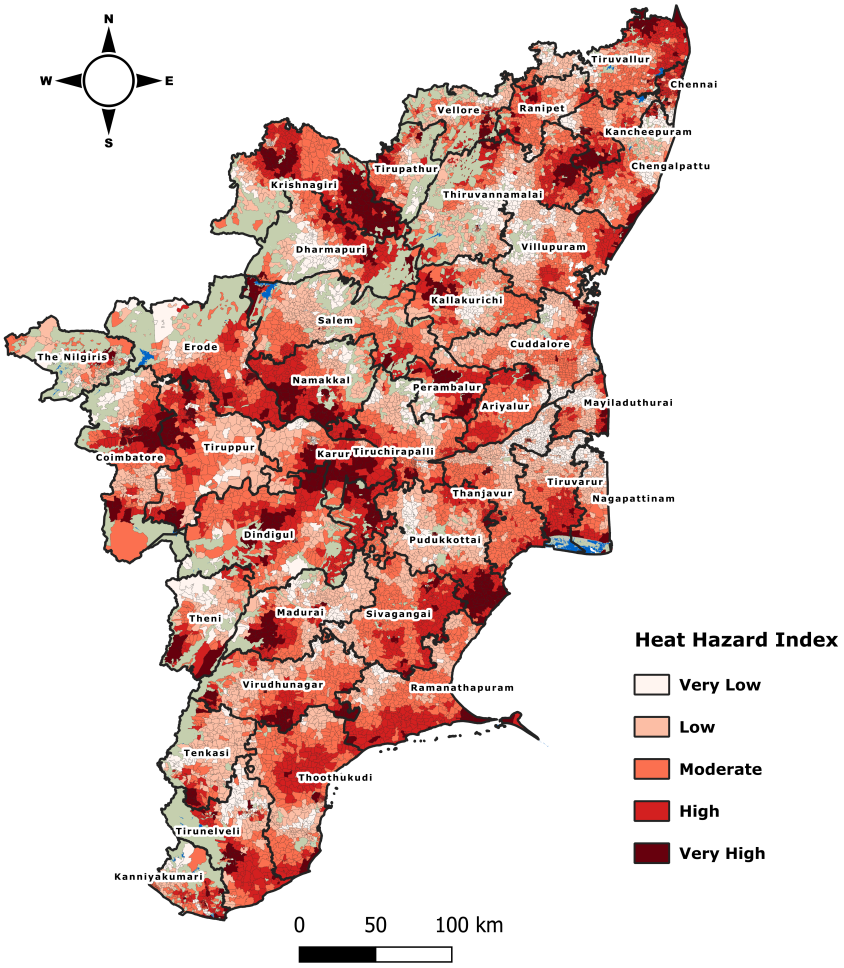
State Heat Action Plan for Tamil Nadu 2026



This map shows heat hazard, taking the districts as basic units for computation, using the indicators of extreme daytime and night time heat, felt temperature, rainfall and urban surface heat. The Land Cover categories of vegetation, water bodies and barren land have been represented as green, blue and grey.

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About The State Heat Action Plan for Tamil Nadu - A dynamic document:

The State Heat Action Plan (State HAP) for Tamil Nadu was developed integrating socio-economic data, historical climate datasets and future climate projections from Indian Monsoon Data Assimilation and Analysis (IMDAA) and Regional Climate Models (RCMs) from the Ministry of Earth Sciences (MoES), for the period from 1982 to 2050. Satellite-derived indices and granular socio-economic information were combined to map heat risk across cities at the level of wards and across districts at the level of village panchayats. Such risk analysis will facilitate efforts in preparedness, response and long-term heat risk mitigation strategies to areas where vulnerability is relatively high, thus promoting focused administrative actions.

The State HAP was formulated in accordance with the guidelines issued by the National Disaster Management Authority (NDMA), 2019 and follows the formats prescribed by the National Programme on Climate Change and Human Health (NPCCHH), Ministry of Health and Family Welfare (MoHFW) and the National Disaster Management Plan (NDMP),2019.

The Tamil Nadu Disaster Risk Reduction Agency (TNDRRA) has led the development of this plan in collaboration with the relevant Heads of departments in State headquarters, the city corporations and the districts in Tamil Nadu. Given the increasing incidence of heatwaves, this plan has been formulated within a short timeframe using openly accessible secondary data source and other data sourced from the respective cities and districts. The plan is intended to be iterative in nature, with provisions for annual updates incorporating other relevant data or latest data updates.

The latest edition of the State HAP can be accessed by scanning the QR code given below. In the electronic version of State HAP, a feature of feedback widget as icon will be made available at the bottom of each electronic page which will enable submission of specific feedback. Feedback is welcome for correction, modification and improvement of the State HAP over the years.

Scan the below QR to access the electronic version of HAP document

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Acknowledgements

Council on Energy, Environment and Water (CEEW)

As per the G.O. (MS) No.9 dated 07.01.2025, the Council on Energy, Environment and Water (CEEW) was entrusted the work of developing the State HAP for Tamil Nadu. CEEW did this pro bono in 2 stages: in the first stage, 11 city Heat Action Plans were brought out in August,2025; in the current second stage, the State Heat Action Plan is being brought out after incorporating the learnings from the first stage. CEEW did the entire work for this document and submitted the same for review and feedback to Tamil Nadu Disaster Risk Reduction Agency (TNDRRA).

About CEEW: The Council on Energy, Environment and Water (CEEW) - a home-grown institution with headquarters in New Delhi is among the world's leading climate think tanks. The Council uses data, integrated analysis and strategic outreach to support public policy, transform markets, shape technology and nudge behaviour. CEEW seeks to explain - and change - the use, reuse, and misuse of resources. It addresses pressing global challenges through an integrated and internationally focused approach. The Council prides itself on the independence of its high-quality research and strives to impact sustainable development at scale. In over 15 years of operation, CEEW has impacted over 400 million lives and engaged with over 20 state governments. For more information on CEEW, click on the link - https://www.ceew.in/. The content of this paragraph is given by CEEW and the content of this link is maintained by CEEW.

The preparation of the Tamil Nadu State Heat Action Plan was supported by a dedicated team from the Council on Energy, Environment and Water (CEEW), led by Dr.Vishwas Chitale, Fellow and Team Lead – Climate Resilience, who provided overall project leadership, strategic oversight, stakeholder coordination and technical review; Mr.Shravan Prabhu, Programme Lead, who co-ordinated the Heat Action Plan development process and supervised technical drafting, field validation and capacity-building activities; and Dr. Pradheeps Muthulingam, Senior Engagement Lead who facilitated stakeholder engagement and coordination with government counterparts while contributing to drafting and review processes. Contributions towards report drafting, data analysis, spatial mapping, risk assessment, field validation, stakeholder consultations, quality assurance and incorporation of stakeholder feedback were made by Mr. Anup Kumar Srivastava, Ms. Prerna Ojha, Ms.Keerthana AS, Mr. Divyanshu Sharma, Ms. Sabarisha Nachimuthu, Mr. Alifshah N, Ms. Sathya Mani, Ms. Sangeetha Vani Pradeep, Dr.Shrutika Rane, Ms. Sravani Arigela, Ms. Sweta Raj, Ms. Mehak Chaudhary and Mr. Anurag Tripathi. Their collective efforts and commitment have been instrumental in shaping a comprehensive and actionable Heat Action Plan for Tamil Nadu. TNDRRA thanks the CEEW leadership and team for their technical expertise, strategic guidance and relentless field-level engagement. TNDRRA also

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thanks Dr. Thirupuguazh IAS, (retd.) for facilitating the engagement with CEEW.

ARTPARK-Indian Institute Science, Bangalore

TNDRRA wanted to bring out a Daily Heat Report with actionable inputs to all relevant field officers. For this purpose, upon completion of the initial draft of the Tamil Nadu Heat Action Plan by CEEW, the document was submitted to ARTPARK for scientific review and technical validation. The review aimed to improve the scientific robustness of the report for becoming the backbone for the actionable Daily Heat Report from TNDRRA. ARTPARK completed the review and recommendation process within 15 days. The outcomes of this exercise and the associated technical inputs are detailed in Chapter 6.

About ARTPARK: AI and Robotics Technology Park (ARTPARK) (registered as I-Hub for Robotics and Autonomous Systems Innovation Foundation) is a not-for-profit Section 8 company established at the Indian Institute of Science (IISc), Bengaluru, to advance translational research and innovation in artificial intelligence and emerging technologies. Through collaborations with government, industry, startups and research institutions, ARTPARK supports the development and deployment of technology-driven solutions that address societal and public-sector challenges. As part of its Climate and Health initiatives, ARTPARK works on the development of AI-enabled forecasting and risk communication systems for climate-sensitive hazards, including extreme events and vector-borne diseases. These efforts aim to support decision-making, strengthen preparedness and early warning systems, resource allocation and enhance resilience to climate and disaster risks.

TNDRRA thanks the support and the contributions of Dr.Vybhav G R, Mr. Harish S Nalawade, Ms. Aishwarya Ramamurthy from ARTPARK for providing technical inputs during the review of the Tamil Nadu State Heat Action Plan. In this HAP, ARTPARK has contributed their expertise towards AI-enabled approaches for heat forecasting, heat early warning systems, forecasting methodologies, operational thresholds, multi-sectoral risk integration, and supported the articulation of future pathways for locally calibrated heat-risk intelligence and decision-support capabilities. These contributions are intended to inform future efforts towards strengthening data-driven and AI-enabled heat-risk preparedness and decision-making in the state.

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Tamil Nadu Disaster Risk Reduction Agency (TNDRRA)

TNDRRA coordinated the entire work for the HAP, facilitated the flow of field data and the preliminary groundtruthing with field officials. Simultaneously TNDRRA developed the "Daily Weather Report – Heat" report format to be brought out electronically on daily basis and to be disseminated for action at taluk and ward level in various departments across the territory of Tamil Nadu, during the heat season.

The Tamil Nadu Disaster Risk Reduction Agency (TNDRRA) expresses its sincere gratitude to the Hon'ble Chief Minister of Tamil Nadu **Thiru C. Joseph Vijay**; the Hon'ble Minister for Revenue and Disaster Management **Thiru K.A. Sengottaiyan**; the Chief Secretary to the Government of Tamil Nadu (and former Commissioner of Revenue Administration who initiated the HAP work), **Dr. M. Sai Kumar**, IAS; the present Additional Chief Secretary/ Commissioner of Revenue Administration, **Thiru N.Muruganantham**, IAS; the Principal Secretary/Commissioner of Disaster Management, **Tmt Sigy Thomas Vaidhyan**, IAS; and the former Director of Disaster Management, **Thiru C. Muthukumaran**, IAS, for their leadership and invaluable support in the preparation of the Tamil Nadu State Heat Action Plan,2026.

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1 Introduction

In January 2025, the India Meteorological Department announced that 2024 was the hottest year on record since 1901. With 2024 recorded as the hottest year globally and the 1.5°C global warming threshold approaching faster than anticipated, the impacts of climate change are becoming increasingly severe. These effects, evident through regional climate variability and extreme weather events, disproportionately affect vulnerable populations, particularly in developing and tropical countries like India (World Meteorological Organization, 2024).

One of the most immediate consequences of climate change is the intensification of heat extremes and the resulting heat stress. Globally, heatwaves have been linked to approximately 166,000 deaths between 1998 and 2017 (World Health Organization, 2018). The summer of 2024 highlighted the growing risks of extreme heat in India. The country faced one of its longest heatwaves, exposing over one billion people to harsh heat across 23 heatwave-prone states (IMD, 2023). The intensity of recent years has been alarming: 2022 saw one of the most prolonged heatwaves, while 2023 had heatwaves declared in 10 states. By April 2024, the IMD had forecast nearly 20 heatwaves days-far above the usual 4-8 days-demonstrating the clear impacts of climate change, exacerbated by phenomena such as El Niñso (IMD, 2024). By the summer of 2024, India recorded 536 heatwave days across its meteorological subdivisions (i.e., cumulative heatwave days recorded across multiple regions rather than calendar days) – the highest since 2010.

Climate projections indicate that heatwaves in India will become more frequent, intense, long-lasting and geographically widespread (Im, Pal and Eltahir, 2017). The health impacts of heat stress are projected to emerge as the most critical climate risk for India and South Asia (IPCC, 2019). With decisive mitigation and adaptation measures, the impact of heatwaves could be reduced. Addressing the escalating risks of heatwaves requires mapping climate variability, tracking extreme heat events and designing robust, localized action plans. This Heat Action Plan for the state of Tamil Nadu state focuses on identifying trends in extreme heat, mapping heat risk hotspots and developing tailored strategies for mitigation, preparedness and response.

1.1 Understanding heat waves

Heatwaves lack a universally agreed-upon definition. The World Meteorological Organization (WMO) defines a heatwave as "*five or more consecutive days of prolonged heat, during which the daily maximum temperature exceeds the average maximum temperature by 5°C (9°F).*" However, definitions and criteria for assessing temperature extremes vary significantly across the world, tailored to local climatological and impact-

specific conditions in each region (WMO, 2011; Alexander et al., 2006; Vose et al., 2005).

For instance, the USA uses a complex "felt temperature" criterion that incorporates both humidity and temperature, while Denmark employs a simpler threshold, defining heatwaves based on a daytime maximum temperature of 28°C. Similarly, countries like China and Brazil use a percentile-based approach to measure heat waves.

In India, the India Meteorological Department (IMD) employs layered criteria to define heatwaves based on geographical regions and temperature departures from the normal.

Figure 1: Criteria for declaring heatwaves in India

Criteria for declaring heatwaves in India	
Criteria 1: Heat wave is only considered if maximum temperature of a station reaches	40°C or more for **plains** 37°C or more for **coasts** 30°C or more for **hills**
Criteria 2: Once criteria 1 is satisfied, the departure from normal should be	Between **4.5°C to 6.4°C** for a heatwave day **More than 6.4°C** for a severe heatwave day
Criteria 3: If criteria 1 and 2 are met in at least in **2 stations** in a Meteorological subdivision for at least **two consecutive days**, a heatwave/severe heatwave is declared on the second day	
However, if the maximum temperature is **≥ 45°C and ≥ 47°C**, a heatwave and severe heatwave is directly declared.	
Source: Indian Meteorological Department, 2019	

A heatwave in India is declared based on a combination of how high the temperature is, how unusual it is for that location and how long it lasts. The "maximum temperature" refers to the highest temperature recorded during the day, usually in the afternoon. However, heatwave classification is not based solely on temperature. It also considers the "departure from normal," which means how much hotter the day is compared to the usual average temperature for that place and time of year. For example, a temperature of 40°C may be normal in one region but extreme in another, depending on local climate patterns. In addition, the heat conditions must persist. The criteria must be met at multiple weather stations within a meteorological subdivision and typically for at least 2 consecutive days, before a heatwave is officially declared. In cases where temperatures reach extremely high levels, such as 45°C or above, a heatwave may be declared directly due to the severity of the heat. Together, these factors ensure that a heatwave reflects not just a hot day, but a sustained and unusually intense heat event relative to local conditions.

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Since 2024, the IMD has also begun issuing forecasts based on maximum temperature percentile exceedances of daily maximum temperature (Tmax), such as the 90th, 95th and 99th percentiles corresponding to yellow, orange and red alerts, respectively. This approach helps capture the district-level long-term normals and climatology, providing more regionally specific assessments of heatwave risks in India.

1.2 Climate change and escalating heat extremes in India

Climatic projections indicate that heat extremes in India will intensify, becoming more frequent, lasting longer and affecting broader geographical areas (Im, Pal and Eltahir, 2017). As per the IPCC's Climate scenarios, both daytime and night time heat extremes are expected to increase two to four-fold by 2050 under Representative Concentration Pathway (RCP) 4.5 and RCP 8.5, respectively (Krishnan et al., 2020). These impacts will be exacerbated by factors such as humidity and the Urban Heat Island Effect, leading to more heat-related deaths, challenging working conditions and a wider spread of vector-borne diseases (Vaghela and Mangal, 2017; Bordoloi and Saharia, 2021), particularly in coastal cities like Thane, Mumbai and Chennai, where the compounded effects will be most severe.

This will have significant impacts on vulnerable populations, such as those living in slums and place additional stress on resource allocation in the context of rapid urbanization. *The International Labour Organization (ILO) predicts a 5.8 percent rise in working hours lost due to heat stress by 2030, equivalent to 34 million full-time jobs (ILO, 2019).* While cities are generally considered most at risk, recent heatwaves in India have also affected other critical sectors, including agriculture and livestock. For example*, the prolonged 2022 heatwave led to wheat yield reductions of 15-25 percent in states across the Indo-Gangetic plain. Moreover, the Indo-Gangetic Plain is experiencing the sharpest rise in heat stress nationally, driven by a 6-9 percent increase in summer relative humidity and a rapid increase in very warm nights (CEEW, 2025). Milch animals also experienced a reduction in milk yield of up to 15 percent due to loss of appetite and elevated body temperature (Indian Council of Agriculture Research, 2022)*. *Moreover, the 2024 heatwave, one of the longest in India's history, resulted in over 44,000 suspected heatstroke cases, record-breaking power demand, declining reservoir water levels and widespread crop damage (National Centre for Disease Control, 2024).*

The labour force, especially in cities like Chennai experiences extreme heat stress exceeding 40°C. The outdoor workers being exposed to the temperature of 34°C- 45°C results in significant productivity loss with projected declines in work performance reaching 39-40 percent by 2050 requiring 25-75 percent rest per hour depending on work intensity and temperatures (Kumar et al., 2024). The sector-wide impact on the population working outdoors is increasingly severe. Rising indoor temperatures, combined with longer working hours and continuous

household responsibilities, result in prolonged heat exposure among women during both daytime and night time hours which goes unrecognized.

The increasing risks from extreme heat and heat stress will disproportionately affect multiple sectors and populations, threatening progress toward the Sustainable Development Goals (SDGs) and alignment with the Sendai Framework for Disaster Risk Reduction.

1.3 Heat Action Plans (HAPs) in India

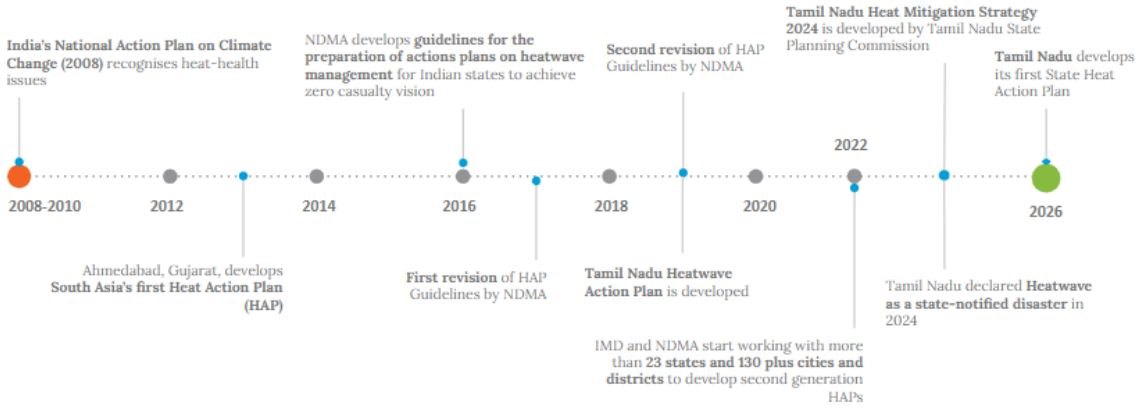
Despite the increasing risk of more frequent and intense heat extremes, vulnerability to this hazard can be significantly reduced from escalating into a disaster by implementing suitable adaptive measures. The key to this lies in the effective implementation of Heat Action Plans (HAPs) across India. HAPs are policy documents developed by state, district and city governments that provide a comprehensive framework to prepare for, respond to, recover from and learn from extreme heat events.

Heat Action Plans have demonstrated measurable benefits when effectively implemented. For instance, Ahmedabad, which launched its Heat Action Plan in 2013, reportedly avoided approximately 1,000 all-cause deaths annually during 2014-2015 compared to the 2007-2010 baseline period (Hess et al., 2018). This evidence underscores the potential of well-designed and timely heat preparedness measures to significantly reduce mortality during extreme heat events.

In 2016, the National Disaster Management Authority (NDMA) issued guidelines for developing HAPs, with a primary focus on enhancing the preparedness and response capacities of health systems and disaster management authorities. The overarching goal was to direct limited healthcare, financial, informational and infrastructural resources toward protecting those most vulnerable to extreme heat within a specific jurisdiction.

The guidelines were further revised in 2017 and 2019 to incorporate short, medium and long-term strategies for heat risk reduction. The updated guidelines feature an eight-point checklist, highlighting the importance of effective coordination between agencies and stakeholders, mapping vulnerable and at-risk populations, establishing localized heat thresholds for early warning systems, creating a stakeholder responsibility matrix and outlining strategies for monitoring, evaluation and regular updates of the plans (NDMA, 2019). The NDMA has also been conducting annual workshops with nodal agencies, states, districts, municipalities, academia, civil society organizations and think tanks to enhance the preparedness before the heatwave season.

Figure 2: Timelines of heat action plans in India and Tamil Nadu



1.4 Nodal agencies

The nodal agencies for Heat Action Plans (HAPs), as outlined in the Ministry of Home Affairs' guidelines on combating extreme weather events - specifically heatwaves-are as follows:

1. National Disaster Management Authority (NDMA): At the national level, the NDMA issued the "National Guidelines for the Preparation of Action Plan - Prevention and Management of Heat Wave" in 2016. These guidelines serve as a framework for implementing, coordinating and evaluating activities related to extreme heatwaves in India. The NDMA revised these guidelines in 2017 and again in 2019 to enhance their effectiveness in managing heatwave risks. *These guidelines are added in Annexure 4 of the report.*

2. India Meteorological Department (IMD): Working in close coordination with the NDMA, the IMD plays a critical role by focusing on early warnings and impact-based forecasts and alerts for heatwave events. These alerts help states implement timely and appropriate mitigation measures. As of 2024, the India Meteorological Department (IMD) is developing and using an India-specific Heat Index on an experimental basis. This index incorporates multiple parameters, including relative humidity, wind speed, night time temperatures and the persistence of heatwave conditions, to better capture heat stress in the Indian context. In addition, IMD has begun providing percentile-based departures from maximum and minimum temperatures as supplementary information to the official heatwave declaration criteria (PIB, 2024; Srivastava, Mohapatra & Kumar, 2022). These developments aim to strengthen the scientific basis for heatwave monitoring and advisories.

3. National Centre for Disease Control (NCDC): The NCDC monitors and compiles data on epidemic-prone diseases on a weekly basis, enhances the capacity of medical personnel and provides certification for illnesses and casualties related to heatwaves. Recently, the NCDC released a template

for the development of District Action Plans on Climate Change and Human Health (DAPCCHH) and formats for recording heat-related illnesses and mortalities.

4. State Government: Several state governments have undertaken preparedness and mitigation measures to address heatwaves. In recent years, many states, districts and cities have developed and are actively implementing Heat Action Plans. These plans provide a comprehensive guide for state governments, district authorities and city administrations to implement measures aimed at preventing heatwave-related mortalities.

5. District Administration: DDMAs primarily focus on developing district level heat action plans, appointing a Nodal Officer with a Task Force Committee and preparing SOP for heatwave response. They coordinate with the nodal officers and line departments with clearly defined roles and responsibilities. The district administration ensures that heat-health facilities are equipped with adequate medicine for short to long-term measures, such as ORS and Glucose etc. This are kept ready as and when required.

6. Urban Local Bodies: Municipal Corporations, Municipalities and Town Panchayats work in coordination with the district administration, State Disaster Management Authorities and relevant line departments to implement Heat Action Plans (HAPs) at the micro level, in urban local bodies. They are responsible for disseminating early warnings and preparing urban spaces to reduce the risk of Urban Heat Island (UHI) effects. These coordinated roles and responsibilities are outlined by the NDMA and can be adopted at the corporation level to minimise the impacts of heatwaves.

7. Panchayat Raj Institutions: The implementation of HAPs at the village level is primarily led by Gram Panchayat authorities, with support from the Panchayat Samhiti (at the block level) and the Zilla Parishad (at the district level). Effective coordination is essential between various panchayat departments, block and district officers to ensure the timely dissemination of early warnings and the implementation of HAPs at the village level. Although the implementation at the village level is done by Gram Panchayat officials, the guidelines and recommendations are drafted as part of national and state level plans.

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2. State Profile of Tamil Nadu and Heat Impacts

2.1 Profile of Tamil Nadu State

Tamil Nadu, located in the southern part of India, is a state known for its rich cultural heritage, diverse geography and robust economy. It is the eleventh largest in area and has the second highest GSDP in India (Tamil Nadu vision $1 Trillion, 2024). It is situated on the south-eastern side of the Indian Peninsula covering an area of 130,058 square kilometres have a coastline of about 1,076 km. Tamil Nadu accounts for nearly 18-20% of the mainland coastline and about 14-15% of India's total coast length. It borders the Bay of Bengal to its east, the Indian Ocean to its south, Andhra Pradesh to its north and Karnataka and Kerala to its west.

Based on its physiographic characteristics, Tamil Nadu is divided into four major regions: the Coastal Plains, the Eastern Ghats, the Central Plateau and the Western Ghats. The flat, fertile eastern coastal plains are widest in the Kaveri River delta and become more arid further south. In contrast, the Western Ghats along the western border feature high mountain ranges such as the Nilgiri, Anaimalai and Palani hills, with Doddabetta in the Nilgiris being a prominent peak and Anai Mudi (Anai Peak) in the nearby Anaimalai Hills being the highest in South India at 2,695 meters above mean sea level. The Eastern Ghats and their outcrops, including the Javadi, Kalrayan and Shevaroy hills, run through the central region of the state of Tamil Nadu contribute to its climate characterized by minimal seasonal temperature variation throughout the year. Tamil Nadu is administratively organised into 38 districts, 94 revenue divisions, 317 taluks and 16744 revenue villages. 25 municipal corporations, 145 municipalities and 479 town panchayats govern the urban areas of Tamil Nadu and 388 blocks and 12,480 village panchayats manage its rural areas.

2.2 Heatwaves and its Impact

Heatwave is a natural hazard that can have a significant impact on society in view of heat-related morbidity and mortality. *Globally, heatwaves were linked to approximately 166,000 deaths between 1998 and 2017 (World Health Organization, 2018). In India, where nearly 80 percent of the population resides in climate-vulnerable districts, around 25,000 heat-related deaths were recorded between 1990 and 2015, despite challenges in directly attributing mortality to extreme heat events (CEEW, 2021; NDMA, 2020).*

Due to climate change, heatwaves have increased in severity. The 2003 heatwave in Europe caused over 15,000 deaths when temperatures remained ≥37°C for many days. While the effects of heat are often exacerbated in cities by the Urban Heat Island (UHI) Effect, the livelihoods and well-being of rural dwellers are also severely disrupted during and after periods of unusually hot weather. Heatwaves can trigger health emergencies and increase the burden on agriculture, water and

transportation, resulting in food shortages. The impact of heatwaves is not uniform in different sectors such as health, agriculture, energy and tourism.

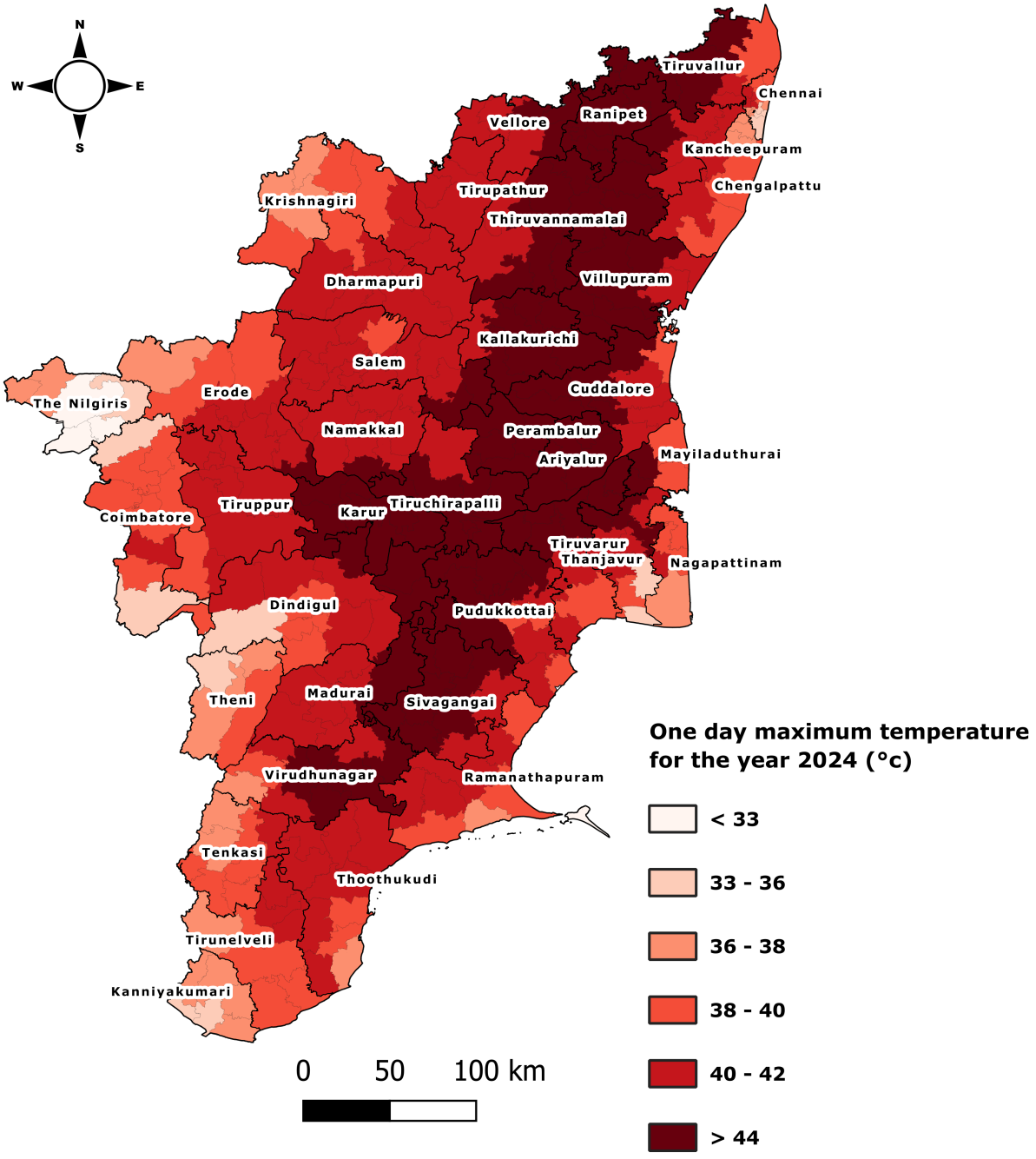
Increase in temperature due to climate change is likely to increase heat stress in occupations that are physically exerting and performed outdoors, which could have adverse health and productivity consequences (Chinnadurai et al., 2016). Agriculture workers could exhibit impaired kidney function due to prolonged heat exposure and dehydration. In tourism-dependent regions, especially the hill stations, rising heat levels can disrupt seasonal tourist flows and local livelihoods. There is increased energy consumption in summer and hot days due to higher use of air conditioning, refrigeration and cooling systems, placing additional stress on power grids. Extreme heat accelerates evaporation from reservoirs, rivers and open water bodies; this reduces soil moisture; lowers groundwater recharge affects irrigation for agriculture and therefore affects farmers' livelihood.

The State Heat Action Plan adopts a people-centred approach, recommending solutions that deliver effective interventions, particularly by strengthening infrastructure and health systems in high-risk areas. The plan prioritizes vulnerable populations, builds the knowledge and capacity needed to tackle extreme heat and identifies context-specific measures to ensure timely, effective and coordinated actions.

2.3 Trend of Heat Extremes in Tamil Nadu

Tamil Nadu experiences hot and humid weather throughout the year. The interior regions of the state are typically hotter than the coastal regions. April and May are the hottest months of the year, with temperatures frequently exceeding 40°C (Climate Change Information Portal, n.d.). There has been a substantial observed increase in the number of days exceeding the 40°C mark (Tamil Nadu Climate Change Mission Document, 2024). Additionally, the state has noted an increased occurrence of heat stress days from March to August along with a rising trend in the frequency of heatwaves (MoES, 2022).

Figure 3: Map showing annual maximum temperature (Tmax) observed in 2024 (the hottest year since 1901)



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Box 1	Methodology for calculating the decadal average number of very hot days and very warm nights

To determine whether a particular day qualifies as a "hot day", this study applies a percentile-based threshold method using long-term temperature data. Specifically, the 95th percentile of daily maximum temperatures (Tmax) is calculated for each calendar day during the baseline period of 1982 to 2011. This calculation employs a 5-day moving window centred on each day (i.e., the day itself, plus two days before and two days after), which captures natural short-term variability while ensuring statistical robustness.

For example, to set the threshold for May 15, Tmax data from May 13-17 for all years from 1982 to 2011 are pooled together. The 95th percentile value from this dataset represents the temperature exceeded by only 5 percent of the historical values. This value serves as the extreme heat threshold for that specific calendar day. If the daily maximum temperature for a given location exceeds this 95th percentile threshold on any day between March and June, that day is classified as a "hot day" for that location.

The difference between the recent and baseline averages was computed to assess the change in frequency.

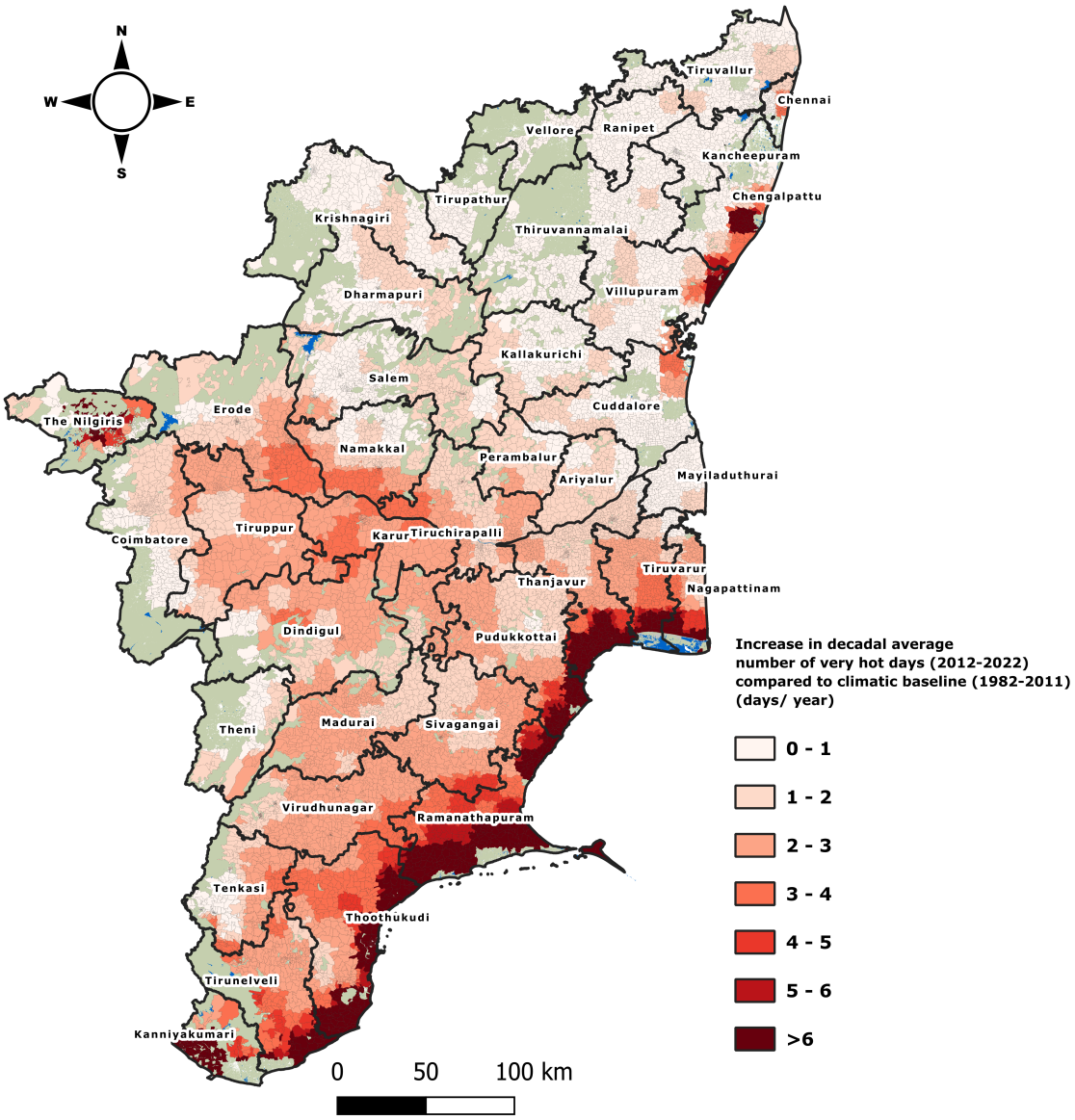
Figure 4 represents the increase in the average number of very hot days and warm nights in the last decade (2012-2022) compared to the climatic baseline (1982-2011). It is observed that the increase in the average number of very warm nights is greater than the increase in the average number of very hot days. This analysis is based on the 95th percentile threshold of Tmax and Tmin, respectively using IMDAA reanalysis data of IMD and NCMRWF.

Once the threshold was set for each day, the number of days in each year that exceeded these thresholds was counted. These annual counts provided the frequency of "very hot days" (based on Tmax) and similarly for "very warm nights" (based on Tmin) for each year. The average annual frequency was then calculated for the baseline period (1982-2011) and compared with the average for the most recent decade (2012-2022). Data for 2023 and 2024 were excluded due to gaps in the IMDAA datasets. A 30-year baseline was utilized because it represents the standard duration recommended by the World Meteorological Organization (WMO) to define a climatic normal (see Box 5). This time span is sufficiently long to capture natural variability while providing a stable reference period for detecting long-term trends.

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Figure 4: Decadal average number of warm nights shows a comparatively higher increase in frequency compared to increase in the average number of very hot days

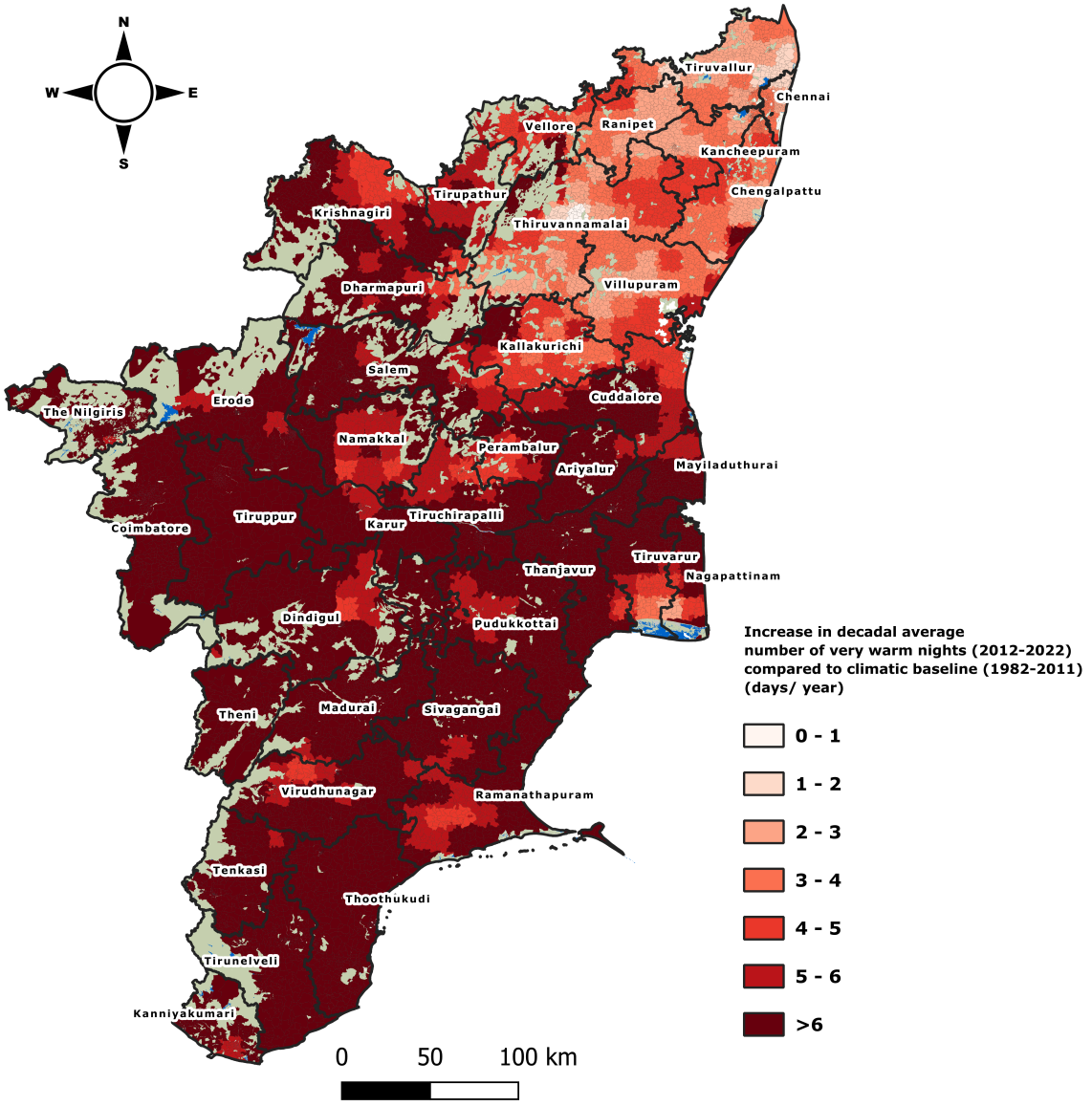
a) Increase in the decadal average number of very hot days in the last decade (2012-2022) compared to the climatic baseline (1982-2011)



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b) Increase in the decadal average number of very warm nights in the last decade (2012-2022) compared to the climatic baseline (1982-2011)

;



Note: The Land Use Land Cover categories of vegetation, water bodies and barren land have been represented as green, blue and grey, respectively

The results show a clear and consistent increase in both "very hot days" and "very warm nights" across all regions of Tamil Nadu. On an average, the number of very hot days rose from approximately 6 to 8 per year, while very warm nights showed a more significant increase, rising from 6 to about 13 per year. The increase in night time temperatures is especially concerning, as it may be driven by the Urban Heat Island (UHI) effect, where heat absorbed by buildings and infrastructure during the day is

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slowly released at night, preventing the cooling that normally is expected to occur during night time. This prolonged exposure to heat, particularly at night, increases the risk of heat-related health issues, especially for vulnerable groups such as children, the elderly, pregnant women and individuals with chronic health conditions.

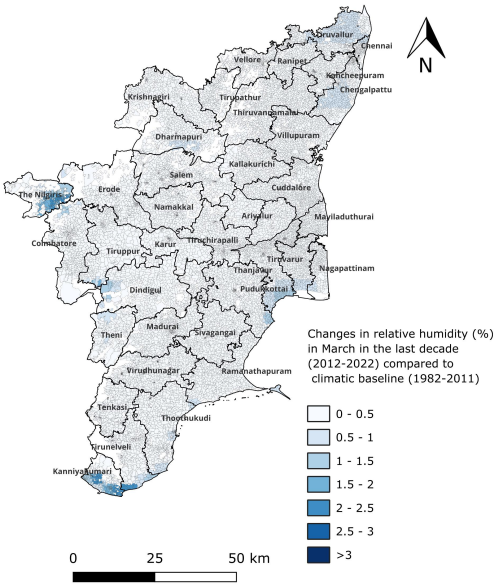
The same calculation methodology was repeated for humidity for the recent decade (2012-2022) and the difference between the two periods was calculated to determine how relative humidity has shifted over time. This month-wise analysis helps reveal seasonal patterns, such as the natural increase in humidity levels from March to June, leading up to the onset of the monsoon.

Figure 5 shows that relative humidity has increased by up to 6 percent across the state in the last decade (2012-2022) compared to the baseline (1982-2011) during the summer months (March to June).

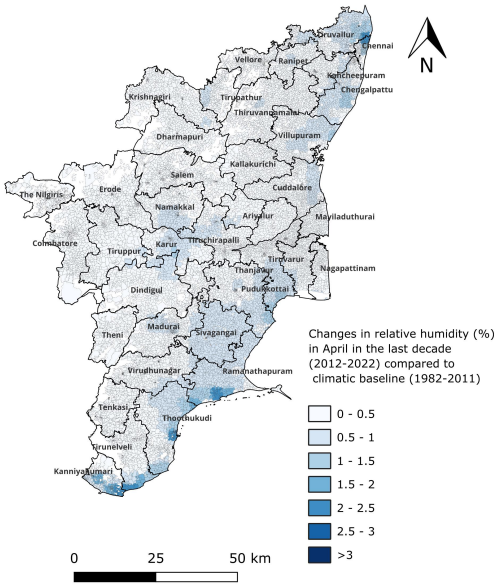
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Figure 5: Relative Humidity has increased by up to 6 percent in the decade 2012-2022 when compared to the climatic baseline 1981-2011

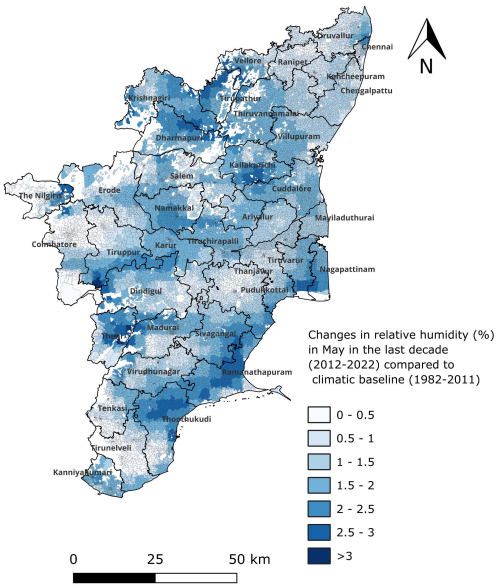
a) Changes in relative humidity (%) in March during the last decade (2012-2022) compared to the climatic baseline (1982-2011)



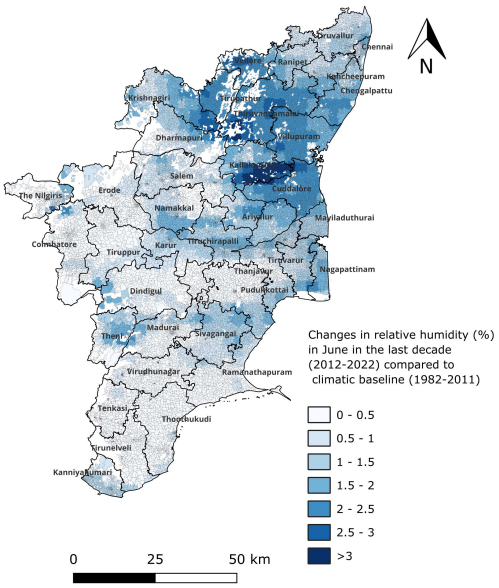
b) Changes in relative humidity (%) in April during the last decade (2012-2022) compared to the climatic baseline (1982-2011)



c) Changes in relative humidity (%) in May during the last decade (2012-2022) compared to the climatic baseline (1982-2011)



d) Changes in relative humidity (%) in June during the last decade (2012-2022) compared to the climatic baseline (1982-2011)



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The figures above illustrate the variations in average daily relative humidity for each summer month - March, April, May and June - over 1982 to 2022. For every grid location, daily relative humidity values were averaged month-wise for each year. These monthly averages were then averaged across the baseline period (1982-2011) to establish a climatological norm for each month.

The results indicate that relative humidity has generally increased across Tamil Nadu, particularly during the hotter months of May and June. Higher humidity in already hot conditions exacerbates heat stress as it interferes with the body's ability to cool itself through the evaporation of sweat. When sweat does not evaporate efficiently, body temperature rises, increasing the risk of heat exhaustion and heatstroke. Understanding changes in both temperature and humidity is therefore crucial for identifying areas most at risk during extreme heat events and for improving heat-health warning systems.

Box 2 **The average relative humidity for Tamil Nadu during the baseline period of 1982–2011.**

These values indicate the ranges of the relative humidity across Tamil Nadu during the baseline period of 1982 - 2011 from which the above change is estimated for the last decade of 2012-2022.

Month	Average Relative Humidity Range (%)
March	55 – 78
April	53 – 85
May	54 – 90
June	52 – 93

2.4 Existing plans, policies and steps for heat resilience taken by Tamil Nadu State

Tamil Nadu has been at the forefront of disaster risk reduction. This section outlines the various initiatives undertaken by the state with regard to heatwaves in recent years.

2.4.1 Heatwave as State-Specific Disaster

Tamil Nadu formally declared heatwaves as a "State-Specific Disaster" through G.O.Ms. No. 419 dated 15.10.2024. This policy enables the systematic use of the State Disaster Response Fund (SDRF) for heatwave preparedness, response and recovery during extreme heat events. The policy also mandates relief and response mechanisms, including the provision of ex gratia compensation to the families of individuals who die due to heat-related causes.

It further directs district administrations and line departments to integrate heatwave risk into their operational protocols by strengthening early-warning dissemination systems, rescheduling outdoor work hours to reduce occupational exposure and ensuring the readiness of public health institutions for heat-related case management and adopting standardised procedures for beneficiary identification and the certification of heat-related deaths. The declaration of heatwave as a state-specific disaster has been an effective measure to focus more on the community at risk and vulnerable locations so that effective measures can be taken, as locally appropriate.

2.4.2 Tamil Nadu Heat Mitigation Strategy 2024

The Heat Mitigation Strategy launched in 2024 focuses on tackling extreme heat events in Tamil Nadu through a structured approach built upon three key pillars: Health and Wellbeing, Ensuring Sustained Resources and Productivity and Cooling Solutions. Under the Health and Wellbeing component, the strategy emphasizes prioritizing access to cool, shaded spaces and clean drinking water, particularly for vulnerable populations such as schoolchildren, patients and the elderly. It also recommends training healthcare professionals and veterinarians in heat-related illness protocols and ensuring equitable access to medical resources. The strategy further calls for uninterrupted water and power supply to critical infrastructure including hospitals, farms and remote areas, while promoting renewable energy solutions and rainwater harvesting. Additionally, it recommends leveraging spatial mapping, AI and other technologies to improve disease surveillance and vaccine storage while suggesting integration of mitigation measures into existing welfare schemes.

The second component, Ensuring Sustained Resources and Productivity, aims to build resilience in agriculture and the economy through long-term planning. This includes developing detailed drought risk profiles at the state, district and local levels to enable targeted interventions. The strategy encourages crop diversification and improved market access for heat-tolerant crops. It also proposes financial incentives for adopting heat-resilient infrastructure and technologies, as well as strengthening cold chain logistics through Public-Private Partnerships (PPP). Furthermore, tourism hubs are to be made heat-safe by implementing contingency plans that include shaded shelters, Oral Rehydration Solution (ORS) booths and public awareness drives.

The Cooling Solutions component advocates for environmentally sound and culturally relevant cooling techniques. It calls for scientific greening practices that align with local ecosystems, promoting the "plant with a plan" philosophy. Passive cooling solutions, such as cool roofs and green roofs, are encouraged to reduce indoor heat. The strategy also highlights the use of traditional construction materials like red oxide flooring and mud walls for their natural cooling properties. In addition, it mandates rainwater

harvesting and wastewater management as critical tools to mitigate drought conditions. Finally, solar energy adoption is promoted to reduce dependence on water-intensive power generation, thereby enhancing both energy and water security in the face of rising temperatures.

2.4.3 Urban Growth and Thermal Stress: A Decadal Assessment of Built-Up Area and Climate Interactions in Tamil Nadu - Report 2025

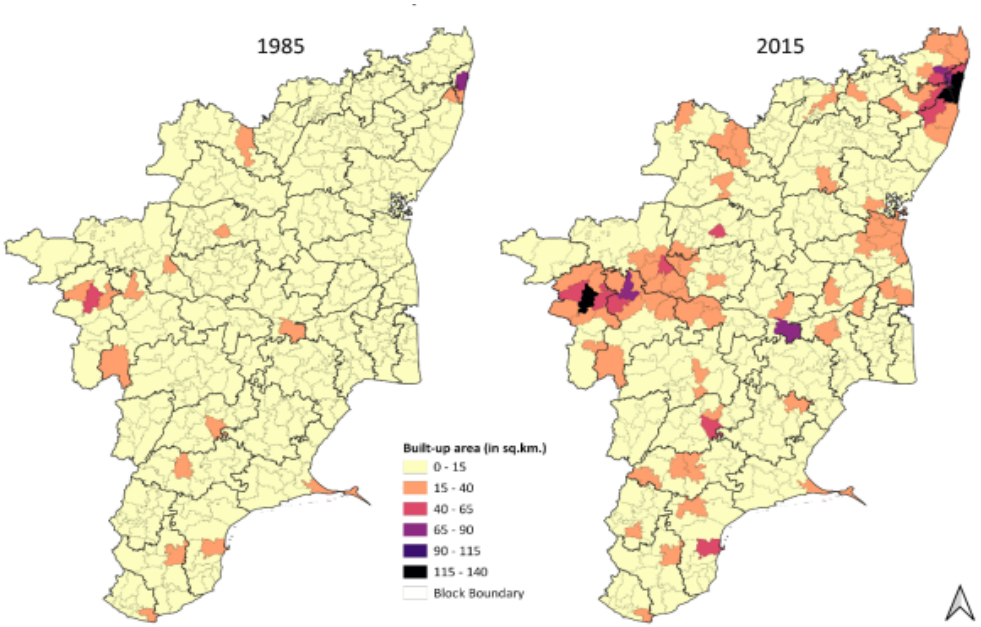
Heat exposure is shaped not only by absolute temperature but by a combination of factors including the pace of warming, ecological sensitivity, urban expansion and the adaptive capacity of communities. The study Urban Growth and Thermal Stress: A Decadal Assessment of Built-Up Area and Climate Interactions in Tamil Nadu (2025) investigates how land-use changes and rapid urbanisation influence local thermal conditions. Using high-resolution spatial datasets, it pinpoints heat-vulnerable blocks and districts and offers evidence-based strategies for targeted interventions.

The study examines how Land Use and Land Cover (LULC) changes over the past three decades particularly how urbanisation, forest degradation and conversion of agricultural lands have contributed to local climate variation. Rapid urban expansion and deforestation have not only altered surface albedo but have also exacerbated the Urban Heat Island effect. Figure 6 exhibits that 94 blocks experienced the sharpest rise in heat over the past four decades, while 64 others, though lacking long-term patterns, currently record temperatures above-average. Within that twenty-five blocks, including Chennai, Karur and Ramanathapuram appear in both categories, making them highly vulnerable. Coastal districts face pronounced risks and new hotspots are emerging in peri-urban areas and hilly zones such as Kodaikanal, Sulur and Theni.

Urbanisation is identified as the primary driver of these trends. Blocks such as Chennai (74 percent built-up in 2015), St. Thomas Malai (43 percent) and peri-urban regions in Coimbatore, Tiruppur and Villupuram reveal a strong correlation between surface development and heat accumulation. In 11 districts, mean temperatures have risen by as much as 2°C above the state average within just two decades, underscoring the urgent need for adaptive planning and resilient infrastructure.

The study recommends spatial targeting, institutional convergence and transparent monitoring and thermal indicators in urban planning, investments in Nature-based Solutions (NbS), climate-sensitive building codes. Furthermore, the findings emphasize the urgent need for prioritized action in high-risk blocks.

Figure 6: Blocks with significant rise in heat and above-average temperatures from 1985 to 2015



Source: "Urban Growth and Thermal Stress: A Decadal Assessment of Built-Up Area and Climate Interactions in Tamil Nadu, TNSPC, 2025"

Between 2011 and 2021, Tamil Nadu experienced an average of more than eight heatwave (HW) days per year, as reported by the Ministry of Earth Sciences (2022). In 2024, the state recorded 13 heatwave days, the highest number observed in at least a decade. This shows intensification of heat extremes. This would trigger impacts across multiple sectors of work, influence agricultural productivity and shift of irrigation patterns leading to groundwater dependence etc., Prolonged heat exposure will lead to a rise in heat-related illnesses, dehydration and cardiovascular and respiratory complications, surges in electricity demand due to increased cooling needs leading to peak load stress, etc,.

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3 Rationale, objectives and approach for Tamil Nadu State Heat Action Plan

3.1 Legal/administrative backdrop for developing State level heat action plans

The National Disaster Management Act (2005) mandates the preparation of disaster management plans at the national, state and district levels. While the Act does not explicitly require sub-divisional or local-level plans, it implies that the effectiveness of district-level plans depends on localized analyses and adaptation strategies to be implemented by Panchayats in rural areas and Urban Local Bodies (ULBs) in urban areas.

As per the amendment to the Disaster Management Act, 2024, at the state level, State Disaster Management Authorities (SDMAs) remain responsible for preparing and implementing state-level disaster management and Heat Action Plans (HAPs) and districts will be required to form District Disaster Management Authorities (DDMAs) to design and operationalize district-level plans and policies.

Box 3	**Power for Panchayat Raj Institutions and Urban Local Bodies under 243G AND 243W of the 73rd Amendment**

The Constitution (Seventy-third Amendment) Act, 1992, which came into effect from 24 April 1993, introduced **Part IX** to the Constitution, **granting constitutional recognition to Panchayati Raj Institutions (PRIs)**. Under **Article 243G**, State Legislatures are empowered to devolve powers and responsibilities to Panchayats, enabling them to function as effective institutions of self-government.

The **XI Schedule of the Constitution lists 29 subjects** to be devolved to Panchayat Raj Institutions, including agriculture, land improvement, land reforms, land consolidation and soil conservation, minor irrigation, water management and watershed development, animal husbandry, dairying and poultry, fisheries, social forestry and farm forestry, minor forest produce, small-scale industries, including food processing industries, khadi, village and cottage industries, rural housing, drinking water, fuel and fodder, roads, culverts, bridges, ferries, waterways and other means of communication, rural electrification, including the distribution of electricity, non-conventional energy sources, poverty alleviation programmes, education, including primary and secondary schools, technical training and vocational education, adult and non-formal education, libraries, cultural activities, markets and fairs, health and sanitation, family welfare, women and child development, social welfare, welfare of the weaker sections and in particular of the Scheduled Castes and the Scheduled Tribes, public distribution system and maintenance of community assets

The **Constitution (Seventy-fourth Amendment) Act, 1992 (CAA)**, which came into effect on 1 June 1993, introduced **Part IXA** to the Constitution, granting constitutional status to Urban Local Bodies (ULBs). **Article 243W of the Act** empowers state legislatures to enact laws that provide ULBs with the authority and responsibilities necessary **to function as institutions of self-government.** It further emphasizes the devolution of powers to these local bodies, particularly for the preparation of plans for economic development and social justice.

