existing illness, poverty, poor-quality housing and physically demanding work. Adaptive capacity includes access to health care, drinking water, cooling, reliable electricity, social protection, early warnings, public institutions and heat-resilient urban or rural infrastructure. This framework prevents the common mistake of equating the hottest places with the most vulnerable places and allows regional contrasts to be interpreted more accurately.

The study does not construct a new heatwave index; instead, it triangulates authoritative datasets and published analyses. IMD evidence identifies the core hazard geography, district-scale studies reveal emerging exposure patterns, government assessments indicate adaptive-capacity deficits, and programme evaluations inform adaptation. Heat-related mortality figures are treated cautiously because attribution and surveillance differ across systems; official counts are therefore interpreted as recorded administrative burdens rather than complete epidemiological estimates.

3. Spatial Patterns and Temporal Change in Heatwaves

The traditional Indian heatwave belt is concentrated across the north-western plains, parts of the Indo-Gangetic region, central India and adjoining eastern and north-eastern peninsular areas. Rajasthan, Punjab, Haryana, Delhi, Uttar Pradesh, Madhya Pradesh, Vidarbha, Chhattisgarh, Jharkhand, Bihar and interior/eastern parts of Odisha frequently experience very high pre-monsoon maximum temperatures. Coastal Andhra Pradesh and parts of Telangana and Rayalaseema also form an important heatwave zone. IMD climatology for 1961–2020 shows average event frequency above two in northern India and parts of the east coast, while event duration commonly reaches four to eight days and exceeds eight days in some central, north-western and east-coast locations. This spatial pattern reflects continentality, dry surface conditions, clear skies and hot-air advection (IMD, 2023).

Long-term change is evident in both station and gridded data. Pai et al. (2013), analysing 103 stations for 1961–2010, found a noticeable increase in heatwave and severe-heatwave days during 2001–2010 compared with earlier decades, with significant increasing trends concentrated in north, north-west and central India. Rohini et al. (2016), using gridded data for 1961–2013, found significant increases in heatwave frequency and duration over north-west India, where

heatwave frequency increased by roughly 0.23 events per decade and total duration by about 1.3 days per decade under their Excess Heat Factor definition. Although exact magnitudes differ with the heatwave index used, the direction of change across the core zone is consistent across major studies.

The physical mechanisms reinforce the warming trend. Indian heatwaves are associated with persistent high-pressure or anticyclonic circulation, subsidence, clear skies, low soil moisture and the transport of hot dry air. Land-atmosphere feedback is especially important: dry soils reduce evaporative cooling, allowing more incoming energy to heat the surface and lower atmosphere. ENSO also influences Indian heat extremes; several studies report enhanced heatwave activity during or following El Niño conditions, although the relationship is not deterministic and varies regionally. Climate change raises the baseline upon which these circulation and land-surface anomalies operate, increasing the likelihood that a particular weather pattern will produce temperatures above historical thresholds.

The year 2024 illustrated the breadth of the contemporary hazard. Government reporting indicated that different parts of India experienced around 10–22 above-normal heatwave days during April–June 2024, with severe conditions affecting eastern India early in the season and shifting towards north-west, north and central India later. IMD's annual climate assessment classified 2024 as India's warmest year since 1901. This does not mean every location experienced its local record, but it demonstrates that the background climate is moving towards higher thermal conditions. A warmer baseline increases the probability of warm nights, earlier seasonal onset and longer periods during which thresholds for human heat stress are exceeded.

A second spatial shift concerns the difference between dry-bulb heatwaves and integrated heat stress. Humidity, wind and radiation alter the body's ability to dissipate heat, making coastal and irrigated regions potentially dangerous even when maximum air temperature is lower than in desert or continental interiors. Shah et al. (2025) analysed 722 districts and found that heat-stress exposure above a UTCI threshold increased from 1981 to 2023, with particularly strong increases in central and eastern India. Their results also showed that daily minimum UTCI rose more than daily maximum UTCI, indicating weaker nocturnal relief. This is a critical adaptation issue because people without air-conditioning or well-ventilated housing depend heavily on cooler nights for recovery.

Urbanisation creates local heat hotspots within the broader regional pattern. Impervious surfaces absorb solar energy, concrete and asphalt store heat, limited tree cover reduces shade and evapotranspiration, and traffic, industry and air-conditioning systems add anthropogenic heat. The urban heat-island effect is often strongest at night, when built surfaces release stored heat and densely constructed neighbourhoods remain warmer than surrounding rural areas. Low-income settlements may face the greatest exposure because of metal or asbestos roofing, overcrowding, limited vegetation, poor ventilation and insecure water supply. Thus, the spatial

scale of analysis matters: a city may not be in India's most extreme meteorological heatwave zone, yet specific wards can experience high heat-health risk.