The **XII Schedule of the Constitution outlines 18 key functions** to be devolved to ULBs, including urban planning, including town planning, regulation of land use and construction of buildings, planning for economic and social development, roads and bridges, water supply for domestic, industrial and commercial purposes, public health, sanitation, conservancy and solid waste management, fire services, urban forestry, environmental protection and ecological promotion, safeguarding the interests of weaker sections of society, including individuals with disabilities, slum improvement and upgradation, urban poverty alleviation, provision of urban amenities such as parks, gardens and playgrounds, promotion of cultural, educational and aesthetic aspects, burial and cremation grounds, cattle pounds and the prevention of cruelty to animals, vital statistics, public amenities and regulation of slaughterhouses and tanneries.

By focusing on mitigation, preparedness and response measures, Urban Local Bodies (ULBs) and Panchayat Institutions can play a pivotal role in addressing the rising frequency and intensity of extreme heatwaves. Their leadership is essential for safeguarding urban and rural communities, ensuring the continuity of essential services and fostering resilience across cities, towns and villages.

3.2 Objectives of Tamil Nadu State Heat Action Plan

The Tamil Nadu State Heat Action Plan 2025 has been developed through a comprehensive strategy. The plan has been developed in a bottom-up manner where hyperlocal risk assessments and findings from each village, ward and Urban Local Bodies directly informed the state-level plan. The plan adopts a holistic framework that integrates many factors to formulate highly effective and localized heat action strategies.

The Tamil Nadu State Heat Action Plan is uniquely designed to map heat risks across village panchayats, town panchayats, municipalities and municipal corporations. This granular approach provides targeted mitigation, preparedness and response strategies tailored to the specific needs of diverse stakeholders and government departments.

Mission

The mission of the Tamil Nadu State Heat Action Plan is to achieve:

- Zero heat-related mortalities
- Reduced heat-induced illnesses and stress
- Minimized economic losses due to extreme heat across key sectors

Objectives

To achieve this mission, the Tamil Nadu state Heat Action Plan focuses on the following objectives:

1. Granular Mapping of extreme heat indices
    - Map heat hazards under observed and projected climate changes *(Refer Annexure 3 for the study on climate change scenarios done by Anna University in Tamil Nadu)*
    - Establish localized heat-health thresholds for early warning systems.
    - Identify vulnerable populations for targeted interventions.
2. Effective Preparedness and Response
    - Design and implement preparedness and response strategies, focusing on health and disaster management.
    - Ensure zero heat-related fatalities through coordinated efforts.
3. Reducing Heat-Health Risks
    - Mitigate heat stress and heat-related illnesses through robust tracking and surveillance systems.
    - Deploy innovative cooling solutions to protect vulnerable populations.
4. Minimizing Economic Losses
    - Implement region-specific heat risk mitigation strategies to reduce long-term economic impacts across sectors.
5. Capacity Building for Stakeholders
    - Build the capacity of stakeholders to effectively prepare for and respond to heat events.
    - Periodically review and refine the Heat Action Plan to ensure its relevance and effectiveness.

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The Tamil Nadu State Heat Action Plan further aims to identify the integration of long-term heat resilience solutions into long term planning for the state. It aims to protect lives, improve health outcomes and mitigate multi-sectoral economic impacts by addressing the growing risks of extreme heat. With its localized, data-driven approach the plan aims to set a replicable model for other states which grapple with the combined impacts of heat and humidity.

3.3 Approach for the development of the Heat Action Plan for Tamil Nadu

To develop this Heat Action Plan, a multidisciplinary approach was adopted, integrating technical tools, scientific analysis, policy evaluation and stakeholder engagement. The plan builds upon the guidelines established by the NDMA in 2019 for Heat Action Plans and the National Disaster Management Plan 2019, providing a comprehensive framework for effective heat action. This framework focuses on three key components:

i. When to take action
ii. Where to take action
iii. Who will take action and what actions will be taken

Further details of this framework are provided in Figure 7. By following this structured approach, the plan ensures targeted, timely and coordinated responses to heat risks.

Figure 7: Framework for development of the Tamil Nadu State HAP

When to take action?	Where to take action?	Who will take action?
Establishment of **taluk-specific heat thresholds** based on biometeorological indices (This would be updated based on real time data eventually)	**Village/town panchayat/municipality level** heat risk index based on IPCC AR5 Risk Assessment Framework to map risk at ward level for municipal corporation and village/ town panchayat/ municipality level for the districts	Line department wise **responsibility matrix** for actions to be taken for mitigation, preparedness and response
Recalibration of alert systems based on established thresholds to provide colour-coded impact based early warnings	Combining climate, socio-economic and geo spatial indicators to map **factors leading to high risk** in each village/town panchayat/municipality	Development of **IEC strategies** for effective communication

Recent studies analysing existing HAPs in India have identified several design gaps in them. These gaps encompassed the absence of localised heat hazard and threshold mapping, insufficient vulnerability and heat risk assessments and a lack of identification of financing mechanisms (Pillai and Dalal, 2023). Consequently, to establish the Tamil Nadu State HAP as a second-generation plan and as a template plan for other states and districts with similar climatic conditions to replicate, the approach was tailored to address these gaps. This HAP will be further revised going toward to make its more recent versions more and more comprehensive.

The approach to developing of the Tamil Nadu State HAP underwent rigorous validation through extensive consultations with various city/district level stakeholders actively participated. The consultations centred around presenting the climatological analysis, the heat risk index with its indicators and the locally developed heat thresholds. Further details on these technical aspects, along with the Stakeholder Responsibility Matrix, are elaborated in subsequent chapters of this heat action plan.

Furthermore, as a primary objective of the HAP is the long-term mitigation of extreme heat, significant emphasis has been placed on urban greening solutions which are brought out in Annexure 6. The possible source of financing the short, medium and long term activities for mitigating impact of extreme heat events is attempted in section 6.2 of this report.

3.3.1 Preparation of Heat Action Plan for Tamil Nadu – Phase 1

As part of the Government Order (GO) N0.9 signed on 07.01.2025, the Council on Energy, Environment and Water (CEEW) have prepared Heat Action Plans (HAPs) for 11 cities in Tamil Nadu under Phase I in 2025, including Avadi, Chennai, Coimbatore, Erode, Madurai, Salem, Tambaram, Thoothukudi, Tiruchirappalli, Tiruppur and Vellore.

In Phase I of HAP preparation, CEEW, with support from the Tamil Nadu Disaster Risk Reduction Agency on behalf of the Tamil Nadu State Disaster Management Authority, adopted a data-driven, granular approach to heat risk assessment. Indicators with socio-economic relevance were used to assess vulnerability, hazard and exposure, as well as being analysed using satellite-derived data enabled the identification of high-risk wards within each city, highlighting areas that are more vulnerable relative to others.

The micro-level approach of this assessment facilitated evidence-based decision-making, allowing city administrations to prioritise targeted heat mitigation measures and preparedness activities. The results were validated through ground truthing consultation with city officials to ensure contextual accuracy and local relevance. In the consultation, wards with high floating populations, such as with major bus stands, railway stations and key religious places, located wards were incorporated in the risk tables

based on city-specific needs, further strengthening the precision of the analysis.

Building on the learnings from Phase I, CEEW undertook Phase II, expanding the preparation of HAPs to 14 additional cities and 37 districts, culminating in a comprehensive State Heat Action Plan for Tamil Nadu (2026). Both phases involved rigorous data collection and close collaboration with city and district officials. The findings and outputs were validated with respective authorities to ensure the plans are context-specific and grounded at the local level. This bottom-up approach strengthens preparedness and supports effective mitigation of heat stress across the state ahead of the coming summer seasons.

Scan the below QR Code to download HAP softcopy for the Phase 1, raw datasets and formulae with TNDRRA Contacts.

NB: TNDRRA shall keep revising State HAP whenever base datasets change made available by the same stated above.

The latest versions of HAP and the handbook will be electronically available linked to the above QR code.

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4 Approach and Methodology used for the risk assessment and establishing local thresholds for the districts (Taluk level) and cities of Tamil Nadu

The Tamil Nadu State Heat Action Plan (HAP) incorporates a comprehensive heat risk assessment that covers both urban and rural contexts. The assessment utilises the IPCC AR5 Risk Framework to estimate the Heat Risk Index, defined by integrating three essential components: Hazard, Exposure and Vulnerability. Analysis was conducted at the Village Panchayat level for rural areas and Town Panchayat, Municipality and Municipal Corporation Ward level for urban areas within the districts, using the following components of assessment:

1. Hazard Analysis: Observed heat extremes (1982-2022) and projected trends (2022-2050) using climate data derived from IMD, NCMRWF and IITM.
2. Exposure Mapping: High-precision mapping using satellite and remote sensing products from Sentinel 2A at 10m resolution and Google Building Footprint.
3. Socio-economic Vulnerability Mapping: Utilizing official data provided by the district/city

An attempt was made to ground truth the results of this study by consulting with officials. This localised approach enables decision-makers to identify 'when to take action' and 'where to prioritise action'.

4.1 Mapping of the Heat Risk Index for the Tamil Nadu State

Heatwave risks arise from the complex interplay of socio-economic, physiological, climatological and behavioural factors. Changes in any of these variables can significantly alter the risk profile, either amplifying or mitigating it. This analysis systematically identifies the specific drivers contributing to heat risk in each ward and village, paving the way for the development of tailored adaptation and mitigation strategies.

The heat risk index for each district and city was developed following the IPCC Fifth Assessment Report (AR5) framework, a globally recognised methodology for climate risk assessment. This approach is also endorsed by the Department of Science and Technology (DST) for national-level evaluations and supported by the Ministry of Environment, Forests and Climate Change (MoEFCC) in India. The framework conceptualises risk as the outcome of dynamic interactions between hazard, exposure and vulnerability.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

Box 4	Understanding the risk and vulnerability frameworks of IPCC's AR5 and AR6

The IPCC's Fifth Assessment Report (AR5) introduced risk as the central analytical concept, defining it as the interaction of hazard, exposure and vulnerability (IPCC, 2014). In this framework, hazard refers to the potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. Exposure refers to the presence of people, assets or ecosystems in hazard-prone areas, while vulnerability captures their susceptibility, shaped by sensitivity and adaptive capacity. The clear conceptual separation of these components has enabled widespread application of AR5 in quantitative and spatially explicit climate risk assessments.

The Sixth Assessment Report (AR6) builds upon this framework by incorporating a broader perspective on climate risk. In addition to hazard, exposure and vulnerability, AR6 emphasizes compound and cascading risks, systemic interactions and the role of development pathways in shaping future risk (IPCC, 2022). This approach enhances the conceptual depth of risk assessment, particularly for long-term planning and transformational adaptation.

In this study, AR5 was chosen because its relatively streamlined structure allows risk to be translated more directly into measurable indicators using available climate, exposure and socio-economic data. The framework supports transparent indicator selection, normalization and aggregation, enabling meaningful comparison across spatial units. Given the study's emphasis on quantitative, sub-national risk estimation, rather than on systemic or pathway-oriented analysis, AR5 offers a robust and practical administrative framework that aligns well with the study objectives. TNDRRA could move on to AR6 in the future, if felt appropriate, building on what is given in Annexure 3.

Risk here is defined as: *"Risk refers to the potential for adverse consequences for human or ecological systems, recognizing the diversity of values and objectives associated with such systems. In the context of climate change, risks emerge from the potential impacts of climate change and human responses to it. Relevant adverse consequences include impacts on lives, livelihoods, health, infrastructure, ecosystems and species."*

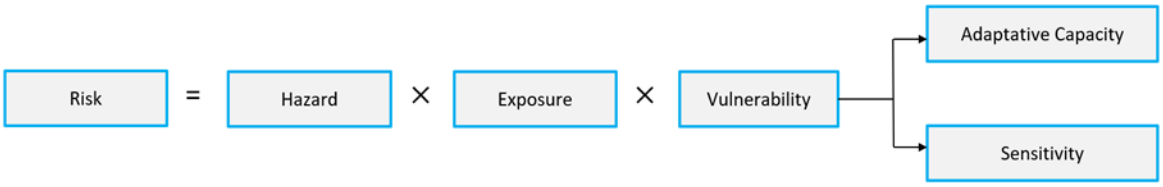
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The risk assessment framework comprises three key components:

1. Hazards: Climatic events that pose threats, such as extreme heat.
2. Exposure: Populations, infrastructure or systems at risk of being affected by hazards.
3. Vulnerability: A function of two sub-components:
    - Sensitivity: The degree to which a system or population is affected by climate variability or change.
    - Adaptive Capacity: The ability of systems, institutions and individuals to adjust to potential damage, seize opportunities, or respond to impacts.

Figure 8: Risk assessment equation



A robust risk assessment requires a systematic, multi-step process guided by clearly defined goals and objectives. These goals indicate the type, scale, tier, indicators and methodology of the assessment. Risk can be assessed through two primary approaches:

- Starting Point/ Contextual Approach: This view defines risk as a pre-existing condition within a system existing independently of and in anticipation of a specific hazard. It focuses on the internal factors that make a population or area inherently sensitive.
- Endpoint/ Outcome Approach: This approach focuses on assessing risk as the residual result after a system is exposed to a hazard, measuring the net impact and the effectiveness of response measures (DST, 2019; Kelly, 2000).

For this action plan, the Starting Point/ Contextual Approach was adopted to identify risks based on the pre-existing conditions within the state. This assessment, centred on current climate hazards, provides critical insights into the existing vulnerabilities of both natural and socio-economic systems. By identifying the specific drivers that contribute to these vulnerabilities, the analysis forms a robust basis for strategies designed to address systemic weaknesses and enhance long-term resilience.

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The first step involved selecting indicators for each risk component: hazard, exposure and vulnerability. Indicators are variables that represent complex phenomena in measurable and quantifiable terms. They allow for the relative assessment of a system's risk profile and serve as valuable tools for the planning, monitoring and evaluation of development interventions over time (Crane et al., 2017).

In this analysis, indicators were selected based on the following criteria:

- Literature Review: A comprehensive review of relevant academic and policy literature was conducted to ensure alignment with established global and national risk determinants.

- Data Availability and Granularity: Indicators were chosen based on the availability of high-quality at the district level. This included data aggregated from village panchayats, town panchayats and municipalities, as well as sub-city level data to provide micro-level insights.

- Stakeholder Consultations: Consultations were held with key stakeholders to ensure relevance that the selected indicators are both relevant to the local context and practically applicable for policy implementation.

The selected indicators reflect the multidimensional nature of risk and provide a robust framework for targeted action. Comprehensive lists of these indicators, including their data sources and rationale, are detailed in Tables 1 to 3. This structured approach ensures a thorough understanding of heat risks across Tamil Nadu, enabling the design of effective, evidence-based mitigation and adaptation strategies.

Limitations of the State heat action plan

- The outdoor temperature (from wet bulb measurements) are not included here. We plan to incorporate the same into Tamil Nadu daily weather reports on an experimental basis for 2 years and then that aspect would be dynamically updated into this report at that time.

- We have limited number of AWS or IOT sensors to measure the relevant parameters real time to inform Tamil Nadu weather daily reports. These will be remedied in the years to come.

- The impact of hot weather on plants/vegetation, the impact on animals (wild & domesticated) and the impact on local water availability/water budget will be taken up step by step.

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While the indicators for hazard and exposure remain consistent across both ward-level and village-level analyses to ensure district-wide comparability, the vulnerability assessment is more tailored. At the district scale, the assessment incorporates supplementary indicators beyond those used in the city-level analysis, allowing for more nuanced socio-economic and infrastructural insights specific to rural and village contexts.

Table 1: Indicators selected for computing heat hazard at ward level & village level

Indicators selected for computing heat hazard at ward level & village level

Indicator	Description and Rationale	Relation to heat risk	Data source
Increase in the decadal average number of very hot days in a year	An increase in frequency of daytime, night time extremes and felt temperatures will directly lead to a higher risk. The indicators have been calculated as an increase in the indicator in the last decade (2012-2022) compared to the climatic baseline (1982-2011) *(See Box 1)*	Direct	CEEW analysis based on IMDAA reanalysis data at 12 km resolution from 1982-2022
Increase in the decadal average number of very warm nights in a year		Direct	
Increase in heat index		Direct	
Decrease in rainy days	A decrease in the number of rainy days will lead to compounding impacts on increasing heat extremes	Direct	
Land Surface temperatures (LST)	LST aids in pinpointing hotspots in specific areas prone to elevated heat conditions, primarily attributed	Direct	CEEW analysis based on Landsat8 data at 30m resolution

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	to the urban heat island phenomenon.		

Table 2: Indicators selected for computing exposure at ward level & village level

Indicator	Description	Relation to heat risk	Data source
Population density	Urban areas with high population density often face heightened vulnerability due to inadequate infrastructure, limited access to cooling resources and elevated socio-economic disparities, which worsen the impact of extreme heat events on health.	Direct	District Administration/ City Authorities
Percentage of built-up area to total geographical area	Areas with high levels of impervious surfaces, such as roads and buildings, may experience higher temperatures due to the Urban Heat Island Effect and the trapping of heat.	Direct	CEEW analysis based on Land Use Land Cover Analysis from Sentinel 2A at 10 m resolution, 2022
Building density	High building density exacerbates heat exposure by intensifying the Urban Heat Island Effect , trapping and radiating heat and elevating temperatures.	Direct	CEEW analysis based on Google building footprint data, 2023

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Box 5	IMDAA Reanalysis data

For this study, we utilized the Indian Monsoon Data Assimilation and Analysis (IMDAA) dataset, a high-resolution regional reanalysis product. Reanalysis datasets integrate numerical weather prediction models with observations from multiple sources, including satellites and ground-based stations. The model outputs provide initial estimates, which are subsequently corrected using observational data to reduce systematic biases. In contrast, purely observational datasets are derived solely from measurements recorded at meteorological stations and are later interpolated onto a spatial grid.

Bias correction is essential to improve the accuracy of reanalysis datasets, which are fundamentally based on model simulations. In the case of IMDAA, this correction is embedded within the system framework and is calibrated using observations from IMD stations to ensure consistency with recorded data.

Several evaluation studies have demonstrated the robustness of the IMDAA dataset, highlighting its capability to capture key weather patterns across different seasons. IMDAA shows strong agreement with observational datasets, such as IMD station data, as well as with global reanalysis products like the ECMWF Reanalysis v5 (ERA5). Owing to its fine spatial resolution, IMDAA is particularly well suited for district-level climate assessments; however, evaluating its ability to accurately represent meteorological trends across India remains important.

Rani et al. (2021) evaluated the performance of IMDAA in representing seasonal weather characteristics across India by comparing it with IMD observational data. Their results indicate that IMDAA successfully captures the primary features and seasonal variability of the Indian monsoon, with performance comparable to that of ERA5. Nonetheless, relative to IMD observations, IMDAA exhibits a slight cool bias during winter and a warm bias during summer.

Despite these minor biases, IMDAA is widely regarded as a reliable high-resolution reanalysis dataset for analyzing weather and climate trends over the Indian subcontinent (Rani et al. 2021; Ashrit et al. 2020; Mahmood et al. 2018; Singh et al. 2021).

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Table 3: Indicators selected for computing vulnerability at the ward level

Indicator	Description and rationale	Relation to heat risk	Data source
Sex ratio	Women often face greater vulnerability to disasters, particularly in developing nations. Social and economic factors can magnify the impact of extreme heat on females, including gender-based inequalities in healthcare, education and economic opportunities.	Direct	City Administration
Number of slum households	Slum populations face higher exposure to extreme heat due to poor housing, overcrowding and lack of green spaces, intensifying the Urban Heat Island Effect. Limited access to electricity, cooling appliances, clean water and healthcare increases their susceptibility to heat-related illnesses.	Direct	
Illiteracy rate	Individuals with lower literacy rates may be more vulnerable to extreme heat events due to reduced awareness of potential dangers and limited access to heat alerts.	Direct	
Green spaces	Normalised Difference Vegetation Index (NDVI) is a remote sensing index employed to evaluate the health of vegetation. Higher NDVI values represent dense and healthy vegetation, which can be used as an indicator to depict green spaces that bring the cooling effect .	Inverse	CEEW analysis based on Landsat8 imagery, 2023

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Proportion of young population to total population (below 5 years)	It is widely acknowledged by the World Health Organisation and NDMA guidelines that the young and elderly populations are more vulnerable to extreme heat due to physiological factors and pre-existing health conditions. Limited adaptive capacity, behavioural considerations and the Urban Heat Island Effect further exacerbate this vulnerability.	Direct	City Administration
Proportion of old population to the total population (above 65 years)			
Proportion of population with chronic health conditions	Heat can lead to severe dehydration, acute cerebrovascular accidents and contribute to thrombogenesis (blood clots). Those with chronic diseases and those on daily medications face an elevated risk of complications and death during heatwaves, along with older individuals and children (WHO 2018, WHO 2004).	Direct	City Administration
Proportion of population with disabilities (Both physical and mental)	Individuals with disabilities often face heightened risks during extreme heat events due to physical, social and economic barriers. These barriers can limit access to emergency services, exacerbate health risks and disrupt essential caregiving and support systems.	Direct	
Access to water sources	Access to water sources is crucial in dealing with extreme heat. Water sources additionally reduce heat risk by moderating temperatures through evaporation and creating localised cooling.	Inverse	CEEW analysis based on Modified Normalised Difference Water Index (MNDWI), 2023, from Landsat 8

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			satellite imagery
Number of Automatic Weather Stations (AWS) per sq. km	A higher number of Automatic Weather Stations (AWS) facilitates the recording of localised meteorological data, enabling timely alerts for extreme heat. Moreover, it contributes to the enhancement of long-term forecasting systems.	Inverse	City Administration
Access to road networks	It ensures quick mobility to healthcare, cooling centres and emergency services during extreme heat events. A well-connected road system allows faster response times and better access to essential resources, reducing heat-related risks.	Inverse	
Number of parks per square kilometre	It plays a crucial role in reducing heat stress by mitigating the urban heat island (UHI) effect. Green spaces provide shade, lower local temperatures through evapotranspiration and improve air quality, benefiting public health.	Inverse	
Number of health centers per thousand population	It is a key indicator of a city's ability to respond to climate-induced health risks, especially during heatwaves. A higher density of health facilities ensures quicker access to medical care for heat-related illnesses like dehydration, heat strokes and cardiovascular issues.	Inverse	

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Number of minor water bodies	Water bodies such as ponds, lakes, rivers, canals and reservoirs have the potential to influence urban climates by altering the surrounding temperature and humidity through various heat transfer mechanisms	Inverse	

Table 4: Indicators selected for computing vulnerability at the village level

Indicator	Description and rationale	Relation to heat risk	Data source
Sex ratio	Women often face greater vulnerability to disasters, particularly in developing nations. Social and economic factors can magnify the impact of extreme heat on females, including gender-based inequalities in healthcare, education and economic opportunities.	Direct	District Administration
Number of families below the Poverty Line (BPL)	The urban and rural poor are disproportionately vulnerable to extreme heat because of poor-quality housing and limited access to cooling.	Direct	
Number of Self-help groups (SHG)	SHGs enhance community resilience by supporting vulnerable households during heatwaves through resource sharing, awareness and collective action.	Inverse	

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Green spaces	Normalised Difference Vegetation Index (NDVI) is a remote sensing index employed to evaluate the health of vegetation. Higher NDVI values represent dense and healthy vegetation, which can be used as an indicator to depict green spaces that bring the cooling effect.	Inverse	CEEW analysis based on Landsat8 imagery 2023
Proportion of young population to total population (below 5 years)	It is widely acknowledged by the World Health Organisation and NDMA guidelines that the young and elderly populations are more vulnerable to extreme heat due to physiological factors and pre-existing health conditions. Limited adaptive capacity, behavioural considerations and the Urban Heat Island Effect further exacerbate this vulnerability.	Direct	District administration
Proportion of the old population to the total population (above 65 years)			
Proportion of the population with chronic health illnesses	Heat can lead to severe dehydration, acute cerebrovascular accidents and contribute to thrombogenesis (blood clots). Those with chronic diseases and those on daily medications face an elevated risk of complications and death during heatwaves, along with older individuals and children (WHO 2018, WHO 2004)	Direct	
Access to water sources	Access to water sources is crucial in dealing with extreme heat. Water sources additionally reduce heat risk by moderating temperatures through evaporation and creating localised cooling.	Inverse	CEEW analysis based on Modified Normalised Difference Water Index (MNDWI), 2023, from Landsat8

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			satellite imagery
Access to the road network	Road network density facilitates the timely delivery of services during heat events by improving accessibility for emergency response, water distribution and medical assistance.	Inverse	District Administration
Health centres per thousand people	It indicates the accessibility of healthcare services for a population, influencing the ability to respond effectively during heat events.	Inverse	
Number of houses with tap water connection	It will reflect population access to reliable drinking water, which is critical for preventing dehydration and heat-related illnesses during extreme heat events.	Inverse	
Scheduled Caste and Scheduled Tribe population	It indicates social vulnerability, as these groups often face limited access to resources.	Direct	
Number of weather monitoring stations per sq. km	A higher number of Automatic Weather Stations (AWS) facilitates the recording of localised meteorological data, enabling timely alerts for extreme heat. Moreover, it contributes to the enhancement of long-term forecasting systems.	Inverse	

The development of the heat risk index at the ward and village levels was fundamentally driven by data availability, ensuring that the indicators provided a robust and micro level understanding of localized heat risk. The selection process was guided by a comprehensive review of national and global literature, as well as an analysis of second-generation Heat Action Plans from Indian cities, including Jodhpur (2023) and Ahmedabad (2019) (Qureshi and Rachid, 2022; Wu et al., 2022a; Liu et al., 2020; Adnan et al., 2022; Xiang et al., 2022; Sidiqui et al., 2022; Estoque et al., 2020; Zhang, McManus and Duncan, 2018; Abrar et al., 2022; Cai et al., 2019;

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Inostroza, Palme and De La Barrera, 2016; Conlon et al., 2020; Rathi et al., 2022; Leal Filho et al., 2018; Nanda et al., 2022; Johnson et al., 2012). Additionally, stakeholder consultations with key line departments involved in the heat action plan played a crucial role in shaping the final set of indicators.

The selected indicators have either direct or inverse relationships with heat risk as defined below:

- Direct Relationship (Positive Correlation): An increase in the indicator value leads to a corresponding rise in risk. For example, a higher proportion of the population with chronic health conditions denotes greater physiological vulnerability, thereby escalating the overall heat risk.

- Inverse Relationship (Negative Correlation): An increase in the indicator value leads to a reduction in risk. For example, improved access to reliable water resources, enhances adaptive capacity, consequently lowering heat risk for a given community.

This dual perspective ensured a comprehensive representation of factors contributing to heat risk across wards.

To bring all variables to a common scale and ensure they are unit-free, the indicators were normalised using the Min-Max normalisation. This process was applied to all indicators categorized under exposure, vulnerability and hazard. In cases where data gaps existed at the ward level, city-wide data was disaggregated using the population apportionment method. Normalisation is determined by the functional relationship between an indicator and vulnerability.

For indicators with a positive relationship where risk increases as the indicator value rises, the following formula is applied:

$$\mathbf{X^{P}_{ij} = X_{ij} - Min_i\{Xij\} / Max_i\{Xij\} - Min_i\{Xij\}}$$

Where X^{P}_{ij} is the normalised value of the indicator *i* for unit *j*, when there is a positive relationship; Xij is the actual value of the indicator *i* for unit *j*; $Min_i\{Xij\}$ is the minimum among all values of the indicator *i*; $Max_i\{Xij\}$is the maximum among all values of the indicator *i*.

For indicators with an inverse relationship - where an increase in the indicator value leads to a reduction in risk (such as increased adaptive capacity), the following formula is used:

$$\mathbf{X^{N}_{ij} = Max_i\{Xij\} - Xij / Max_i\{Xij\} - Min_i\{Xij\}}$$

Where X^{N}_{ij} is the normalised value of the indicator *i* for unit *j*, when there is a negative relationship; Xij is the actual value of the indicator *i* for unit *j*;

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$Min_i\{Xij\}$ is the minimum among all values of the indicator *i*; $Max_i\{Xij\}$is the maximum among all values of the indicator *i*.

The normalised values for each indicator range between 0 and 1 where a value of 1 represents a ward/village/town panchayat/municipality with maximum risk and 0 represents a ward with minimum vulnerability for that specific indicator. Due to a lack of empirical data regarding the specific weightages of indicators contributing to heat risk in the Indian context and the absence of such weightages in existing Indian HAPs and academic literature, an equal weighting approach was adopted. Consequently, equal weights were assigned when calculating the scores for each individual risk component (Hazard, Exposure and Vulnerability).

This meticulous approach to indicator selection and normalisation ensures that the Heat Risk Index accurately reflects the varying levels of risk across the administrative units (village panchayats, town panchayats and municipalities). The risk map categorisation was conducted using the Equal Interval Classification methods (Zha et al., 2024).

On the final risk scale of 0 to 1, administrative units were classified into five distinct risk categories based on their scores:

- ≤ 0.2: Very Low Risk
- > 0.2 and ≤ 0.4: Low Risk
- > 0.4 and ≤ 0.6: Moderate Risk
- > 0.6 and ≤0.8: High Risk
- > 0.8 and ≤ 1.0: Very High Risk

4.2 Approach for establishing local heat-health Thresholds

Heatwaves are often described as an "invisible disaster" because their impacts are not immediately apparent on physical assets or infrastructure. As slow-onset events, they affect human health gradually, with their full impact becoming evident only through the sustained analysis of meteorological and health data.

In addition to identifying where actions are needed through the Heat Risk Index presented in Chapter 4, it is equally important to determine when such actions should be initiated. Unlike sudden-impact hazards such as floods or cyclones, heatwaves intensify over time and their cumulative effects pose significant risks to human health. Establishing the specific temperature and humidity thresholds at which conditions become hazardous is therefore essential for a timely and effective response.

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This section outlines the development and application of localised heat-health thresholds tailored specifically to the context of Tamil Nadu. These thresholds will facilitate the issuance of precise and actionable early warnings and alerts during heatwave conditions.

In India, the India Meteorological Department is the designated agency responsible for heatwave forecasting and early warning. It has established the national criteria for declaring heatwaves and hot weather conditions, which form the basis for routine forecasts and alerts nationwide. The present analysis is intended to complement these national criteria by utilizing long -term climatic data from the past forty years, sourced from official institutions such as the India Meteorological Department and the Ministry of Earth Sciences. The objective is to generate evidence at the city and district levels to support more localised and responsive heat early warning systems, specifically for Tamil Nadu for facilitating local administrative action at the right time.

Heat-health thresholds differ from general heatwave criteria by focusing on the specific impacts of extreme heat on the human body. In 2015, the World Meteorological Organization (WMO) and the World Health Organization (WHO) introduced guidelines for Heat Health Warning Systems (HHWS), emphasizing the critical role of early warning systems within Heat Action Plans (HAPs). These guidelines outline two primary methods for establishing heat thresholds:

1. Biostatistical Analysis

This method identifies the statistical relationship between extreme temperature variables and health outcomes. It often uses health indicators such as:

- All-cause daily mortality (standardized to account for seasonal variability)
- Cause-specific daily mortality (e.g., non-accidental deaths or mortality in people aged 65 and older)
- Daily hospital admissions or emergency service calls (e.g., ambulance service data)

For meteorological variables, thresholds are determined using either:

- A single parameter, such as maximum temperature (T.Max)
- A composite parameter, like the Heat Index, considering geographical and historical data availability.

Widely referenced studies (e.g., Sheridan and Kalkstein, 2004; Pascal et al., 2006) have utilized these approaches.

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2. Biometeorological Indices

In cases where health data is unavailable, percentile-based thresholds (e.g., 90th or 95th percentile) derived from long-term temperature data serve as warning triggers. This percentile approach, endorsed by WHO-WMO, has been applied globally to identify critical thresholds for extreme heat events.

In India, a hybrid approach combining both methodologies have been employed. For instance, the Ahmedabad Heat Action Plan (HAP) established thresholds by developing a dose-response relationship between the daily maximum temperature during summer and the corresponding all-cause mortality. Expanding on this initiative, in 2019, the National Disaster Management Authority (NDMA) conducted a comprehensive study to establish these thresholds for 103 cities across India. *This involved a time-series analysis of temperature and mortality for five cities, determining thresholds based on published research for two cities and the establishment of seasonal and monthly maximum temperature thresholds using the 75th, 85th and 95th percentile values for 96 cities (Srivastava et al., 2019).*

For the purpose of this HAP, the local heat thresholds for the districts of Tamil Nadu are developed by leveraging the latest fine-resolution IMDAA reanalysis data, which provides a high resolution 12-km spatial grid.

Figure 9 provides a detailed methodology for computing heat thresholds for districts and cities in Tamil Nadu. For this plan, the 90th, 95th and 99th percentiles have been analysed to compute yellow, orange and red colour-coded alert thresholds, respectively, aligning with the IMD thresholds. It is important to note that the heat index used in this plan to develop thresholds is intended solely for estimating heat stress during the summer season.

Figure 9: Schematic representation of the approach for calculating percentile heat thresholds over districts and cities of Tamil Nadu

Indian Monsoon Data Assimilation and Analysis (IMDAA) hourly reanalysis data for temperature and relative humidity (1982 - 2022) at 12 KM resolution grid and IMD gridded data 2 m above ground
Preparation of hourly and daily time series datasheets of maximum temperatures and heat index for each grid falling in Tamil Nadu State and aggregation to district and cities using the zonal statistics method
Calculating 90th, 95th and 99th percentile thresholds of daily maximum dry temperatures for March, April, May and June

A percentile is a method of ranking temperatures by comparing them to historical data. For example, if the 95th percentile is 38°C in a specific region, it means that 95 percent of the historical temperatures recorded

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there were below 38°C; consequently, any temperature above this value is considered unusually hot for that area. This approach, recommended by organizations like WHO, WMO and IMD, accounts for local climate variations and the specific level of heat acclimatization among different populations. Where necessary, rigorous data cleaning procedures were applied to remove outliers and ensure the reliability of the analysis. The resulting thresholds were then validated through stakeholder consultations with relevant line departments and officials from each city and district in Tamil Nadu.

The heat thresholds derived from the analysis were field-validated through consultations with district authorities and the Tamil Nadu Disaster Risk Reduction Agency (TNDRRA) and were cross-checked against observed impacts from recent years. Wherever required, thresholds were adjusted to better reflect ground realities. While the long-term climate data used in the assessment is robust and quality-controlled by the India Meteorological Department (IMD) and the Ministry of Earth Sciences (MoES), it is available at a spatial resolution of up to 12 km. In districts with significant topographical variation, this resolution may not adequately capture local climatic variability. Accordingly, thresholds were revised in specific cases. For instance, in the Nilgiris district, the 90th percentile threshold derived from historical data was found to be below 30°C; however, this was adjusted to 34°C to align with IMD criteria, which states that heatwave be only considered for hills after temperature crosses 30°C and to better reflect the physiological impacts associated with extreme heat conditions.

To maintain consistency with IMD's operational criteria, these percentile-based thresholds were mapped against IMD's heatwave definitions. The Heat Index (which combines temperature and humidity) of IMD was integrated to capture cumulative heat stress. This approach ensures that the thresholds remain locally relevant to the specific climatic conditions of Tamil Nadu while remaining fully aligned with the IMD's national forecasting standards.

The sections below present taluk and city wise dry temperature thresholds (Yellow, Orange and Red) for Tamil Nadu during the summer months, highlighting how thermal conditions vary across different terrains and climatic zones. The clear progression from Yellow to Orange to Red alerts underscores the increasing risk levels and the importance of early warnings in preparing for heat impacts.

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Box 6 | Steadman Heat Index

To assess human-perceived thermal stress, we also used the Steadman Heat Index (HI), which combines air temperature and relative humidity to represent the apparent temperature experienced by the human body. Originally developed by Steadman (1979), the index is widely used to evaluate heat stress under warm, humid conditions and is particularly relevant to public health and urban climate studies. By incorporating both temperature and moisture effects, the Steadman Heat Index provides a more realistic representation of heat stress than air temperature alone.

Heat Stress Index															
	Relative Humidity														
Temperature (°C)	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
27	26.4	26.6	26.9	27.1	27.4	27.7	28.1	28.5	28.9	29.3	29.7	30.2	30.7	31.3	31.8
28	27.1	27.4	27.7	28	28.4	28.9	29.4	30	30.7	31.4	32.1	32.9	33.7	34.7	35.6
29	27.9	28.2	28.6	29.1	29.7	30.3	31	31.8	32.7	33.7	34.7	35.9	37.1	38.4	39.7
30	28.8	29.2	29.7	30.3	31	31.9	32.8	33.9	35	36.3	37.7	39.1	40.7	42.4	44.2
31	29.7	30.3	30.9	31.7	32.6	33.7	34.8	36.2	37.6	39.2	40.9	42.7	44.7	46.8	49
32	30.8	31.5	32.3	33.2	34.4	35.6	37.1	38.7	40.4	42.3	44.4	46.6	49	51.5	54.2
33	32	32.8	33.8	34.9	36.3	37.8	39.5	41.4	43.5	45.7	48.1	50.8	53.5	56.5	59.7
34	33.3	34.3	35.4	36.8	38.4	40.2	42.2	44.4	46.8	49.4	52.2	55.2	58.4	61.9	65.5
35	34.7	35.8	37.2	38.8	40.7	42.7	45.1	47.6	50.3	53.3	56.5	60	63.7	67.6	71.7
36	36.2	37.5	39.1	41	43.1	45.5	48.1	51	54.2	57.5	61.2	65.1	69.2	73.6	78.2
37	37.8	39.3	41.2	43.4	45.8	48.5	51.4	54.7	58.2	62	66.1	70.4	75.1	80	85.1
38	39.4	41.3	43.4	45.9	48.6	51.6	55	58.6	62.5	66.7	71.3	76.1	81.2	86.6	92.4
39	41.2	43.3	45.8	48.5	51.6	55	58.7	62.7	67.1	71.8	76.8	82.1	87.7	93.7	99.9
40	43.1	45.5	48.3	51.3	54.8	58.5	62.6	67.1	71.9	77	82.5	88.3	94.5	101	107.9
41	45.1	47.8	50.9	54.3	58.1	62.3	66.8	71.7	77	82.6	88.6	94.9	101.6	108.7	116.1
42	47.2	50.3	53.7	57.5	61.7	66.2	71.2	76.5	82.3	88.4	94.9	101.8	109	116.7	124.8
43	49.4	52.8	56.6	60.8	65.4	70.4	75.8	81.6	87.8	94.5	101.5	108.9	116.8	125.1	133.7
44	51.7	55.5	59.6	64.2	69.3	74.7	80.6	86.9	93.6	100.8	108.4	116.4	124.9	133.7	143
45	54.1	58.3	62.8	67.9	73.3	79.2	85.6	92.4	99.7	107.4	115.6	124.2	133.2	142.7	152.7
46	56.6	61.2	66.2	71.6	77.6	84	90.9	98.2	106	114.3	123	132.2	141.9	152.1	162.7
47	59.2	64.2	69.6	75.6	82	88.9	96.3	104.2	112.6	121.4	130.8	140.6	150.9	161.7	173
48	62	67.4	73.3	79.7	86.6	94	102	110.4	119.4	128.8	138.8	149.3	160.2	171.7	183.7
49	64.8	70.6	77	83.9	91.4	99.4	107.9	116.9	126.4	136.5	147.1	158.2	169.9	182.1	194.8
50	67.7	74	80.9	88.4	96.4	104.9	114	123.6	133.7	144.4	155.7	167.5	179.8	192.7	206.2

Bio-meteorological formula

$$\mathrm{HI} = c_1 + c_2T + c_3R + c_4TR + c_5T^2 + c_6R^2 + c_7T^2R + c_8TR^2 + c_9T^2R^2$$

where

HI = heat index (in degrees Fahrenheit)

T = ambient dry-bulb temperature (in degrees Fahrenheit)

R = relative humidity (percentage value between 0 and 100)

$$c_1 = -42.379, \quad c_2 = 2.049\,015\,23, \quad c_3 = 10.143\,331\,27,$$
$$c_4 = -0.224\,755\,41, \quad c_5 = -6.837\,83 \times 10^{-3}, \quad c_6 = -5.481\,717 \times 10^{-2},$$
$$c_7 = 1.228\,74 \times 10^{-3}, \quad c_8 = 8.5282 \times 10^{-4}, \quad c_9 = -1.99 \times 10^{-6}.$$

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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5 Hazard, Exposure, Vulnerability and Risk Assessment of districts and cities of Tamil Nadu

In this chapter, the findings from the analysis of heat hazard, exposure vulnerability and risk are provided for the state of Tamil Nadu, arrived at and relevant at a district level.

Box 7	Note on the Interpretation and Comparability of Heat Risk Levels Across Tamil Nadu

The risk levels shown across the state of Tamil Nadu are not directly comparable across districts because the analysis was conducted at multiple administrative scales, including village, ward, and Town Panchayat (TP) levels. According to the Intergovernmental Panel on Climate Change (IPCC), risk is conceptualised as a function of hazard, exposure, and vulnerability. These components vary substantially across districts due to differences in geographical features, climatic conditions, demographic characteristics, infrastructure and socioeconomic profiles.

Although the map may display similar colour gradients across the state, this is primarily a result of aggregating results generated at highly granular administrative levels into a single state-level visualisation. The risk scores were calculated using indicator weights specific to each local unit of analysis (in this case the district of comparison) and the final composite index integrates the three dimensions of hazard, exposure, and vulnerability within those units.

Therefore, the risk values and associated colour categories are only comparable within the same administrative scale used in the analysis (for example, wards compared with wards). The composite risk index and its underlying components should not be interpreted as directly comparable across the entire state because the calculations are context-specific and derived from locally weighted indicators. Further, the risk maps primarily represent settlement areas, while forest and high-vegetation areas are included in the broader analysis, they are not explicitly depicted in the risk map representation.

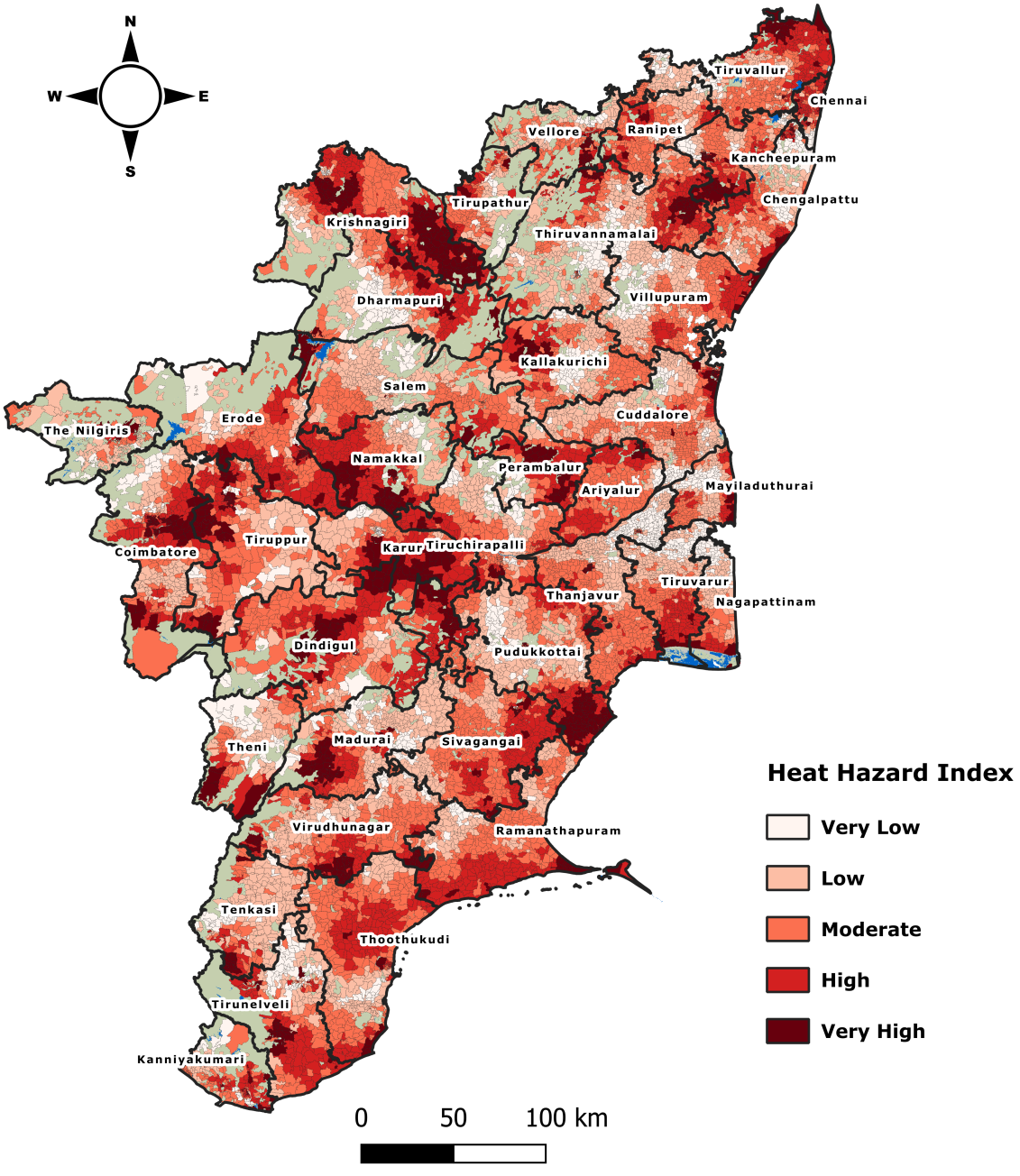
This was done because the purpose of the preparation of State HAP by Tamil Nadu was creating a scientific basis for providing daily district-wise weather outlooks and reports. The taluk and city was chosen as the unit of analysis in the background because of this scientific study, because the taluk and city is the lowest unit of coherent, co-ordinated administrative action on a daily basis in Tamil Nadu.

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The following maps show the hazard, exposure, vulnerability and heat risk index estimated over various units - villages (rural areas) and at municipality, town panchayat level for the districts and ward level for cities (urban areas which are under city corporations)

Figure 10: Map representing the heat risk index estimated for the state of Tamil Nadu

a) Hazard Index (this is given in the front cover of this report)

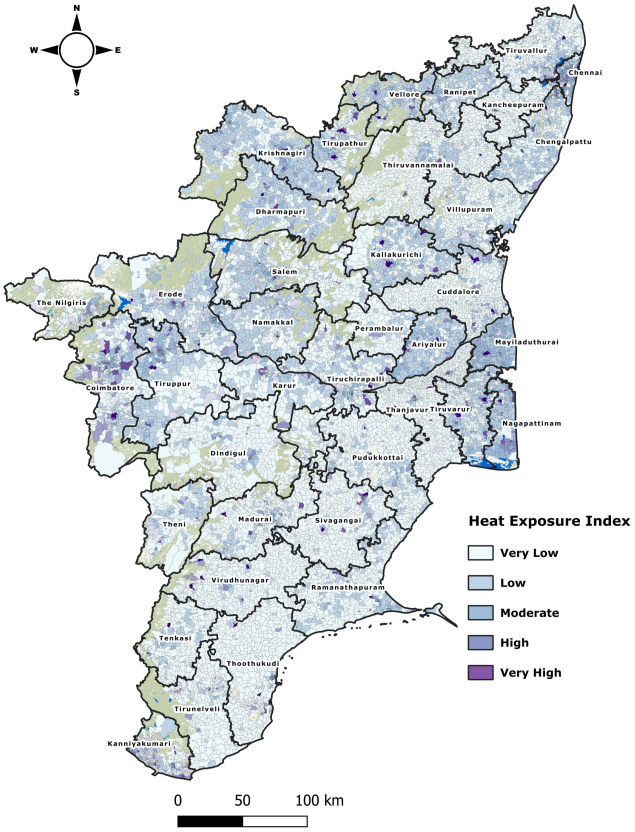


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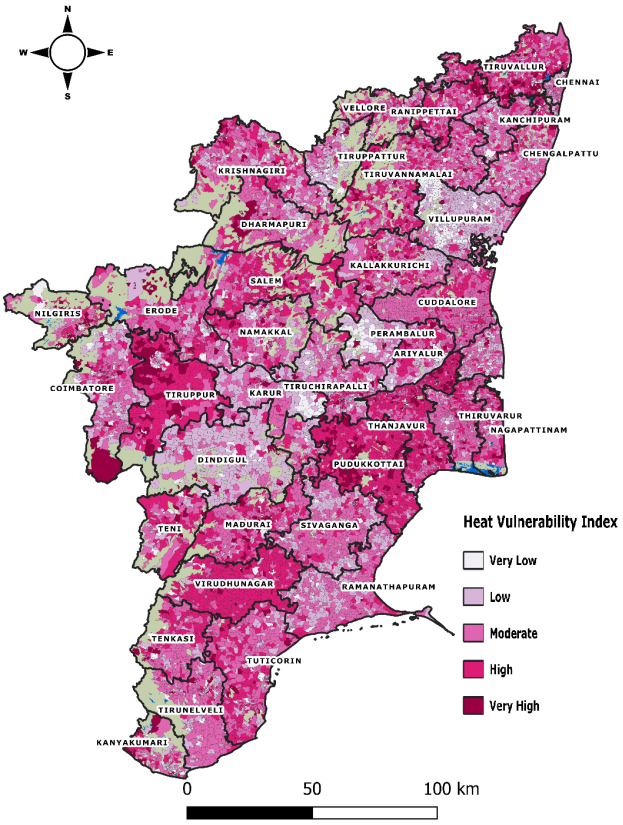
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b) Exposure Index



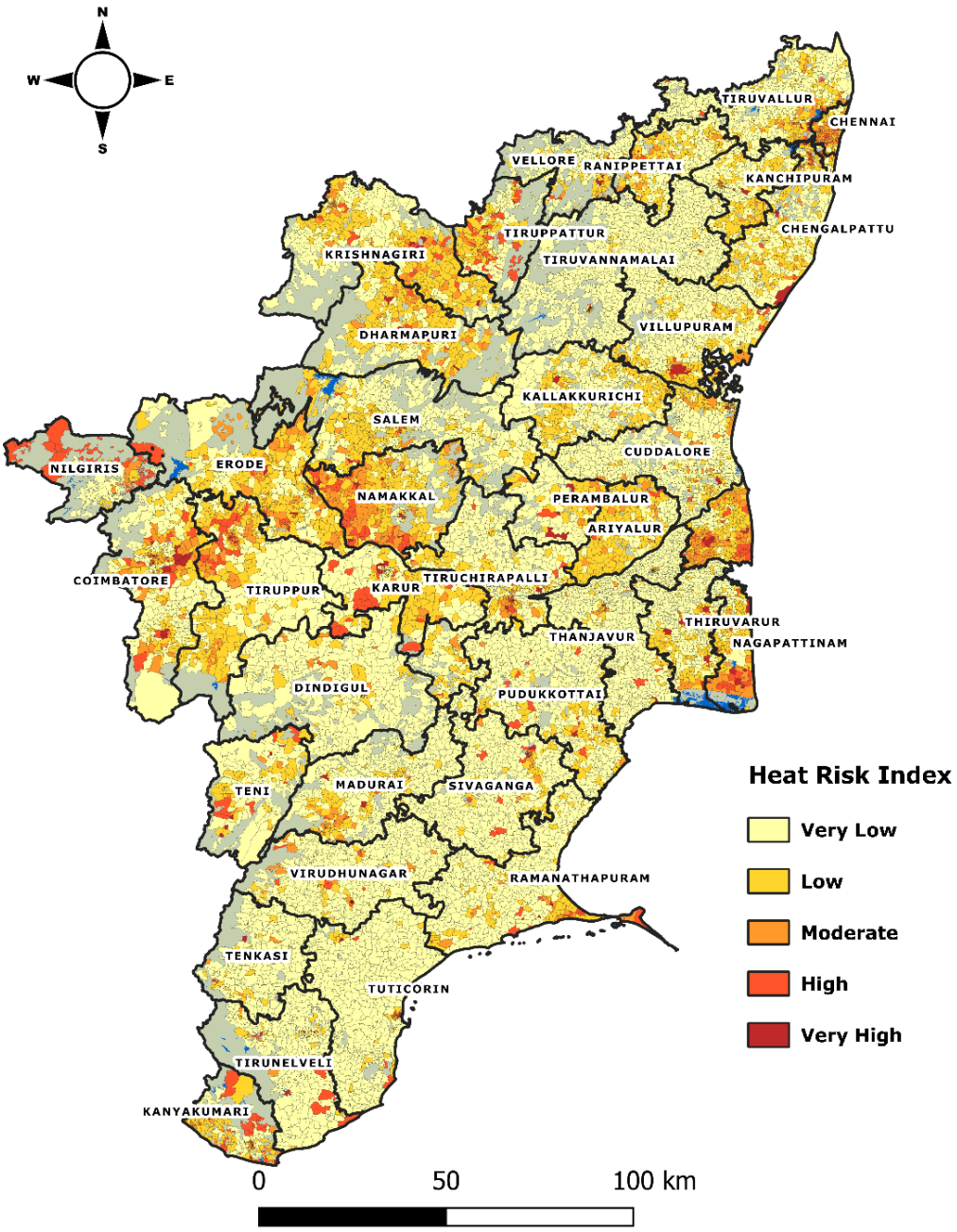
c) Vulnerability Index



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d) Heat Risk Index



Note: The Land Use Land Cover categories of vegetation, water bodies and barren land have been represented as green, blue and grey respectively.

5.1 Mapping of Heat Risk Index for the cities and districts of Tamil Nadu

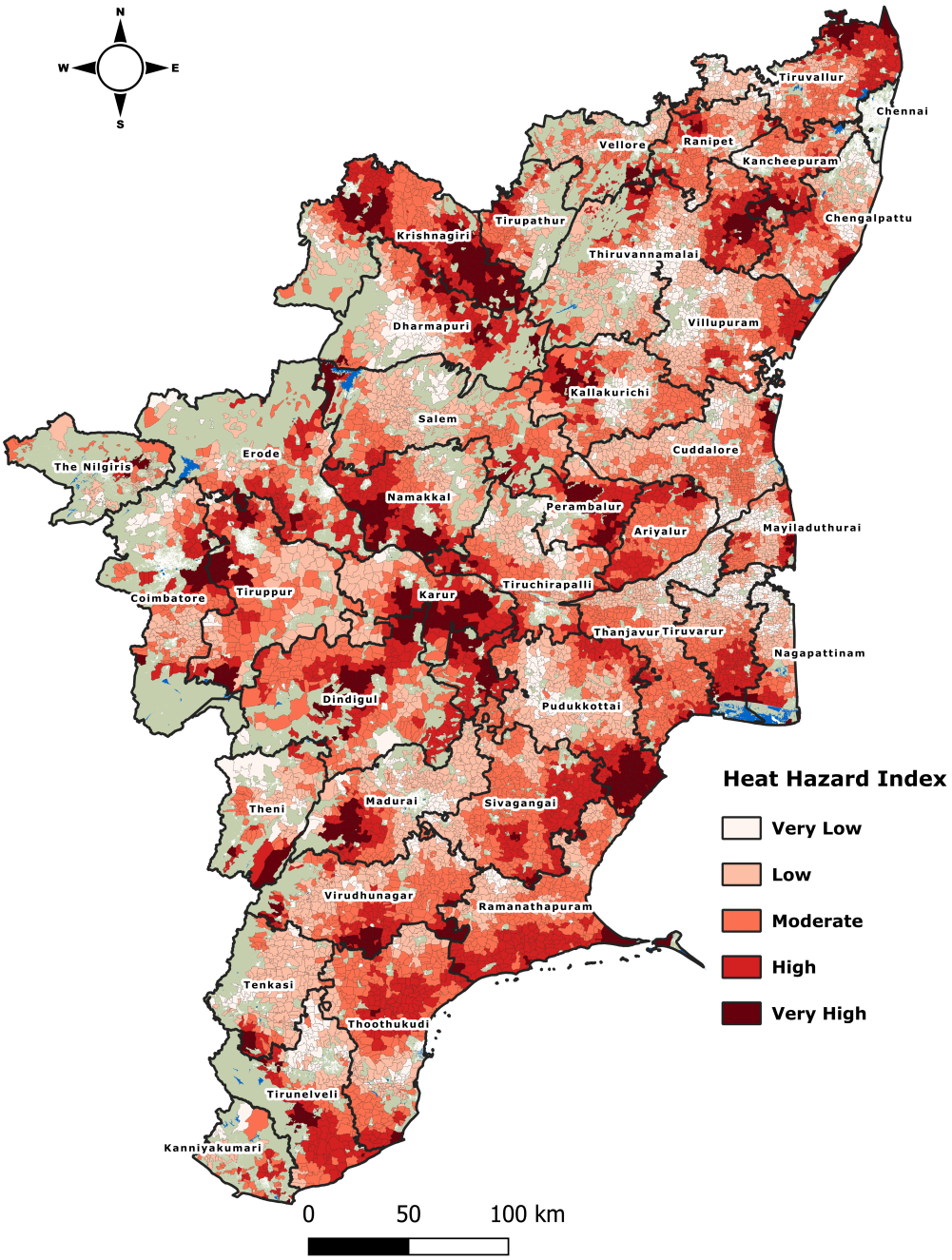
The following maps (Figures 11 a-d) represent the heat risk index estimated over the Village Panchayat level and (Figures 12 a-d) at the Town Panchayat/municipality level for the districts. The risk map categorisation was done using equal interval classification method, where on a final scale of 0-1, those units which received between 0-0.2 fell in very low risk

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category, those in 0.2-0.4 in the low risk, 0.4-0.6 in the moderate risk, 0.6-0.8 in high risk, 0.8-1 in very risk category.

Figure 11: Map representing the heat risk index estimated for the state of Tamil Nadu at the Village Panchayat level

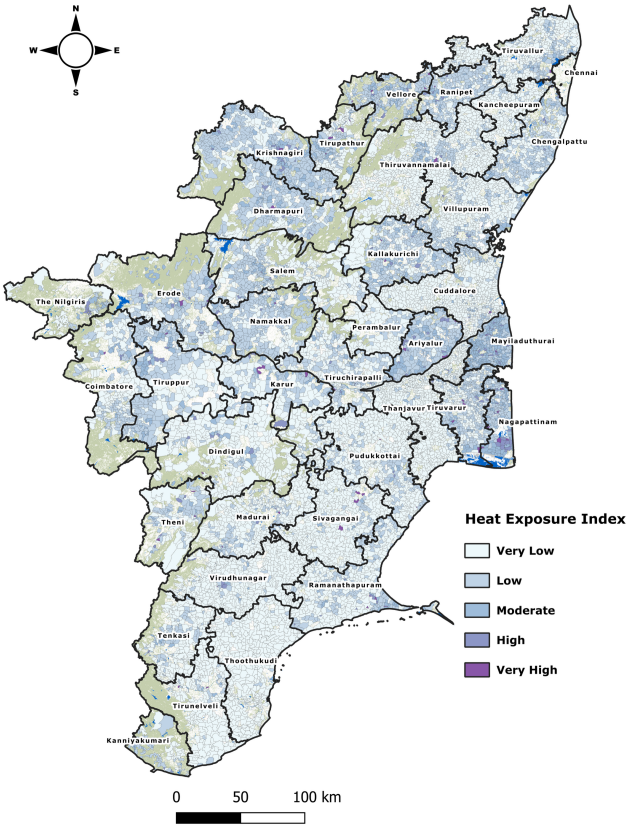
a) Hazard Index (excluding urban areas)



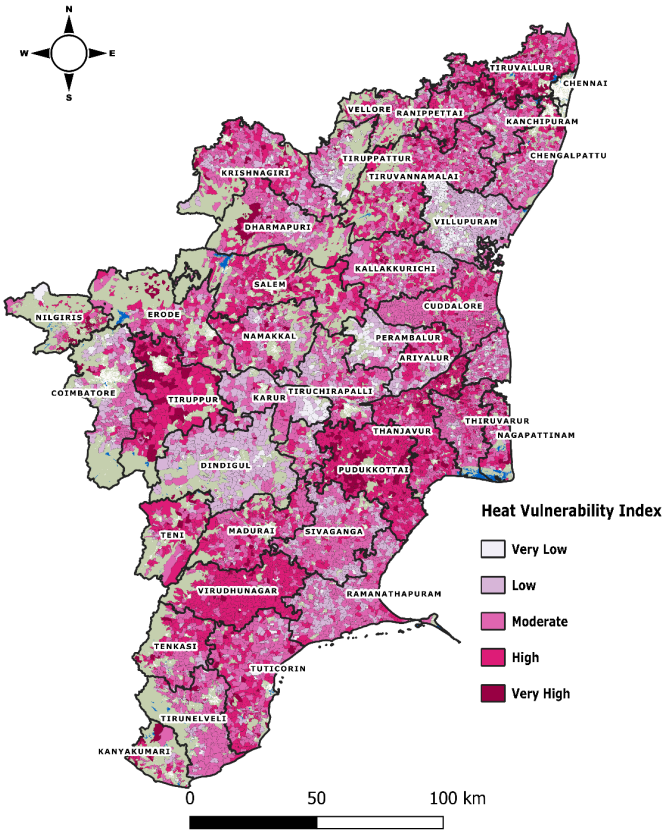
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b) Exposure Index (excluding urban areas)



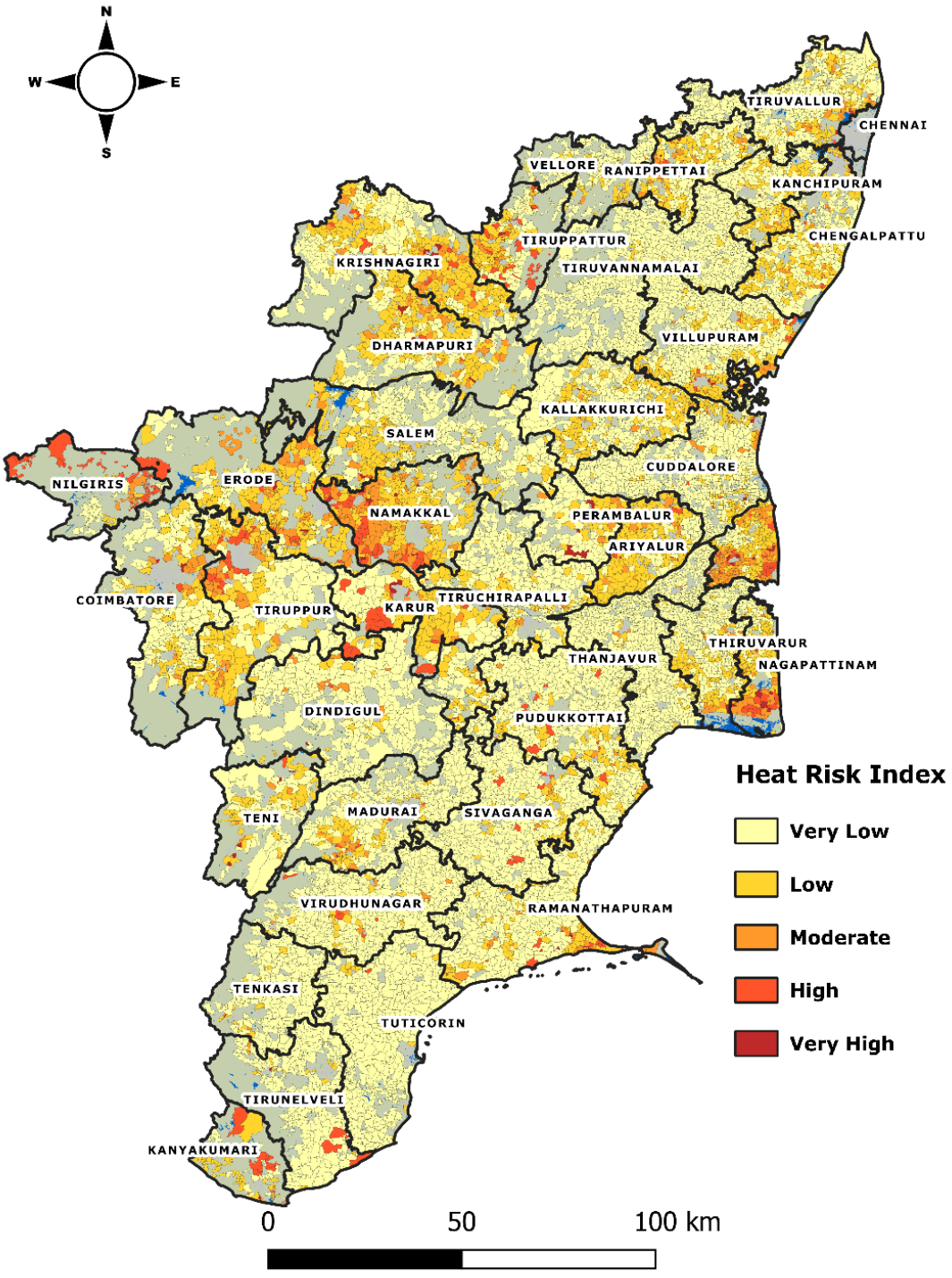
c) Vulnerability Index (excluding urban areas)



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d) Heat Risk Index (excluding urban areas)



Note: The Land Use Land Cover categories of vegetation, water bodies and barren land have been represented as green, blue and grey respectively.

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The classification of villages into heat risk categories is based on a relative heat risk assessment conducted at the district level, rather than a comparison of absolute land or air temperatures. A state-level relative risk assessment was developed using a bottom-up approach, informed by these district-level assessments. A village is designated as "Very High Risk" when it exhibits a higher cumulative risk resulting from the integration of its hazard, exposure and vulnerability parameters relative to other villages. This elevated risk implies that during extreme heat events, these villages are more susceptible to adverse impacts than their neighbouring counterparts.

Beyond classifying villages risk categories, the analysis also identified the specific drivers contributing to an elevated Heat Risk Index in each location. This level of detail promotes targeted action by enabling the policy makers to design interventions that address unique, localized risk factors. The analysis, which includes identifying several recurring factors contributing to high heat risk at the village level, includes elevated Land Surface Temperature (LST) trends, an increase in built-up areas and a deficiency of green cover and water bodies, natural features that would otherwise help alleviate thermal stress.

In addition to the data-driven analysis, a ground-truthing exercise was conducted with district officials to reassign heat risk categories based on an on-ground understanding of local realities. These adjustments have been integrated into the final Heat Risk Index maps presented in this plan. Furthermore, stakeholder consultations identified several critical localized factors not fully captured by satellite data, such as high floating populations, elevated humidity levels and forest fire risks, all of which were incorporated to refine the risk profile.

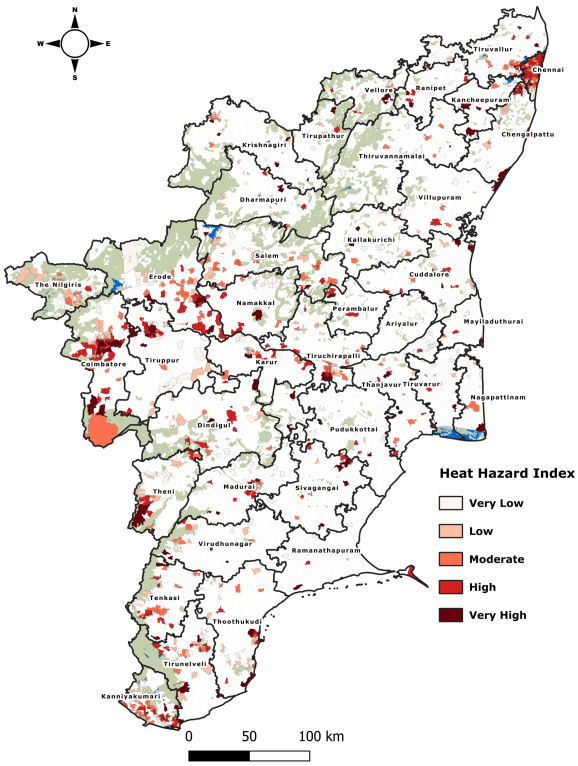
The village-wise factors contributing to very high risk, high risk and moderate risk are brought out as Annexure 5.

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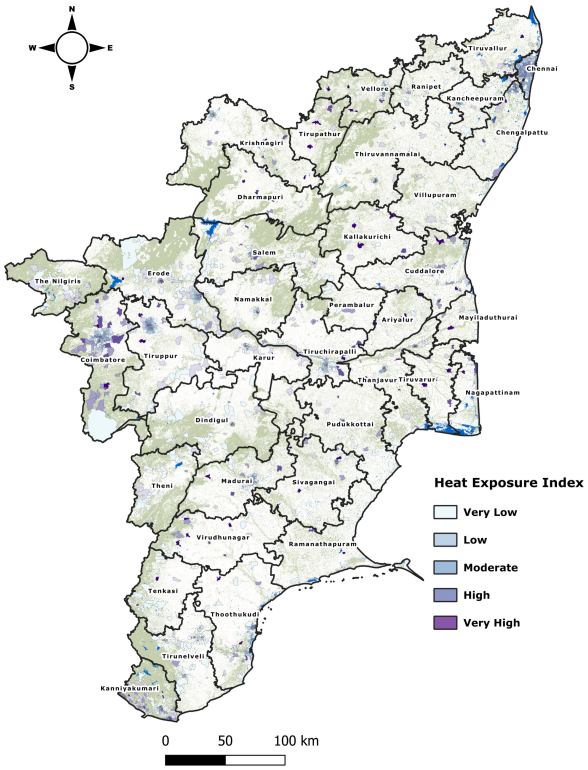
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Figure 12: Map representing the heat risk index estimated for the state of Tamil Nadu excluding rural areas

a) Hazard Index (excluding rural areas)



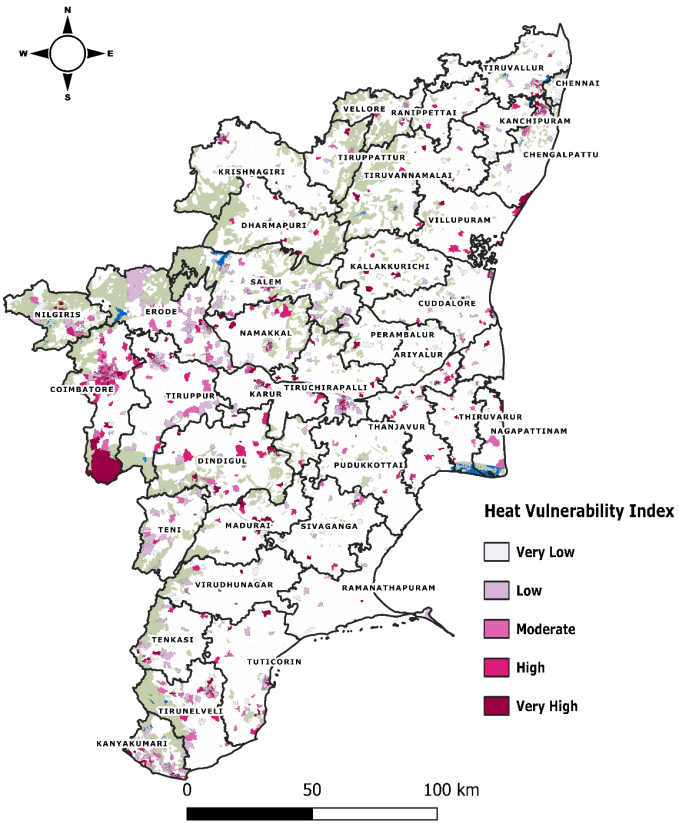
b) Exposure Index (excluding rural areas)



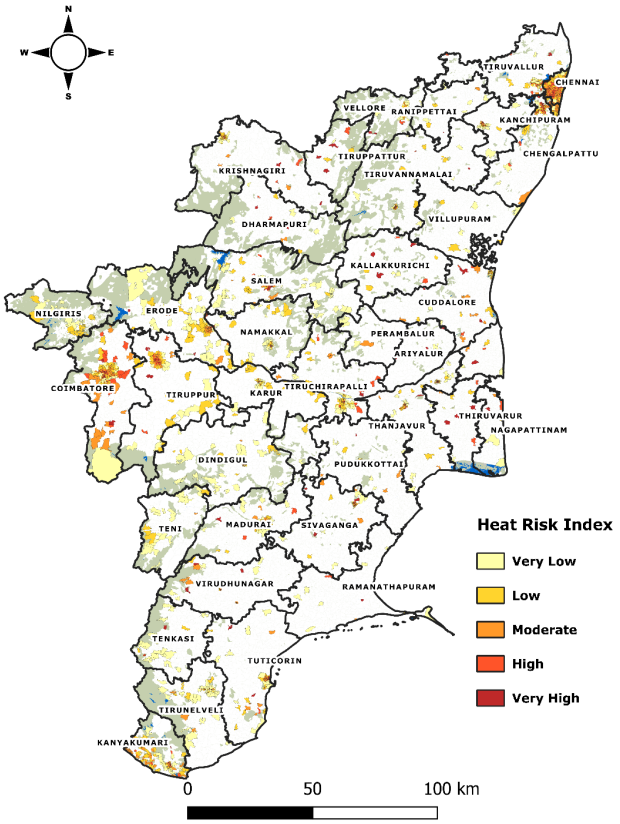
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c) Vulnerability Index (excluding rural areas)



d) Heat Risk Index (excluding rural areas)



Note: The Land Use Land Cover categories of vegetation, water bodies and barren land have been represented as green, blue and grey, respectively

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The classification of Town Panchayats/Municipalities within the "Very High Risk" category is based on a relative heat risk assessment conducted at the district level. A state-level relative risk assessment was developed using a bottom-up approach, informed by these district-level assessments. These administrative units exhibit a higher cumulative risk due to the specific interplay of hazard, exposure and vulnerability parameters. During periods of extreme heat, these Town Panchayats and Municipalities are more susceptible to impacts compared to other units within their respective districts.

Along with classifying Town Panchayats/Municipalities into these categories, the analysis also identified the factors that led to elevated heat risk indices in each Town Panchayat/Municipality. This will help promote targeted action by enabling the planning of measures to address these individual risks. Various factors identified as contributing to the heat risk index in Town Panchayats/Municipalities through analysis, which include elevated Land Surface Temperature trends, increased built-up areas and insufficient green spaces and water bodies that could have helped alleviate heat stress.

In addition to this, following the ground-truthing exercise with district officials, the heat risk index category of Town Panchayats/Municipalities was reassigned according to an understanding of the ground reality. Several other factors, such as a floating population, increased humidity or forest fire risk, industry areas and outdoor workers were identified through these discussions. This has been incorporated into the heat risk index maps represented here.

The ULB-wise factors contributing to very high risk, high risk and moderate risk are brought out as Annexure 5.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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5.2 Mapping of risks and thresholds for the districts of Tamil Nadu

This section presents the summer months thresholds for dry temperature and heat stress, wherein the dry temperature thresholds have been derived at both city and taluk. For the Heat Index, which represents the combined effect of temperature and humidity, a single state-wide threshold has been adopted based on the biometeorological conditions derived from the Steadman Heat Index matrix, as detailed in Box 6 of Chapter 4.

The currently adopted Heat index threshold for the state is provided as detailed in Table:43 of Chapter 6.

In subsequent versions of the Heat Action Plan, more comprehensive scientific studies, including percentile-based analyses and region-specific climatological assessments, will be undertaken at granular scale to establish more robust and realistic heat thresholds that almost reflect the diverse geographic and climatic conditions across different regions of the state.

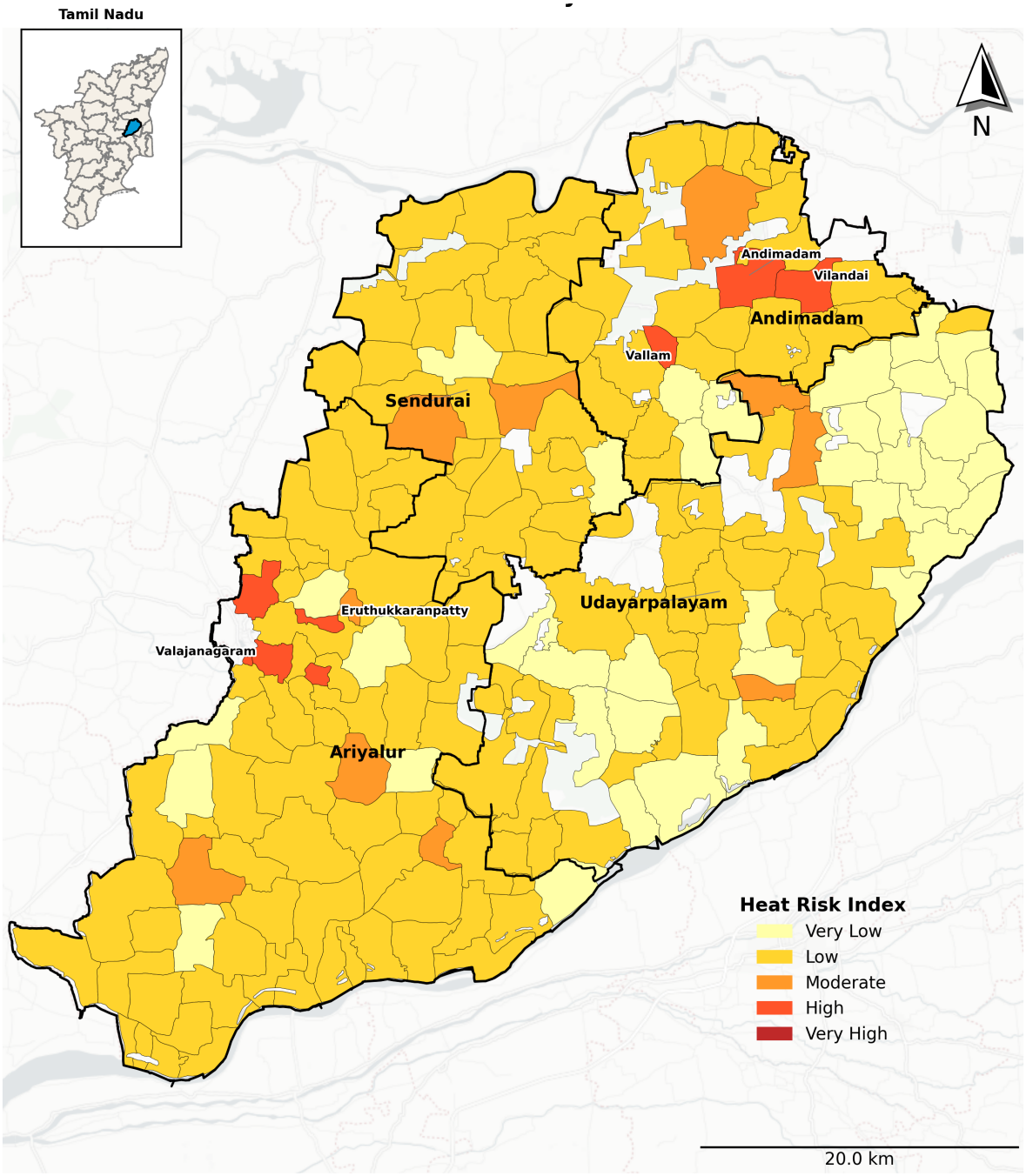
Ariyalur District

Table 5: Ariyalur Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Andimadam	40°C	42°C	44°C
Ariyalur	40°C	42°C	44°C
Udayarpalayam	40°C	42°C	44°C
Sendurai	40°C	42°C	44°C

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Figure A: Heat Risk Index Map of Ariyalur District at Village Panchayats level

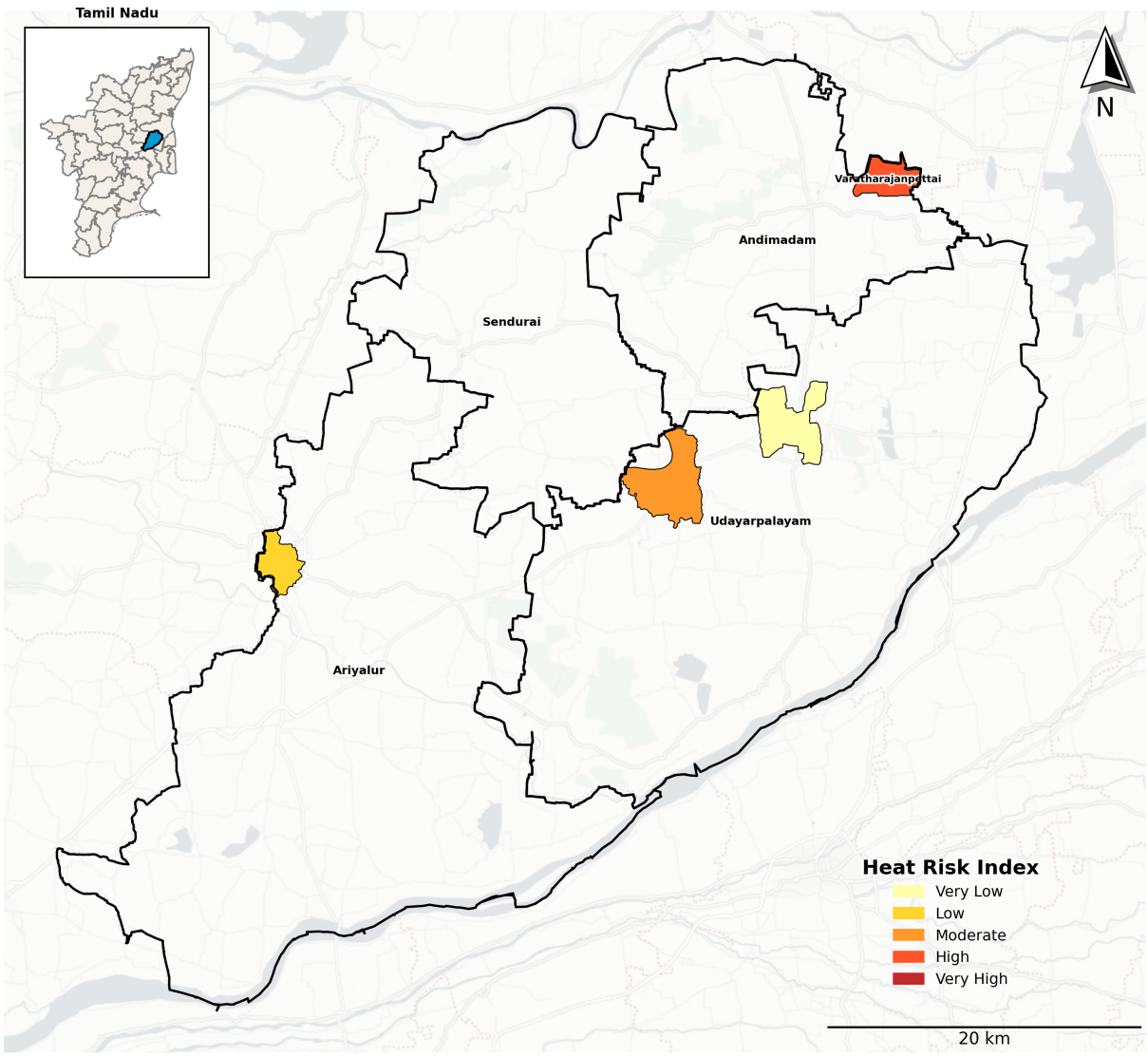


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure B: Heat Risk Index Map of Ariyalur District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Ariyalur

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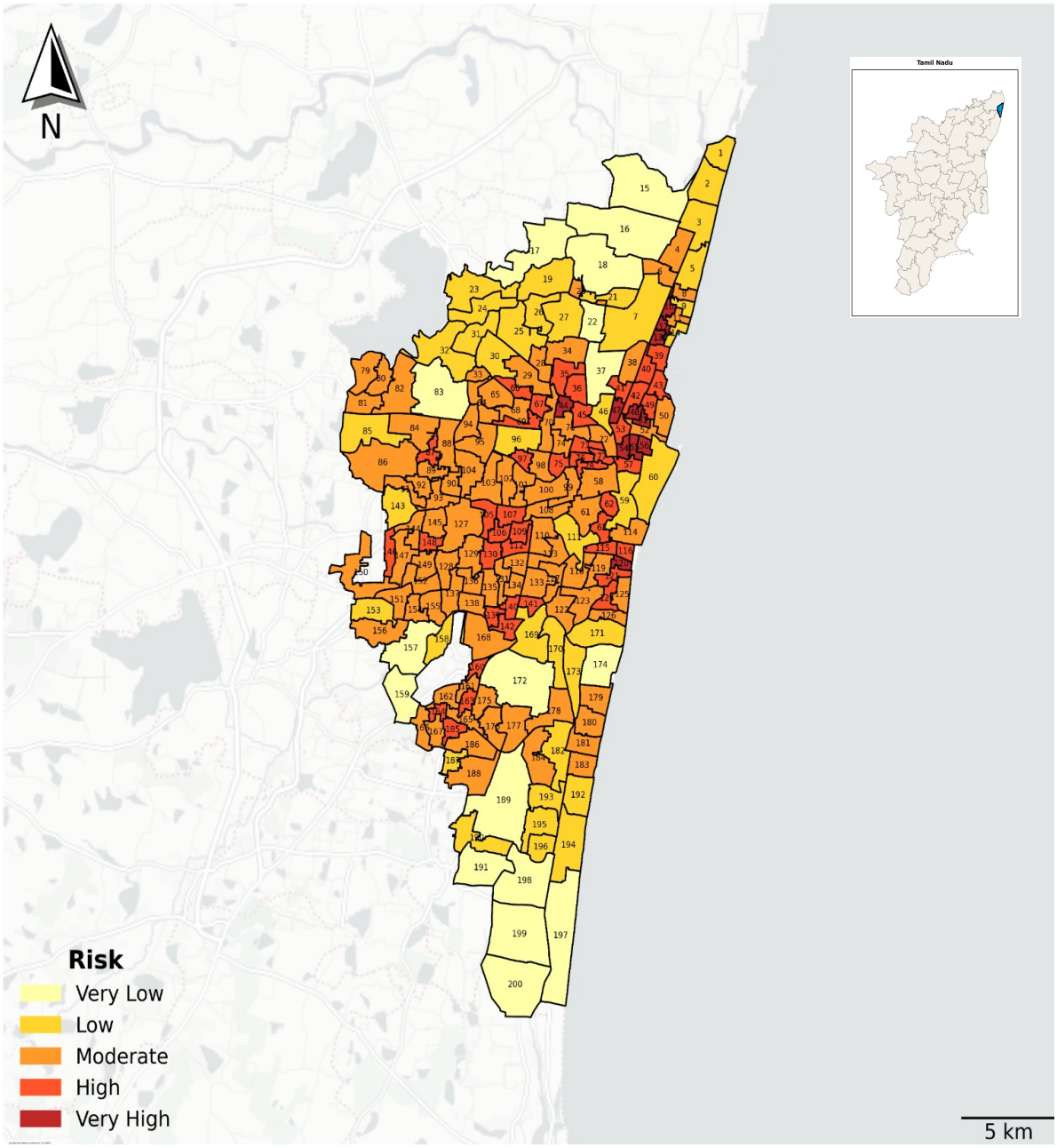
Chennai District

Table 6: Chennai Heat thresholds based on dry temperature for March-June (summer season)

Zone	Yellow alert	Orange alert	Red alert
Zone 3 Madhavaram	38°C	40°C	42°C
Zone 10 Kodambakkam	38°C	40°C	42°C
Zone 11 Valasaravakkam	38°C	40°C	42°C
Zone 7 Ambattur	38°C	40°C	42°C
Zone 13 Adyar	37°C	39°C	41°C
Zone 14 Perungudi	37°C	39°C	41°C
Zone 15 Sholinganallur	37°C	39°C	41°C
Zone 4 Tondiarpet	37°C	39°C	41°C
Zone 5 Royapuram	37°C	39°C	41°C
Zone 6 Thiru. Vi. Ka. Nagar	37°C	39°C	41°C
Zone 8 Anna Nagar	37°C	39°C	41°C
Zone 9 Teynampet	37°C	39°C	41°C
Zone 1 Thiruvottiyur	37°C	39°C	41°C
Zone 2 Manali	37°C	39°C	41°C
Zone 12 Alandur	37°C	39°C	41°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Chennai	37°C	39°C	41°C

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Figure A: Heat Risk Index Map of Chennai District at ward level



Note: The area colored white within the district is the St. Thomas Mount Cantonment, which is governed by the St. Thomas Mount Cantonment Board under the Ministry of Defence.

For detailed contributing factors, refer here: [Chennai]

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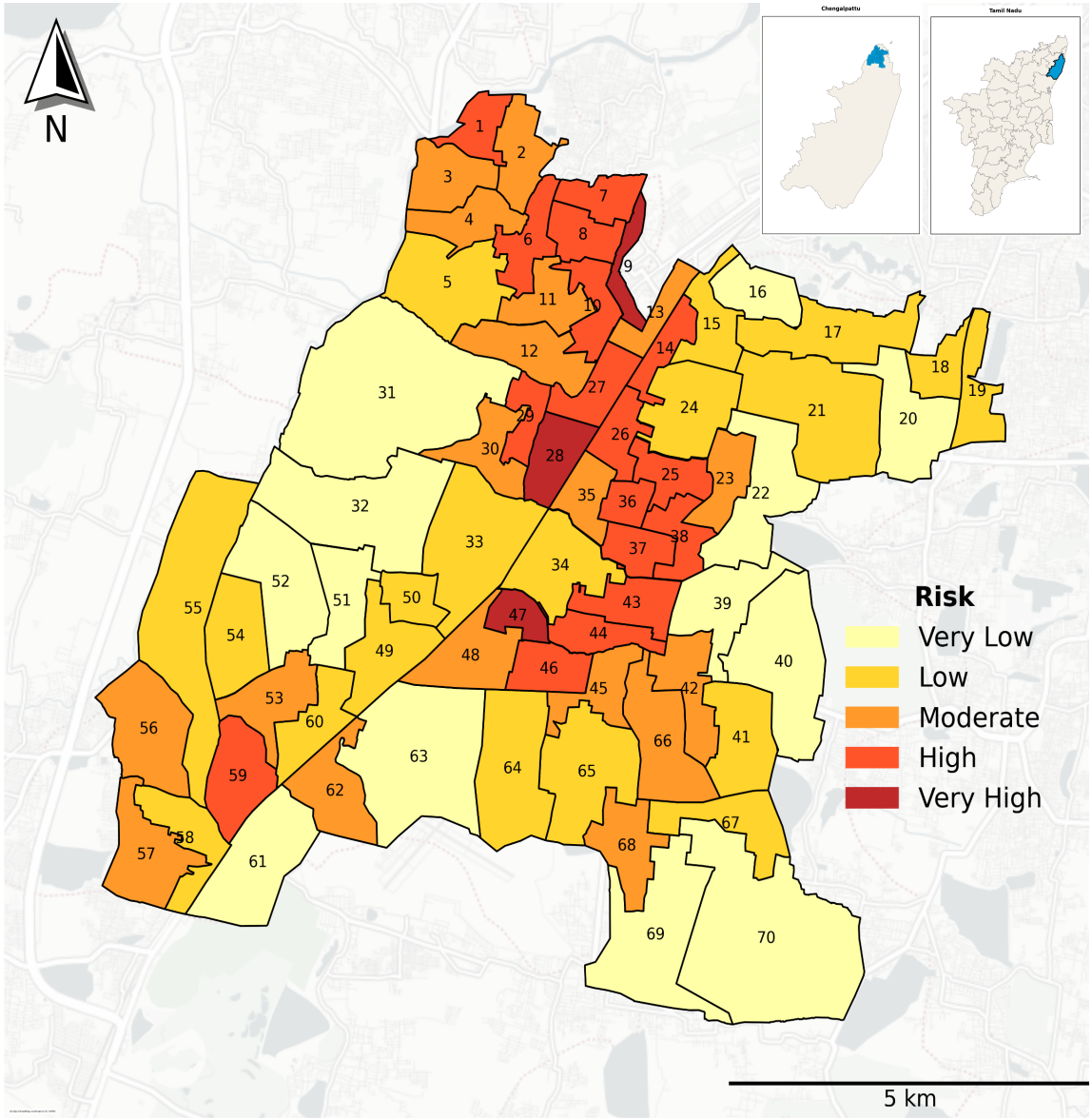
Chengalpattu District

Table 7: Chengalpattu Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Madhurantakam	39°C	41°C	43°C
Thirupporur	38°C	40°C	42°C
Chengalpattu	38°C	40°C	42°C
Vandalur	37°C	39°C	41°C
Pallavaram	37°C	39°C	41°C
Tambaram	37°C	39°C	41°C
Thirukkalukundram	37°C	39°C	41°C
Cheyyur	37°C	39°C	41°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Tambaram	37°C	39°C	41°C

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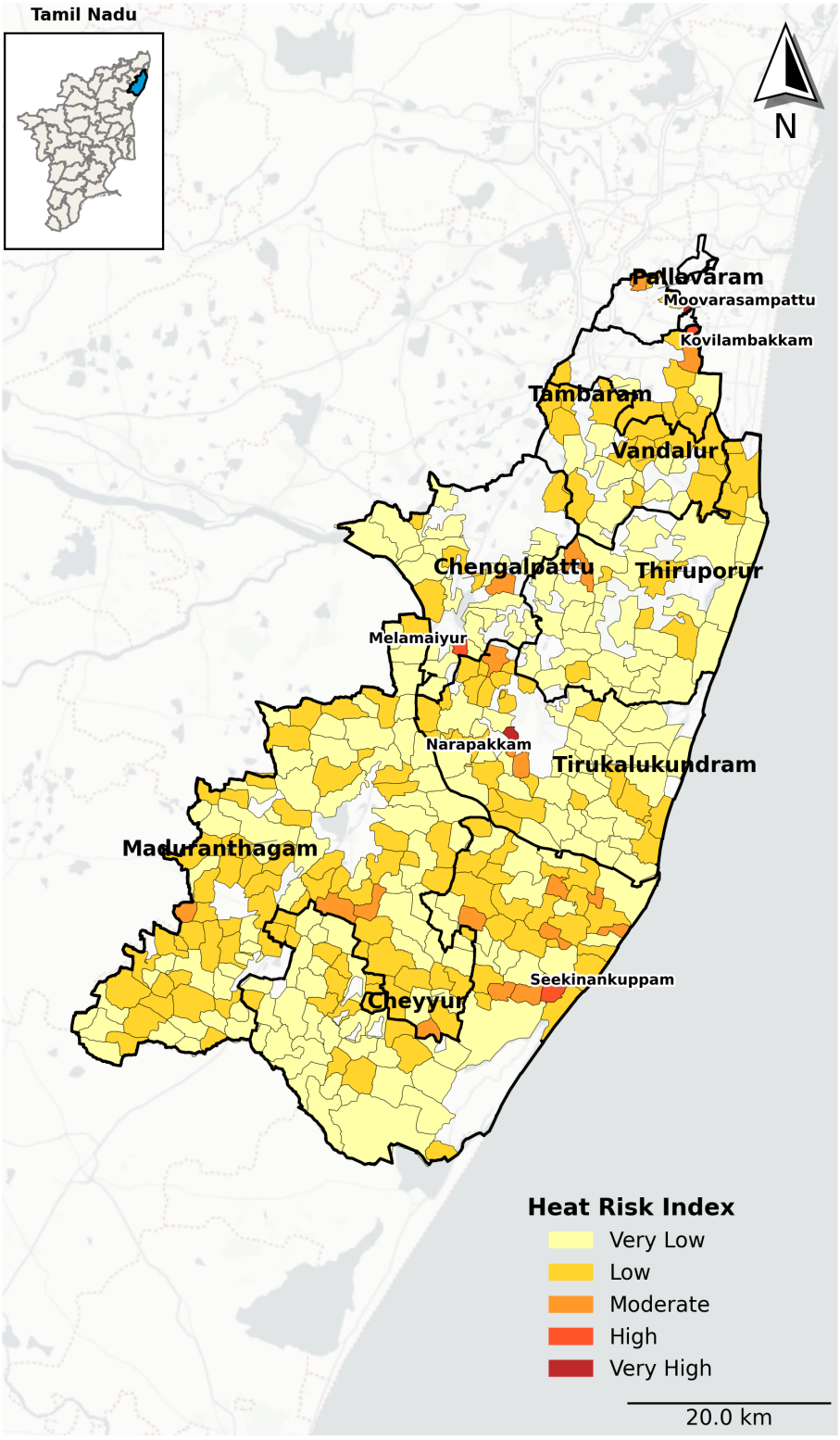
Figure A: Heat Risk Index Map of Tambaram City at Ward Level



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Figure B: Heat Risk Index Map of Chengalpattu District at Village Panchayats level

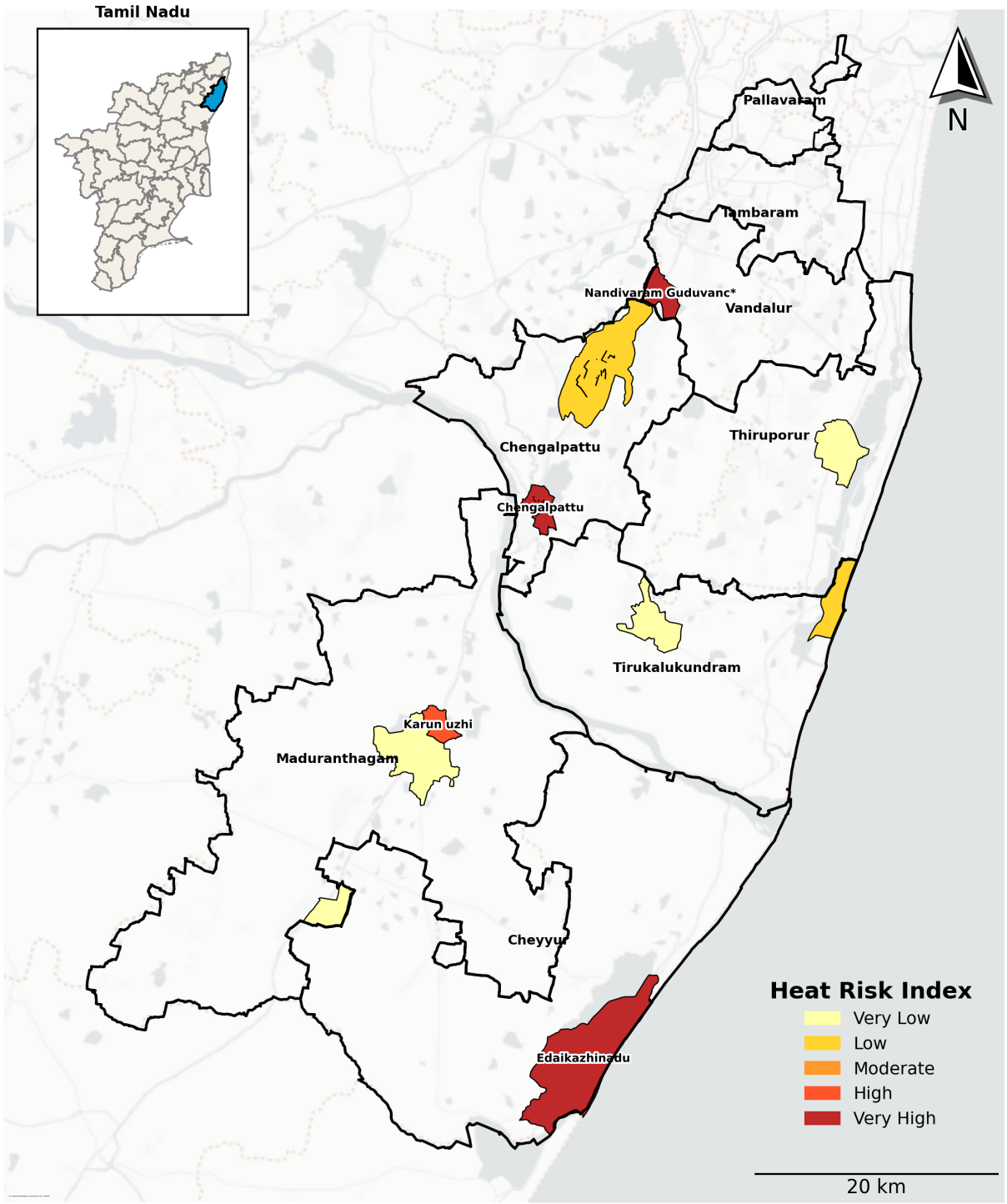


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure C: Heat Risk Index Map of Chengalpattu District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Chengalpattu

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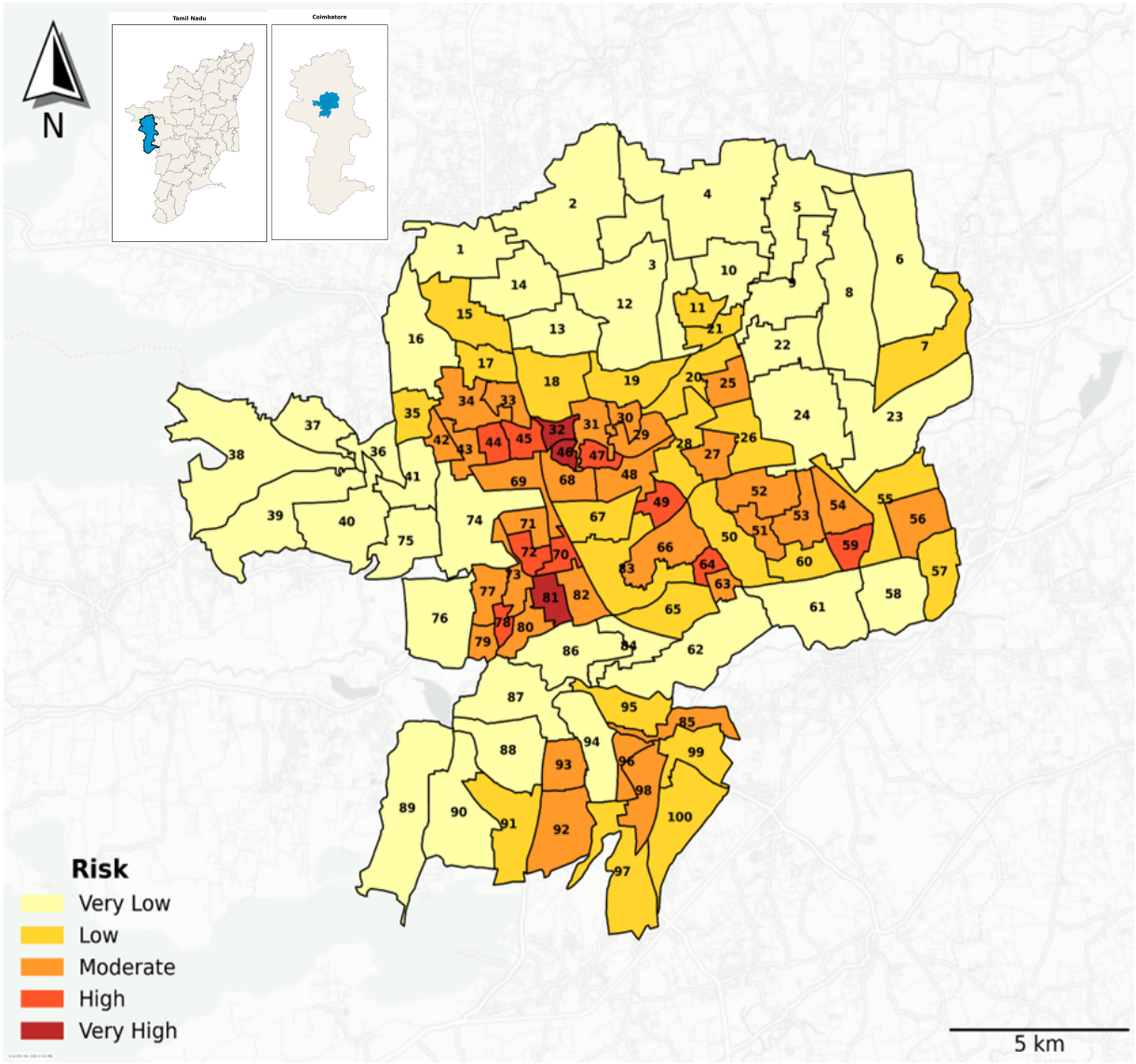
Coimbatore District

Table 8: Coimbatore Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Mettupalayam	39°C	41°C	43°C
Perur	39°C	41°C	43°C
Coimbatore north	39°C	41°C	43°C
Coimbatore south	39°C	41°C	43°C
Madukarai	39°C	41°C	43°C
Annur	39°C	41°C	43°C
Pollachi	39°C	41°C	43°C
Sulur	39°C	41°C	43°C
Kinathukadavu	39°C	41°C	43°C
Anaimalai (hills)	34°C	36°C	39°C
Valparai	31°C	33°C	35°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Coimbatore	39°C	41°C	43°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

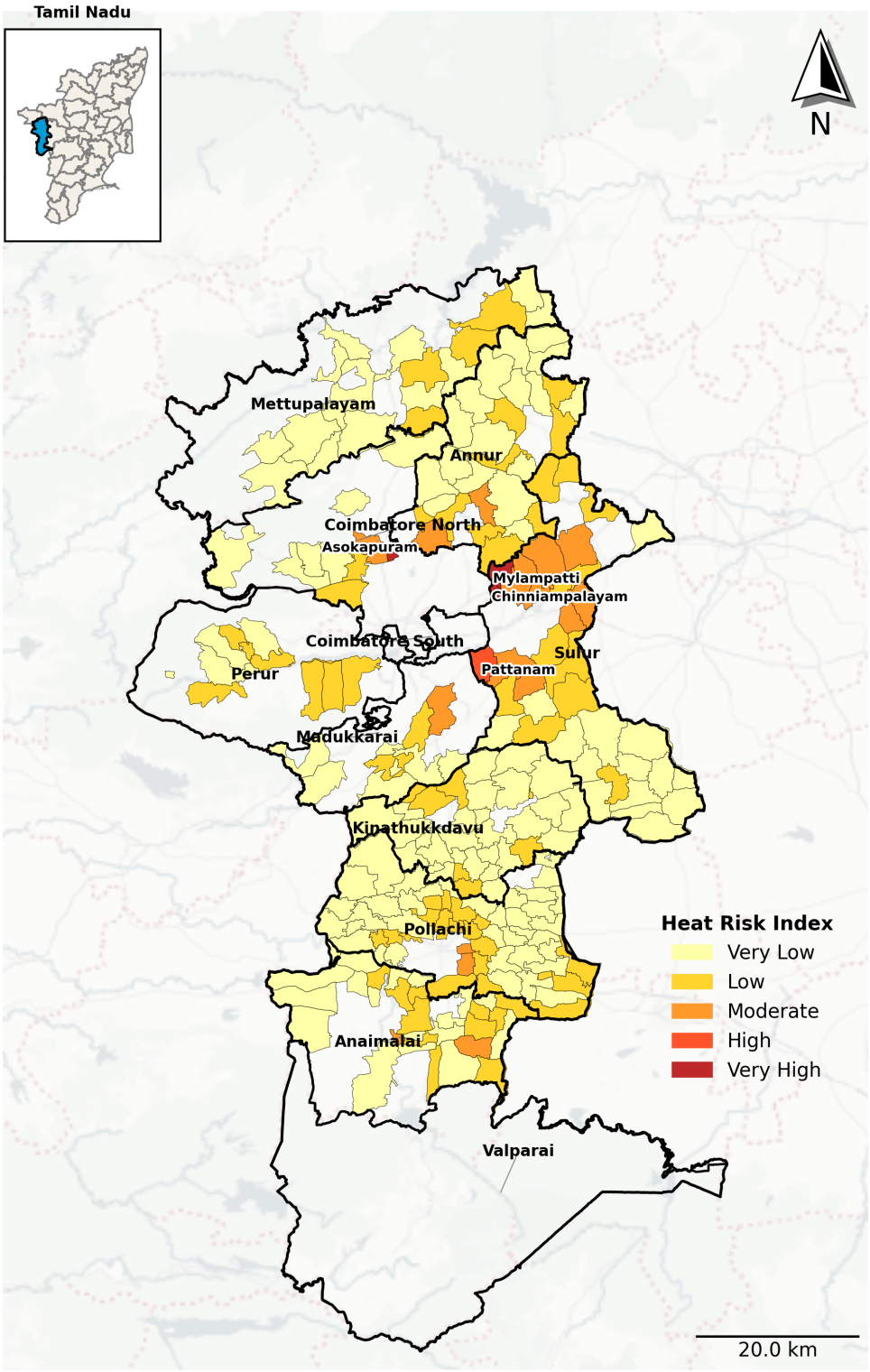
Figure A: Heat Risk Index Map of Coimbatore City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Coimbatore District at Village Panchayats level

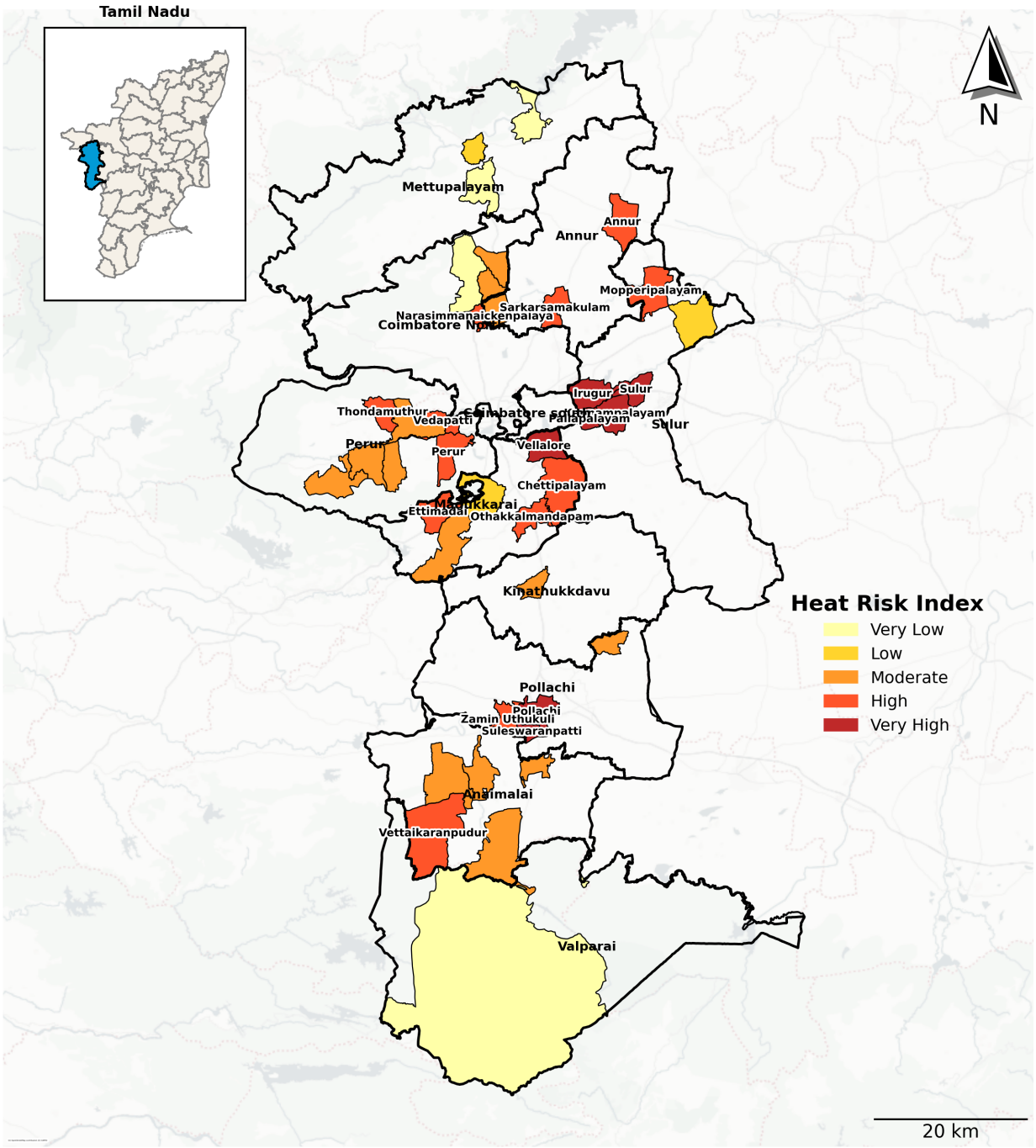


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure C: Heat Risk Index Map of Coimbatore District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: [Coimbatore]

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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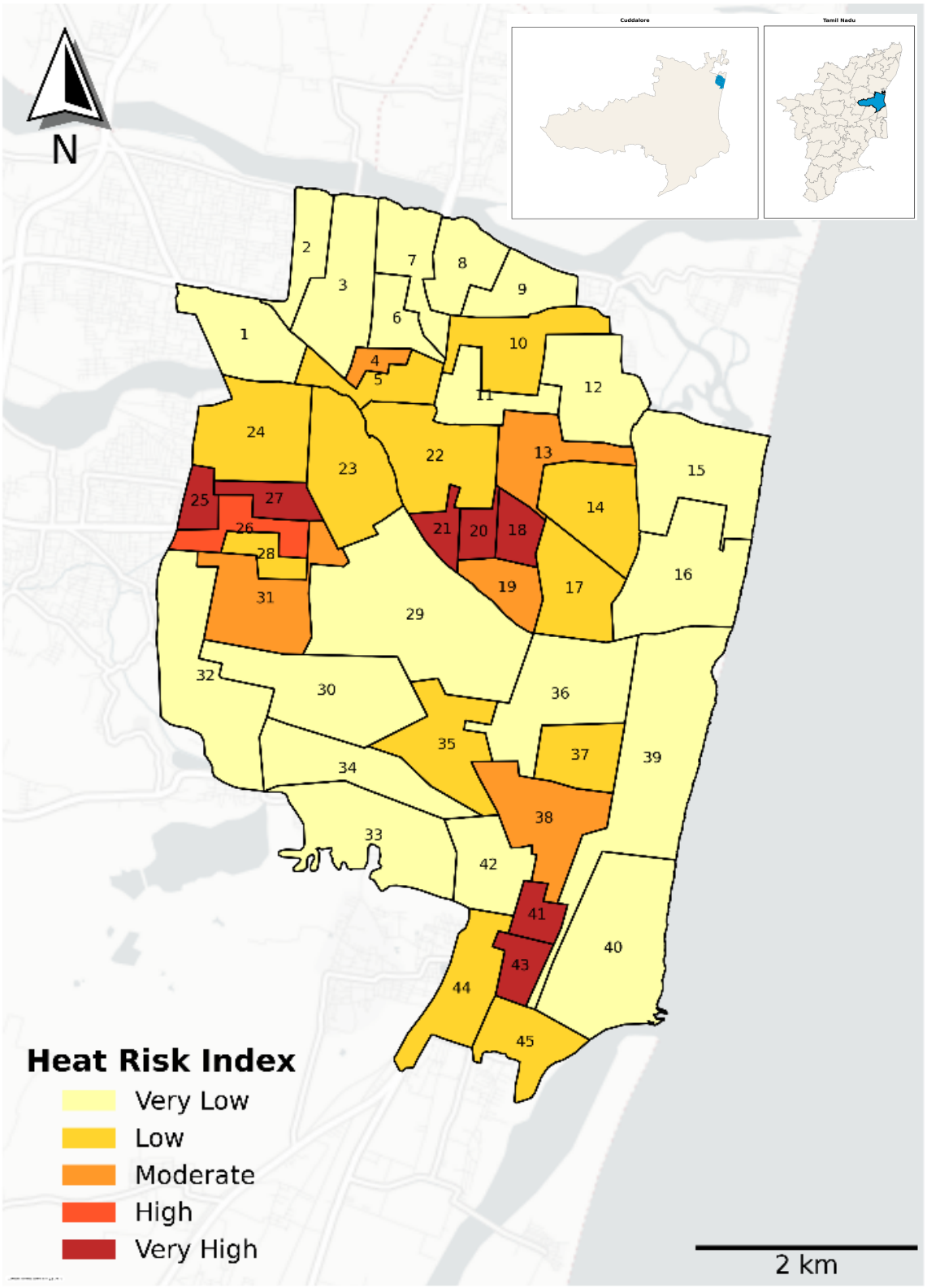
Cuddalore District

Table 9:Cuddlore Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Vridhachalam	40°C	42°C	44°C
Titagudi	40°C	42°C	44°C
Veppur	40°C	42°C	44°C
Panruti	39°C	41°C	43°C
Srimushanam	40°C	42°C	44°C
Kurinjipadi	39°C	41°C	43°C
Kattumannarkoil	39°C	41°C	43°C
Chidambaram	39°C	41°C	43°C
Bhuvanagiri	39°C	41°C	43°C
Cuddalore	41°C	43°C	45°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Cuddalore	41°C	43°C	45°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