Climate projections indicate further intensification if global warming continues. The MoES assessment projected that, under a high-emissions pathway, summer heatwaves over India could become several times more frequent by the end of the twenty-first century and last longer relative to a late-twentieth-century baseline (Krishnan et al., 2020; Arulalan et al., 2023). More recent CMIP6-based studies continue to project substantial increases in temperature and heat extremes across India, even though the magnitude varies by emissions pathway and region. The policy implication is straightforward: current Heat Action Plans designed around recent climatology will require periodic recalibration because the distribution of future temperatures will not remain stationary.

4. Vulnerability, Exposure and Socio-economic Impacts

Heat vulnerability is produced when high thermal hazard intersects with exposed populations and limited capacity to adapt. The DST (2021) national climate vulnerability assessment identified Jharkhand, Mizoram, Odisha, Chhattisgarh, Assam, Bihar, Arunachal Pradesh and West Bengal among the states with relatively high overall climate vulnerability under its indicator framework. This ranking does not imply that these states experience India's highest maximum temperatures, nor that states ranked lower are safe from heat. Rather, it reflects indicators related to socio-economic conditions, primary-sector livelihoods, biophysical characteristics and institutional capacity. The distinction is vital: Rajasthan may experience extremely high temperature hazard, while an eastern state may have greater composite vulnerability because a larger share of households depend on climate-sensitive livelihoods and possess fewer adaptive resources.

Outdoor workers are among the most exposed groups. Agriculture, construction, street vending, transport, mining, sanitation and informal manufacturing require physical activity under direct or poorly ventilated heat. Exposure can lower work capacity, increase dehydration and kidney stress, impair judgement and raise the risk of occupational accidents. India's large informal economy magnifies this problem because many workers lack enforceable rest breaks, shaded work areas, drinking water, health insurance or the bargaining power to stop work during high-risk hours. Heat adaptation therefore cannot depend exclusively on individual behaviour; it must include labour standards, employer responsibilities and public provision for workers whose income depends on daily attendance.

Rural vulnerability has a distinctive geography. Farmers and agricultural labourers experience direct solar exposure at the same time that crops, livestock and water resources are stressed. Terminal heat can reduce yields of temperature-sensitive crops when it coincides with flowering or grain filling, while higher evapotranspiration increases irrigation demand. Livestock suffer reduced feed intake, fertility and milk productivity under thermal stress. Households dependent

on rain-fed agriculture or with limited irrigation and savings have fewer options to absorb these losses. In drought-prone central and western India, heat and water scarcity can become compound hazards; in irrigated areas, humidity generated through land-water interactions can increase moist heat stress even where irrigation moderates surface temperature locally.

Urban vulnerability is shaped by density, housing and infrastructure inequality. High-rise commercial districts may have extensive mechanical cooling, while nearby informal settlements may depend on fans, intermittent electricity and shared water points. Tin-roofed dwellings can become dangerously hot in the afternoon, and poor ventilation may maintain high indoor temperatures into the night. People living alone, older adults, infants, pregnant women and individuals with cardiovascular, respiratory or renal disease are more sensitive to thermal stress. Homeless people and migrants may have almost no control over exposure. Because heat risk varies at neighbourhood scale, city-wide temperature averages can conceal local pockets of extreme vulnerability.

Public-health effects range from heat rash and cramps to heat exhaustion, heat syncope and potentially fatal heatstroke. Extreme heat can also aggravate cardiovascular, respiratory, renal and metabolic disease. The NCDC (2021) National Action Plan on Heat Related Illnesses recognises the need for surveillance, clinical preparedness and public-health response across government and private health facilities. However, heat mortality remains difficult to measure. Death certificates may record cardiovascular failure or other proximate causes without identifying heat as a contributing factor, while surveillance coverage differs among states. Therefore, administrative counts should be interpreted as minimum recorded burdens rather than complete estimates of heat-attributable mortality.

Official mortality data nevertheless demonstrate the severity of past events. In a parliamentary response, MoES (2024a) cited NCRB data showing that 1,908 deaths associated with heat/sunstroke were recorded nationally in 2015, the highest total in the series referenced by the government. A related parliamentary response reported 729 deaths in 2022, with substantial state variation (MoES, 2024b). Another government response acknowledged WMO reporting of 110 heatstroke fatalities in India in 2023. Comparisons across years must be cautious because reporting practices and event intensity vary, but the figures make clear that heat has repeatedly produced significant mortality. The epidemiological burden is likely broader when excess deaths and heat-aggravated illnesses are considered.