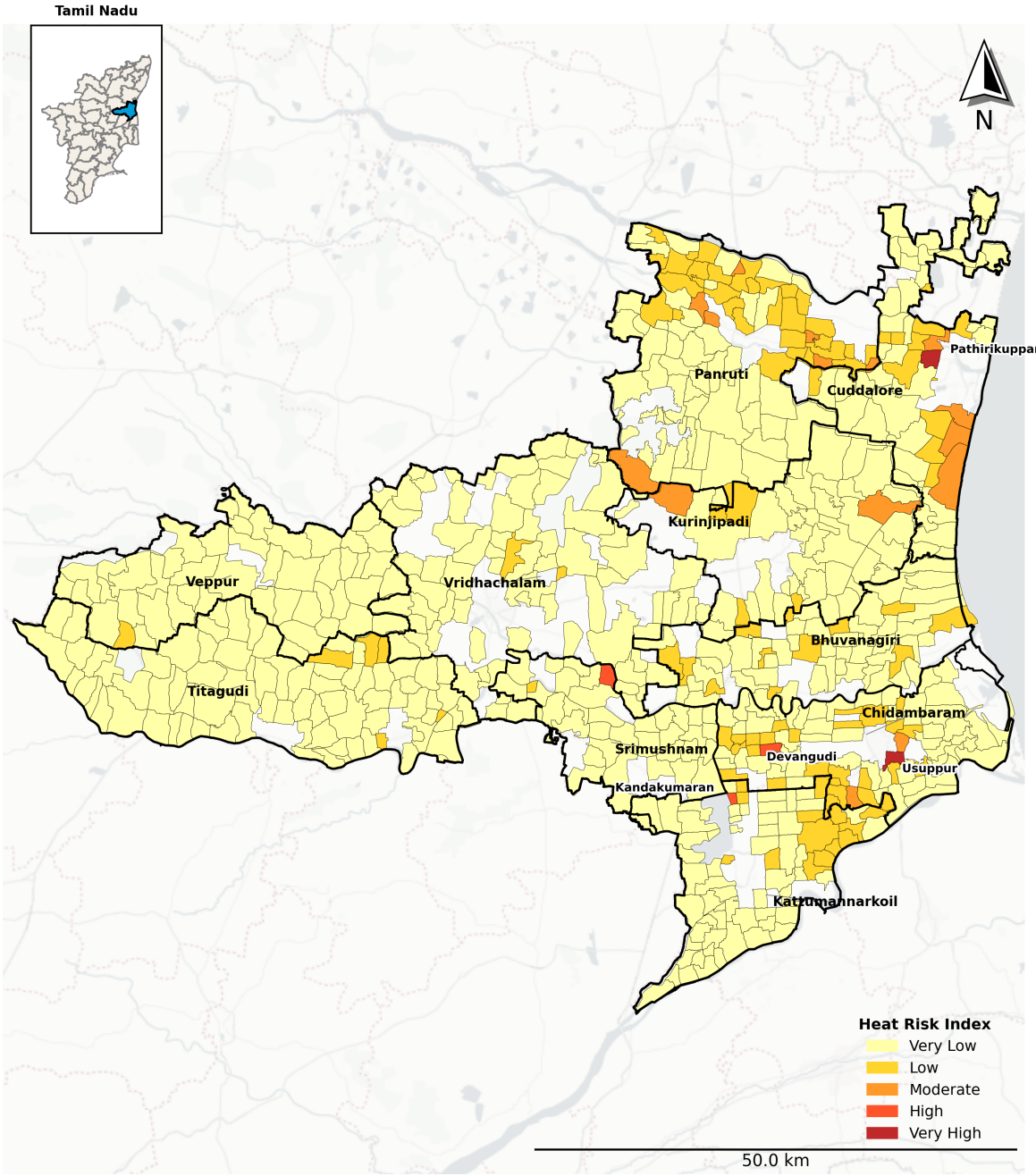
Figure A: Heat Risk Index Map of Cuddalore City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Cuddalore District at Village Panchayats level

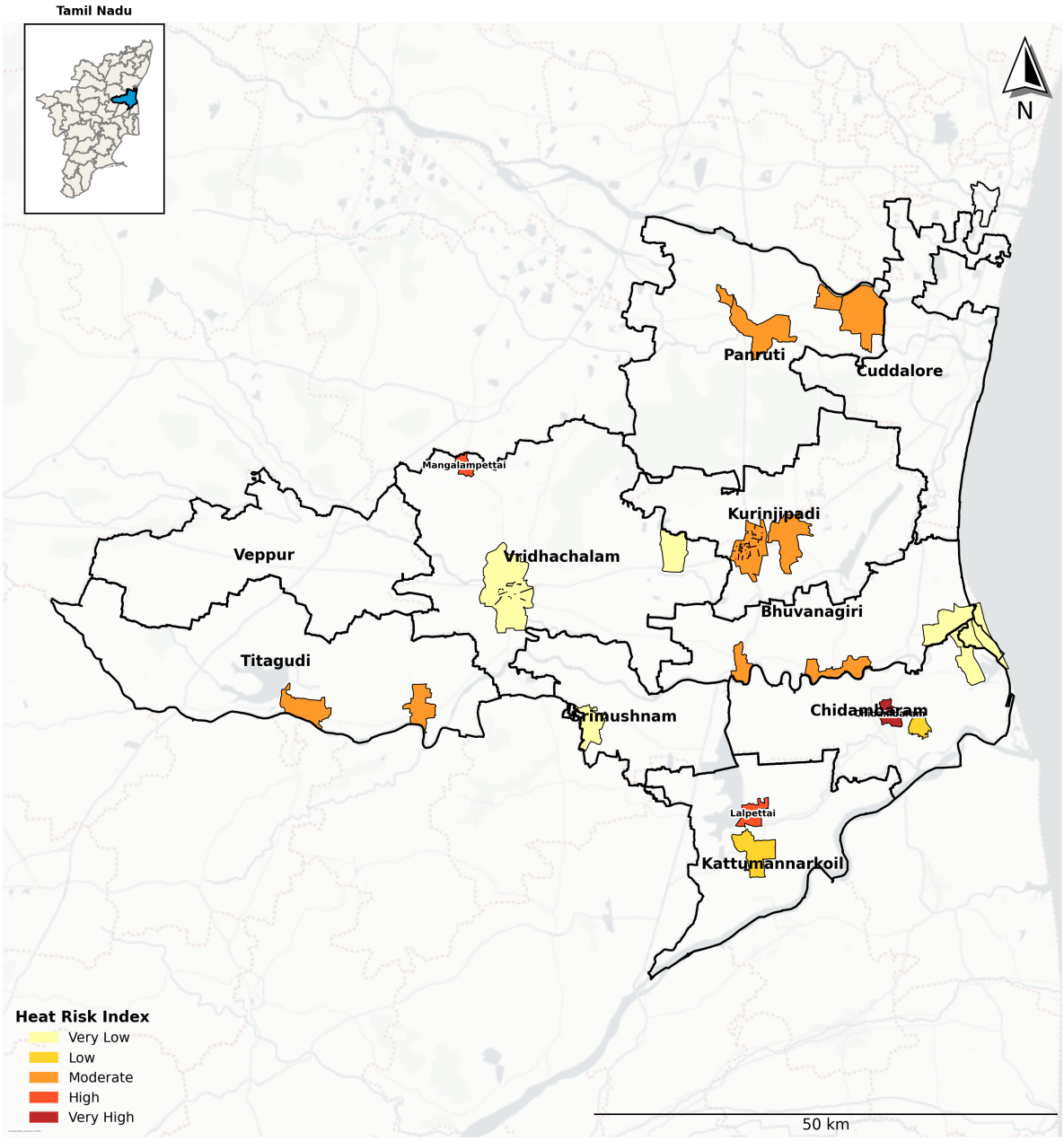


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure C: Heat Risk Index Map of Cuddalore District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Cuddalore

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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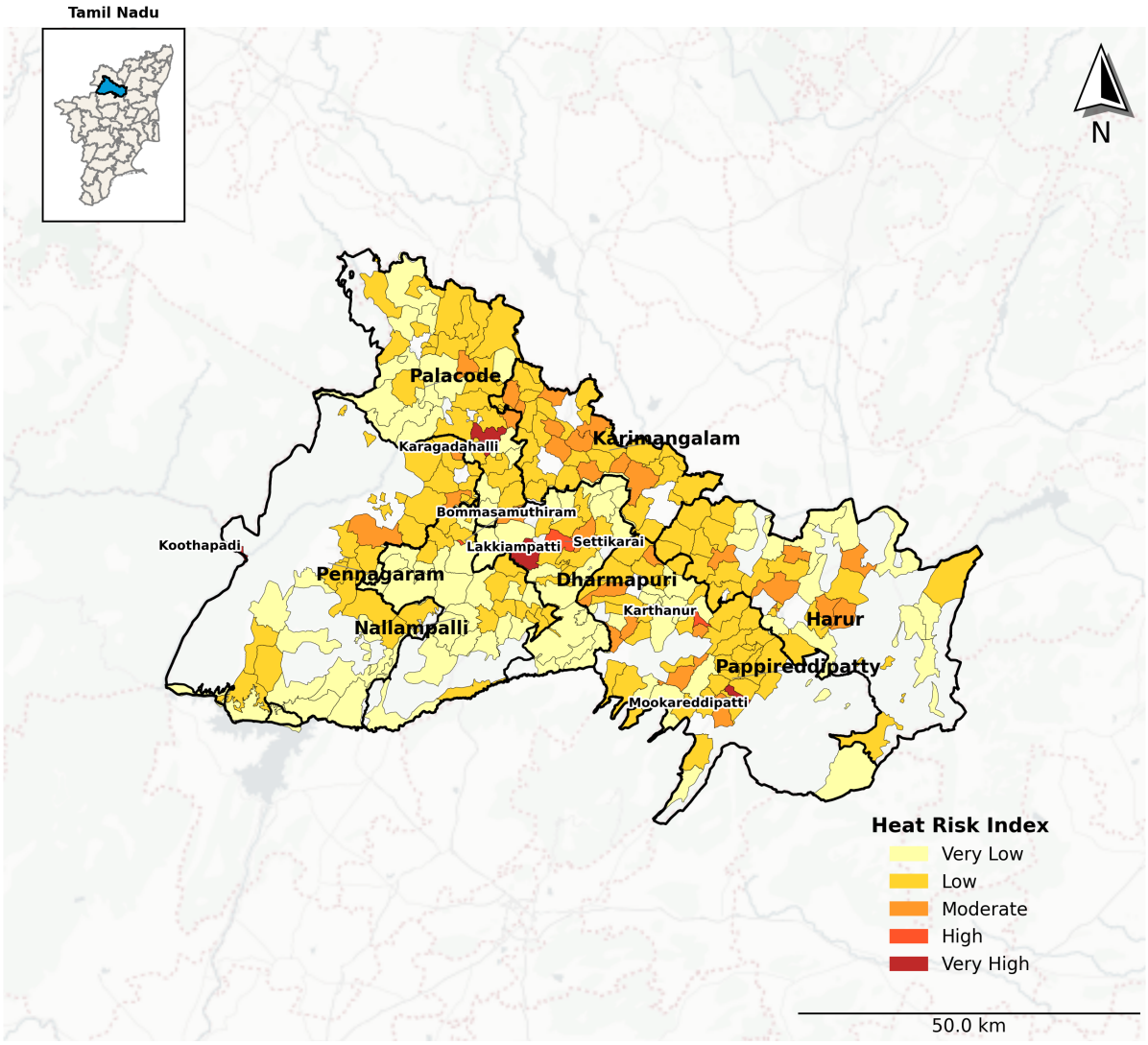
Dharmapuri District

Table 10: Dharmapuri Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Dharmapuri	39°C	41°C	43°C
Pappireddipatti	39°C	41°C	43°C
Karimangalam	39°C	41°C	43°C
Nallampalli	39°C	41°C	43°C
Pennagaram	39°C	41°C	43°C
Harur	38°C	40°C	42°C
Palacode	38°C	40°C	42°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

Figure A: Heat Risk Index Map of Dharmapuri District at Village Panchayats level

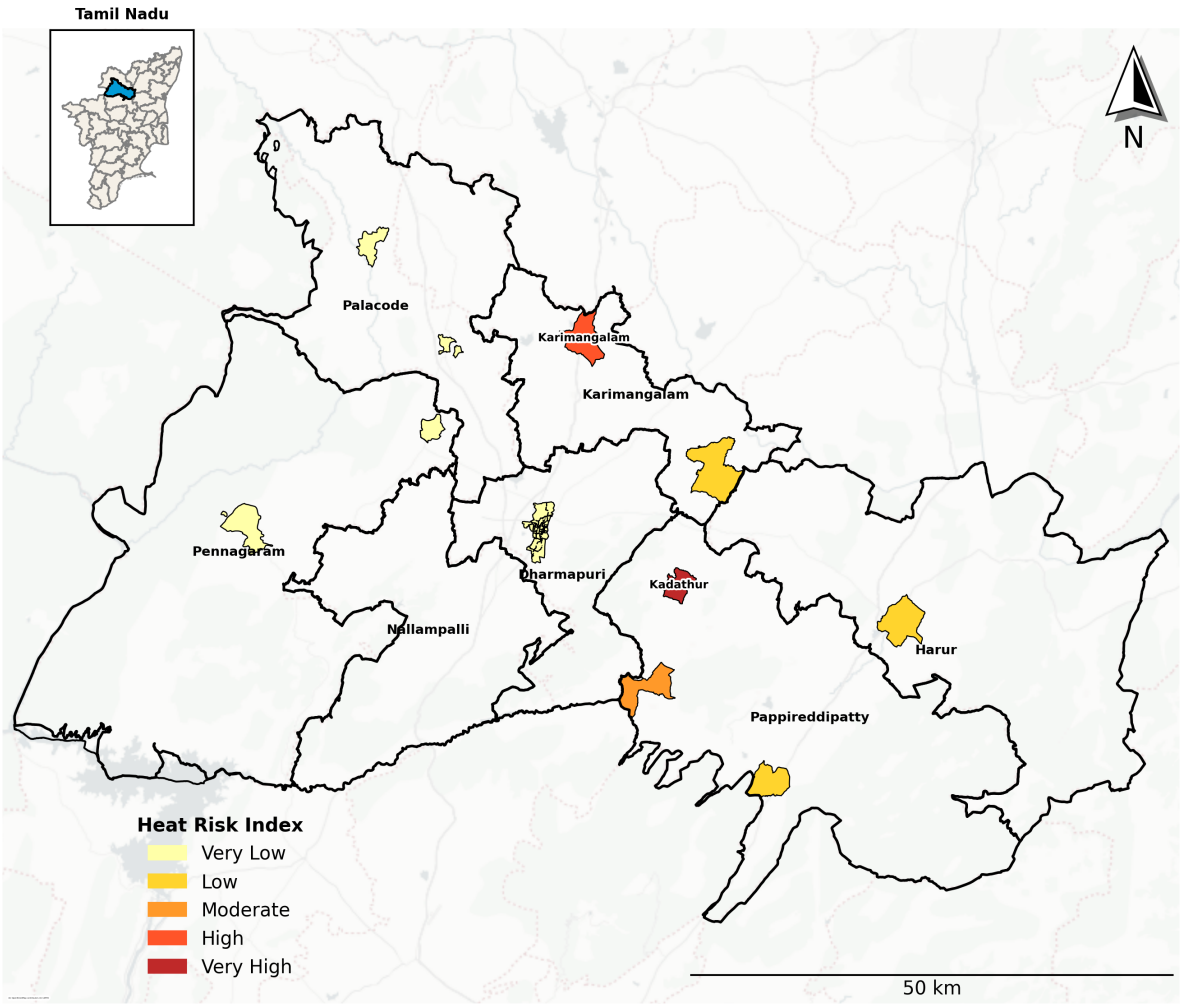


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Dharmapuri District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Dharmapuri

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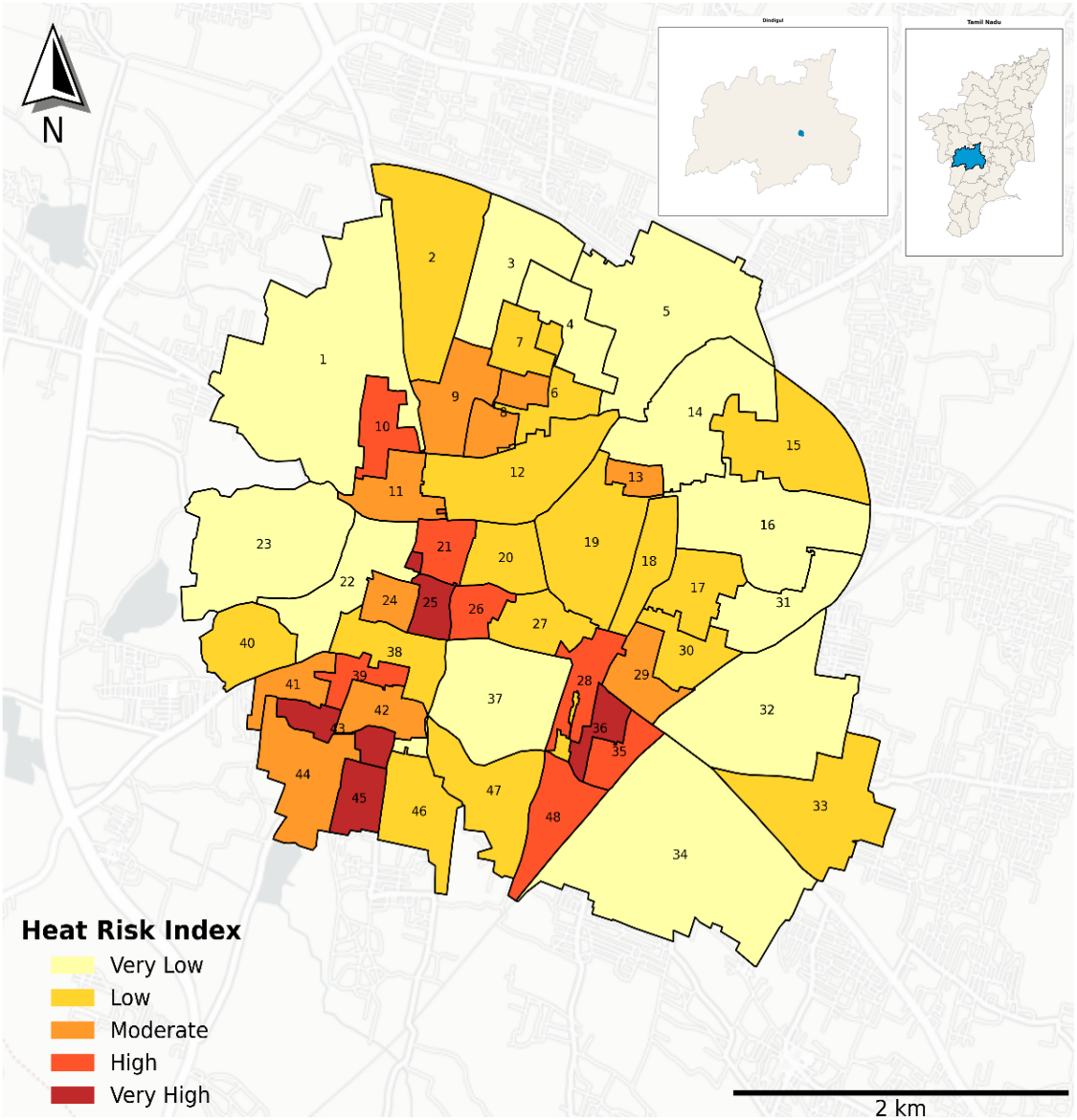
Dindigul District

Table 11: Dindigul Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Athoor	39°C	41°C	43°C
Dindigul east	39°C	41°C	43°C
Oddenchatram	39°C	41°C	43°C
Palani	39°C	41°C	43°C
Natham	39°C	41°C	43°C
Vedasandur	39°C	41°C	43°C
Nilakottai	39°C	41°C	43°C
Gujiliamparai	39°C	41°C	43°C
Dindigul west	36°C	38°C	40°C
Kodaikanal	31°C	33°C	35°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Dindigul	39°C	41°C	43°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

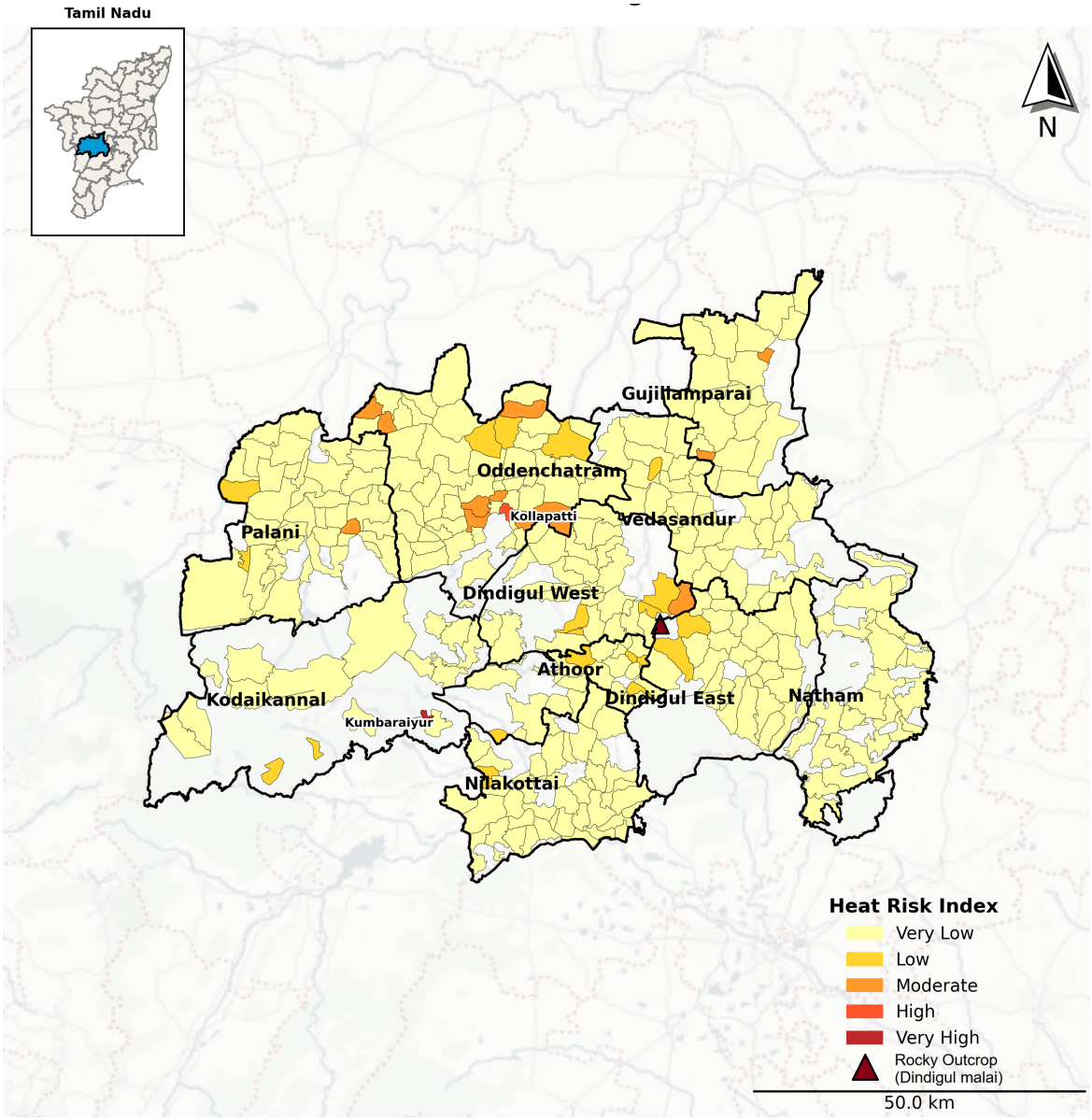
Figure A: Heat Risk Index Map of Dindigul City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Dindigul District at Village Panchayats level



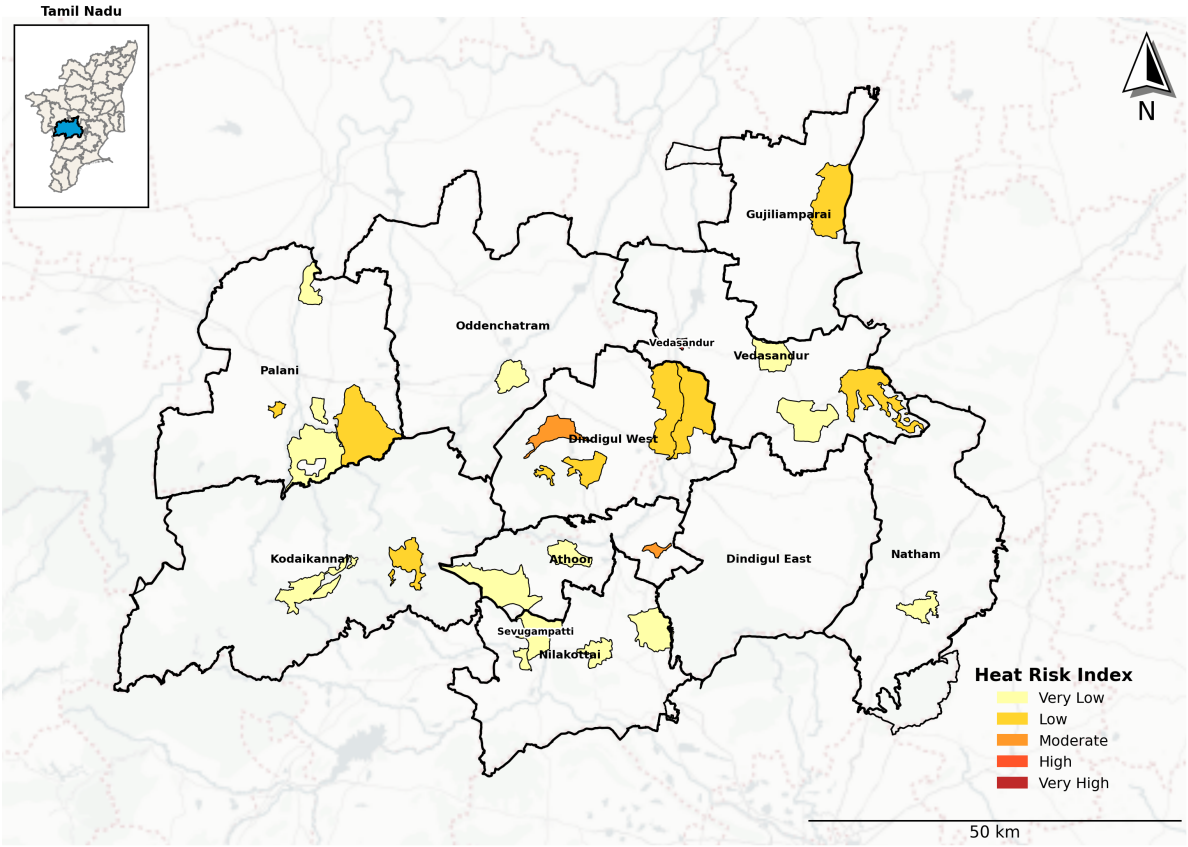
Disclaimer: Presence of bare rock/rocky hills can elevate surface temperature locally through heat reflectance, influencing mapped heat-risk levels.

Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure C: Heat Risk Index Map of Dindigul District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Dindigul

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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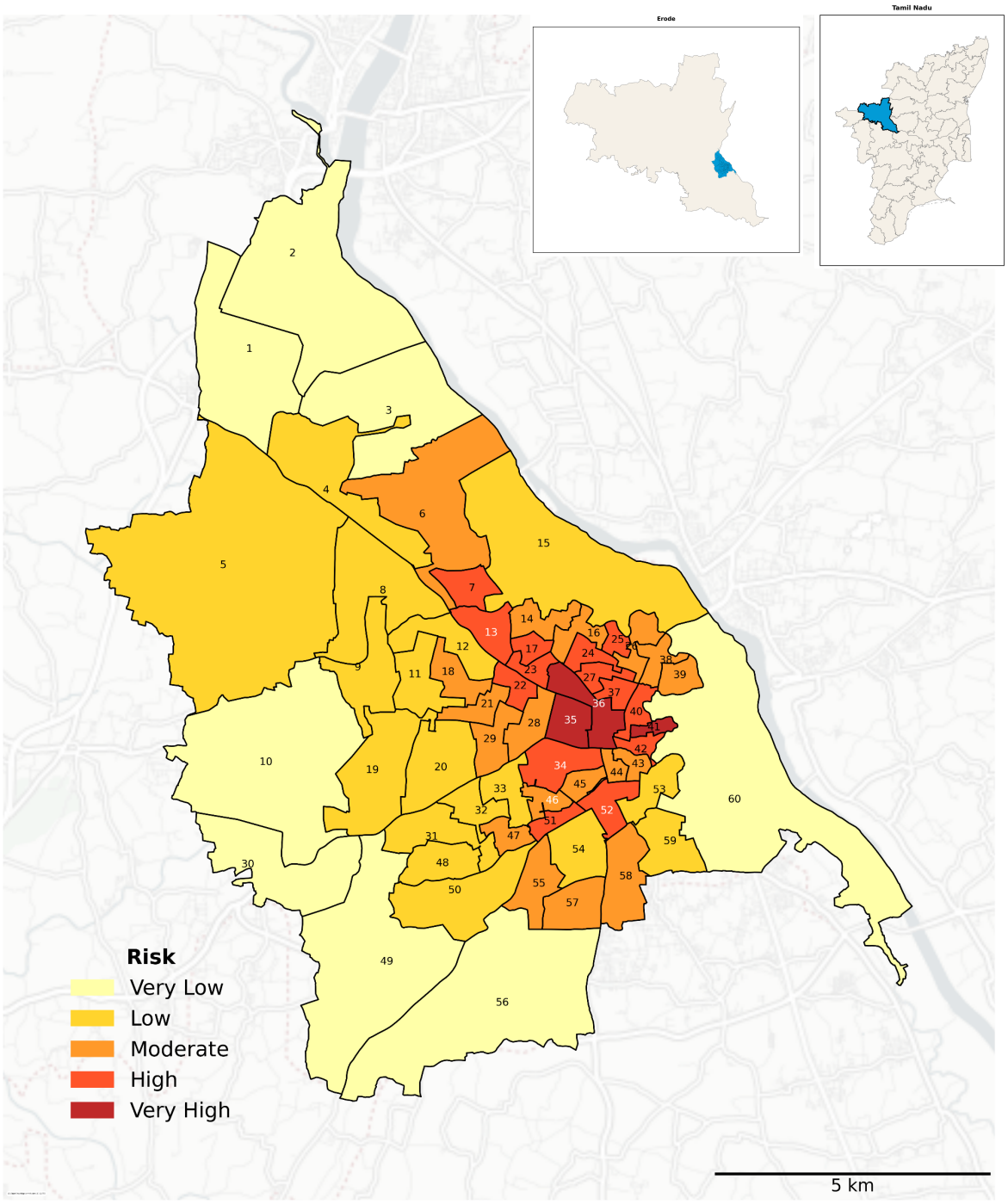
Erode District

Table 12: Erode Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Sathyamangalam	39°C	41°C	43°C
Gobichettipalayam	39°C	41°C	43°C
Modakkurichi	39°C	41°C	43°C
Nambiyur	39°C	41°C	43°C
Bhavani	39°C	41°C	43°C
Kodumudi	39°C	41°C	43°C
Erode	39°C	41°C	43°C
Perundurai	39°C	41°C	43°C
Anthiyur	38°C	40°C	42°C
Thalavadi	35°C	37°C	39°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Erode	39°C	41°C	43°C

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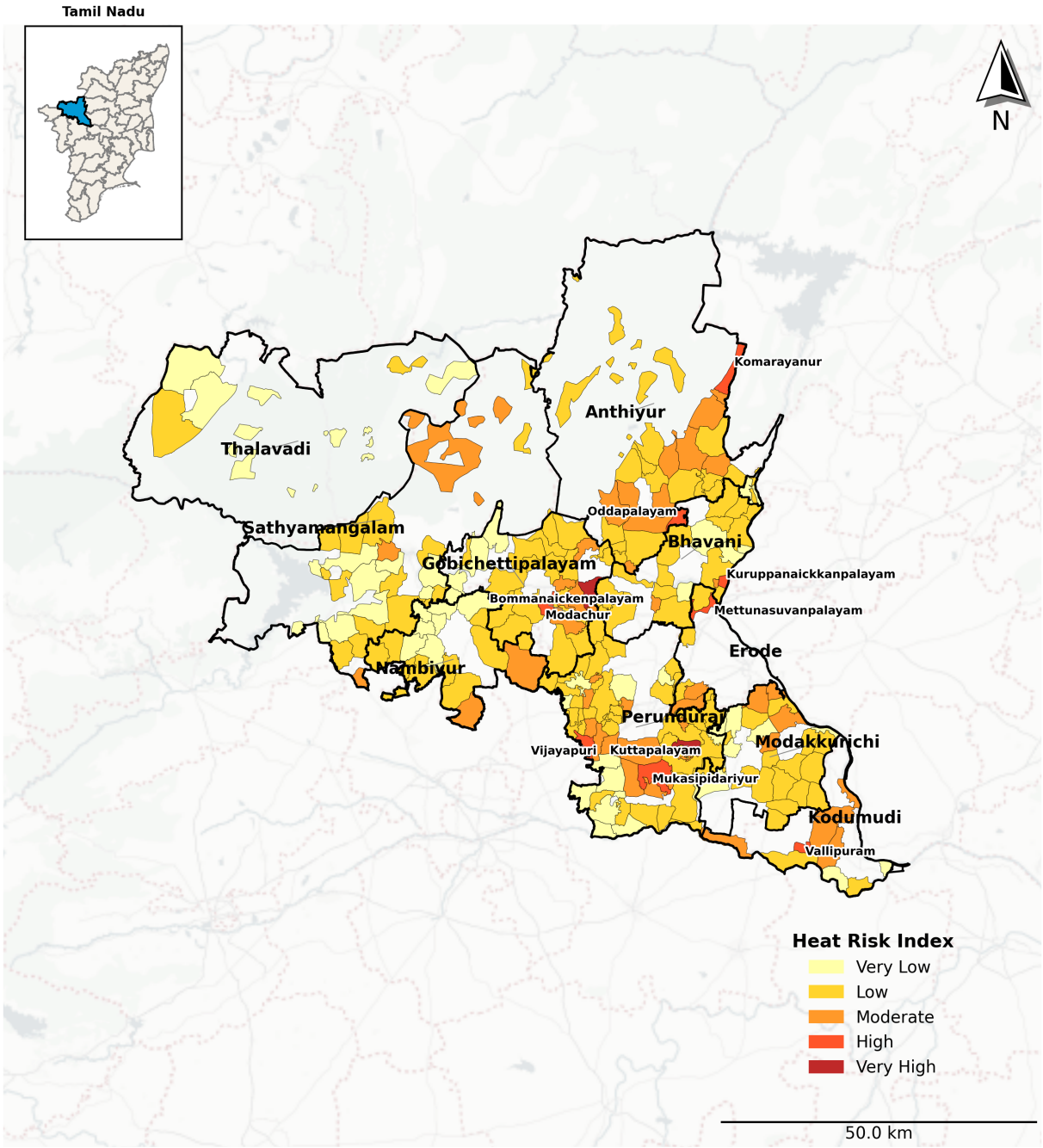
Figure A: Heat Risk Index Map of Erode City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Erode District at Village Panchayats level

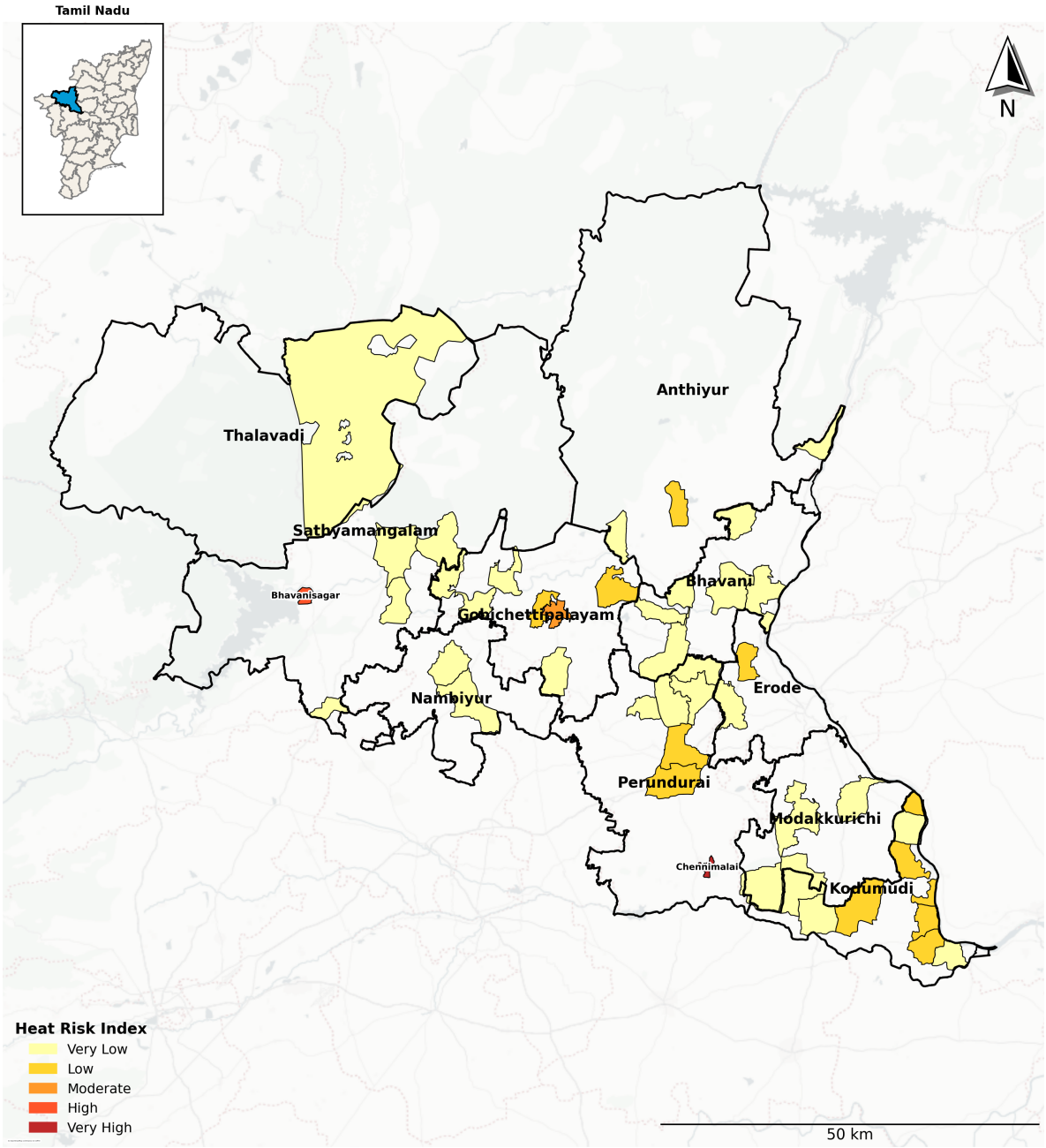


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure C: Heat Risk Index Map of Erode District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Erode

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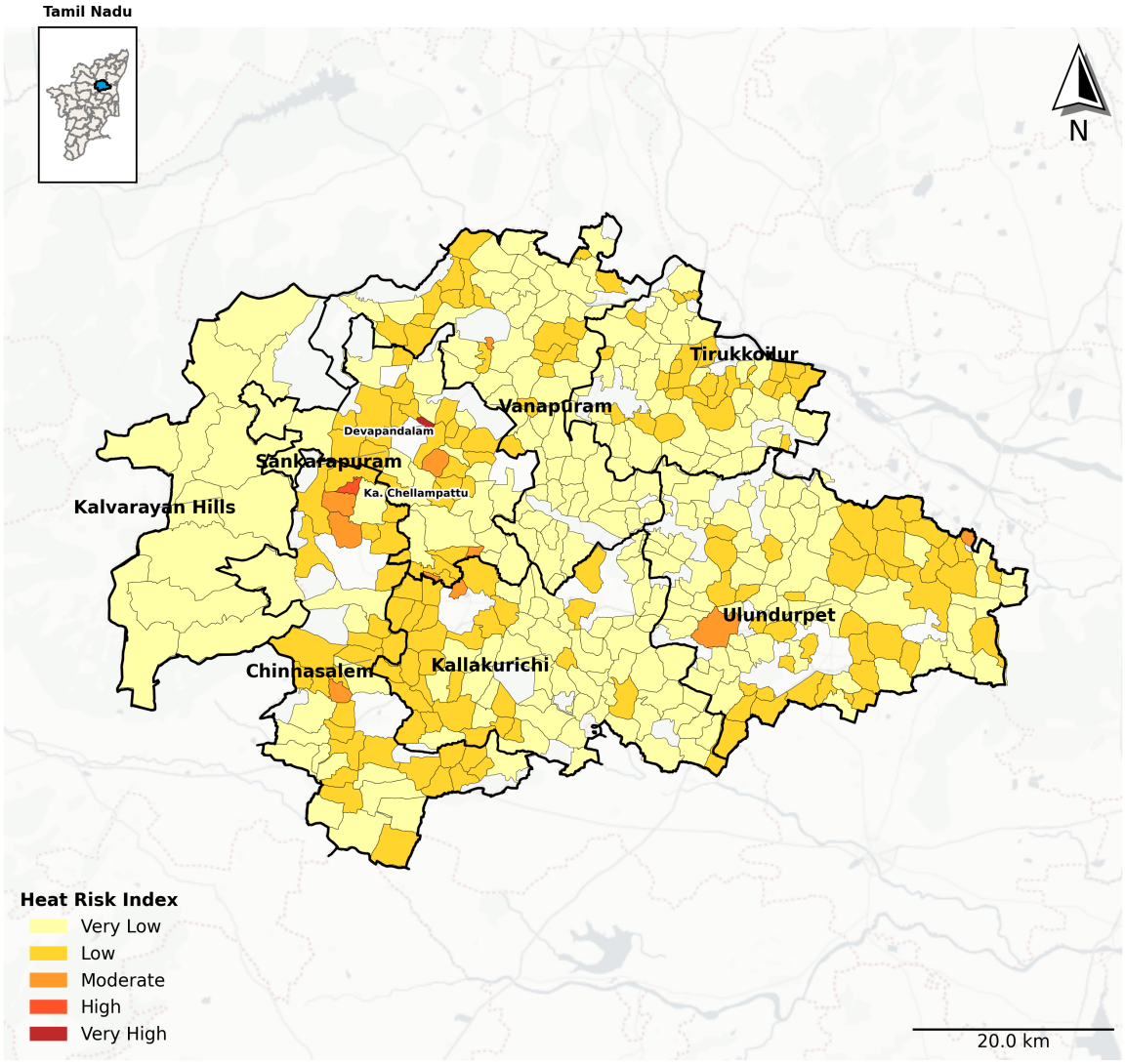
Kallakurchi District

Table 13: Kallakuruchi Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Tirukkoilur	40°C	42°C	44°C
Ulundurpet	40°C	42°C	44°C
Kallakurichi	40°C	42°C	44°C
Vanapuram	40°C	42°C	44°C
Sankarapuram	39°C	41°C	43°C
Chinnaselam	39°C	41°C	43°C
Kalvarayan hills	37°C	39°C	41°C

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Figure A: Heat Risk Index Map of Kallakurchi District at Village Panchayats level

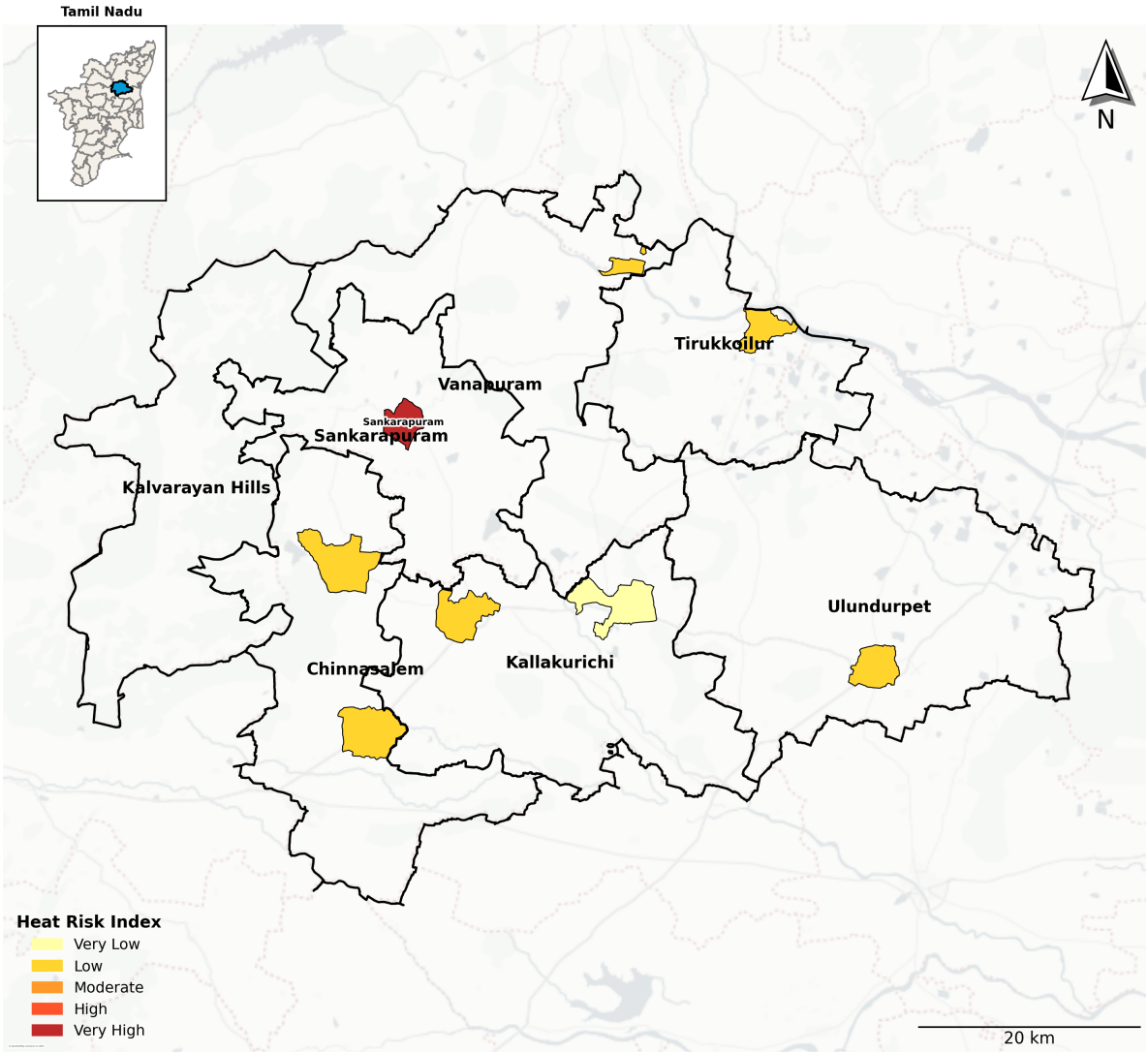


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure B: Heat Risk Index Map of Kallakurchi District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Kallakurichi

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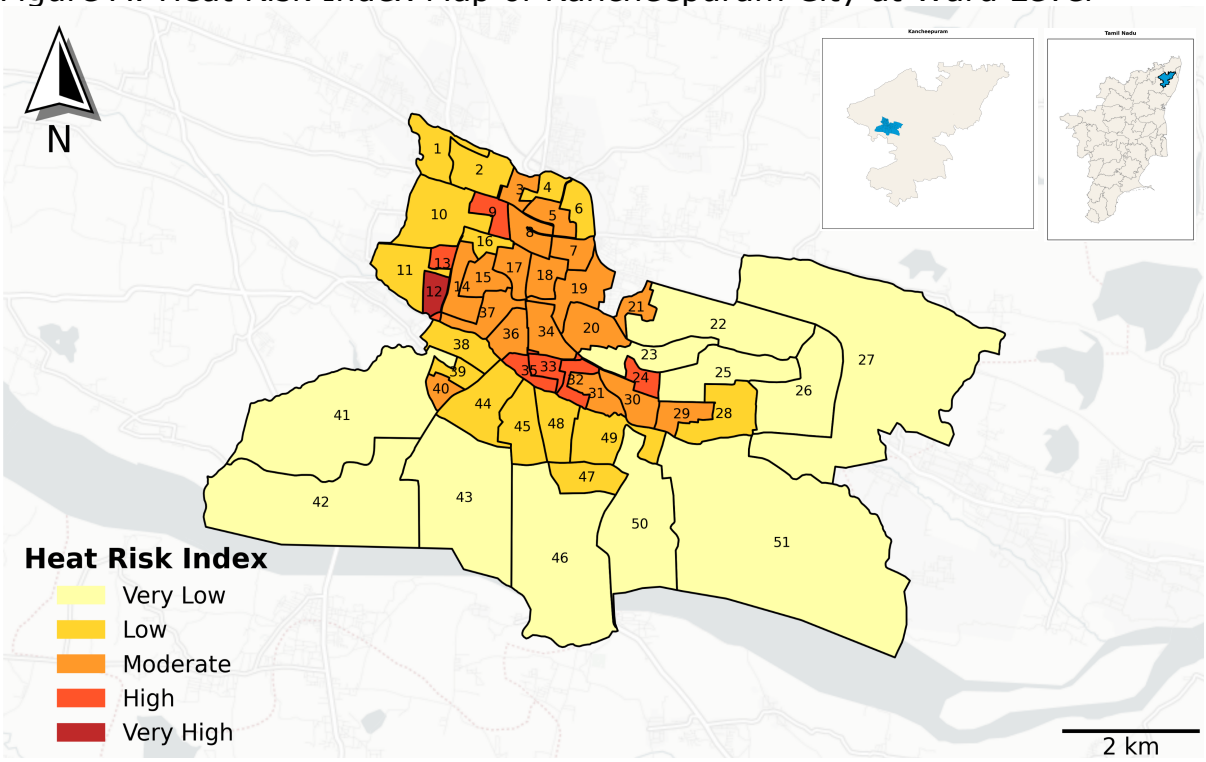
Kancheepuram District

Table 14: Kancheepuram Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Sriperumbudur	40°C	42°C	44°C
Kancheepuram	40°C	42°C	44°C
Uthiramerur	40°C	42°C	44°C
Walajabad	40°C	42°C	44°C
Kundrathur	39°C	41°C	43°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Kancheepuram	40°C	42°C	44°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

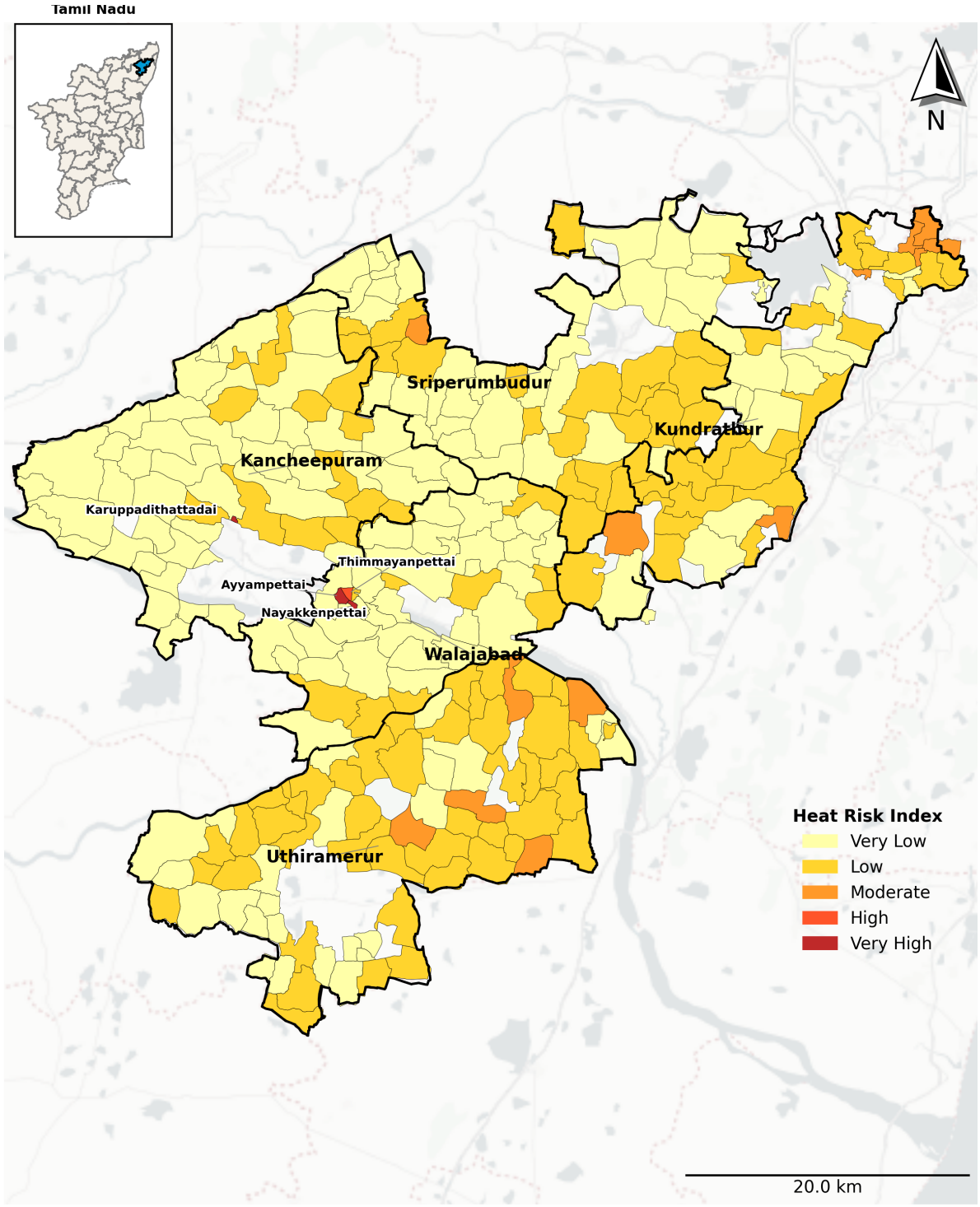
Figure A: Heat Risk Index Map of Kancheepuram City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Kancheepuram District at Village Panchayats level

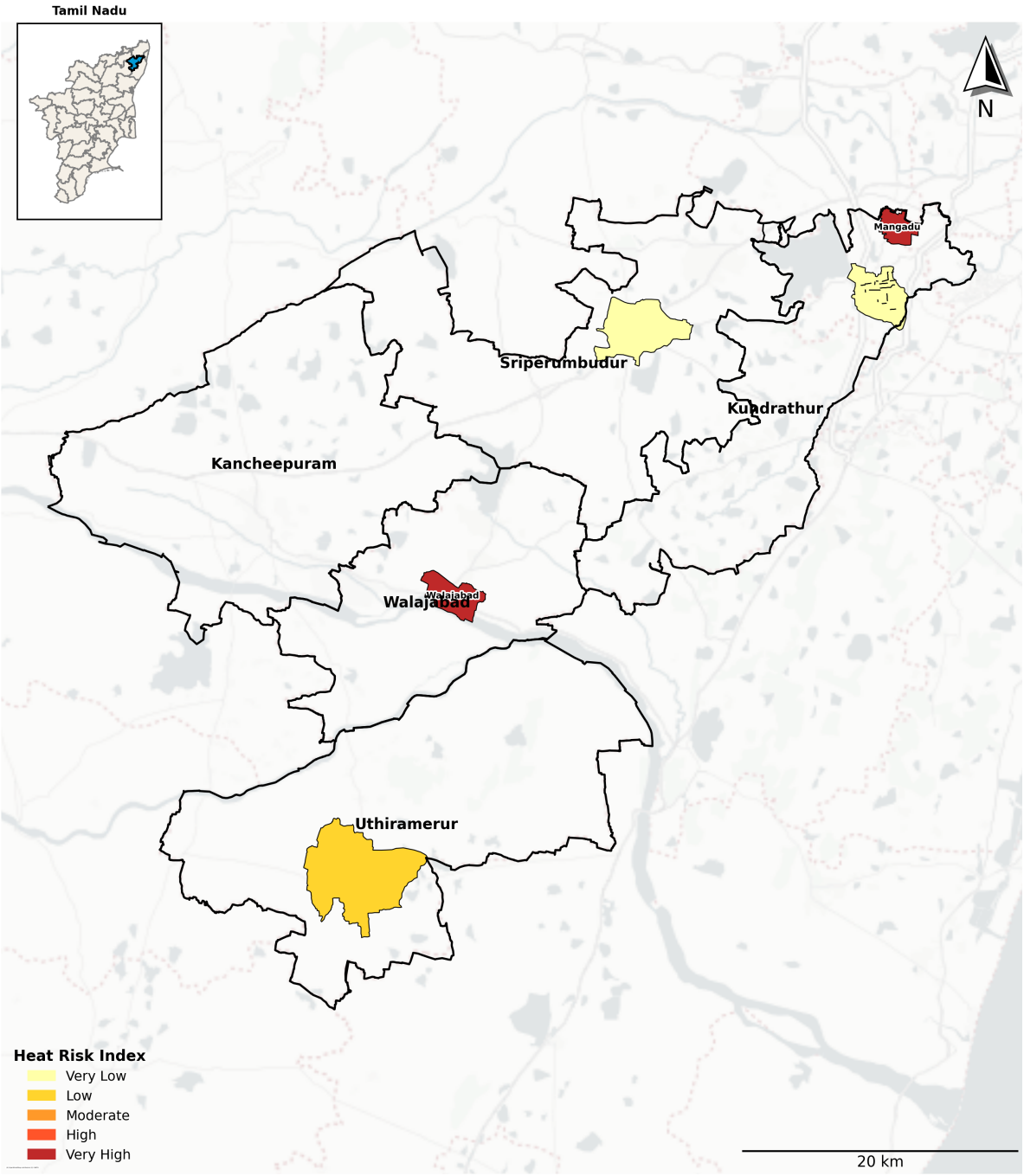


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure C: Heat Risk Index Map of Kancheepuram District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Kancheepuram

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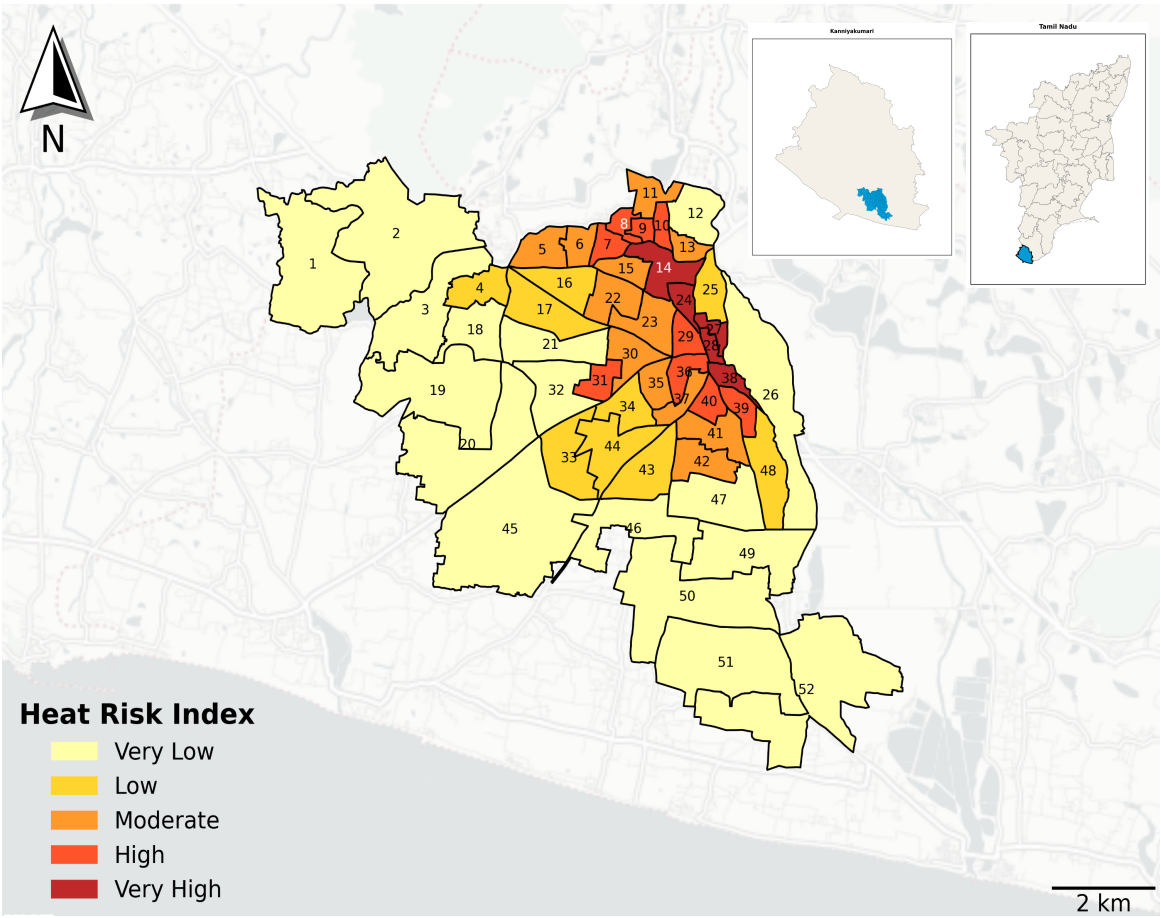
Kanniyakumari District

Table 15: Kanyakumari Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Killiyoor	37°C	39°C	41°C
Agastheeswaram	38°C	40°C	42°C
Kalkulam	37°C	39°C	41°C
Vilavancode	37°C	39°C	41°C
Thovalai	37°C	39°C	41°C
Thiruvattar	35°C	37°C	39°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Nagercoil	38°C	40°C	42°C

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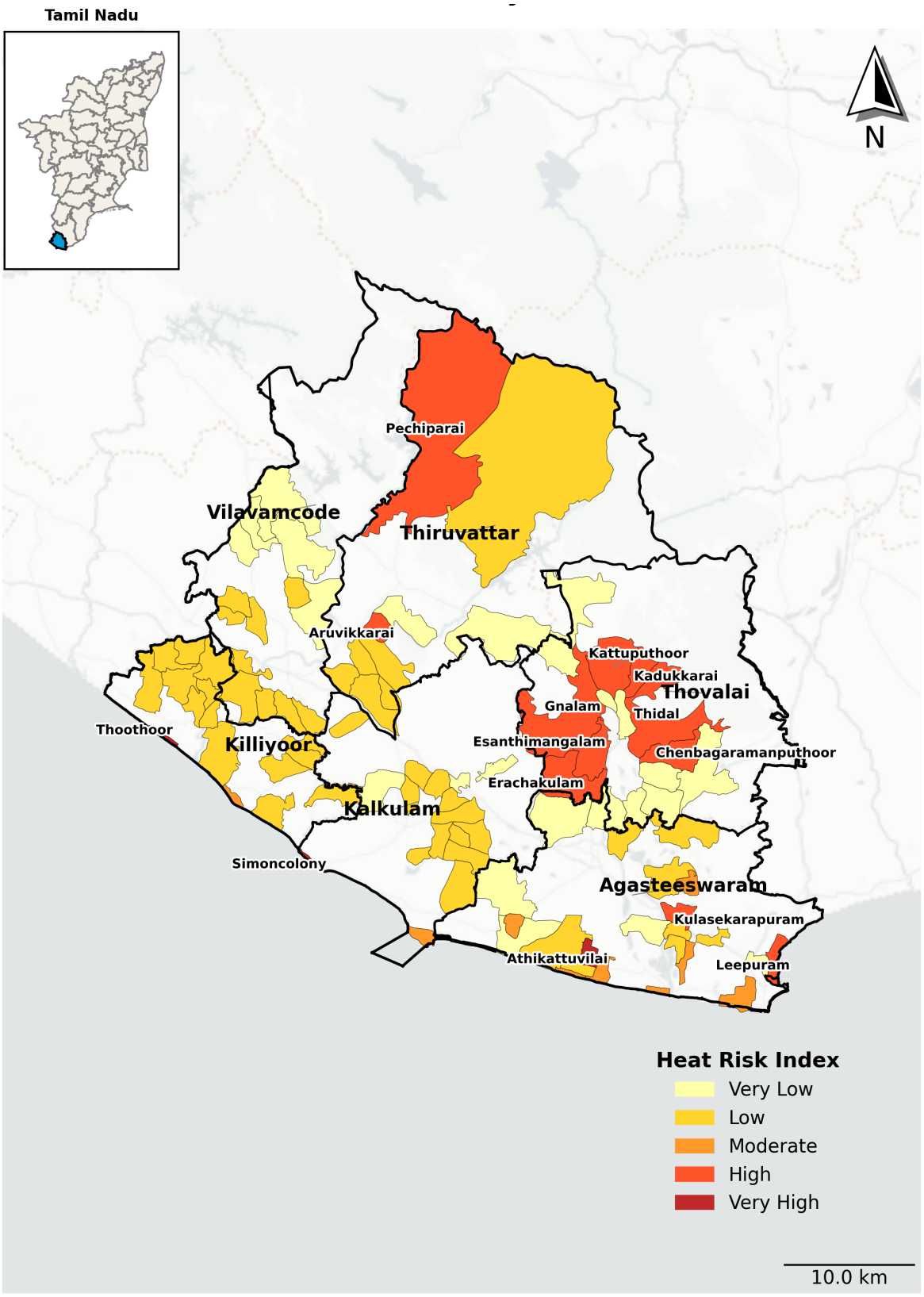
Figure A: Heat Risk Index Map of Nagercoil City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Kanniyakumari District Village Panchayats level

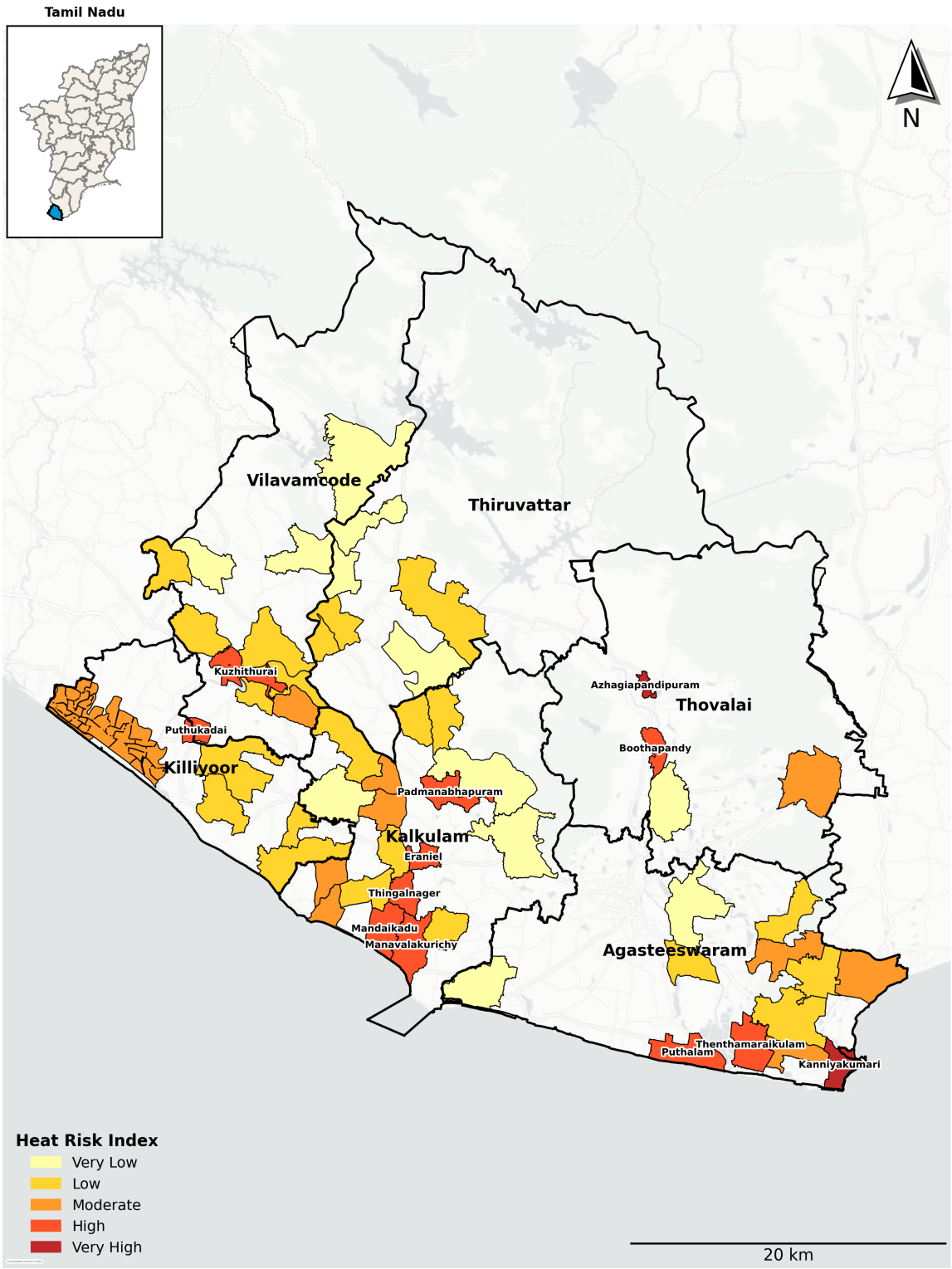


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure C: Heat Risk Index Map of Kanniyakumari District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: [Kanniyiakumari]

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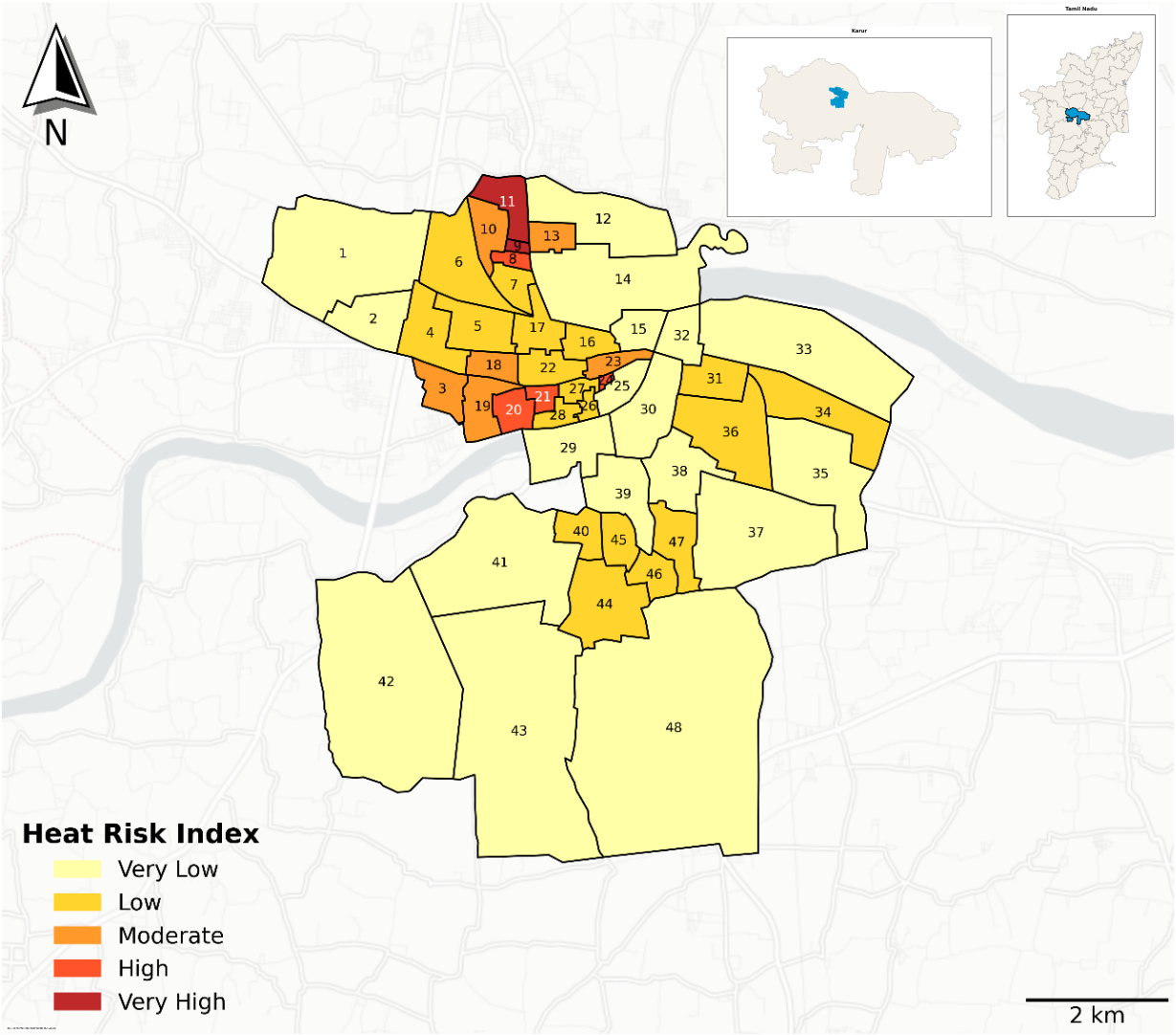
Karur District

Table 16: Karur Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Krishnarayapuram	39°C	41°C	43°C
Manmangalam	39°C	41°C	43°C
Karur	40°C	42°C	44°C
Kulithalai	39°C	41°C	43°C
Pugalur	39°C	41°C	43°C
Aravakurichi	39°C	41°C	43°C
Kadavur	39°C	41°C	43°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Karur	40°C	42°C	44°C

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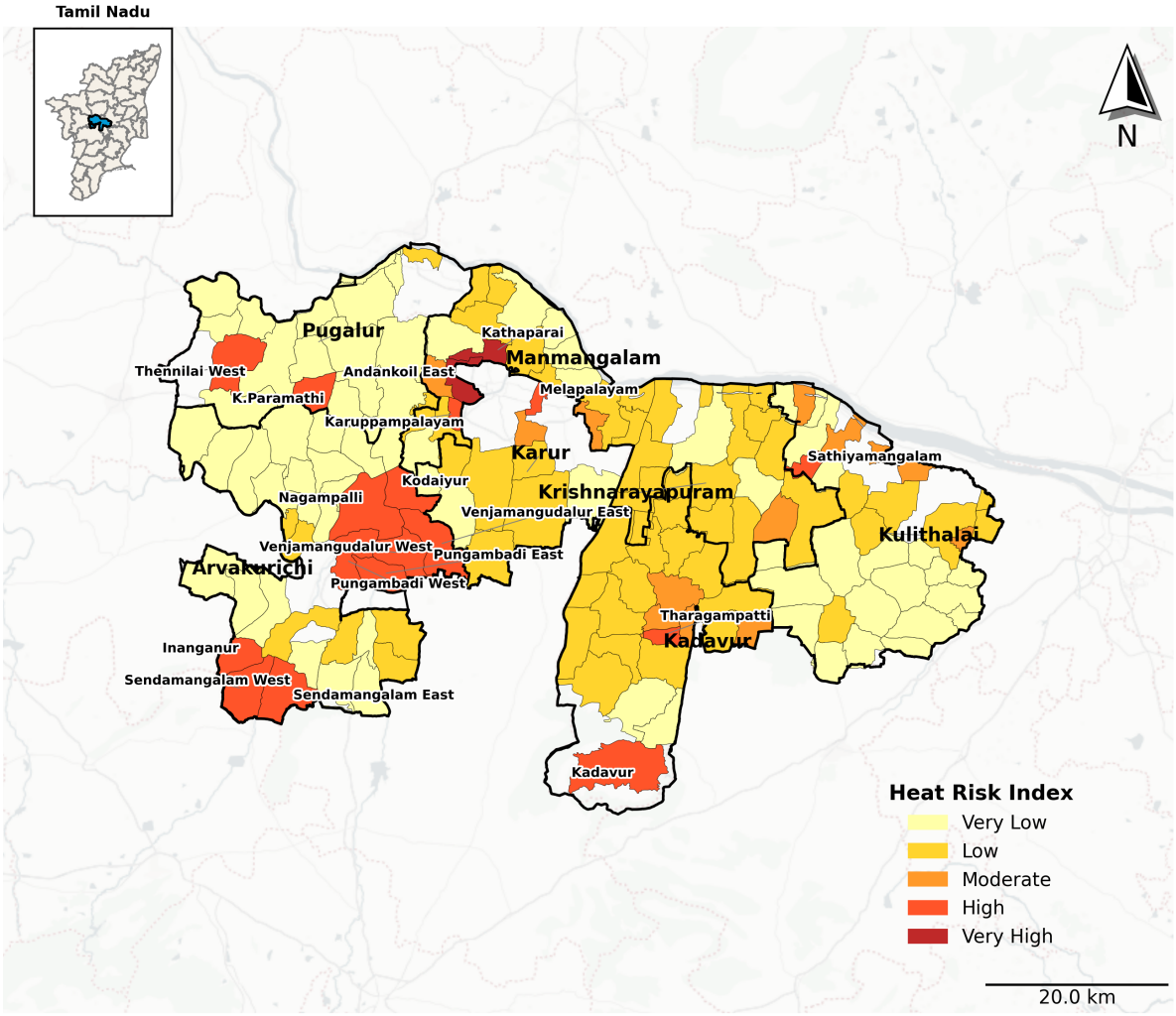
Figure A: Heat Risk Index Map of Karur City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Karur District at Village Panchayats level

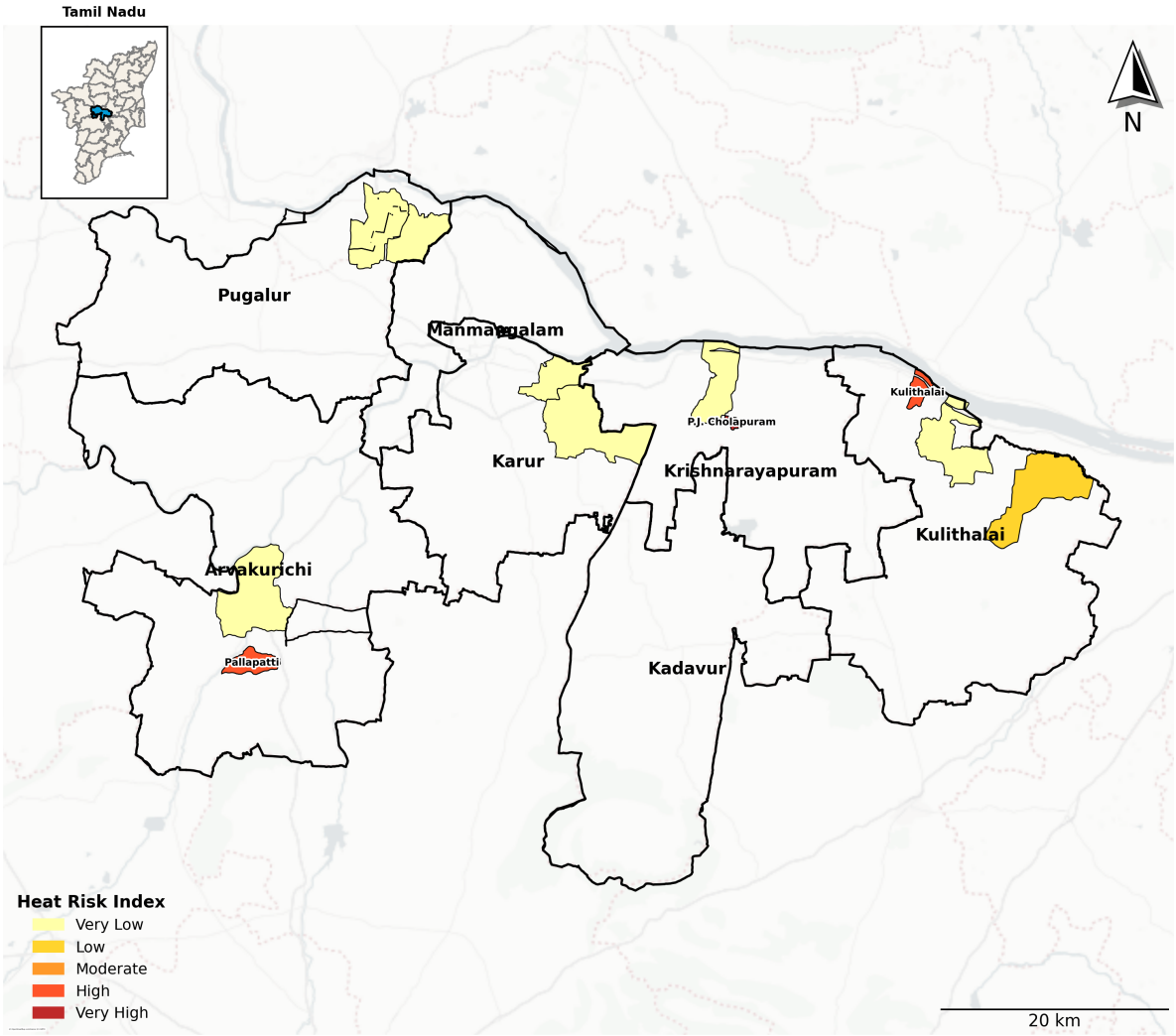


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure C: Heat Risk Index Map of Karur District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: [Karur]

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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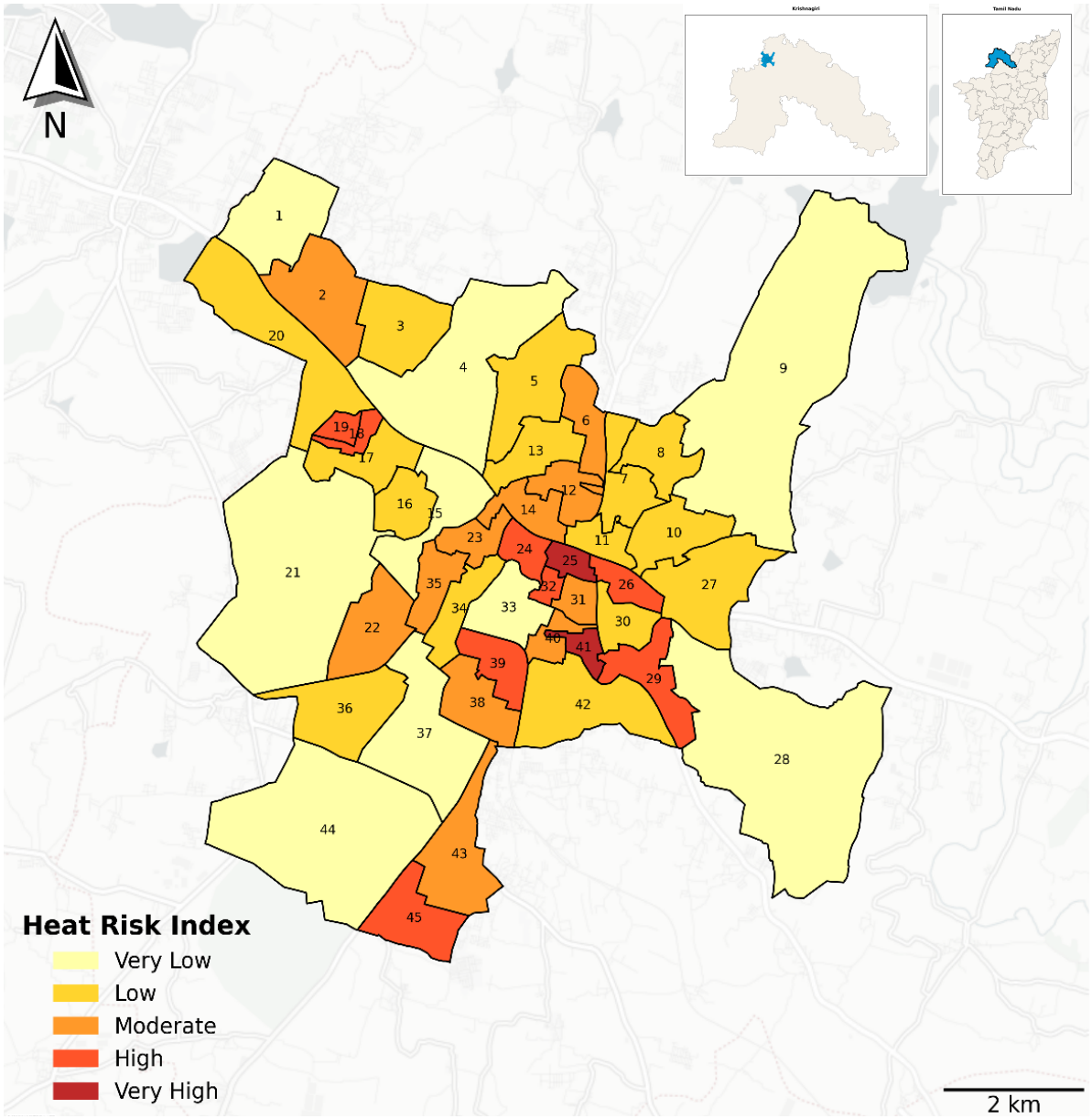
Krishnagiri District

Table 17: Krishnagiri Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Bargur	39°C	41°C	43°C
Uthangarai	39°C	41°C	43°C
Pochampalli	39°C	41°C	43°C
Krishnagiri	38°C	40°C	42°C
Anchetty	37°C	39°C	41°C
Denkanikottai	36°C	38°C	40°C
Shoolagiri	35°C	37°C	39°C
Hosur	35°C	37°C	39°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Hosur	35°C	37°C	39°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

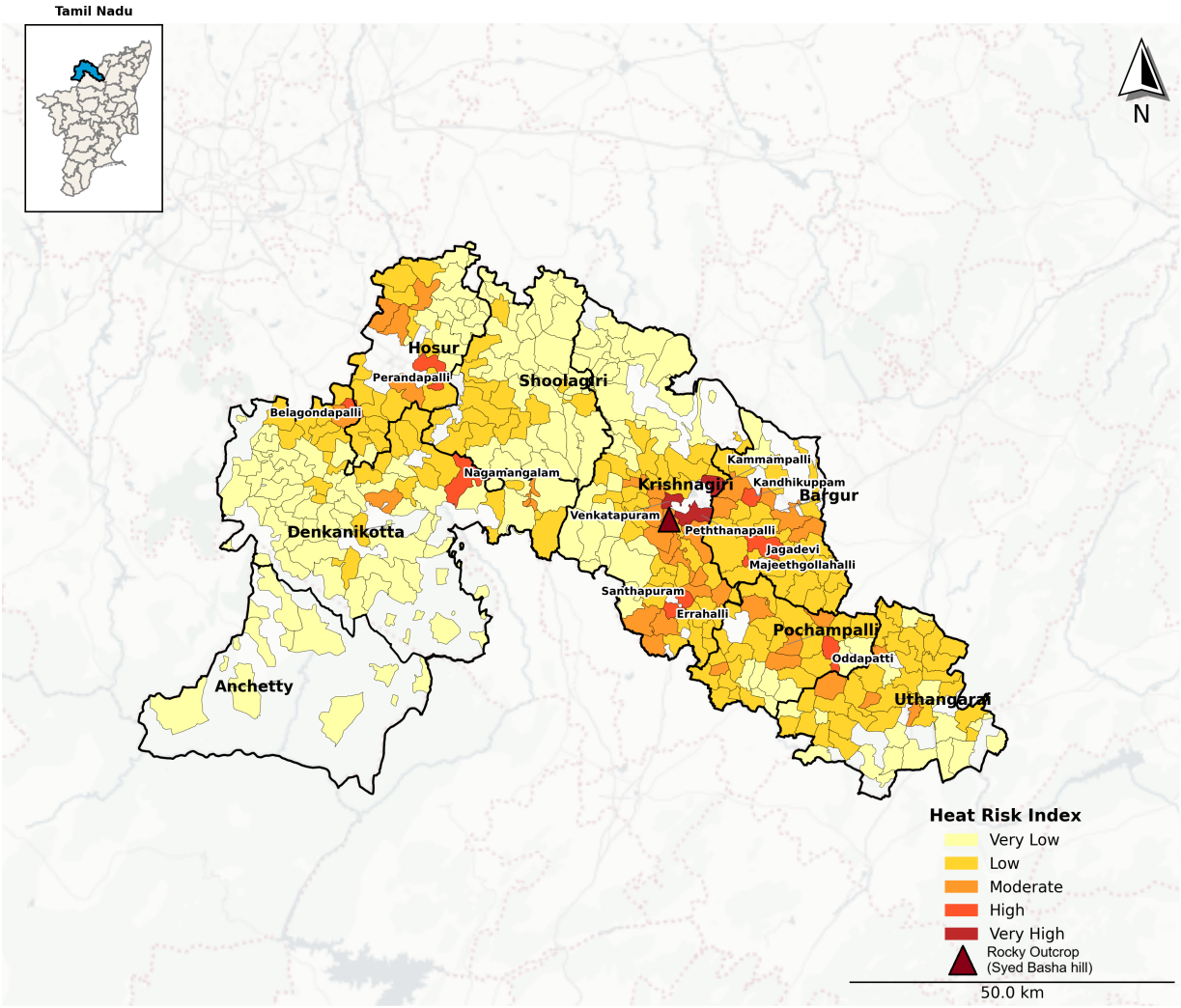
Figure A: Heat Risk Index Map of Hosur City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Krishnagiri District at Village Panchayats level



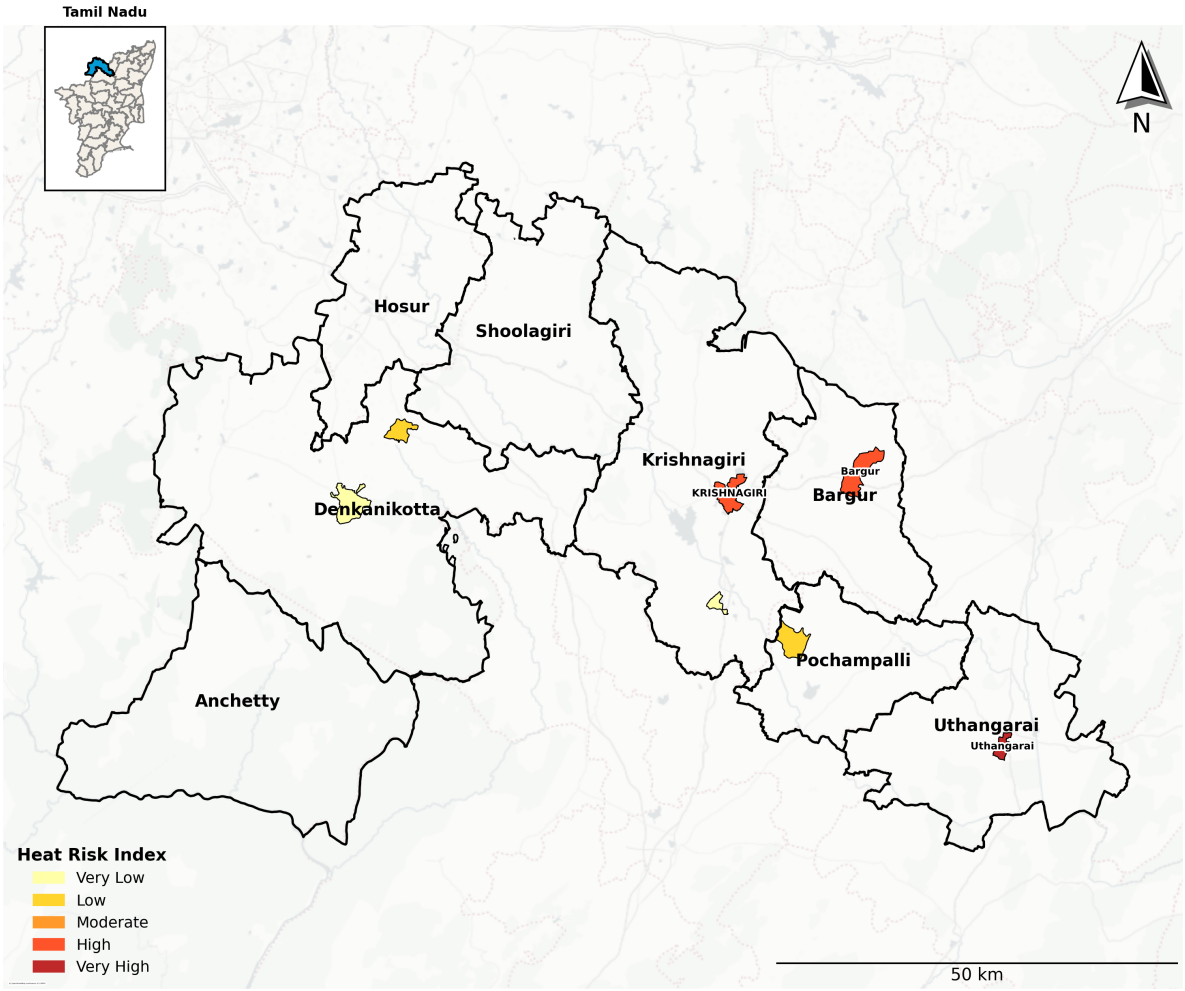
Disclaimer: Presence of bare rock/rocky hills can elevate surface temperature locally through heat reflectance, influencing mapped heat-risk levels.

Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure C: Heat Risk Index Map of Krishnagiri District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Krishnagiri

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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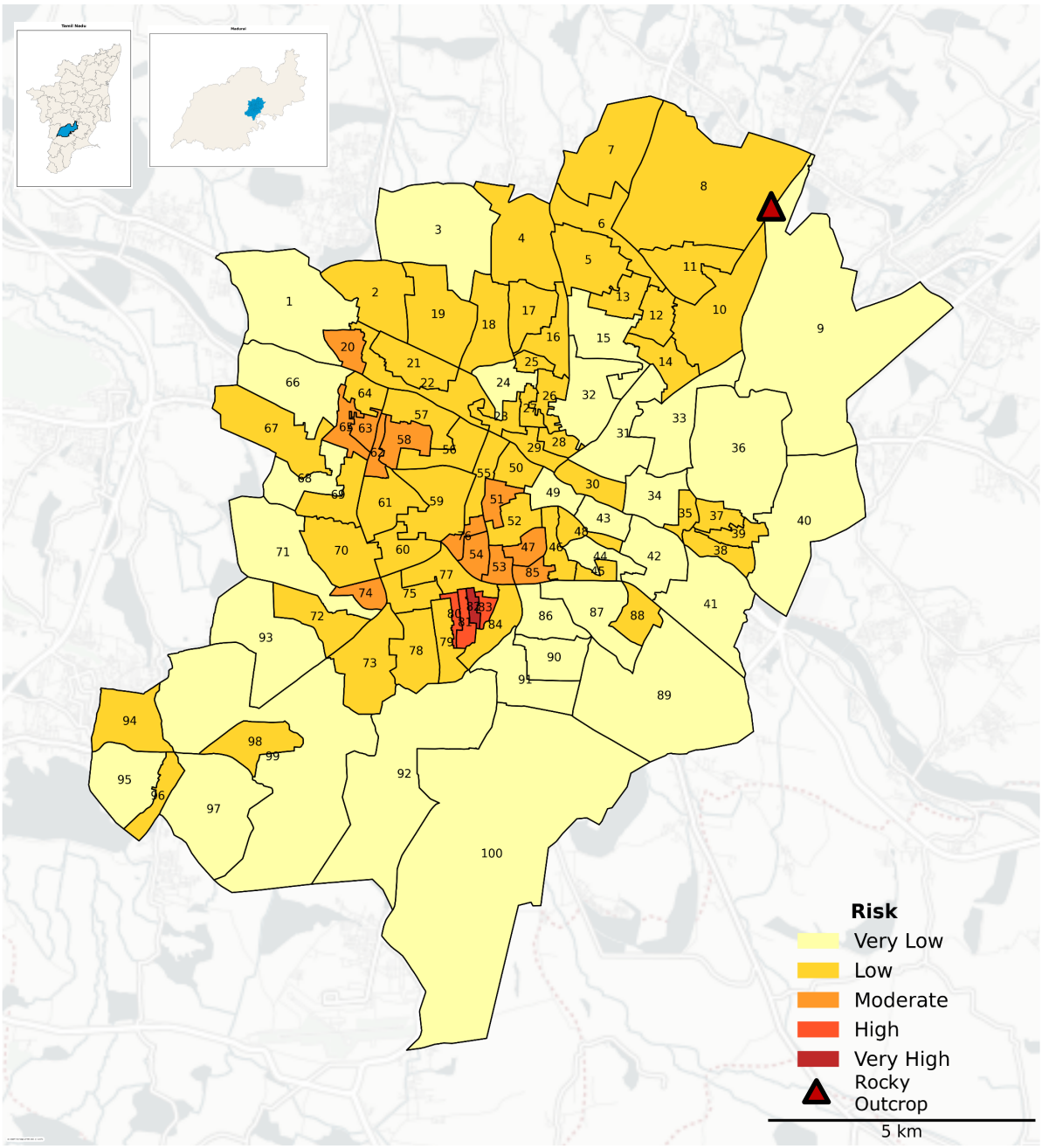
Madurai District

Table 18: Madurai Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Vadipatti	39°C	41°C	44°C
Usilampatti	39°C	41°C	44°C
Madurai north	39°C	41°C	43°C
Thirupparankundram	39°C	41°C	43°C
Tirumangalam	39°C	41°C	43°C
Madurai west	39°C	41°C	43°C
Kalligudi	39°C	41°C	43°C
Madurai south	39°C	41°C	43°C
Madurai east	39°C	41°C	43°C
Melur	39°C	41°C	43°C
Peraiyur	39°C	41°C	43°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Madurai	39°C	41°C	43°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

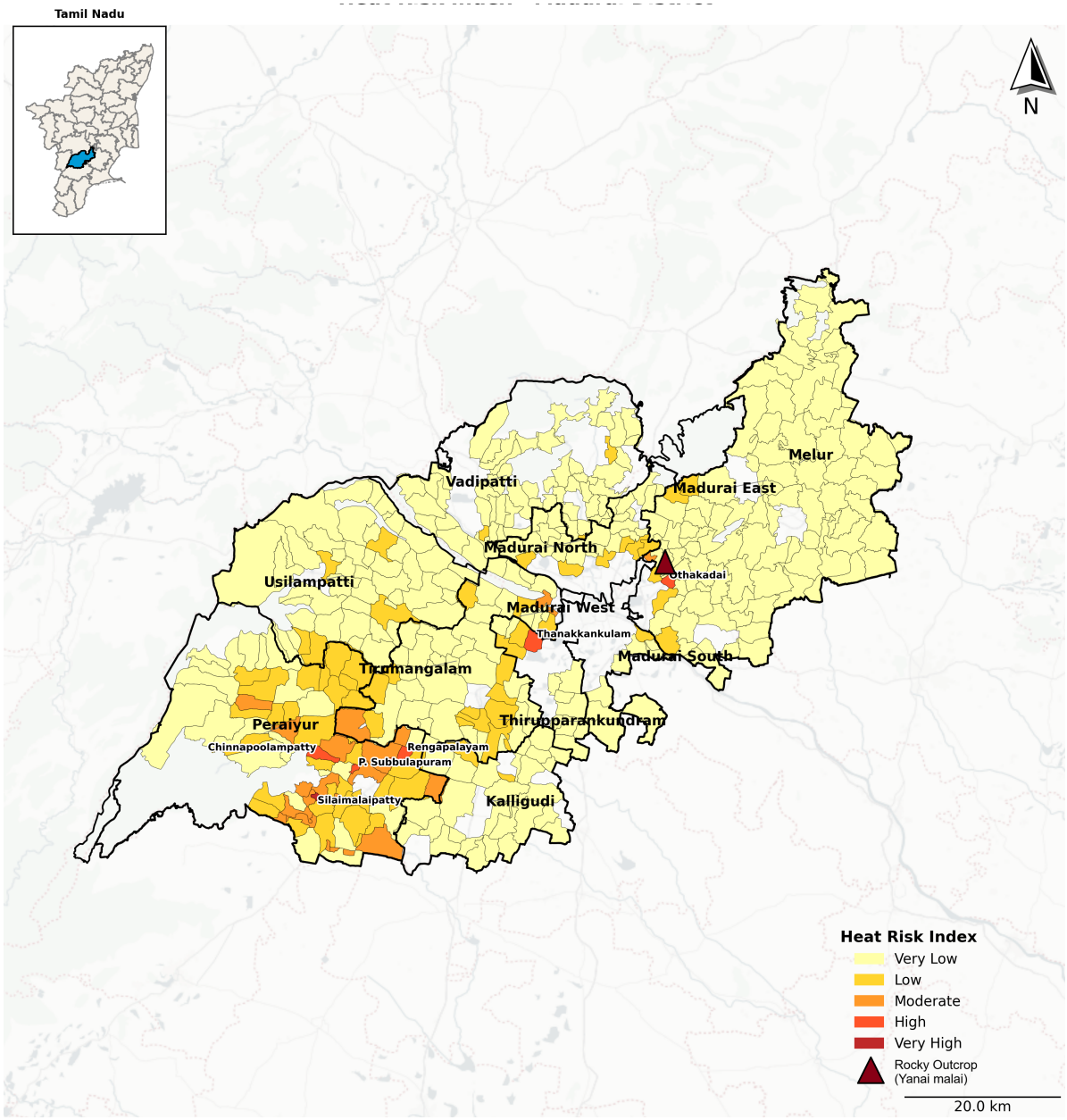
Figure A: Heat Risk Index Map of Madurai City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Madurai District at Village Panchayats level



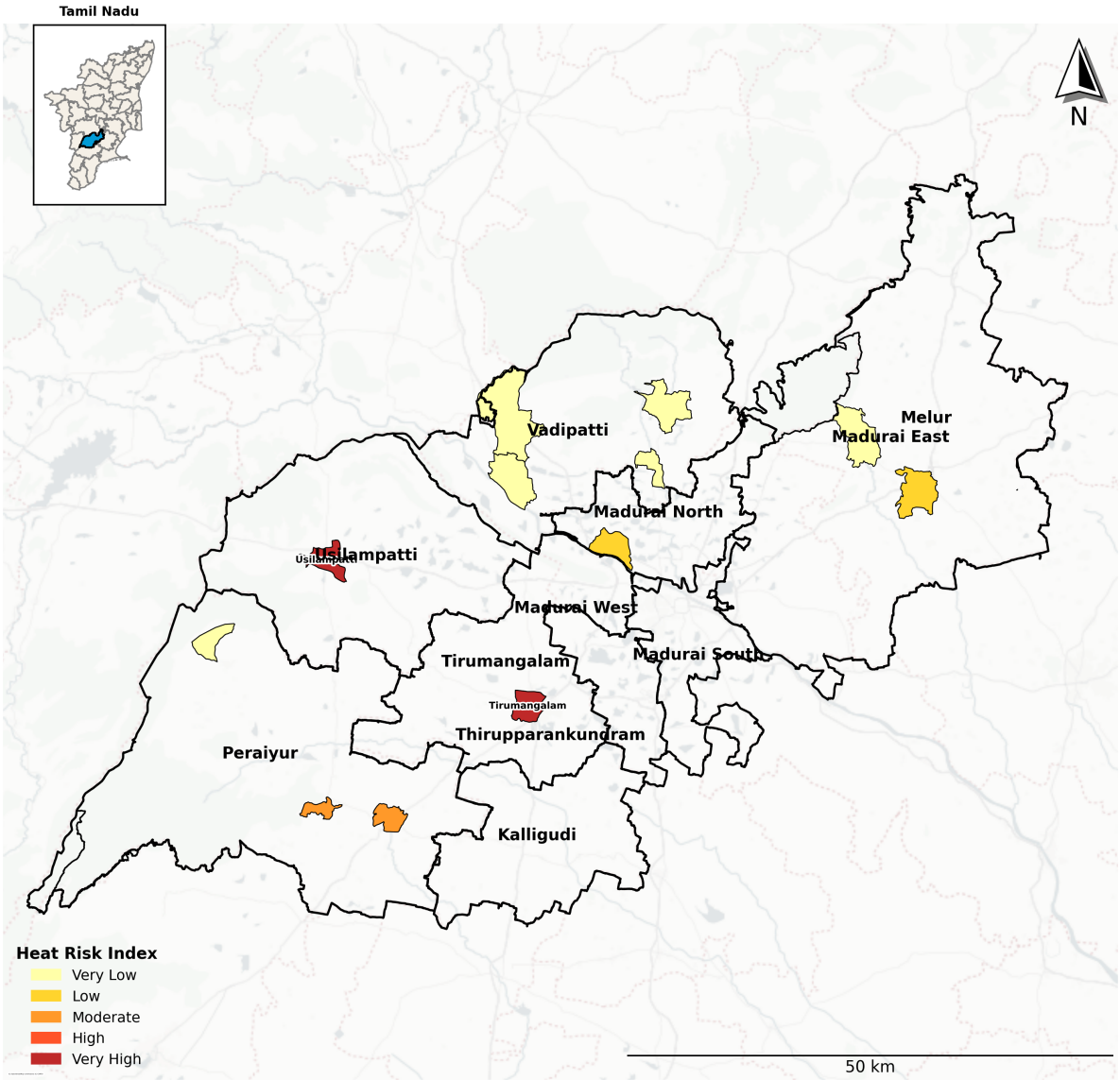
Disclaimer: Presence of bare rock/rocky hills can elevate surface temperature locally through heat reflectance, influencing mapped heat-risk levels.

Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure C: Heat Risk Index Map of Madurai District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Madurai

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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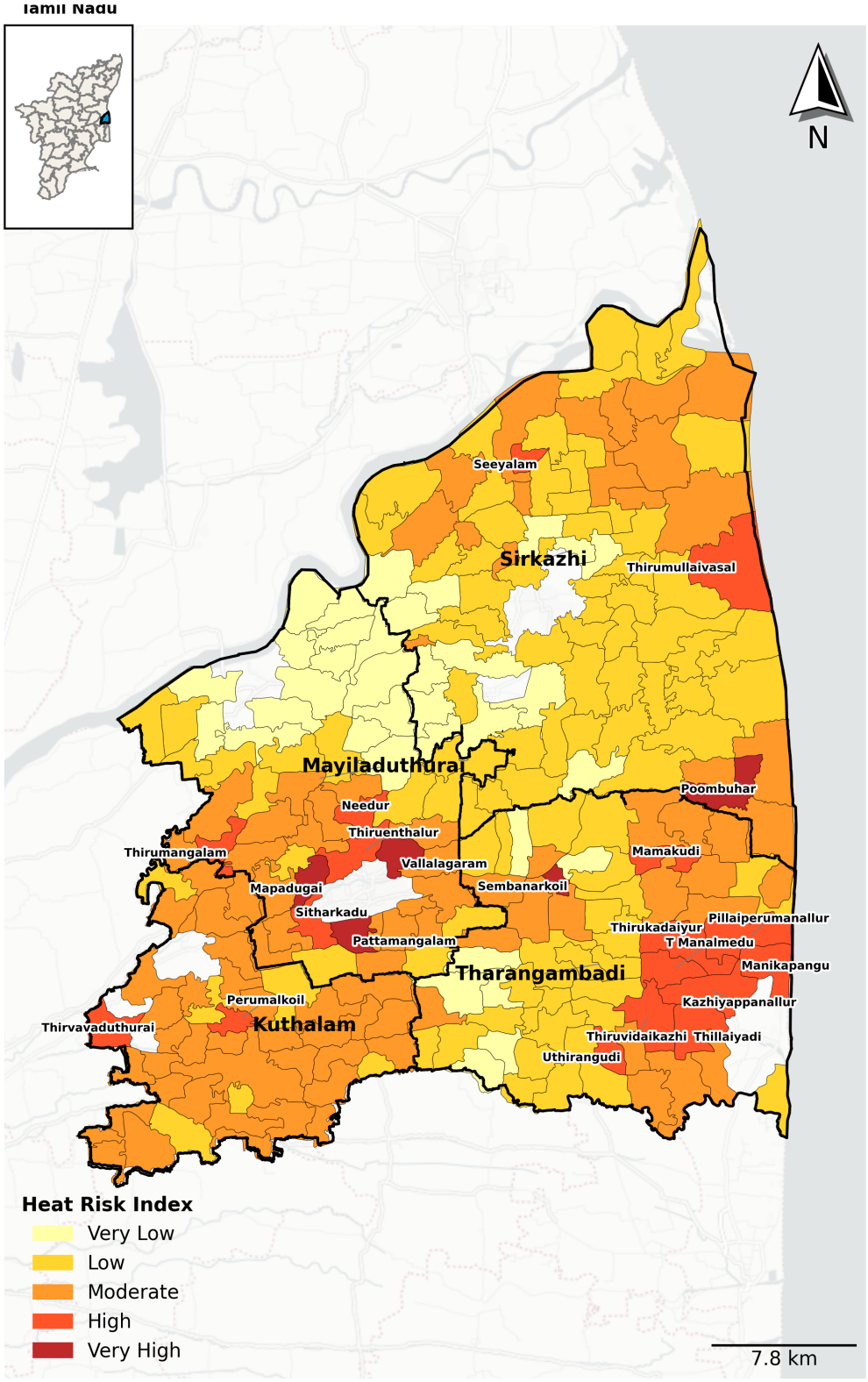
Mayiladuthurai District

Table 19: Mayiladuthurai Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Mayiladuthurai	39°C	41°C	43°C
Sirkazhi	39°C	41°C	43°C
Kuthalam	39°C	41°C	43°C
Tharangambadi	39°C	41°C	43°C

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Figure A: Heat Risk Index Map of Mayiladuthurai District at Village Panchayats level

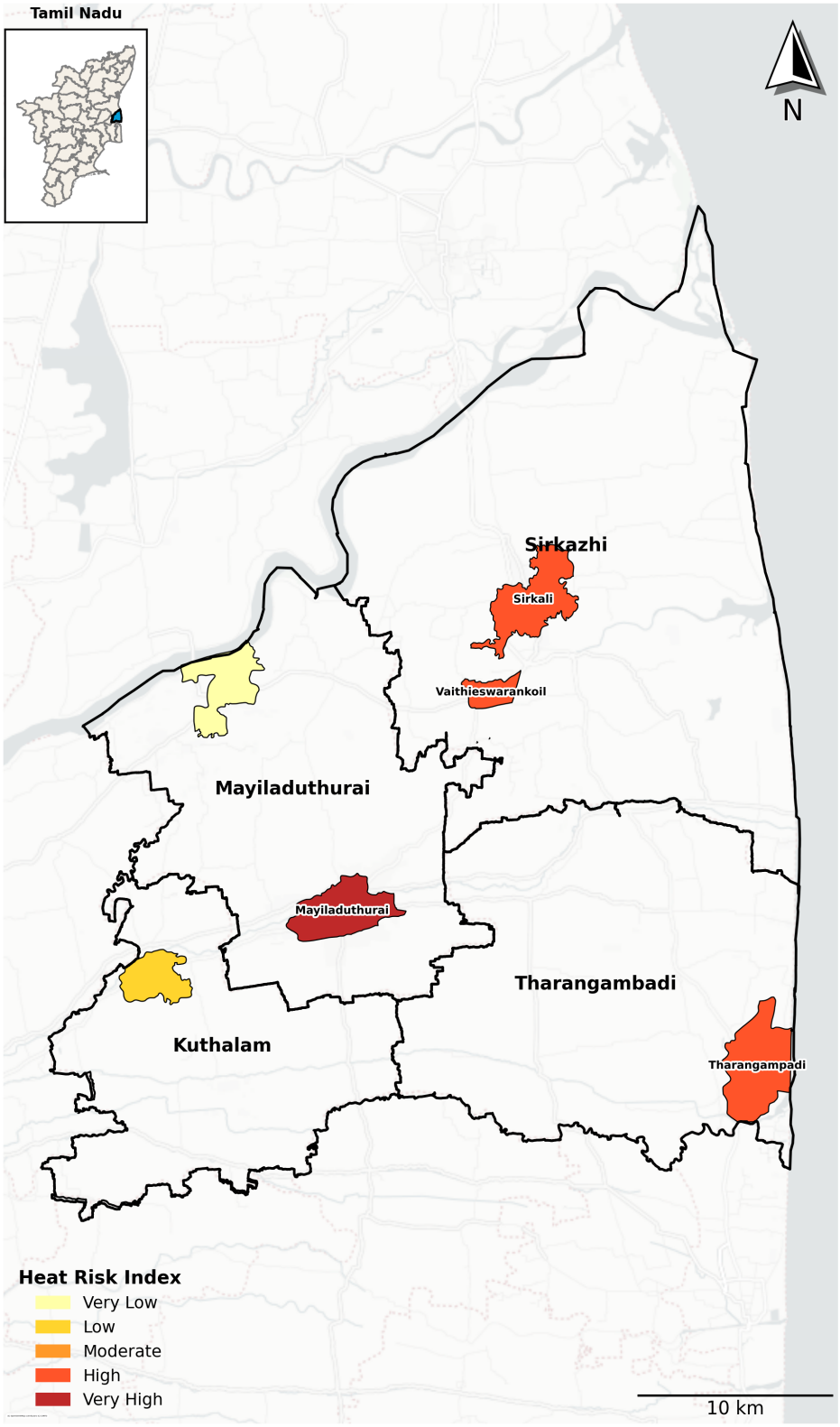


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Mayiladuthurai District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Mayiladuthurai

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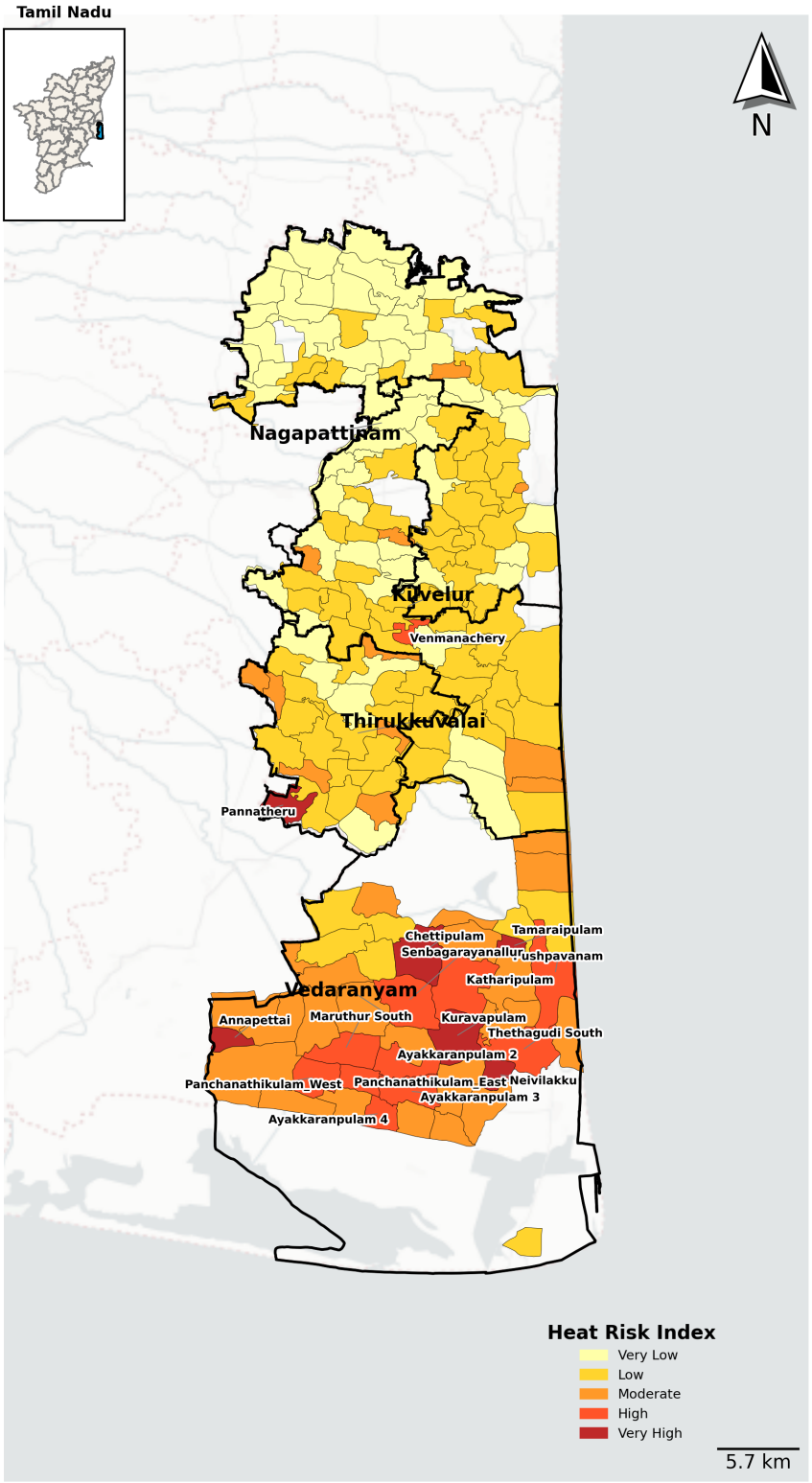
Nagapattinam District