Social inequality determines who can avoid dangerous exposure. Air-conditioning is an effective protective technology but remains unequally distributed and depends on reliable electricity. Even households with coolers or fans can face thermal stress during power cuts or water shortages. Women may experience distinct risks because unpaid domestic work continues through hot periods and kitchens can be poorly ventilated. Children face exposure during travel to school and in classrooms without adequate cooling, while older adults may have reduced thermoregulatory

capacity. Migrants may lack local social networks and access to health information. These differences show why public warnings must be paired with targeted outreach and material support.

Heat also generates systemic economic impacts. Cooling demand can strain electricity grids, water demand rises while drought and evaporation may reduce supply, and labour productivity falls when physical work slows or hours must be reduced. Infrastructure and urban services also face thermal stress. Recent modelling for Indian cities indicates that early warning and urban greening can produce benefits exceeding their costs, supporting the treatment of heat adaptation as productive public investment (Takacs et al., 2025).

5. Adaptation Strategies and Heat Governance

India has made important progress in recognising heat as a governable disaster risk. IMD now provides seasonal and monthly temperature outlooks, extended-range forecasts, district-wise warnings, impact-based heatwave information, heat-index products and Web-GIS services. By 2024, government responses stated that Heat Action Plans were being implemented across 23 heatwave-prone states in collaboration with NDMA and state governments (MoES, 2024a, 2024b). These systems create an institutional bridge between meteorological forecasting and public action. Their effectiveness, however, depends on whether warnings are translated into changes in work schedules, health-system readiness, water provision, school timing, shelter access and municipal operations.

The Heat Action Plan model is one of India's most significant adaptation innovations. Ahmedabad developed South Asia's first city HAP after the severe 2010 heatwave. Its components included forecast-based alert thresholds, inter-agency coordination, public communication, health-worker training and targeted measures for vulnerable groups. A peer-reviewed evaluation found lower summertime mortality after implementation and estimated approximately 1,190 average annualised deaths avoided in the post-HAP period, although the study design cannot attribute all change exclusively to the plan (Hess et al., 2018). The Ahmedabad experience demonstrates that relatively low-cost preparedness can save lives, but it should be treated as a model to adapt locally rather than a template to copy mechanically.

Recent evaluations of Indian urban HAPs reveal uneven quality (Singh et al., 2024). Plans differ in the populations they classify as vulnerable, the temperature or health thresholds they use, the agencies responsible for action and the extent to which long-term urban planning is included. Some remain heavily focused on short-term awareness campaigns without strong mechanisms for monitoring outcomes, financing implementation or revising thresholds. A mature HAP should specify who acts, at what trigger, with what resources and how performance will be evaluated. It should also distinguish between emergency response for a forecast heatwave and structural adaptation intended to reduce baseline exposure over years.

Early warning should be progressively impact-based and locally calibrated. Temperature alone is insufficient in humid regions, for outdoor work and during warm nights. Forecast systems should integrate humidity, minimum temperature, duration, vulnerability profiles and expected health impacts. District and city authorities can pre-identify high-risk wards, labour clusters, schools, markets and health facilities, then link alert levels to pre-agreed actions. Messages should be delivered in local languages through mobile alerts, radio, television, local institutions, employers, self-help groups and community health workers. Warning credibility is strengthened when people receive practical instructions and can access water, shade, transport or medical care needed to follow them.

Occupational heat protection deserves much stronger emphasis. During high-risk periods, work-rest cycles should be adjusted, physically demanding outdoor work should be shifted away from the hottest afternoon hours, shaded rest areas and safe drinking water should be mandatory, and first-aid protocols should be available at work sites. Public employment programmes and government contracts can lead by embedding heat-safety clauses into operating rules. For informal workers, municipal cooling shelters, shaded vending zones, water stations and flexible market timing are especially relevant. Such measures reduce the unfair situation in which the people with the least economic security are expected to bear the greatest climatic exposure.

Urban design offers major long-term adaptation opportunities. Cool roofs and reflective materials reduce solar heat absorption and can lower indoor temperatures in low-rise buildings. Trees and connected green spaces provide shade and evapotranspirative cooling, while blue infrastructure and water-sensitive urban design can improve local thermal comfort where water availability permits. Building regulations can encourage passive ventilation, insulation, shaded façades and climate-responsive orientation. Heat-risk mapping should guide investments so that interventions reach the hottest and most socially vulnerable neighbourhoods rather than only high-visibility central areas. Because poorly designed greening can increase water demand, strategies must be adapted to local ecology and water budgets.

Health-system adaptation requires year-round capacity, not only emergency instructions in May and June. NCDC guidance provides a basis for training clinicians to recognise and treat heat-related illness, establishing surveillance and ensuring health facilities are prepared for surges. Hospitals and primary health centres need reliable electricity, cooling for critical areas, safe water and emergency protocols for mass heat exposure. Health data should be integrated with meteorological alerts to identify temperature-health relationships and locally appropriate trigger thresholds. Better cause-of-death certification and real-time heat-illness surveillance would also reduce the current uncertainty surrounding the scale and distribution of mortality.