Table 20: Nagapattinam Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Nagapattinam	38°C	40°C	42°C
Thirukkuvalai	38°C	40°C	42°C
Kilvelur	38°C	40°C	42°C
Vedaranyam	38°C	40°C	42°C

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Figure A: Heat Risk Index Map of Nagapattinam District at Village Panchayats level

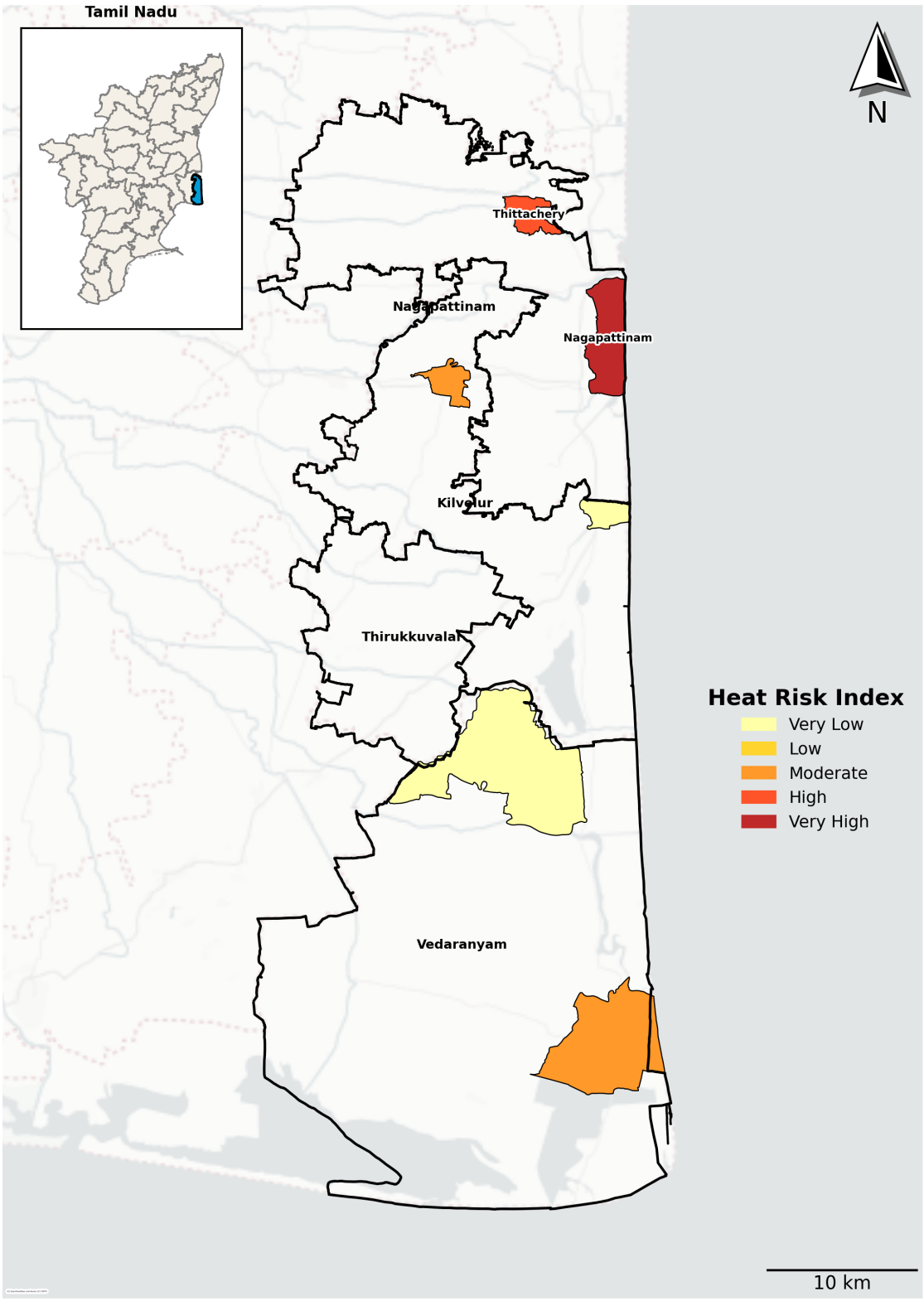


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Nagapattinam District at Village Panchayats level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: [Nagapattinam]

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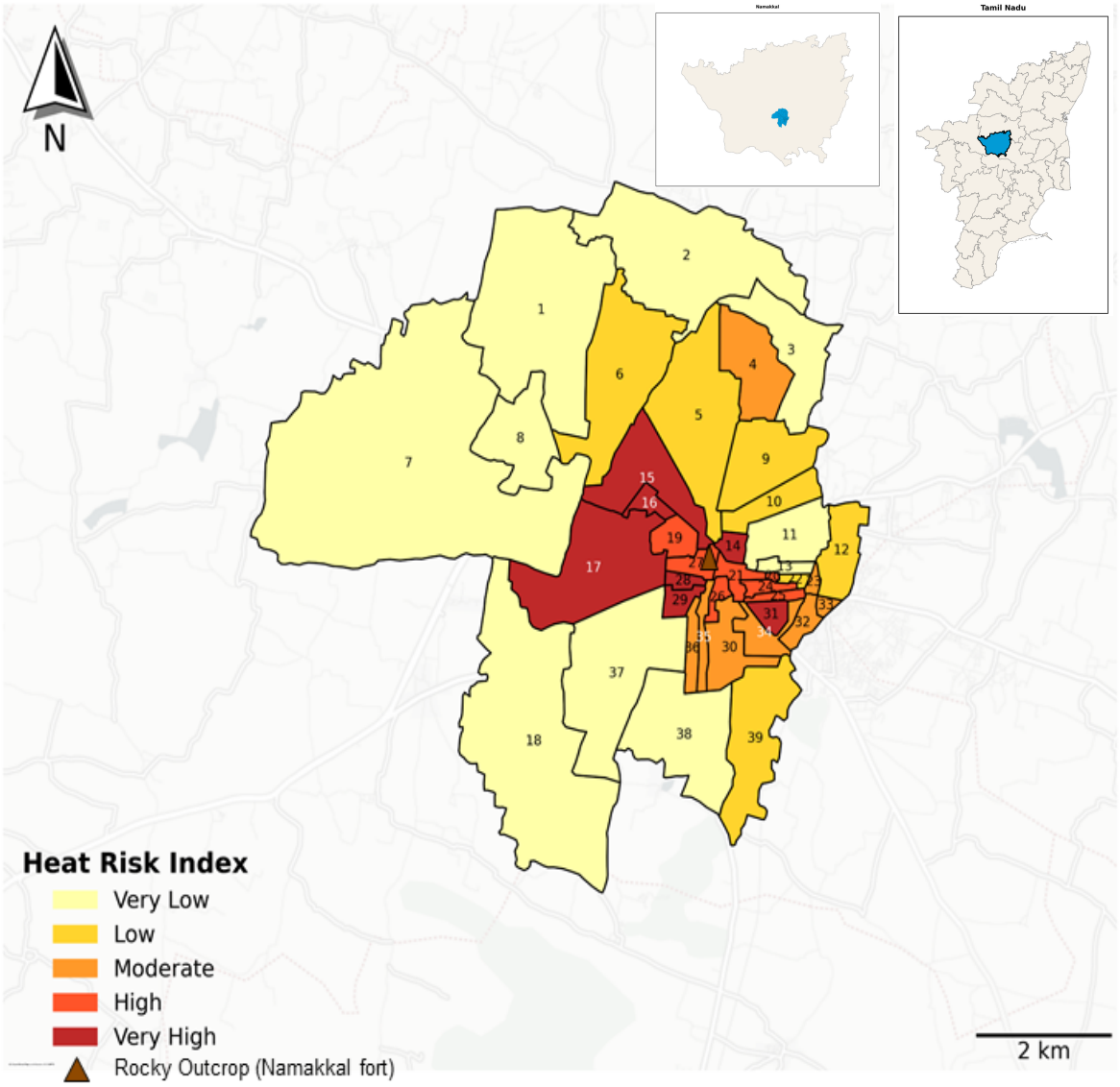
Namakkal District

Table 21: Namakkal Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Tiruchengode	40°C	42°C	44°C
Mohanur	39°C	41°C	43°C
Namakkal	40°C	42°C	44°C
Paramathi velur	39°C	41°C	43°C
Sendamangalam	39°C	41°C	43°C
Rasipuram	39°C	41°C	43°C
Kumarapalayam	39°C	41°C	43°C
Kolli hills	34°C	36°C	38°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Namakkal	40°C	42°C	44°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

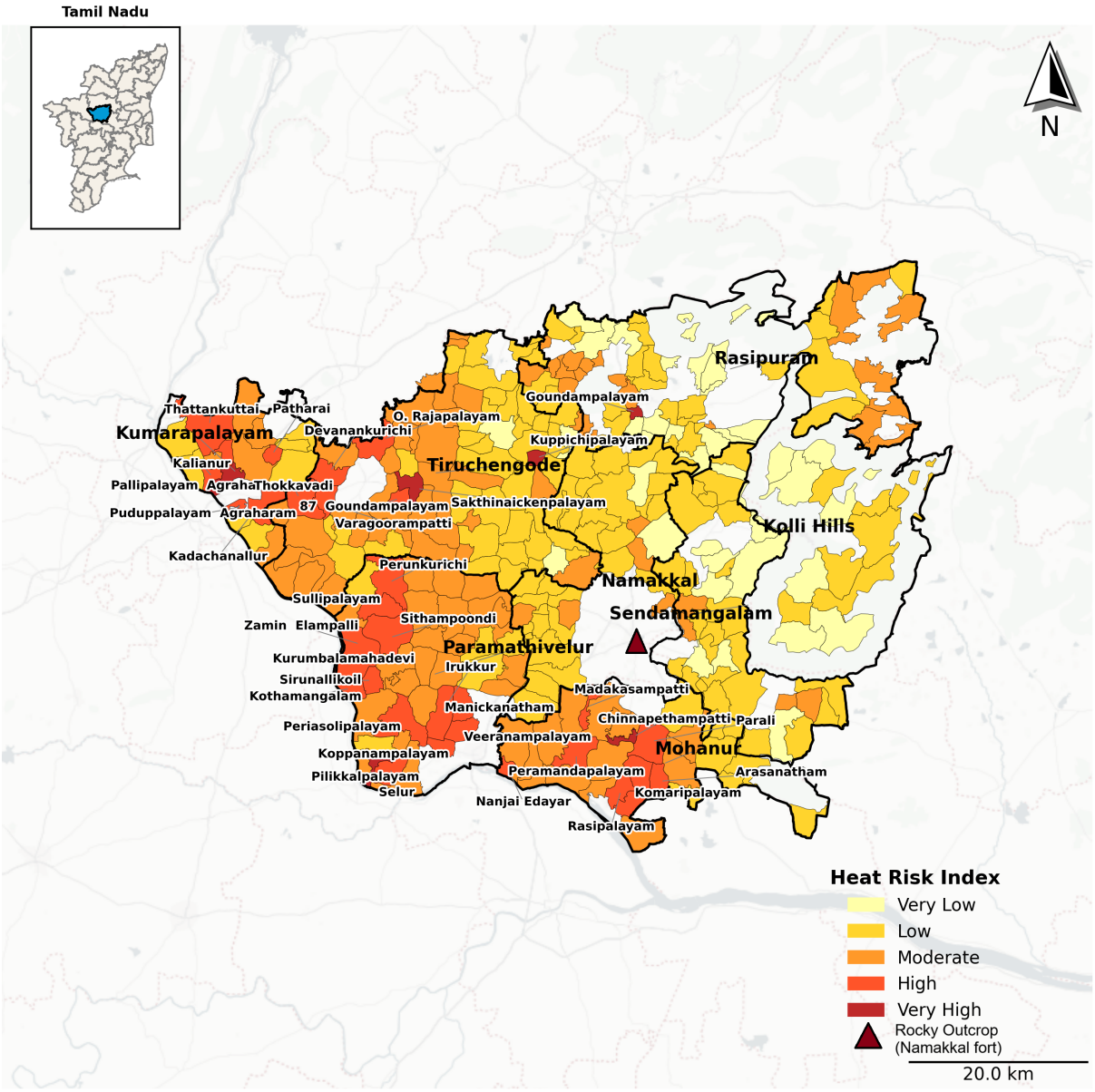
Figure A: Heat Risk Index Map of Namakkal City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Namakkal District at Village Panchayats level



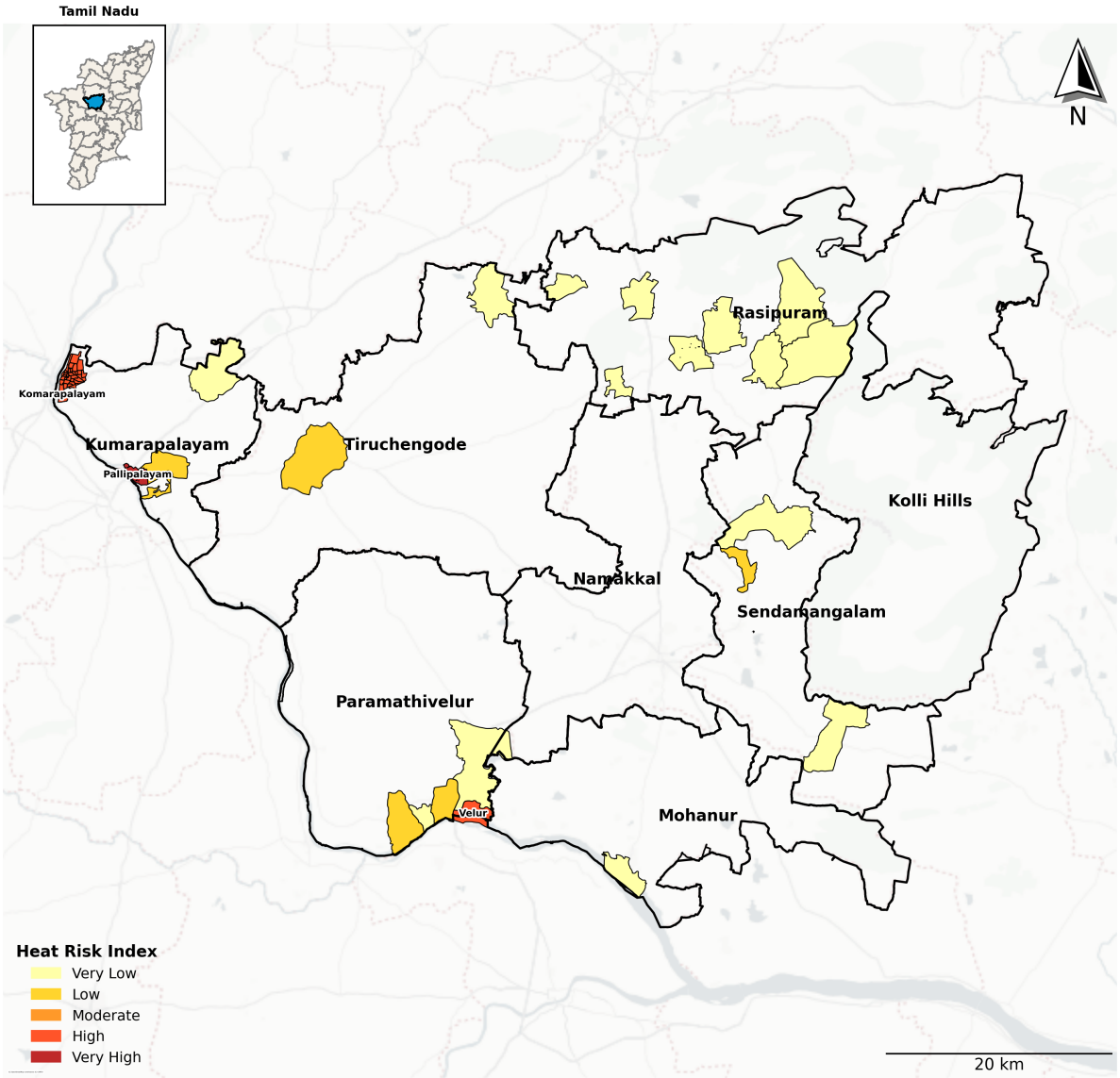
Disclaimer: Presence of bare rock/rocky hills can elevate surface temperature locally through heat reflectance, influencing mapped heat-risk levels.

Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure C: Heat Risk Index Map of Namakkal District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Namakkal

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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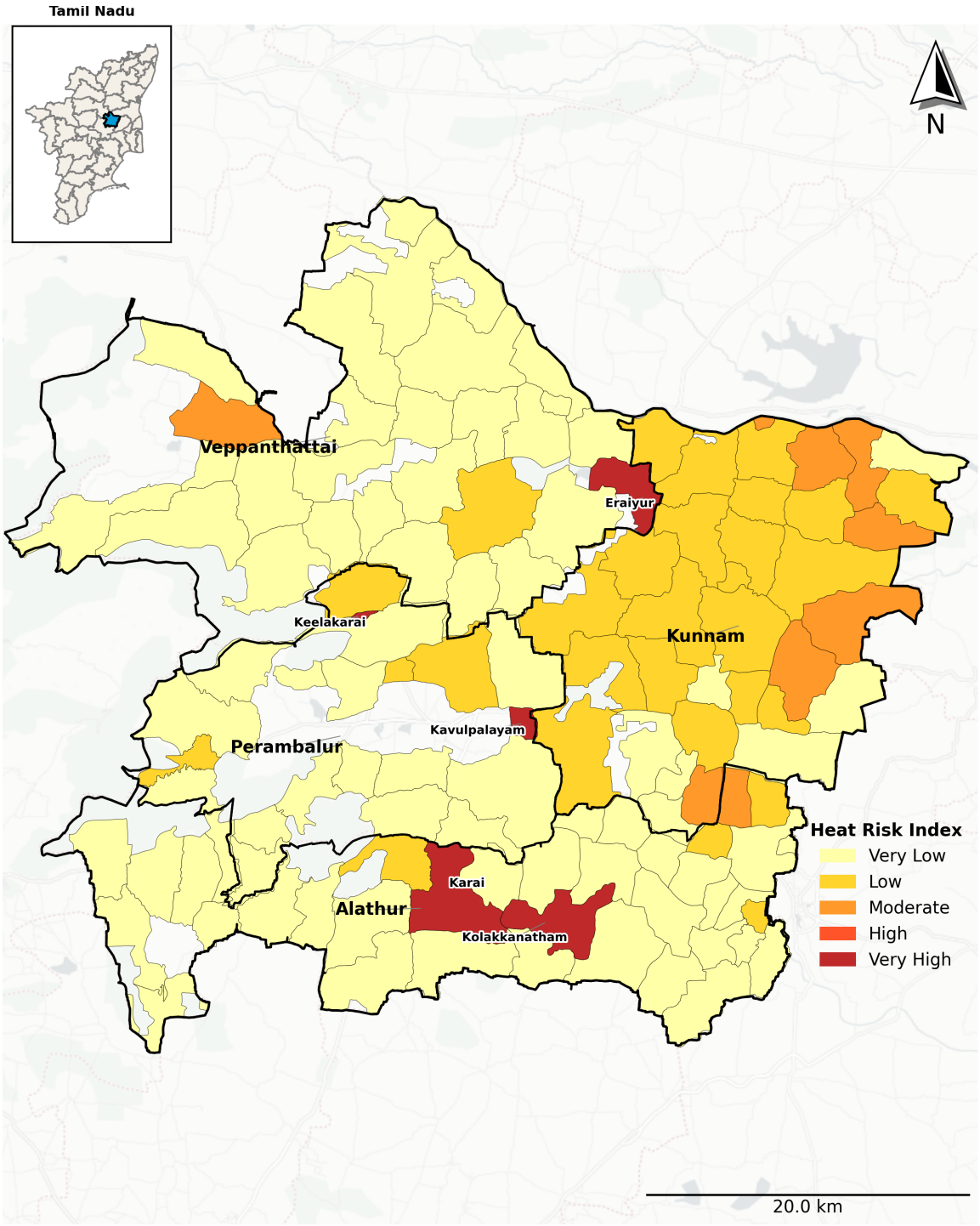
Perambalur District

Table 22: Perambalur Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Kunnam	40°C	42°C	44°C
Alathur	40°C	42°C	44°C
Veppanthattai	40°C	42°C	44°C
Perambalur	39°C	41°C	43°C

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Figure A: Heat Risk Index Map of Perambalur District at Village Panchayats level

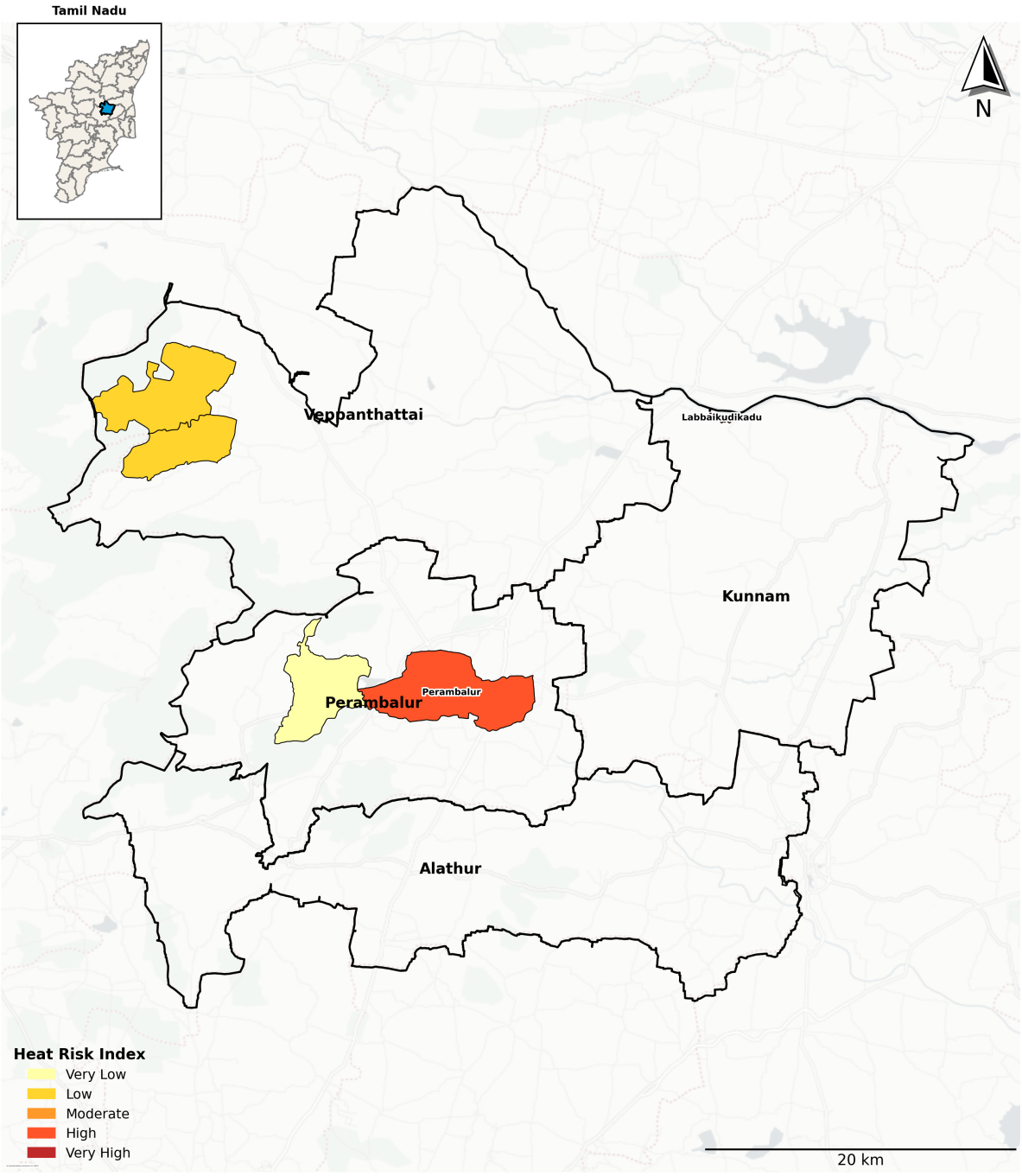


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure B: Heat Risk Index Map of Perambalur District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Perambalur

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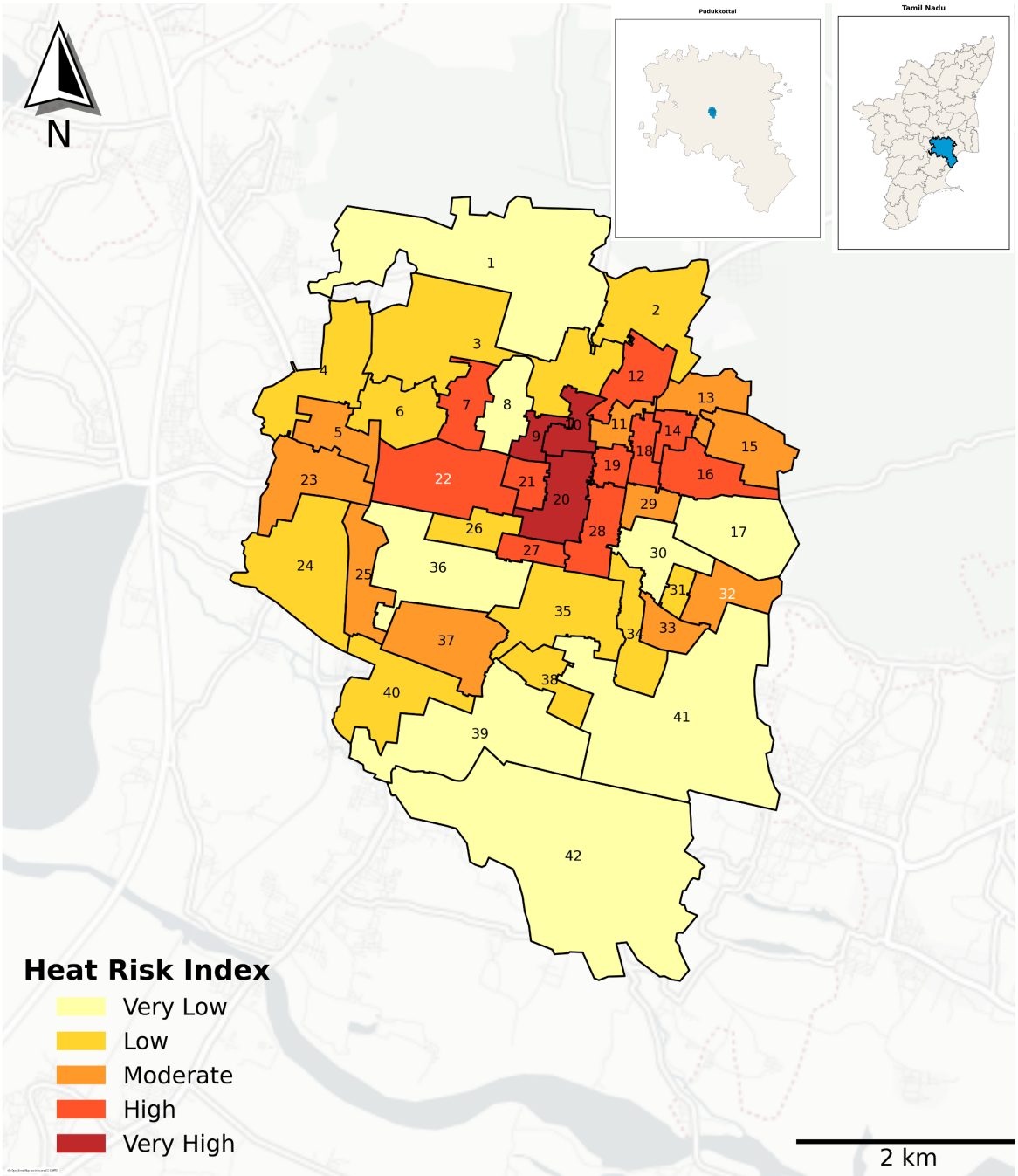
Pudukkottai District

Table 23: Pudukottai Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Kulathur	40°C	42°C	44°C
Illupur	39°C	41°C	43°C
Thirumayam	39°C	41°C	43°C
Gandarvakottai	39°C	41°C	43°C
Pudukkottai	39°C	41°C	43°C
Manamelkudi	38°C	40°C	42°C
Ponnamaravathi	39°C	41°C	43°C
Viralimalai	39°C	41°C	43°C
Alangudi	39°C	41°C	43°C
Karambakudi	38°C	40°C	42°C
Aranthangi	38°C	40°C	42°C
Avudaiyarkoil	38°C	40°C	42°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Pudukkottai	39°C	41°C	43°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

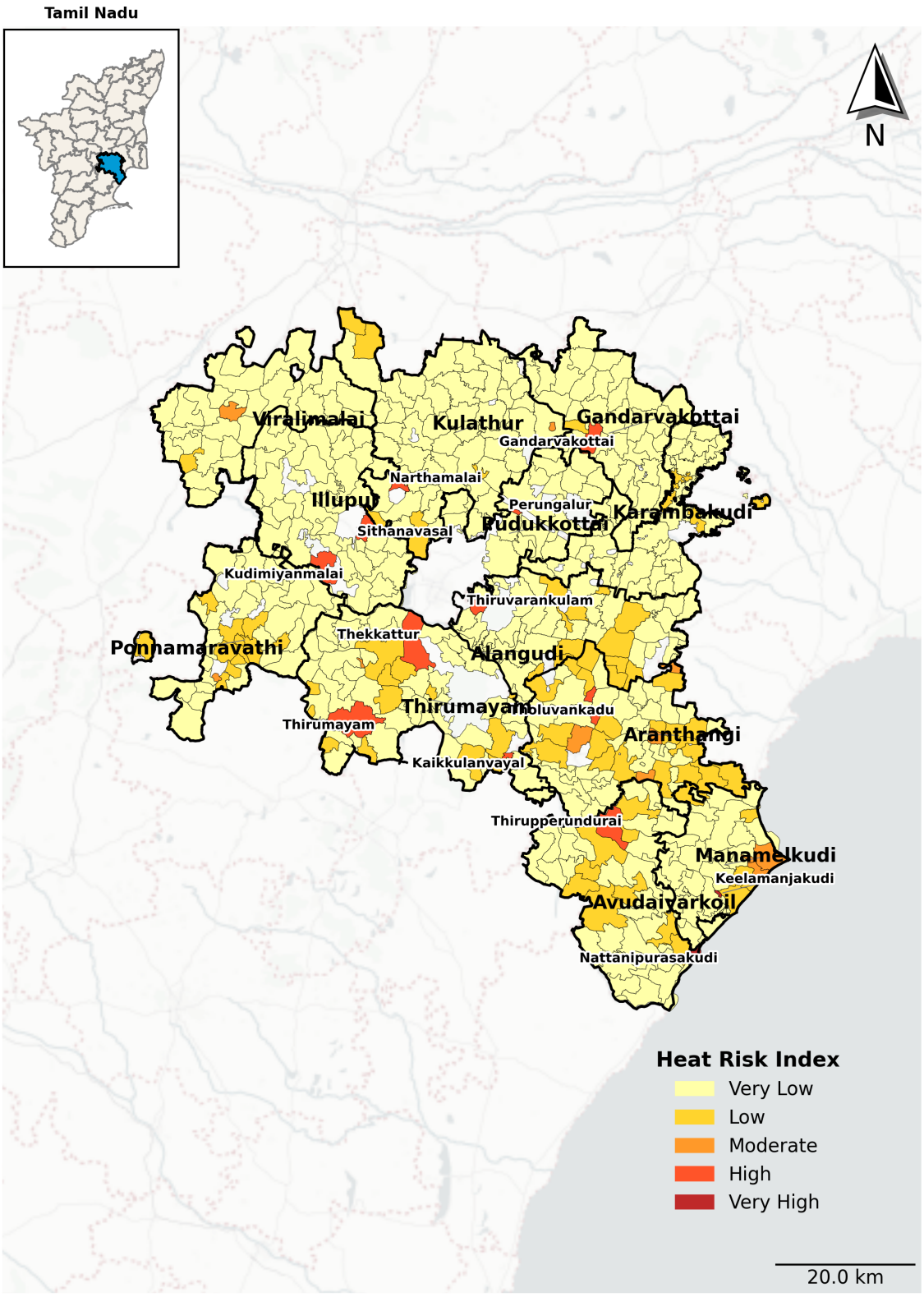
Figure A: Heat Risk Index Map of Pudukkottai City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Pudukkottai District at Village Panchayats level

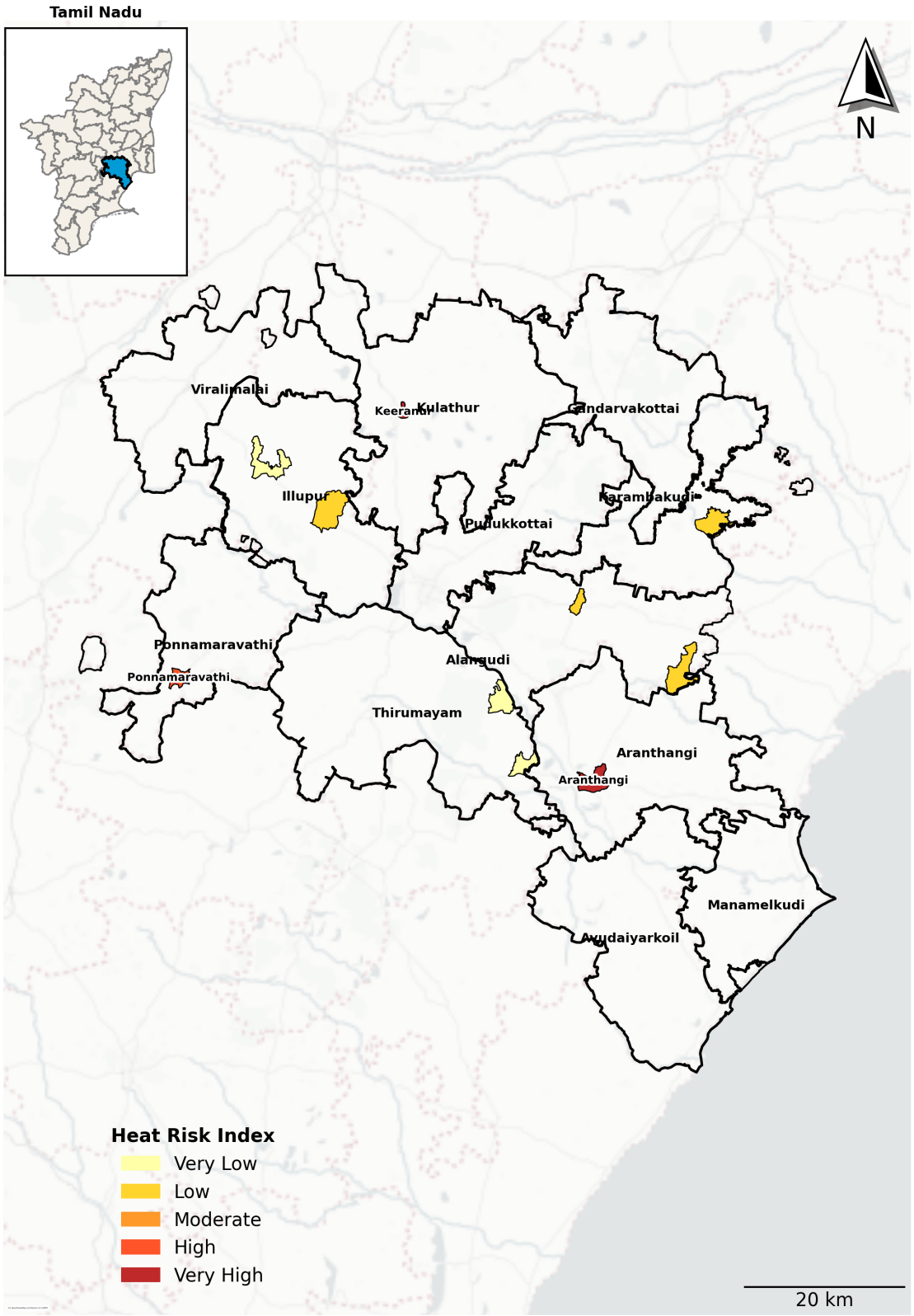


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure C: Heat Risk Index Map of Pudukkottai District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: [Pudukkottai]

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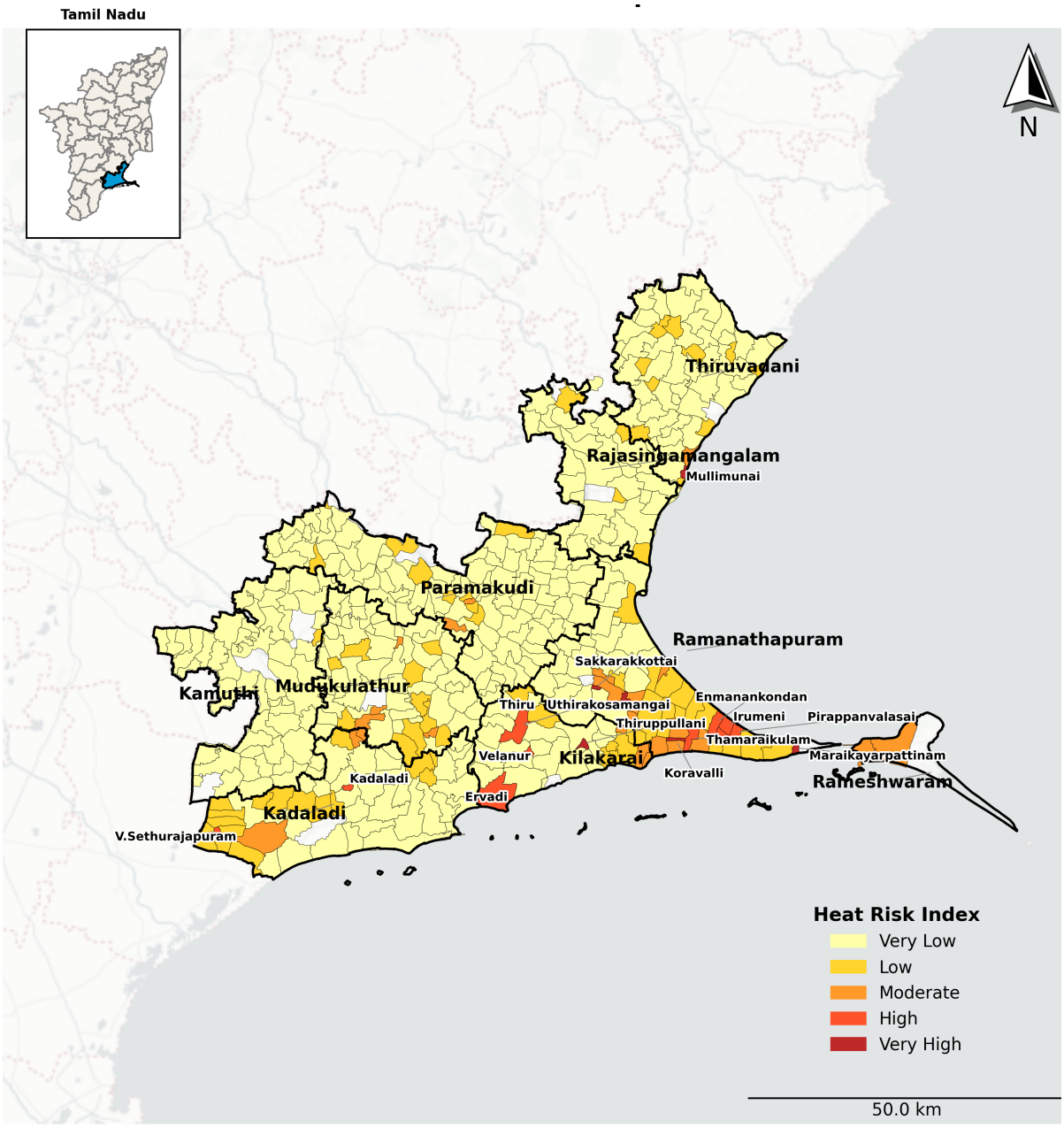
Ramanathapuram District

Table 24: Ramanathapuram Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Rameswaram	38°C	40°C	42°C
Keelakarai	38°C	40°C	42°C
Kadaladi	38°C	40°C	42°C
Thiruvadani	38°C	40°C	42°C
Paramakudi	39°C	41°C	43°C
Kamuthi	39°C	41°C	43°C
Mudukulathur	38°C	40°C	42°C
Rajasingamangalam	38°C	40°C	42°C
Ramanathapuram	37°C	39°C	41°C

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Figure A: Heat Risk Index Map of Ramanathapuram District at Village Panchayats level

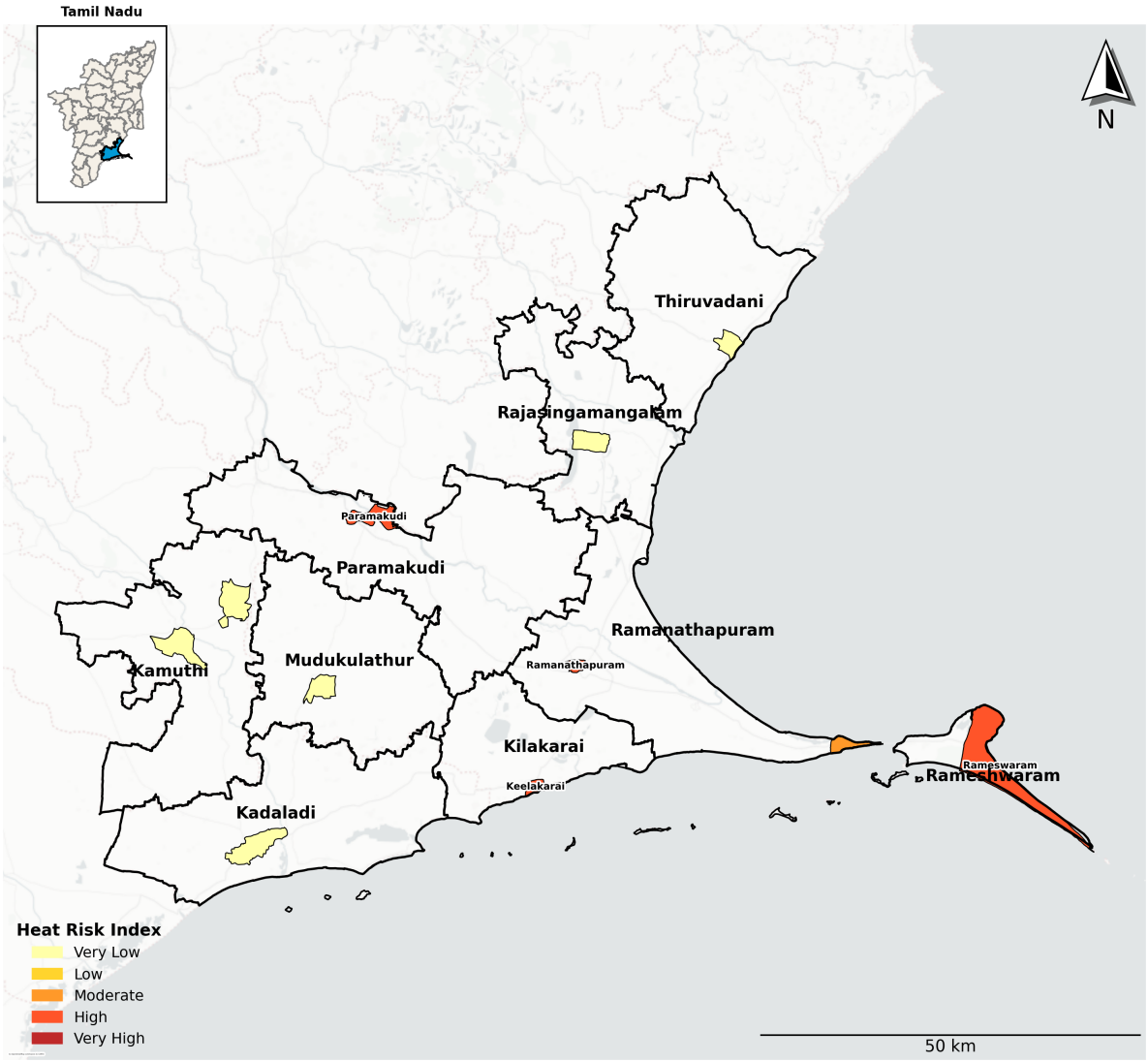


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure B: Heat Risk Index Map of Ramanathapuram District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: [Ramanathapuram]

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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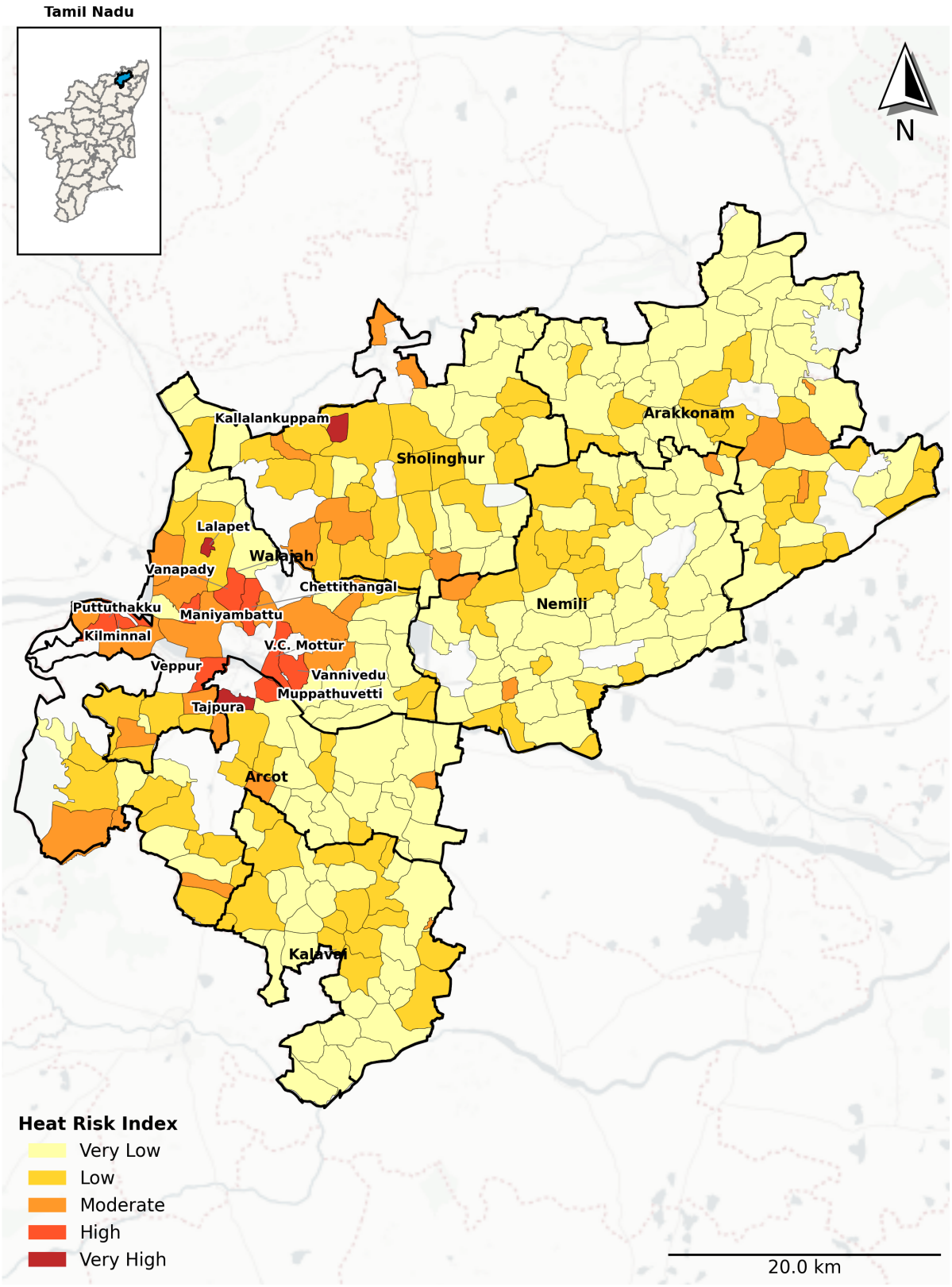
Ranipet District

Table 25: Ranipet Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Arakkonam	40°C	42°C	44°C
Nemili	40°C	42°C	44°C
Walajah	40°C	42°C	44°C
Arcot	40°C	42°C	44°C
Kalavai	40°C	42°C	44°C
Sholingur	40°C	42°C	44°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

Figure A: Heat Risk Index Map of Ranipet District at Village Panchayats level

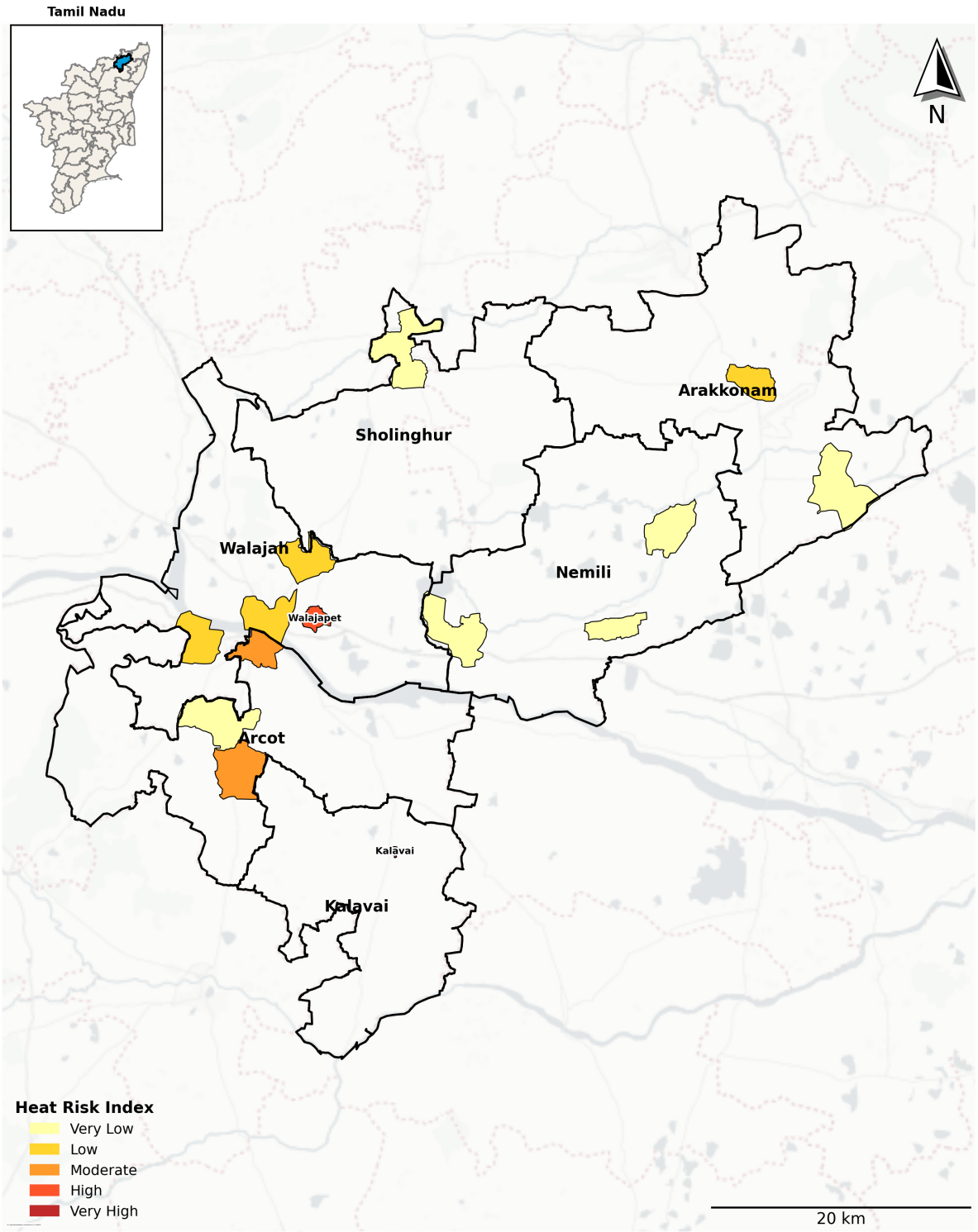


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Ranipet District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Ranipet

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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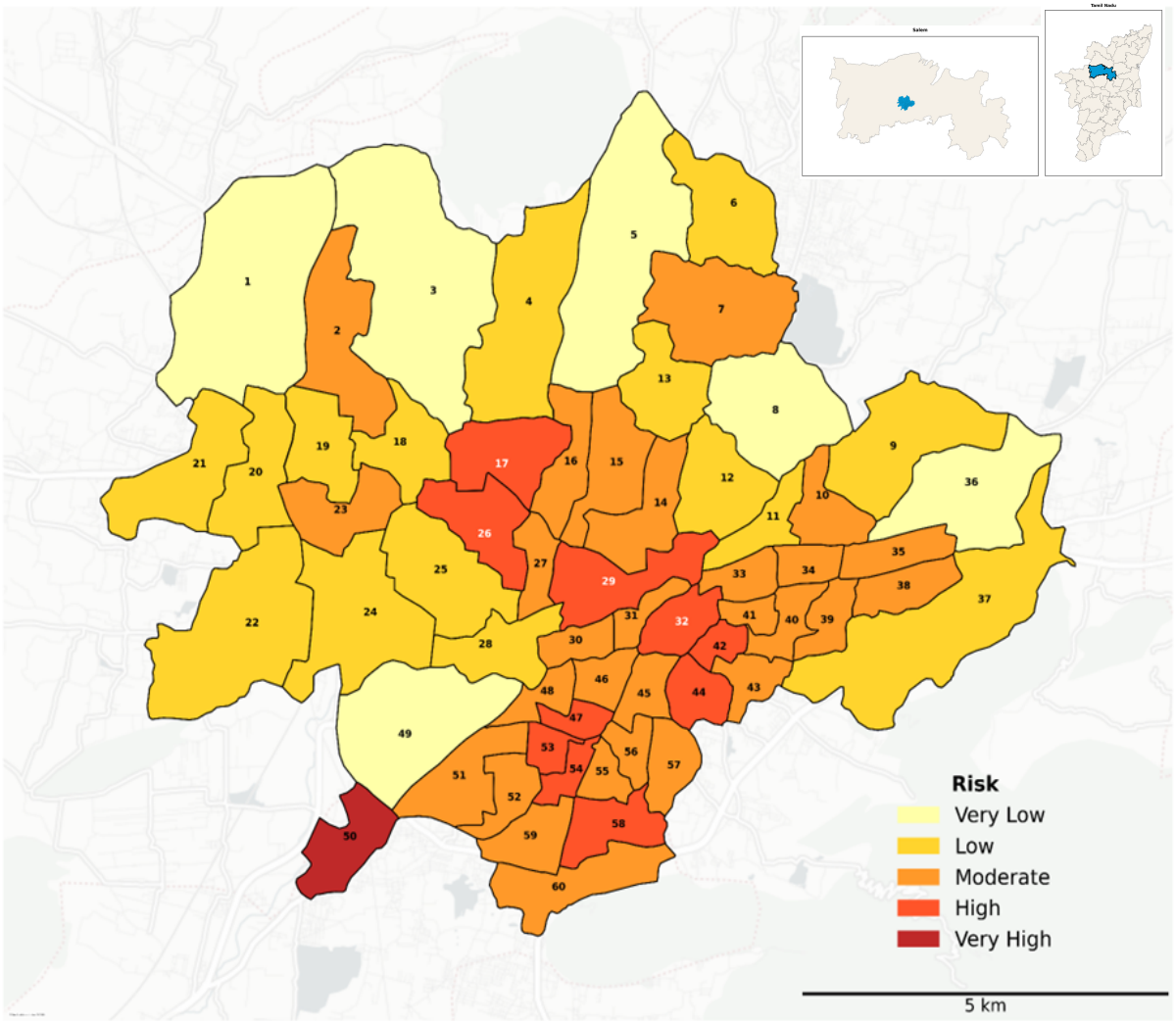
Salem District

Table 26: Salem Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Thalaivasal	39°C	41°C	43°C
Mettur	39°C	41°C	43°C
Sankari	39°C	41°C	43°C
Omalur	39°C	41°C	43°C
Salem south	39°C	41°C	43°C
Salem west	39°C	41°C	43°C
Edappady	39°C	41°C	43°C
Attur	38°C	40°C	42°C
Kadayampatti	38°C	40°C	42°C
Salem	38°C	40°C	42°C
Valapady	38°C	40°C	42°C
Pethanaickenpalayam	38°C	40°C	42°C
Ganagavalli	38°C	40°C	42°C
Yercaud	34°C	36°C	38°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Salem	38°C	40°C	42°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

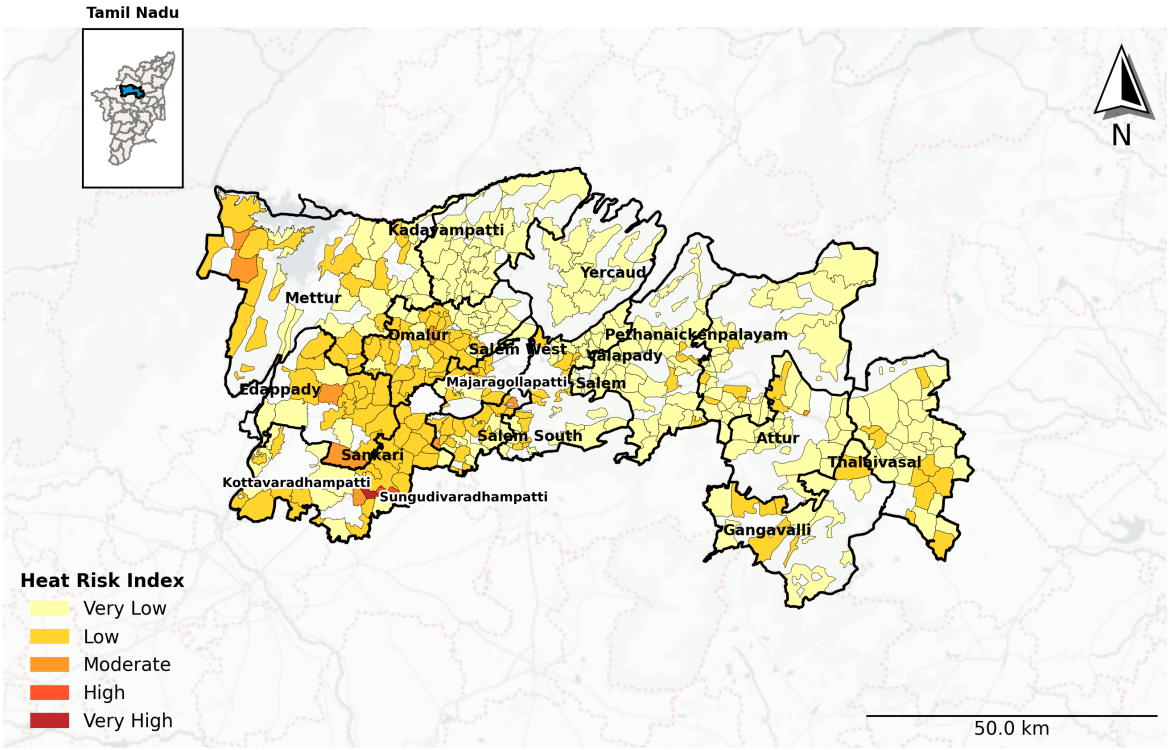
Figure A: Heat Risk Index Map of Salem City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

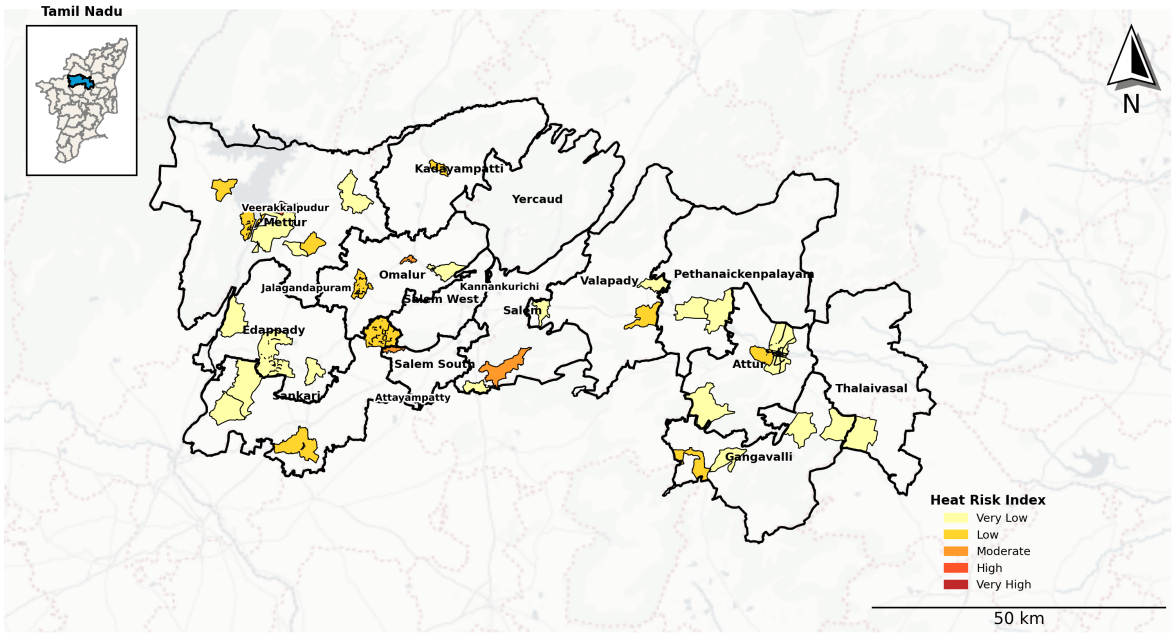
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Figure B: Heat Risk Index Map of Salem District at Village Panchayats level



Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

Figure C: Heat Risk Index Map of Salem District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: [Salem]

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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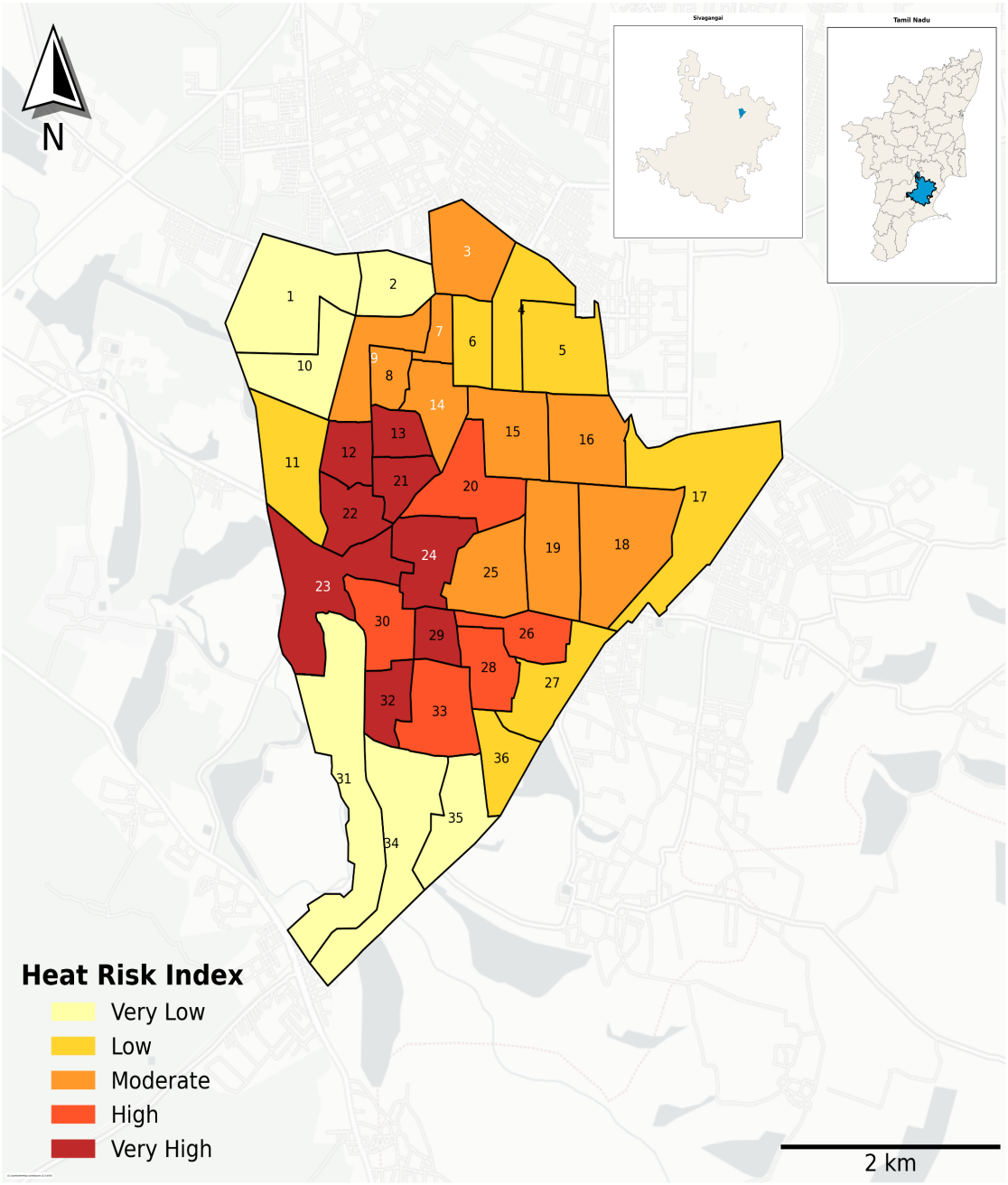
Sivagangai District

Table 27: Sivagangai Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Ilayankudi	39°C	41°C	43°C
Thirupattur	39°C	41°C	43°C
Sivagangai	39°C	41°C	43°C
Singampunari	39°C	41°C	43°C
Manamadurai	39°C	41°C	43°C
Thiruppuvanam	39°C	41°C	43°C
Karaikudi	39°C	41°C	43°C
Kalaiyarkovil	39°C	41°C	43°C
Devakottai	38°C	40°C	42°C
Ilayankudi	38°C	40°C	42°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Karaikudi	39°C	41°C	43°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

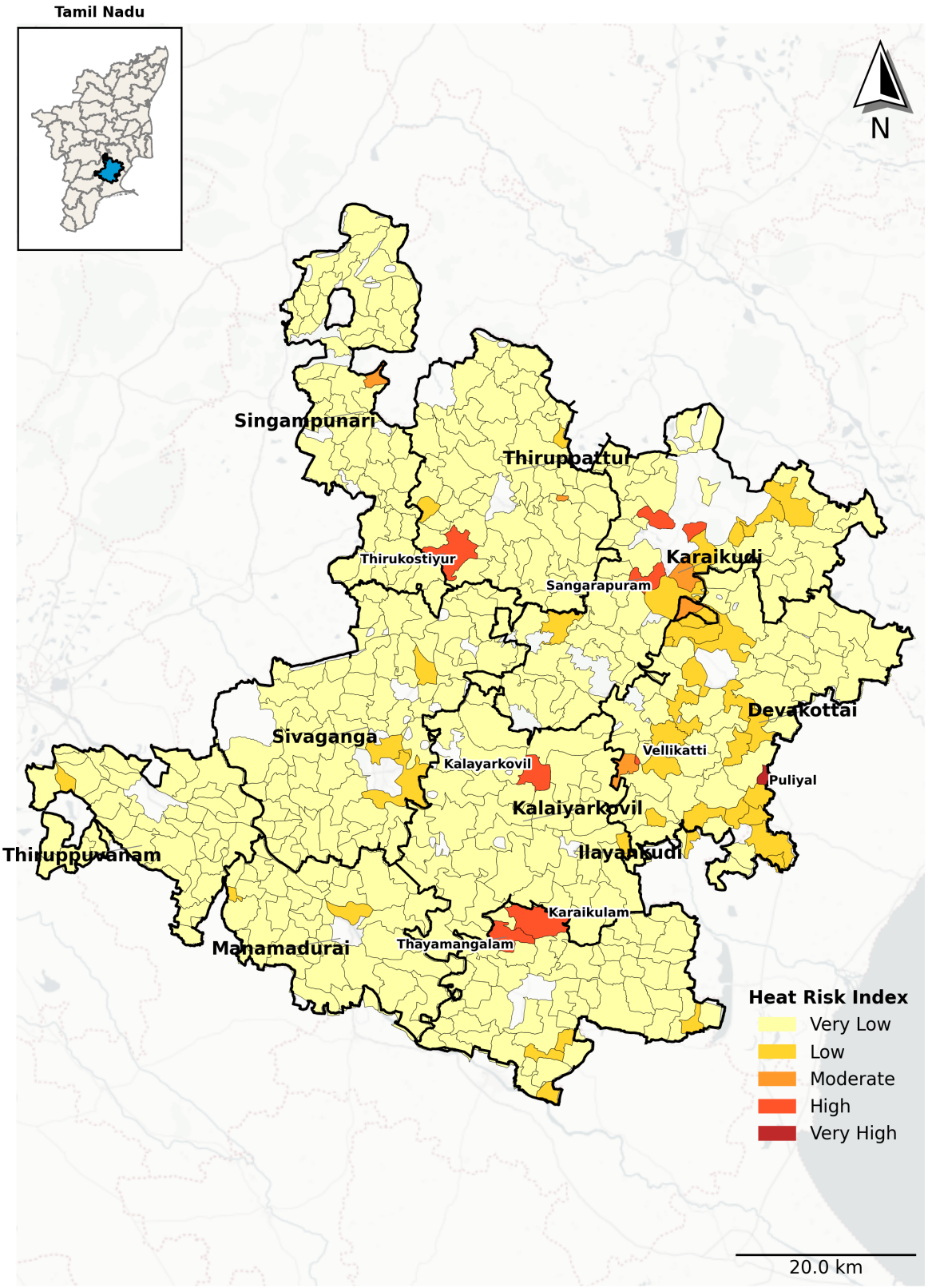
Figure A: Heat Risk Index Map of Karaikudi City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Sivagangai District at Village Panchayats level

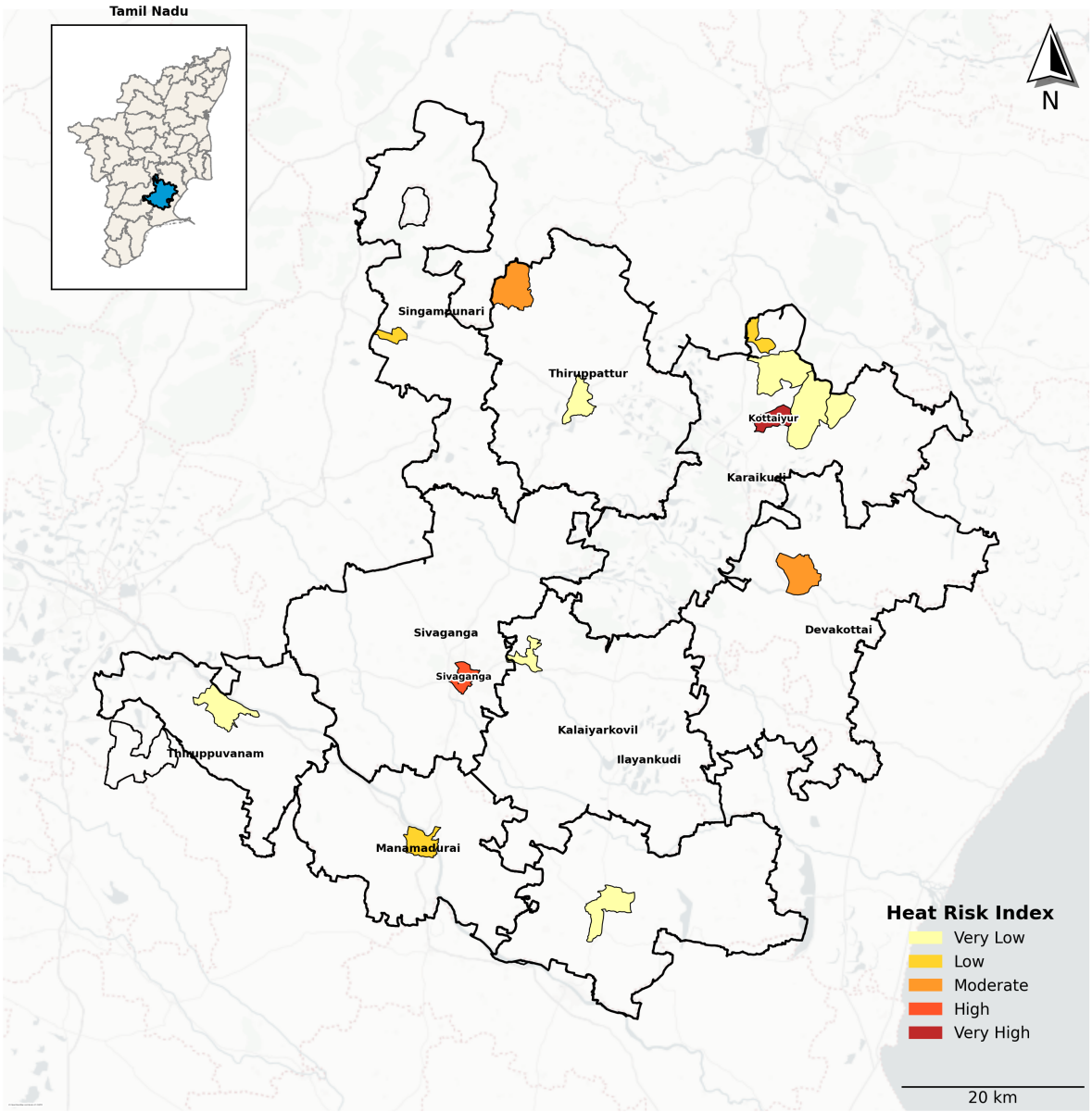


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure C: Heat Risk Index Map of Sivagangai District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Sivagangai

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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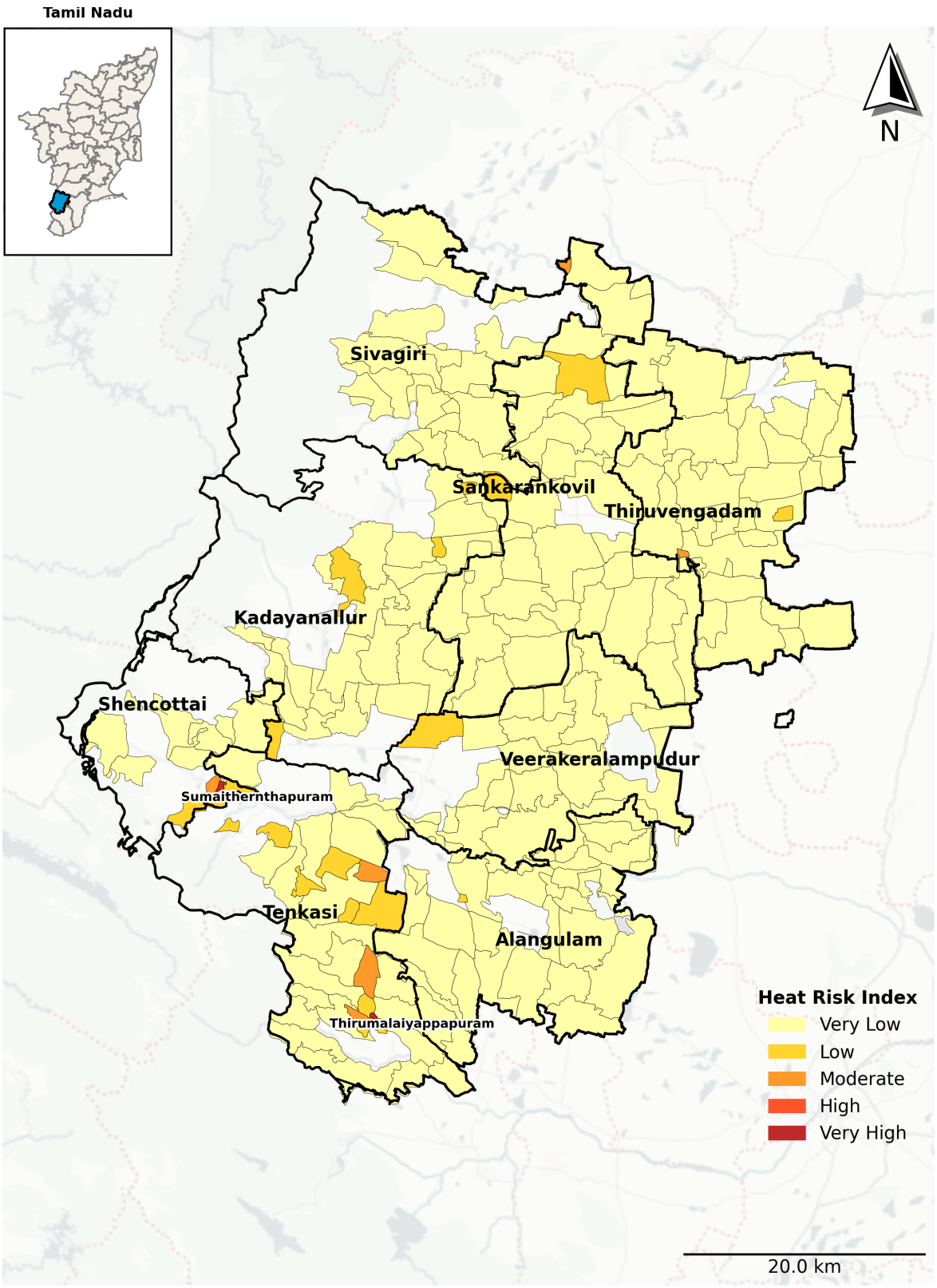
Tenkasi District

Table 28: Tenkasi Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Shencottai	39°C	41°C	43°C
Thiruvengadam	39°C	41°C	43°C
Sankarankovil	38°C	40°C	42°C
Alangulam	37°C	39°C	41°C
Tenkasi	37°C	39°C	41°C
Kadayanallur	37°C	39°C	41°C
V.K.Pudur	37°C	39°C	41°C
Sivagiri	34°C	36°C	38°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

Figure A: Heat Risk Index Map of Tenkasi District at Village Panchayats level

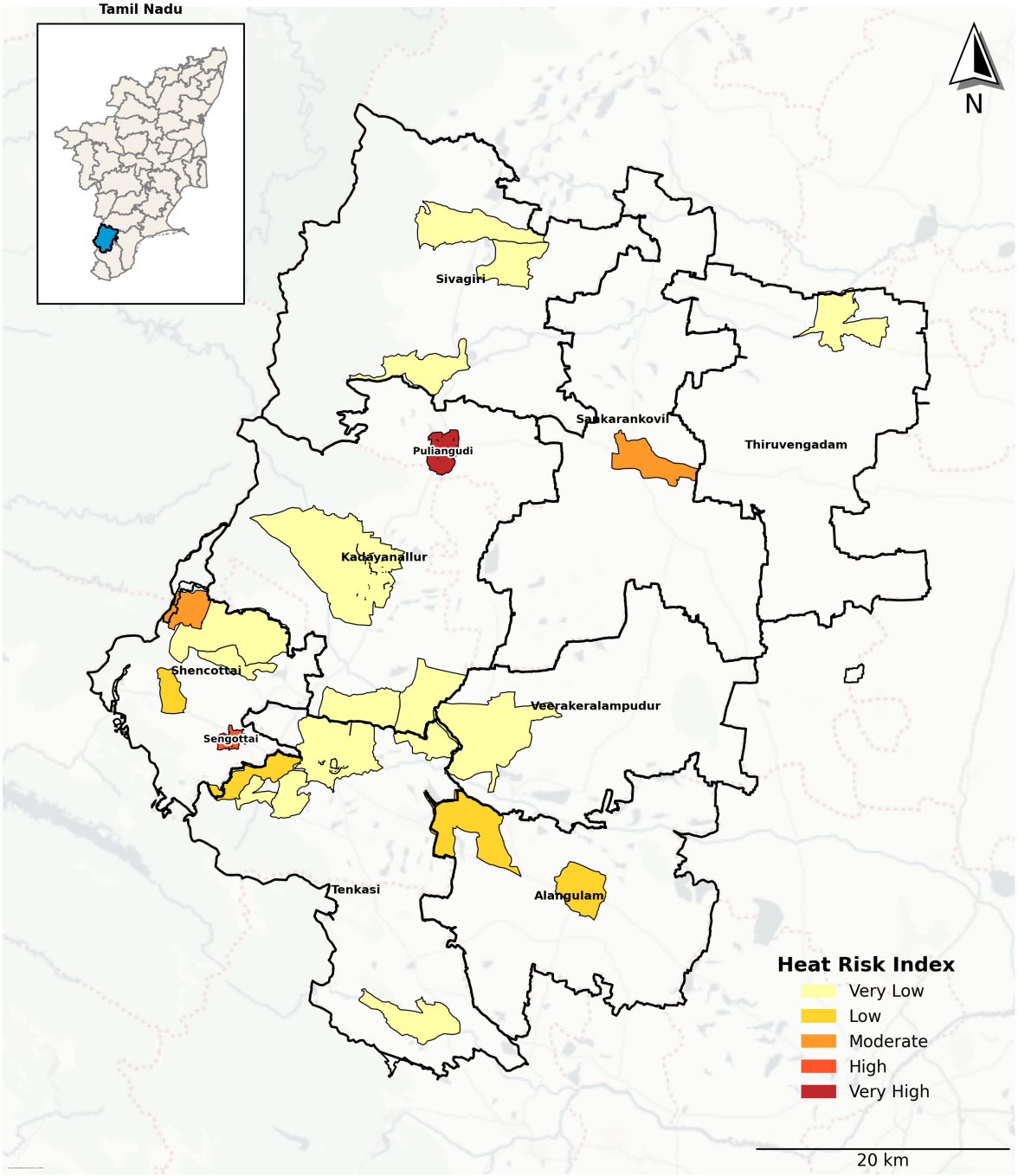


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure B: Heat Risk Index Map of Tenkasi District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Tenkasi

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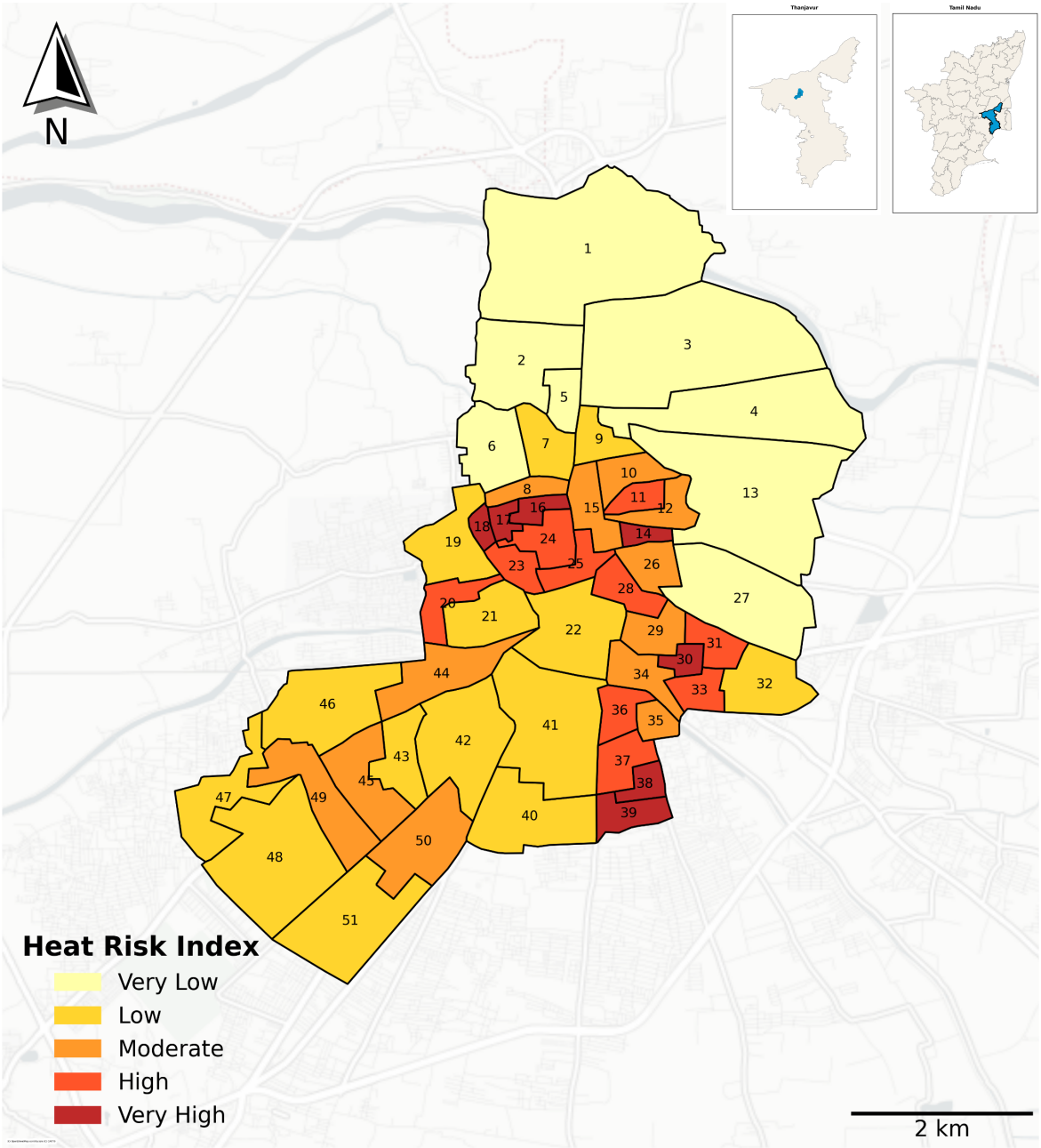
Thanjavur District

Table 29: Thanjavur Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Papanasam	40°C	42°C	44°C
Thiruvaiyaru	40°C	42°C	44°C
Thiruvidaimaruthur	40°C	42°C	44°C
Kumbakonam	40°C	42°C	44°C
Budalur	40°C	42°C	44°C
Thanjavur	40°C	42°C	44°C
Orathanad	39°C	41°C	43°C
Peravurani	39°C	41°C	43°C
Pattukottai	39°C	41°C	43°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Thanjavur	40°C	42°C	44°C
Kumbakonam	40°C	42°C	44°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

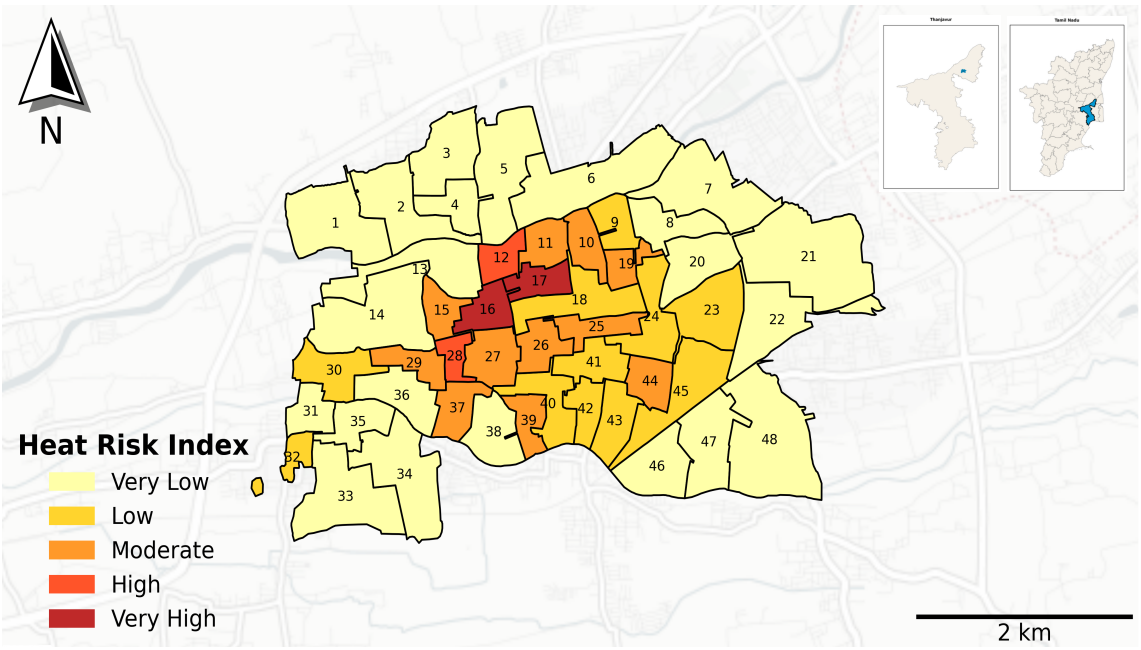
Figure A: Heat Risk Index Map of Thanjavur City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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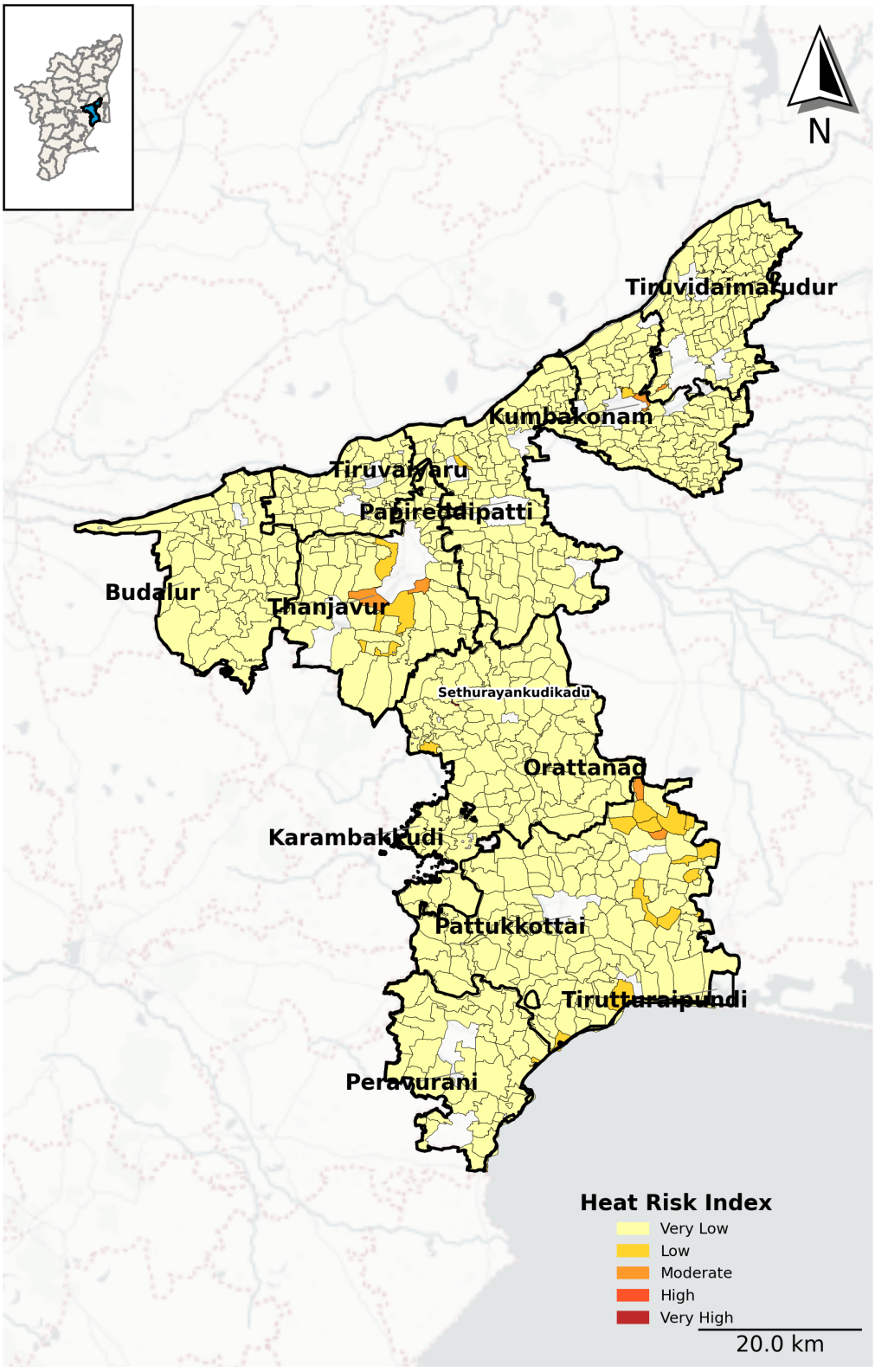
Figure B: Heat Risk Index Map of Kumbakonam City at Ward Level



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Figure C: Heat Risk Index Map of Thanjavur District at Village Panchayats level

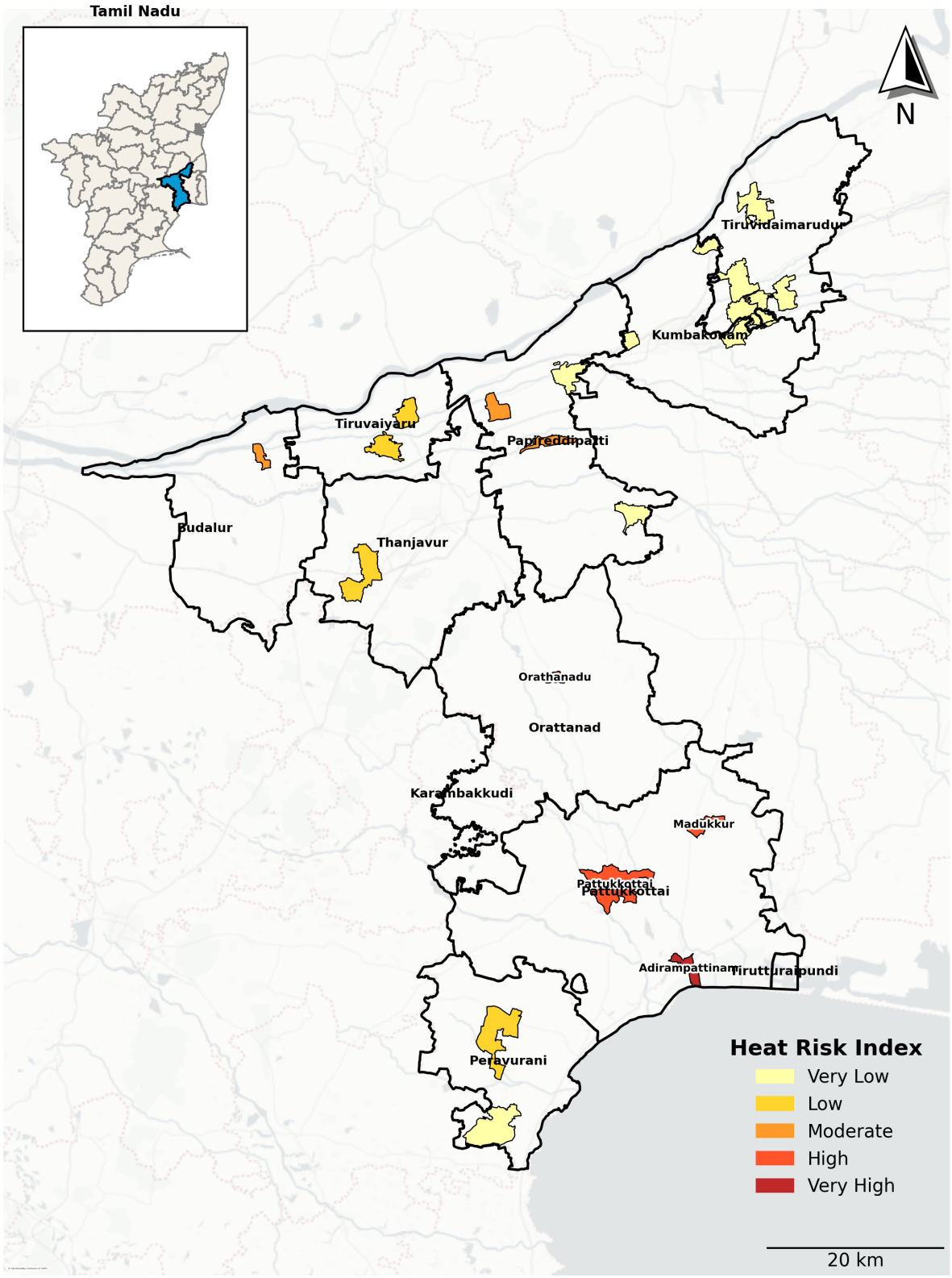


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure D: Heat Risk Index Map of Thanjavur District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: [Thanjavur]

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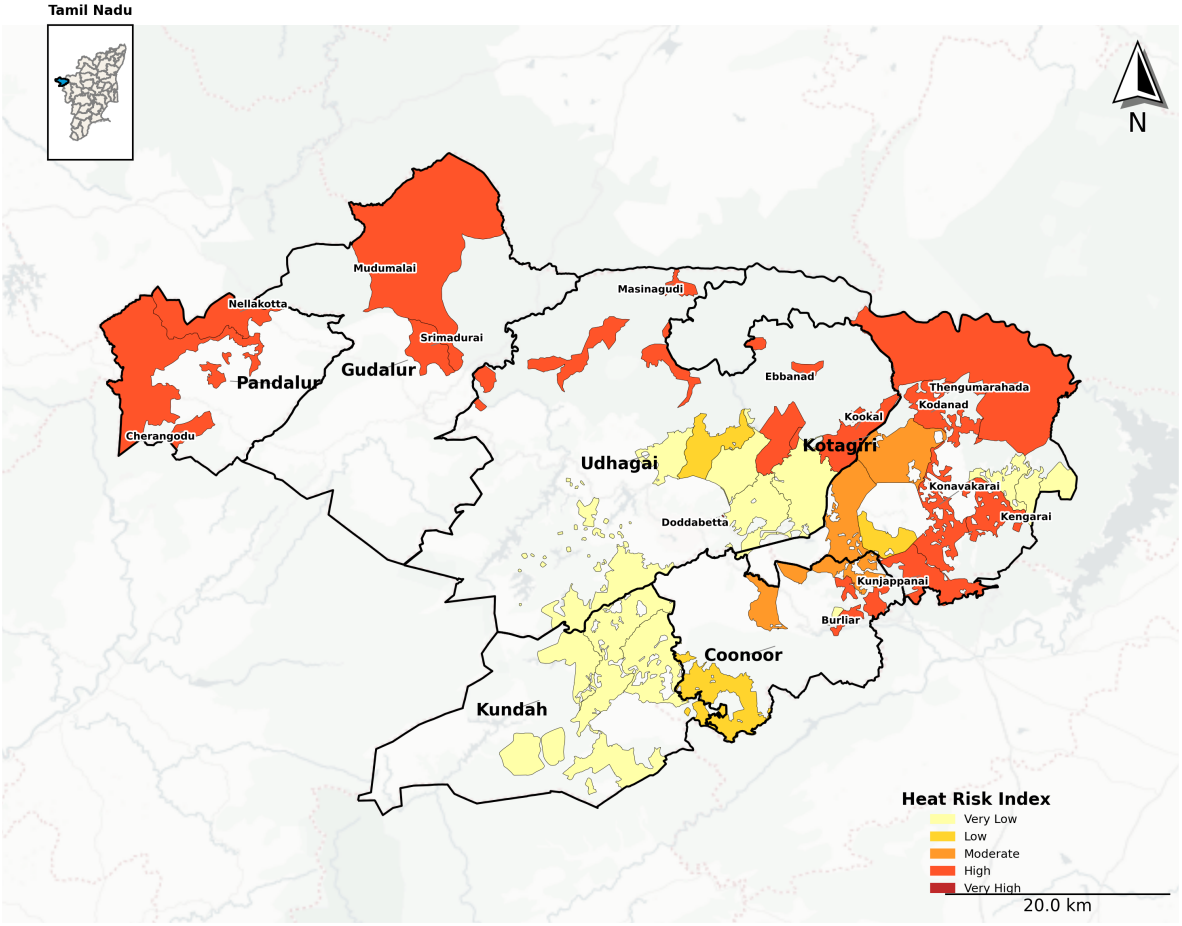
The Nilgiris District

Table 30: The Nilgiris Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Pandalur	34°C	36°C	39°C
Gudalur	33°C	35°C	38°C
Kotagiri	31°C	33°C	36°C
Coonoor	30°C	32°C	35°C
Kundah	30°C	32°C	35°C
Udhagai	30°C	32°C	35°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

Figure A: Heat Risk Index Map of the Nilgiris District at Village Panchayats level

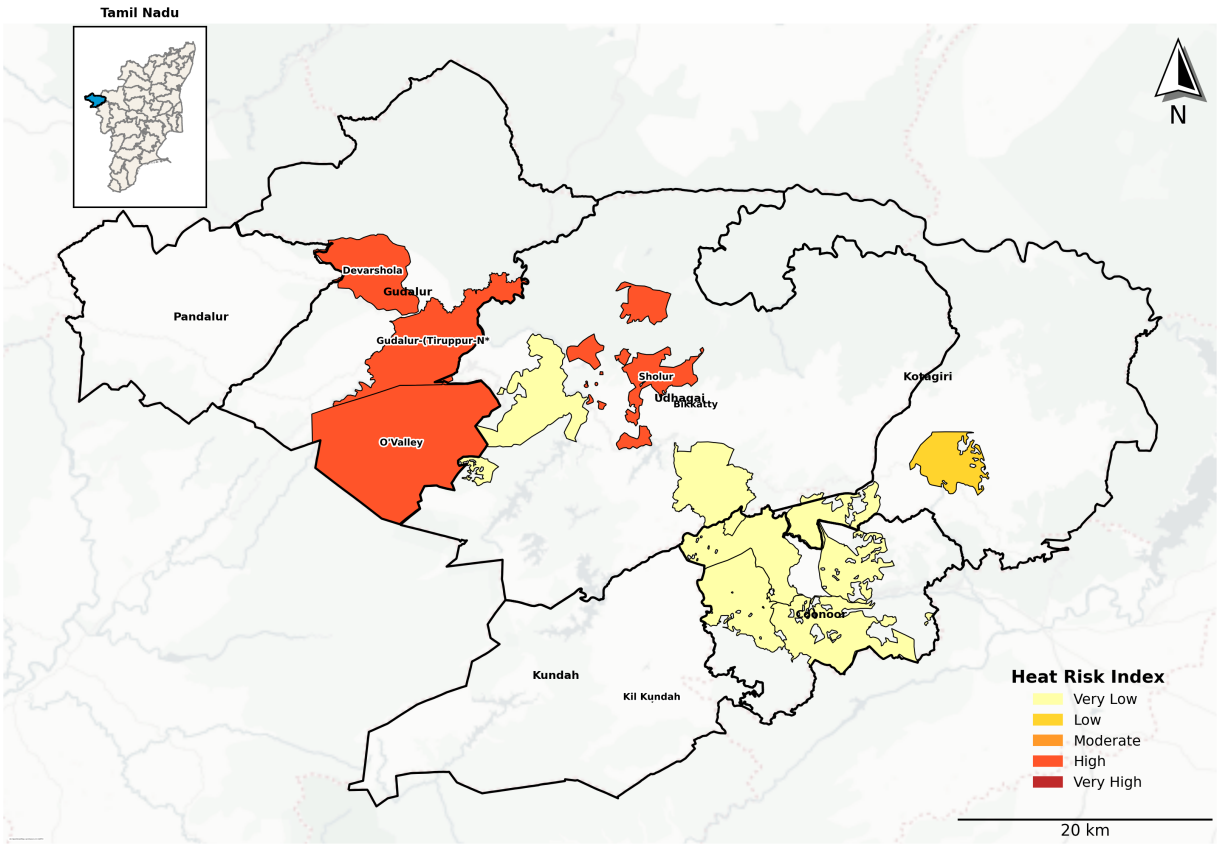


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure B: Heat Risk Index Map of the Nilgiris District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: [The Nilgiris]

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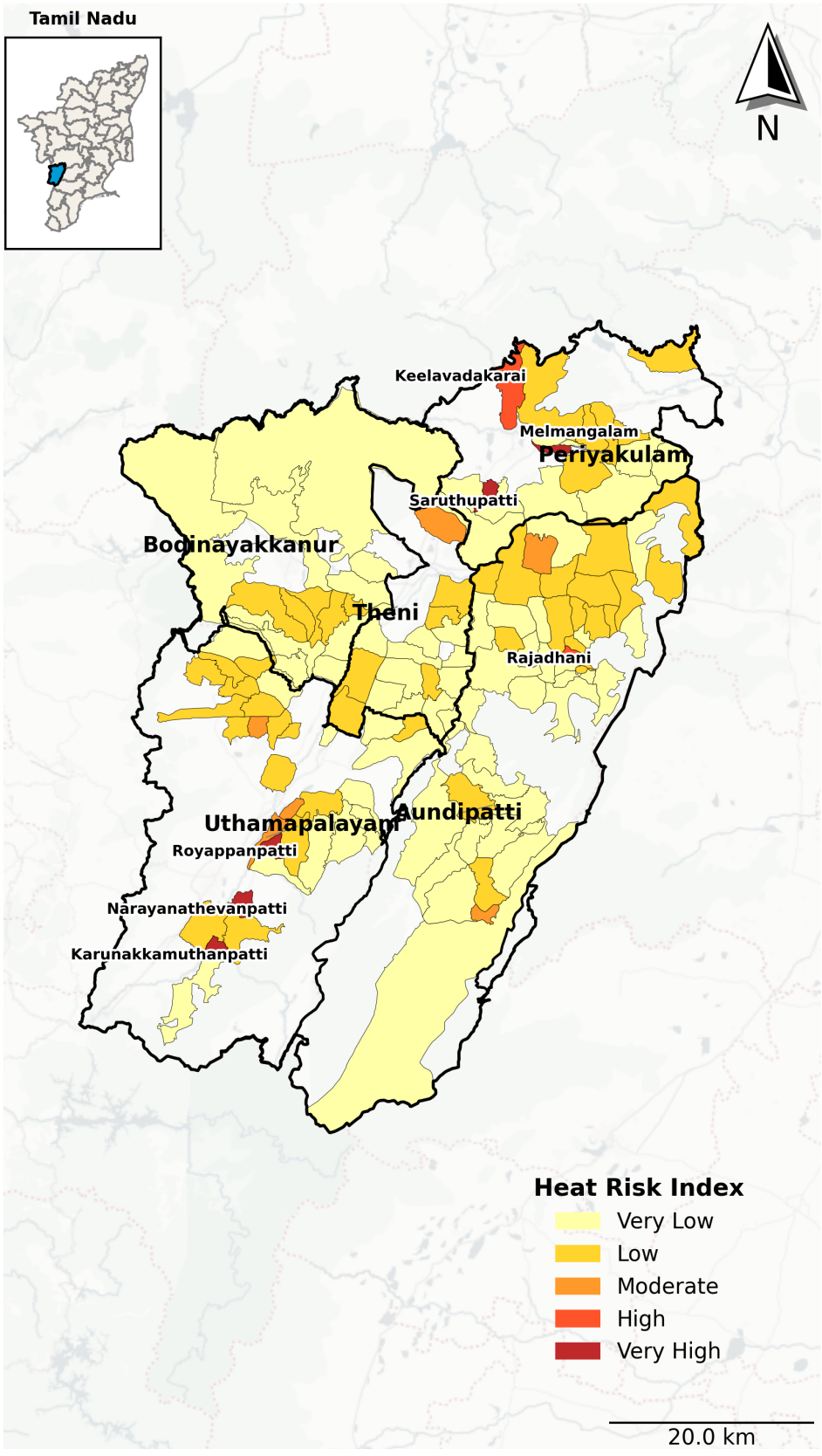
Theni District

Table 31: Theni Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Aundipatti	38°C	40°C	42°C
Theni	36°C	38°C	40°C
Periyakulam	37°C	39°C	41°C
Bodinayakanur	36°C	38°C	40°C
Uthamapalayam	35°C	37°C	39°C

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Figure A: Heat Risk Index Map of Theni District at Village Panchayats level

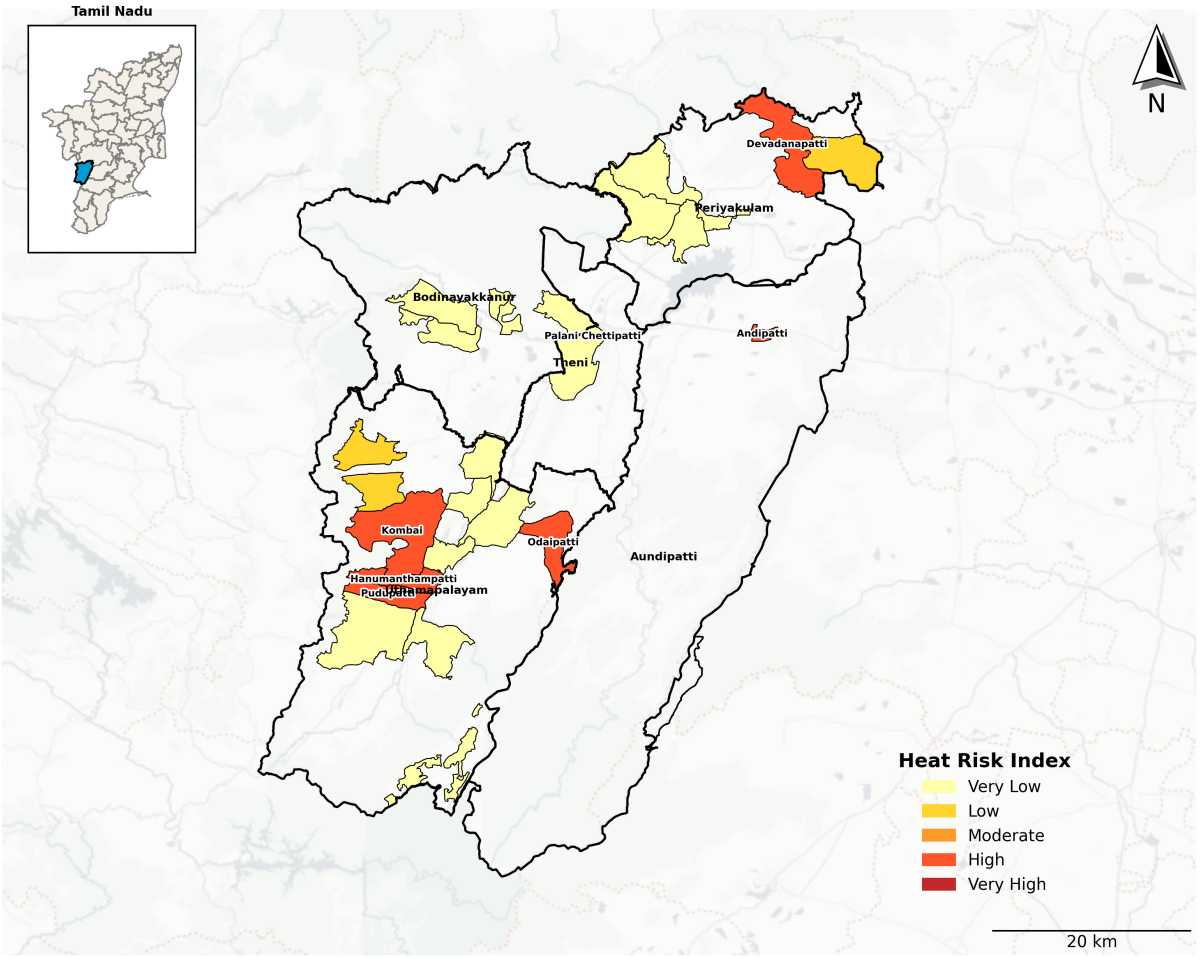


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure B: Heat Risk Index Map of Theni District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Theni

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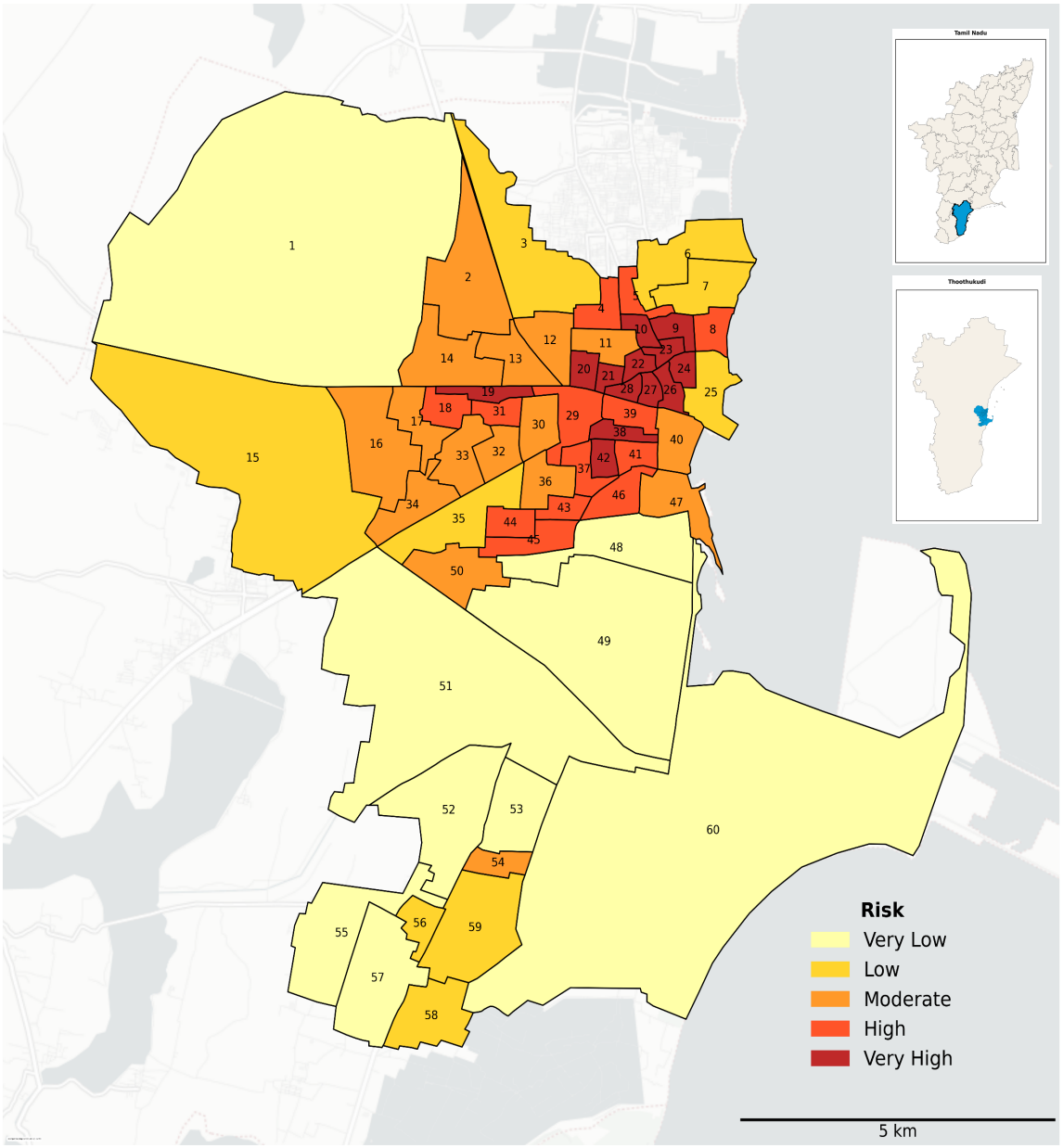
Thoothukudi District

Table 32: Thoothukudi Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Ettayapuram	40°C	42°C	44°C
Kovilpatty	40°C	42°C	44°C
Tiruchendur	37°C	39°C	41°C
Vilathikulam	39°C	41°C	43°C
Kayathar	38°C	40°C	42°C
Ottapidaram	38°C	40°C	42°C
Srivaikundam	38°C	40°C	42°C
Sattankulam	38°C	40°C	42°C
Thoothukudi	39°C	41°C	43°C
Eral	37°C	39°C	41°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Thoothukudi	39°C	41°C	43°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