Rural adaptation should connect heat planning with agriculture, water management and social protection. Heat-resilient crop varieties, altered sowing dates, agroforestry, soil-moisture conservation, efficient irrigation, livestock shade and drinking-water provision can reduce

sensitivity. Weather advisories should communicate not only maximum temperature but expected crop and livestock implications. Rural housing programmes can incorporate reflective roofs, ventilation and shaded outdoor areas. Where heat and drought threaten livelihoods, employment guarantees, insurance and income support become forms of climate adaptation because they reduce the need for households to continue unsafe work during extreme conditions.

Adaptation should also complement mitigation. Mechanical cooling is often necessary for health, but inefficient air-conditioning can increase electricity demand, waste heat and emissions. Efficient cooling, passive building design and low-carbon electricity can expand thermal safety without locking cities into highly energy-intensive pathways.

6. Major Findings and Discussion

The synthesis yields five principal findings. First, India's heatwave hazard is intensifying against a rising background temperature, with north-western, northern and central India remaining the strongest dry-heat core and eastern and peninsular locations also experiencing important exposure. Second, the geography of heat stress is broader than the geography of IMD-defined heatwaves because humidity, warm nights and repeated exposure matter. Third, vulnerability is not determined by temperature alone; poverty, outdoor labour, health status, housing, water, electricity and institutional capacity strongly shape outcomes. Fourth, official mortality counts confirm serious impacts but likely understate the full heat-attributable burden. Fifth, adaptation works when warnings are connected to funded, enforceable and locally targeted action rather than remaining only informational.

A major policy implication is the need to replace a binary "heatwave/no heatwave" mindset with continuous heat-risk management. High-risk populations can experience harmful exposure before a meteorological threshold is formally met, and chronically warm nights may limit recovery during multi-day events. District-level risk systems should therefore combine hazard forecasts with vulnerability maps and health surveillance. The most useful operational question is not simply how hot a district will be, but which groups will be exposed, what consequences are likely and which agency must intervene. This shift is consistent with the broader international movement towards impact-based forecasting and anticipatory action.

The spatial mismatch between hazard and vulnerability means resources should not be allocated only according to historical maximum temperature. High-hazard states need strong warning and emergency capacity, while highly vulnerable districts may require deeper investment in health systems, housing, livelihoods and basic services. Ward-level urban targeting and livelihood-sensitive rural planning should connect national forecasting with district and neighbourhood implementation.

7. Conclusion

Climate change is transforming extreme heat from a seasonal weather hazard into a persistent development challenge for India. Long-term IMD evidence and peer-reviewed research show increasing heatwave frequency and duration across major parts of the country, especially the north-western and central heatwave core. The record national warmth of 2024 and research published through 2025 reinforce the conclusion that adaptation must account for a non-stationary climate. At the same time, integrated heat-stress studies show that harmful exposure is not restricted to places experiencing the highest dry-bulb temperatures; humidity, hot nights, urban form and occupational conditions are expanding the geography of risk.

The most vulnerable populations are those with the least control over their exposure and the fewest resources for recovery. Outdoor workers, low-income urban households, migrants, farmers, older adults, children and people with chronic illness face disproportionate risk. Climate vulnerability assessments further show that socio-economic and institutional disadvantage can make states and districts highly vulnerable even when they are not India's hottest places. This makes heat policy an issue of climate justice as well as disaster management. Adaptation must reduce unequal exposure rather than simply improve average urban comfort.

India already has important institutional foundations: IMD impact-based forecasts, NDMA guidance, NCDC health preparedness and Heat Action Plans across many states. The next stage should focus on quality, enforcement, financing and evaluation. Every high-risk district and city needs a locally calibrated HAP linked to health surveillance, occupational standards, water and power continuity, school and work protocols, emergency shelters, and spatially targeted cool-roof and green-blue infrastructure programmes. Plans should be reviewed after each hot season using mortality, morbidity, service-delivery and warning-response indicators rather than only counting awareness activities.

Ultimately, a heat-resilient India will require the integration of climate science with public health, labour policy, social protection, agriculture, energy and urban planning. Early warnings can prevent immediate deaths; cool roofs, trees and passive buildings can reduce exposure; resilient health systems can reduce mortality; and social protection can allow workers to avoid dangerous conditions without losing their livelihoods. These measures are most effective when combined with rapid mitigation of greenhouse-gas emissions, because adaptation becomes progressively more difficult as baseline temperatures rise. Treating heat as a central planning variable—rather than an exceptional summer emergency—offers the strongest pathway for protecting lives, productivity and regional development under a warming climate.

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