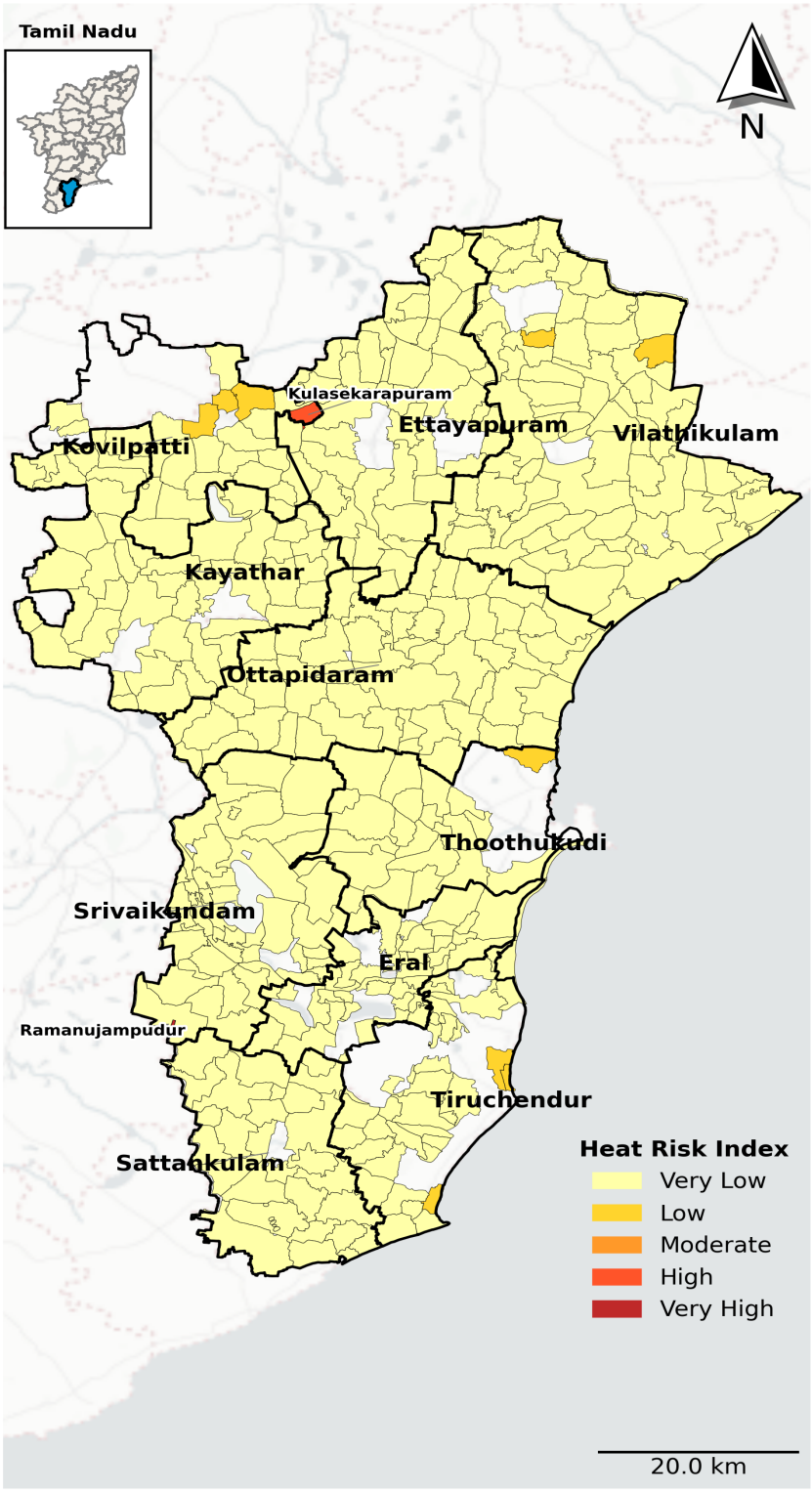
Figure A: Heat Risk Index Map of Thoothukudi City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Thoothukudi District at Village Panchayats level

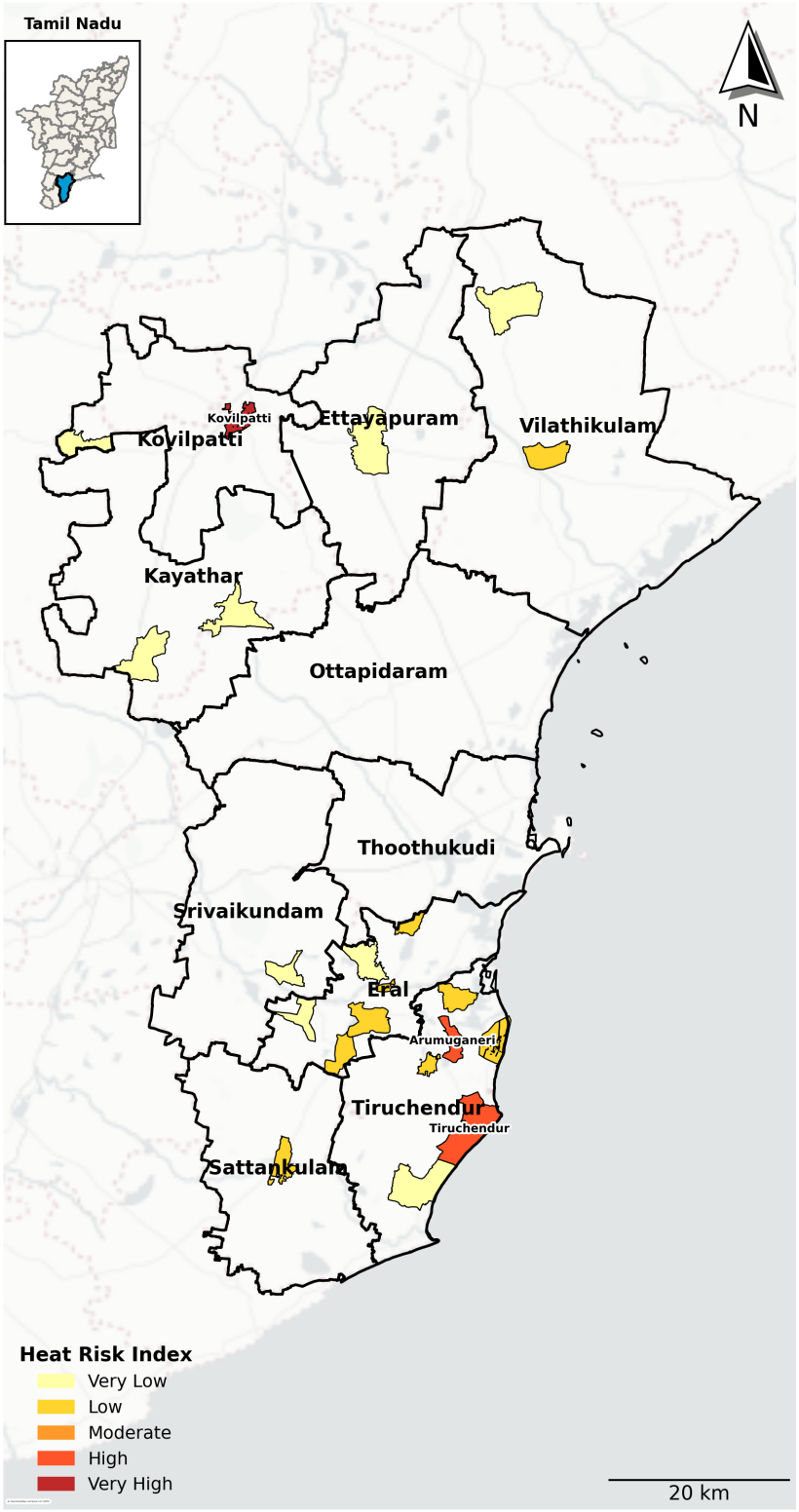


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure C: Heat Risk Index Map of Thoothukudi District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: [Thoothukudi]

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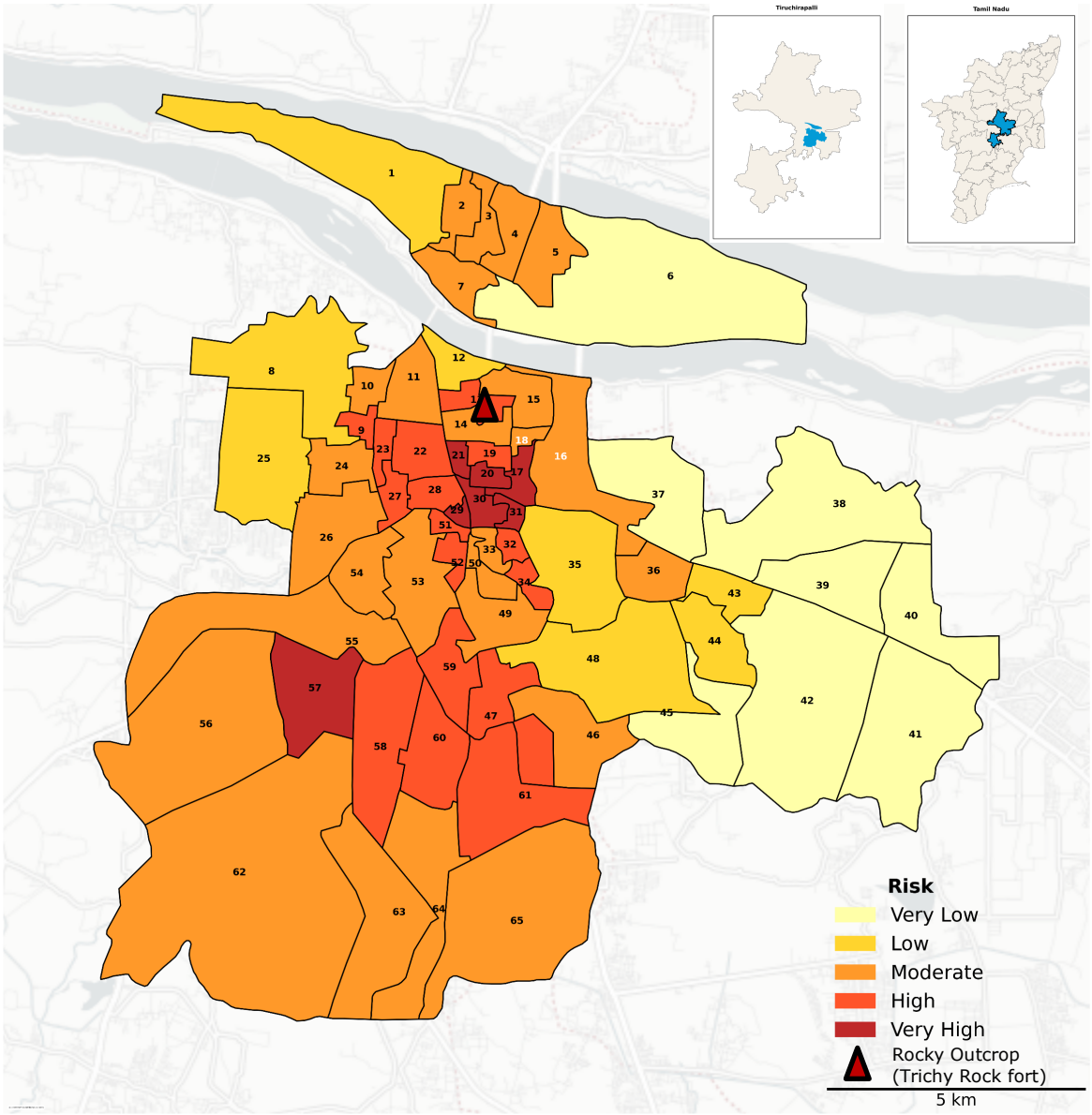
Tiruchirappalli District

Table 33: Tiruchirapalli Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Lalgudi	40°C	42°C	44°C
Mannachanallur	40°C	42°C	44°C
Musiri	40°C	42°C	44°C
Thottiam	40°C	42°C	44°C
Thiruchirapalli-west	40°C	42°C	44°C
Tiruchirappalli-east	40°C	42°C	44°C
Marungapuri	40°C	42°C	44°C
Manapparai	40°C	42°C	44°C
Thuraiyur	40°C	42°C	44°C
Srirangam	40°C	42°C	44°C
Thiruverumbur	40°C	42°C	44°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Tiruchirappalli	40°C	42°C	44°C

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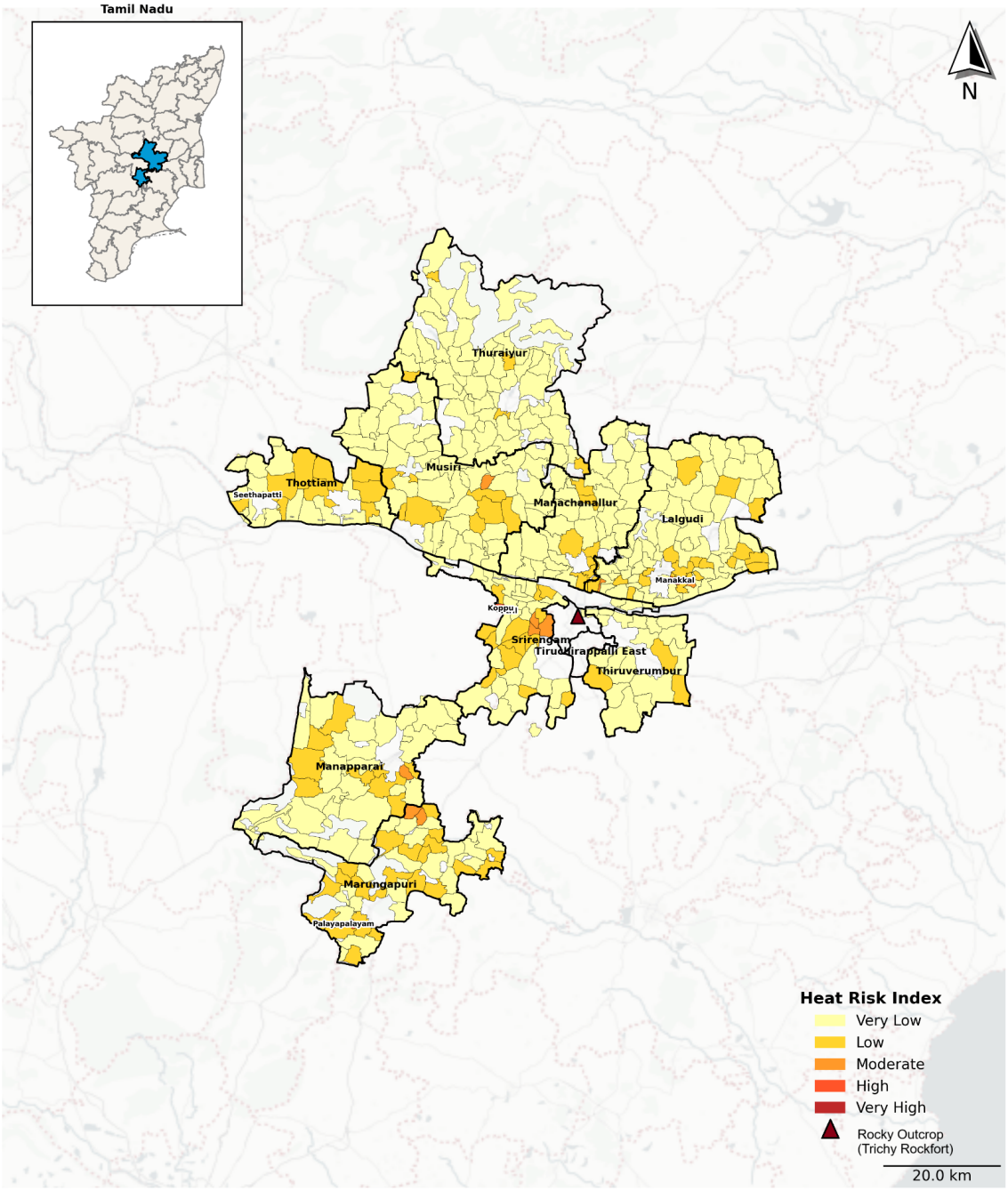
Figure A: Heat Risk Index Map of Tiruchirappalli City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Tiruchirappalli District at Village Panchayats level



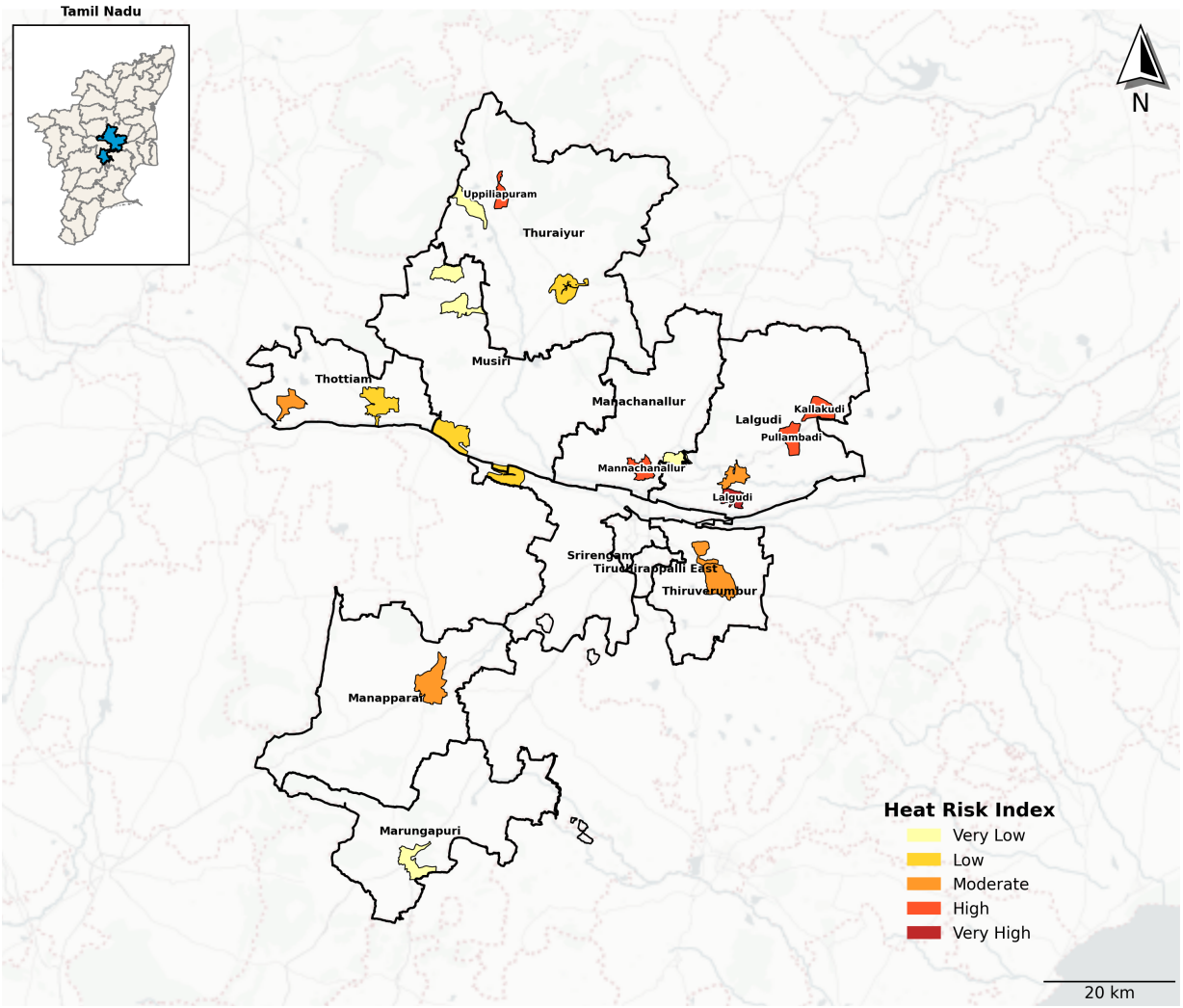
Disclaimer: The presence of bare rock/rocky hills can locally elevate surface temperatures through heat reflectance, influencing mapped heat-risk levels.

Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure C: Heat Risk Index Map of Tiruchirappalli District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: [Tiruchirappalli]

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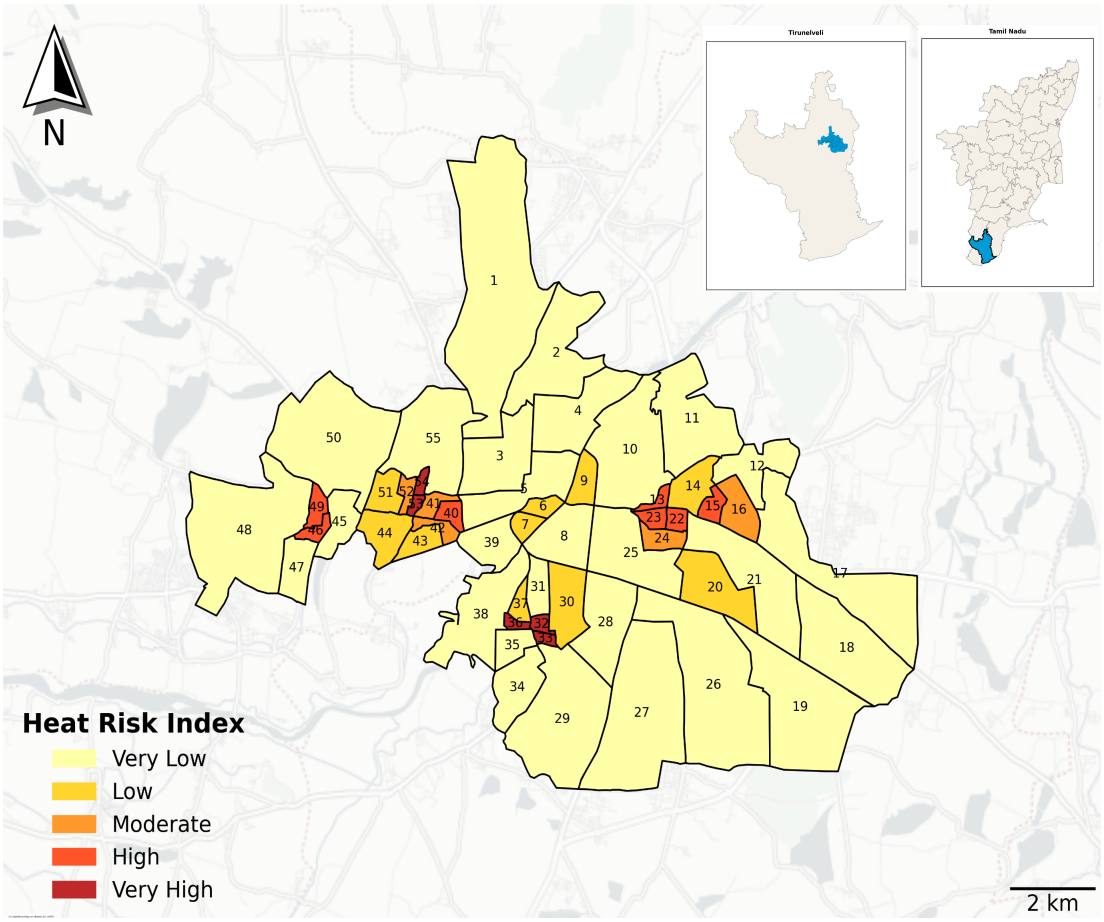
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Tirunelveli District

Table 34: Tirunelveli Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Radhapuram	37°C	39°C	41°C
Thisayanvilai	37°C	39°C	41°C
Manur	38°C	40°C	42°C
Tirunelveli	39°C	41°C	43°C
Palayamkottai	39°C	41°C	43°C
Cheranmahadevi	38°C	40°C	42°C
Nanguneri	37°C	39°C	41°C
Ambasamudram	37°C	39°C	41°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Tirunelveli	39°C	41°C	43°C

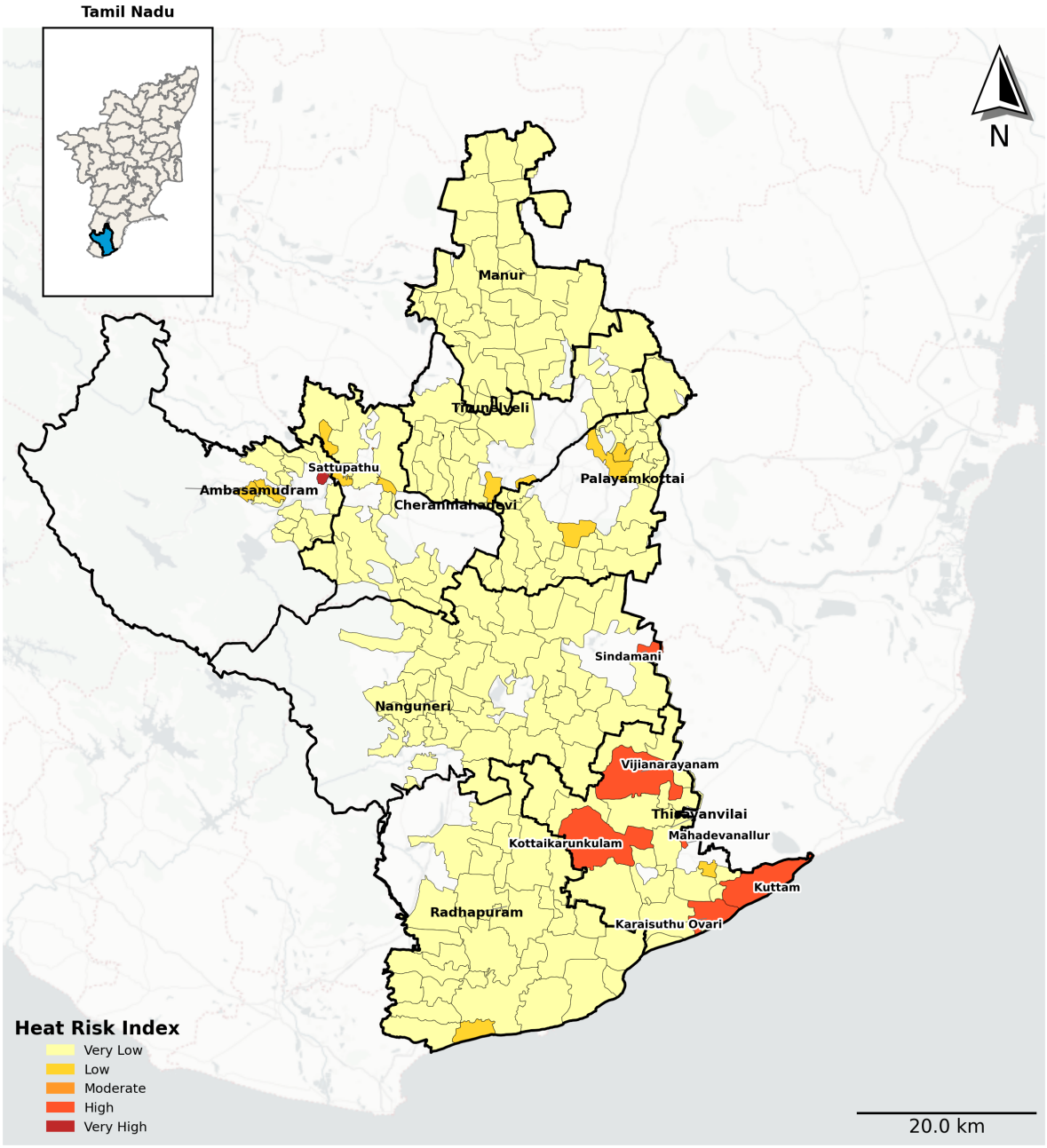
Figure A: Heat Risk Index Map of Tirunelveli City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Tirunelveli District at Village Panchayats level

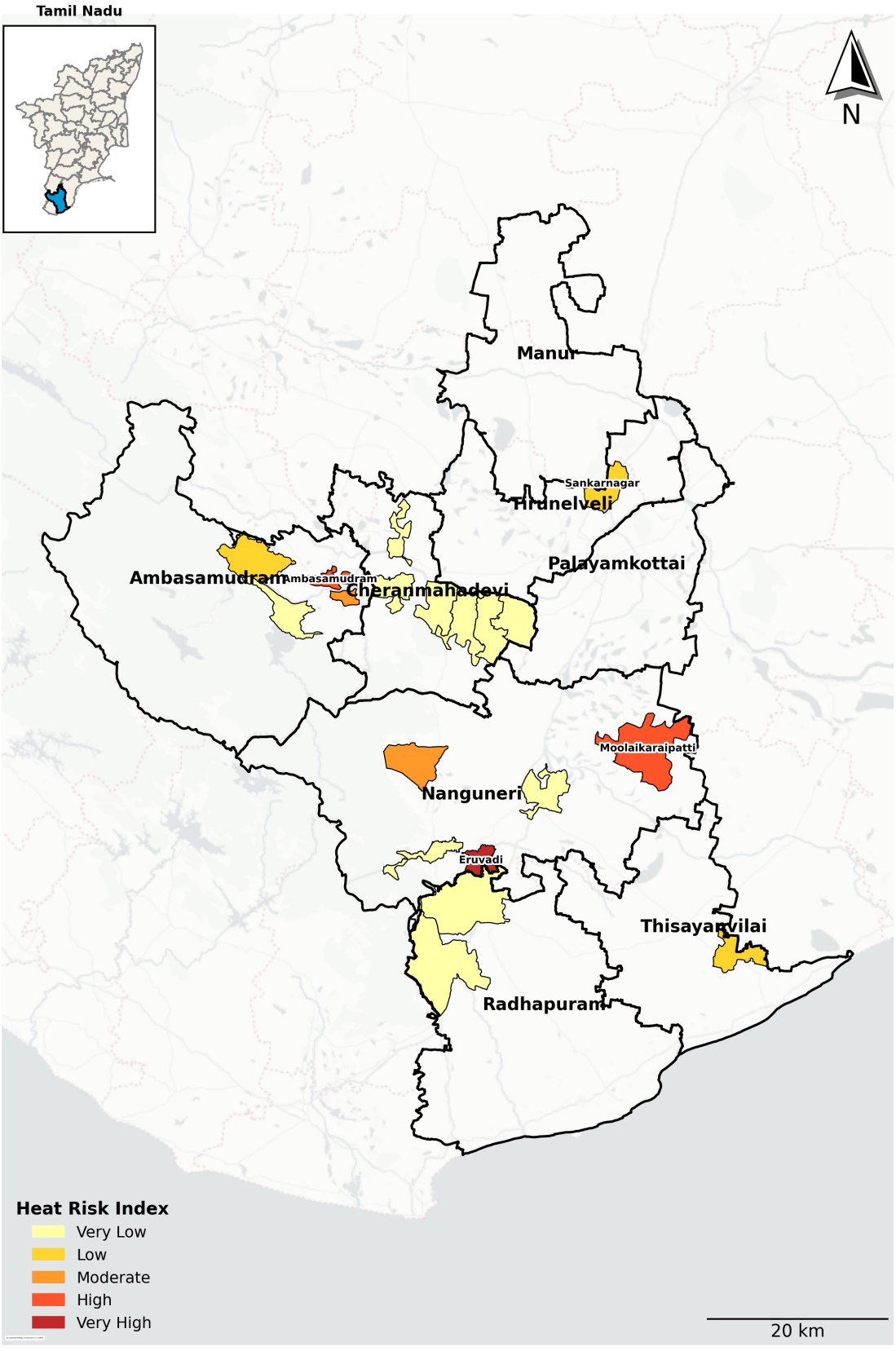


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure C: Heat Risk Index Map of Tirunelveli District at Village Panchayats level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: [Tirunelveli]

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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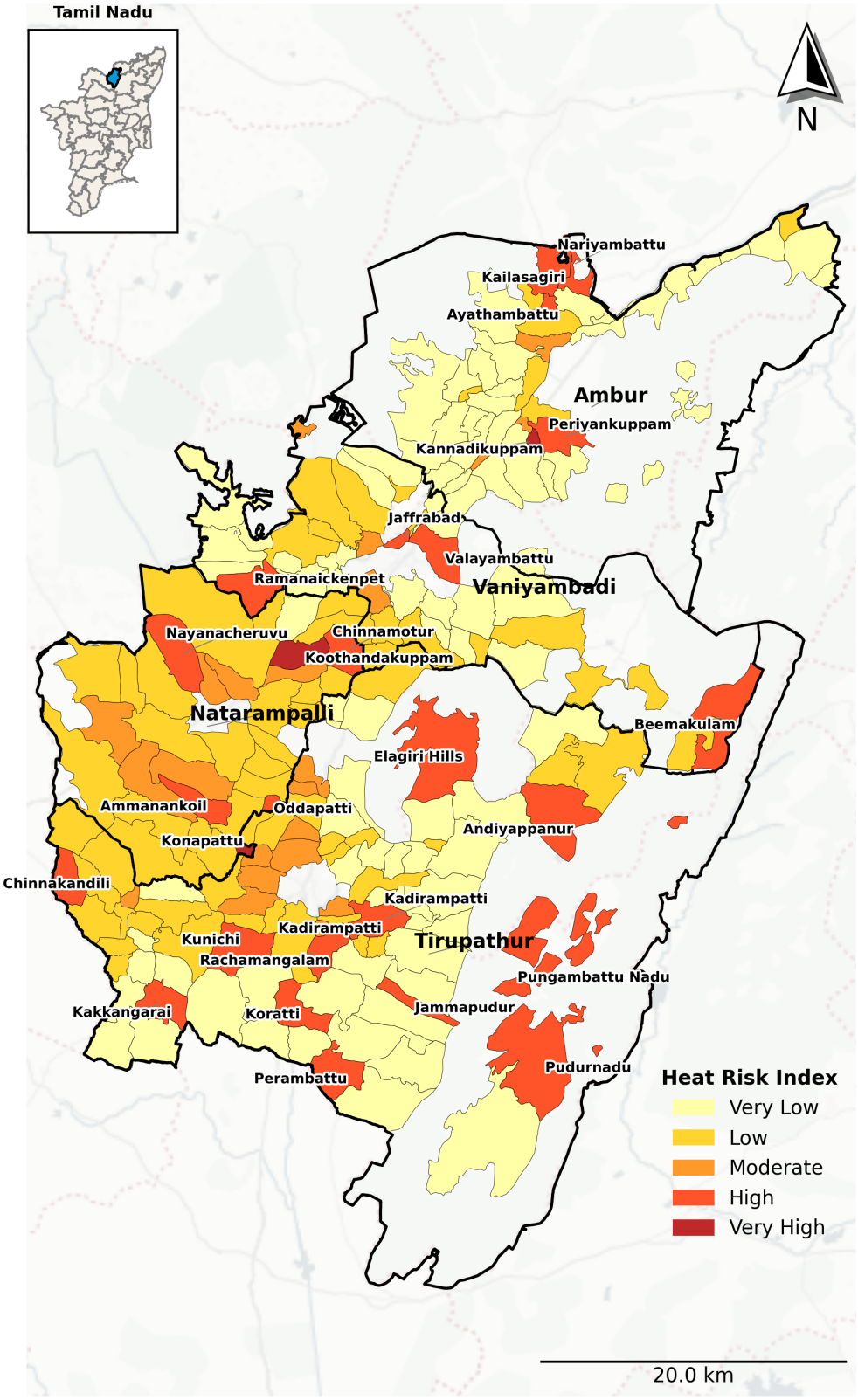
Tirupathur District

Table 35: Tiruapttur Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Natrampalli	40°C	42°C	44°C
Vaniyambadi	40°C	42°C	44°C
Ambur	40°C	42°C	44°C
Tirupattur	38°C	40°C	42°C

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Figure A: Heat Risk Index Map of Tirupathur District at Village Panchayats level

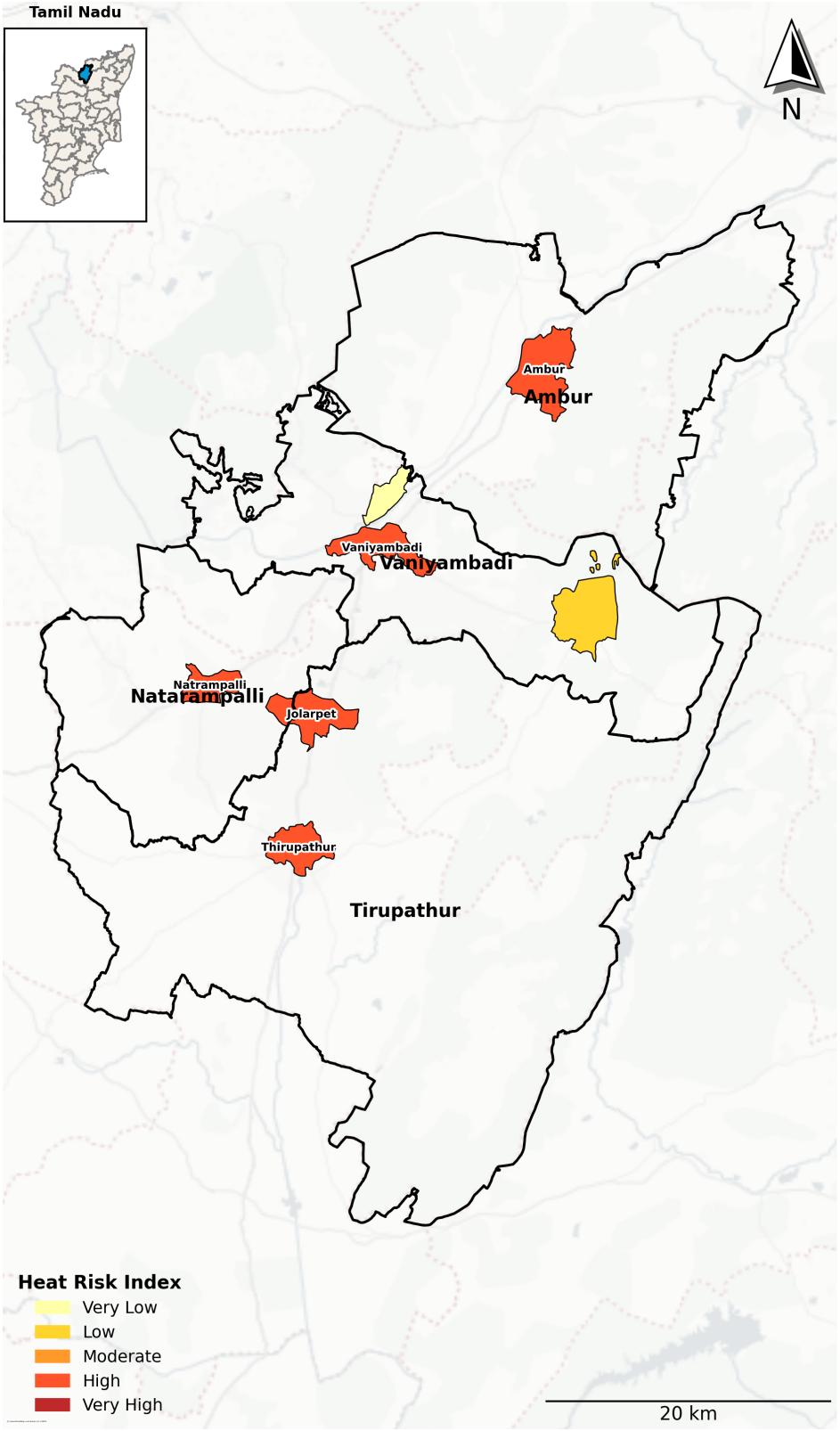


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Tirupathur District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Tirupathur

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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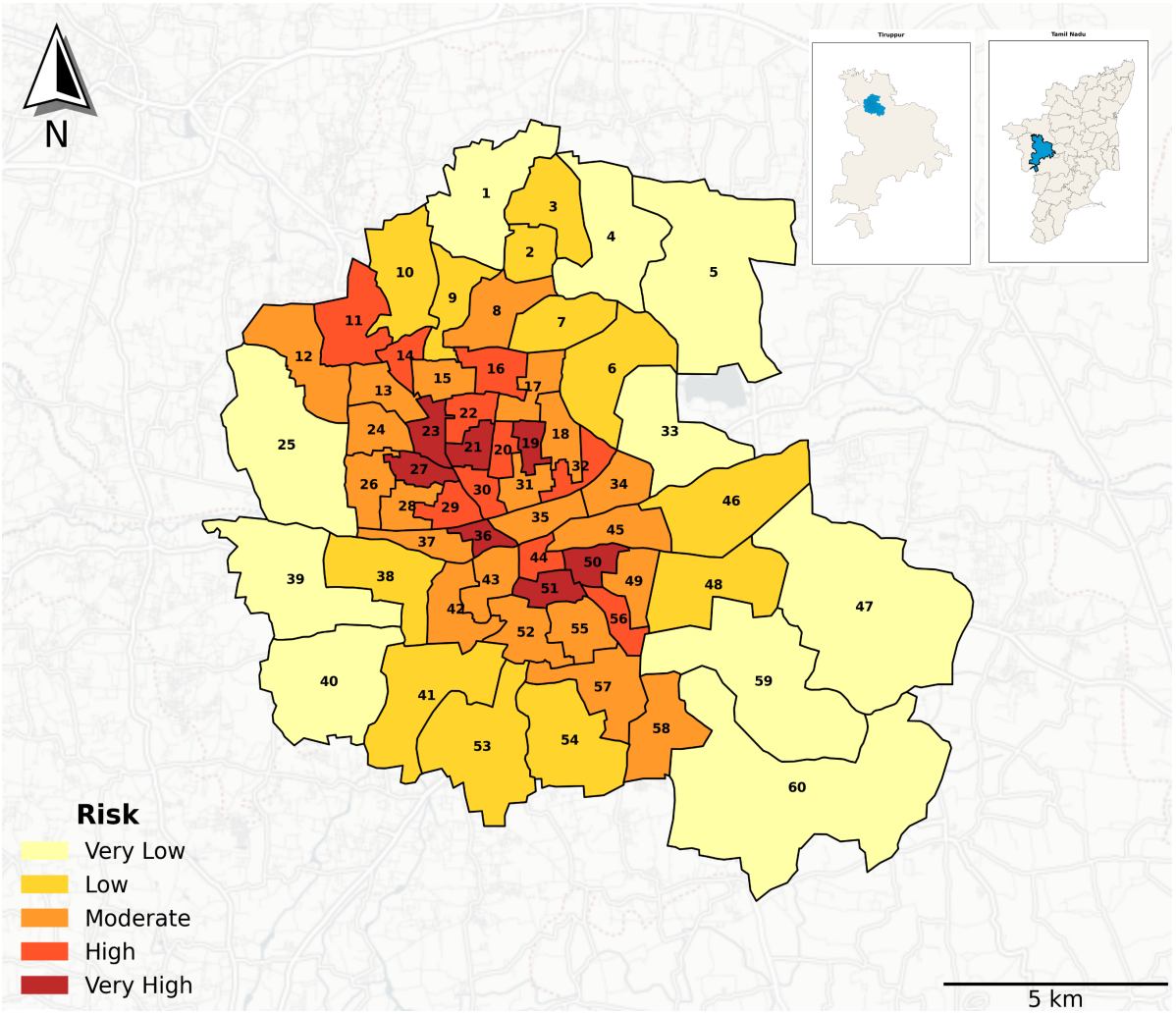
Tiruppur District

Table 36: Tiruppur Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Tiruppur south	39°C	41°C	43°C
Tiruppur north	39°C	41°C	43°C
Madathukkulam	39°C	41°C	43°C
Avinashi	39°C	41°C	43°C
Uthukkuli	39°C	41°C	43°C
Kangeyam	39°C	41°C	43°C
Dharapuram	39°C	41°C	43°C
Udumalpet	37°C	39°C	41°C
Palladam	38°C	40°C	42°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Tiruppur	39°C	41°C	43°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

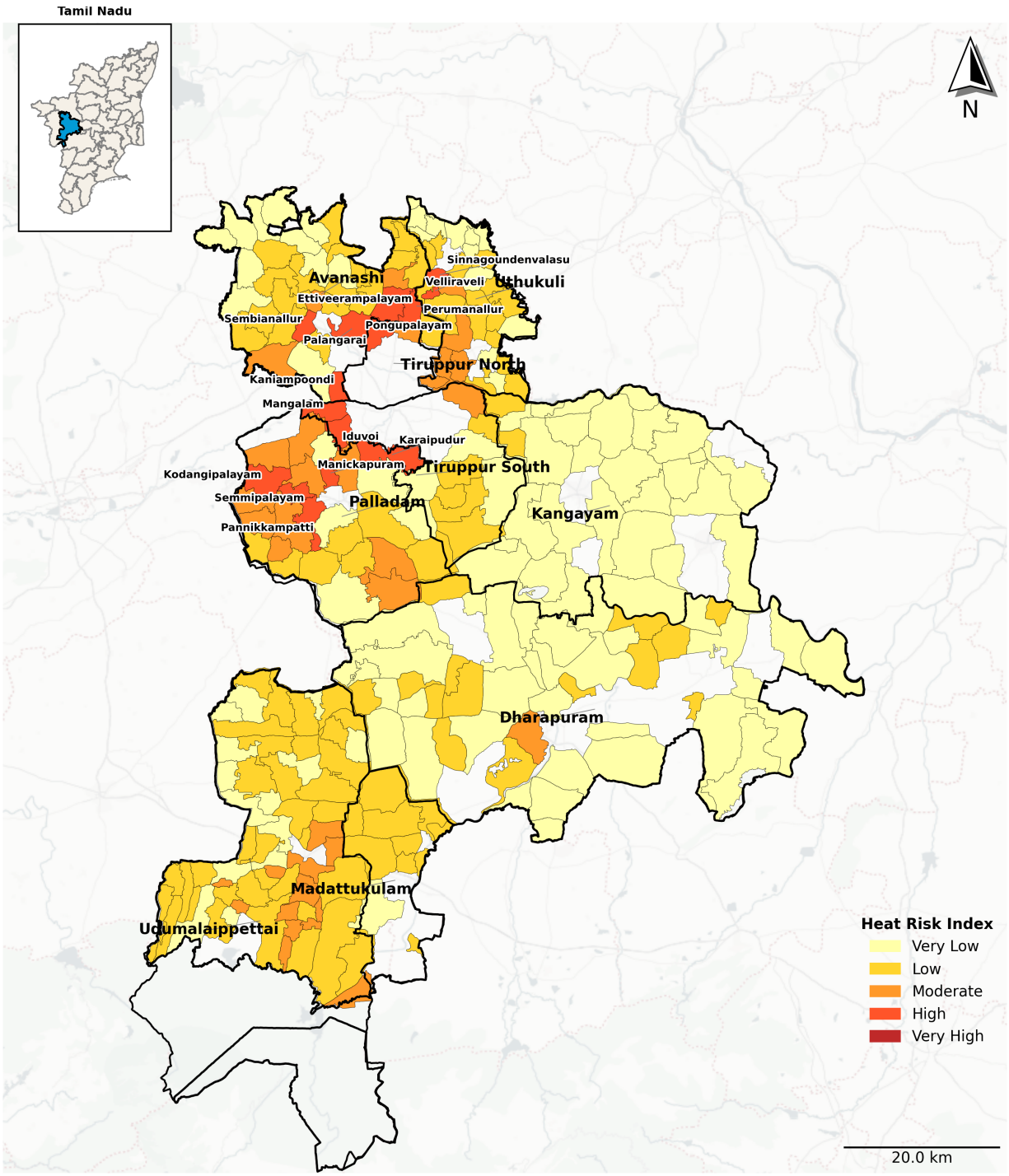
Figure A: Heat Risk Index Map of Tiruppur City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Tiruppur District at Village Panchayats level

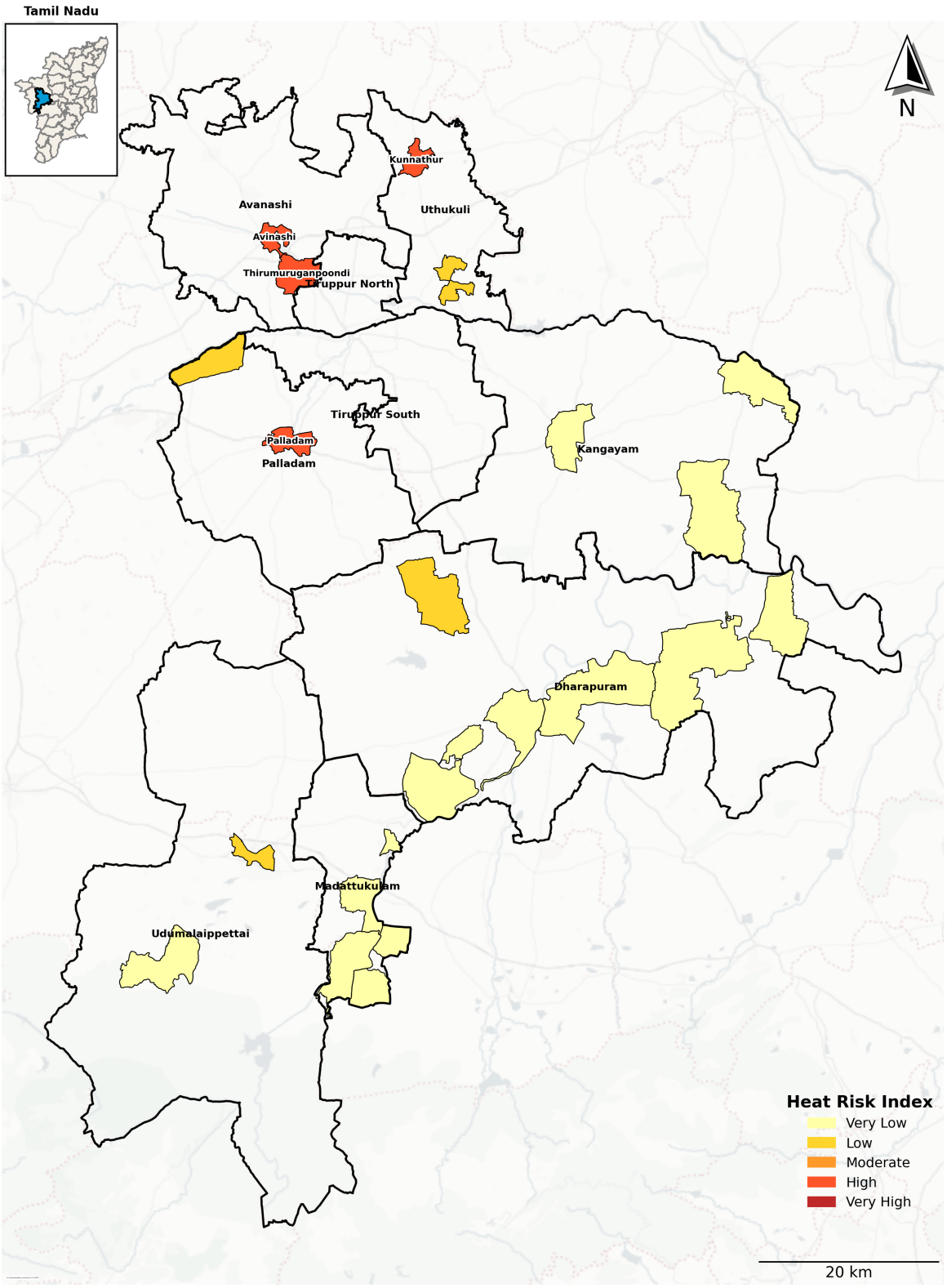


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure C: Heat Risk Index Map of Tiruppur District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: [Tiruppur]

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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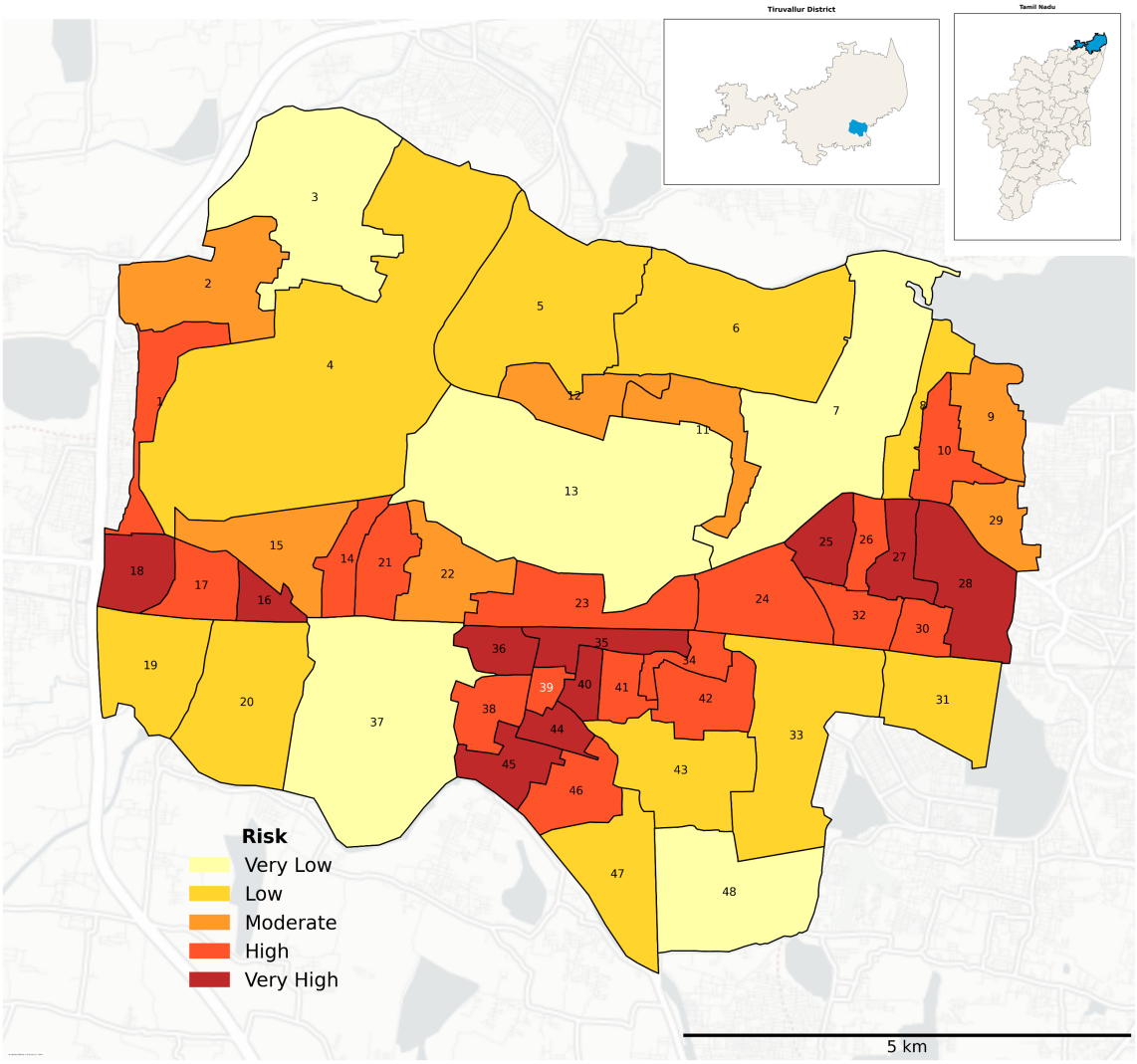
Tiruvallur District

Table 37: Tiruvallur Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Tiruvallur	40°C	42°C	44°C
Tiruttani	40°C	42°C	44°C
Gummidipoondi	40°C	42°C	44°C
Uthukottai	40°C	42°C	44°C
Avadi	38°C	40°C	42°C
Poonamallee	39°C	41°C	43°C
R.k. pettai	40°C	42°C	44°C
Pallipattu	40°C	42°C	44°C
Ponneri	37°C	39°C	41°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Avadi	38°C	40°C	42°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

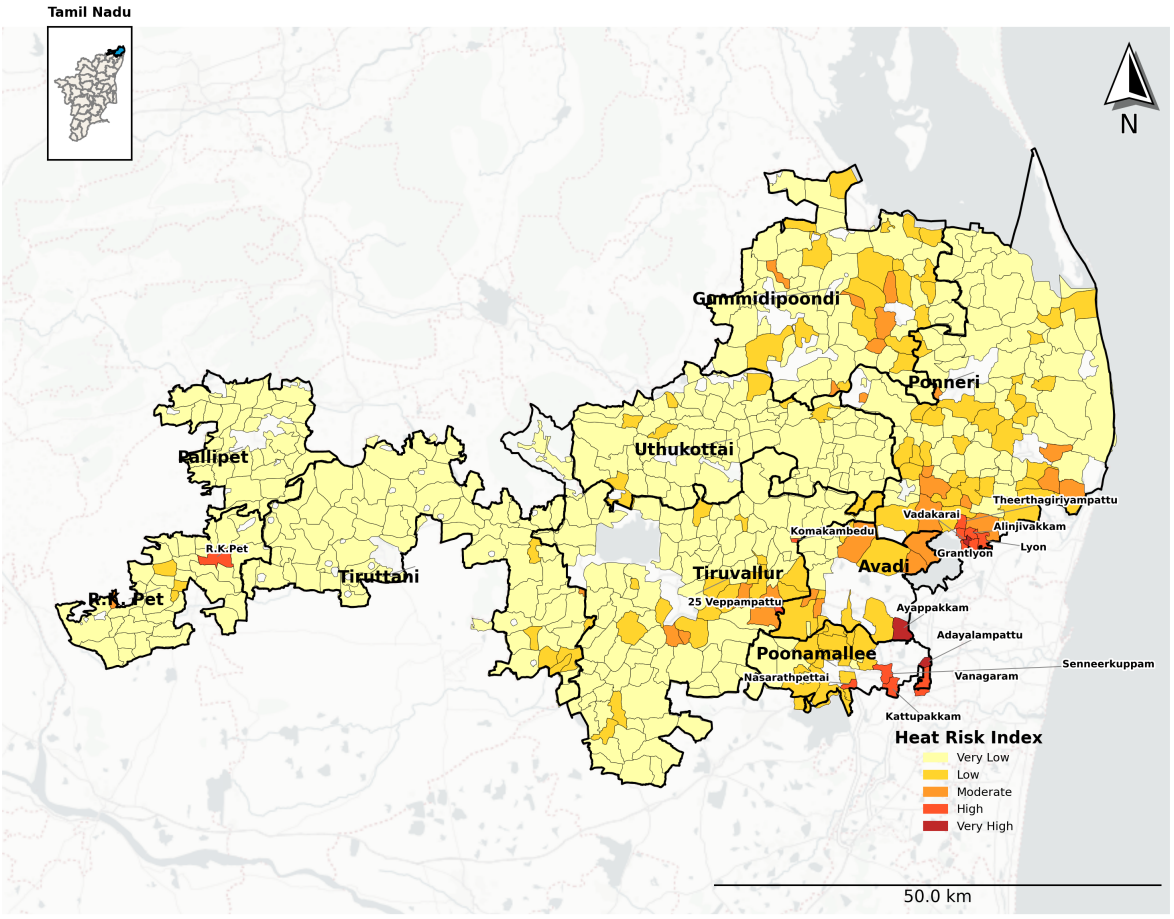
Figure A: Heat Risk Index Map of Avadi City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Tiruvallur District at Village Panchayats level

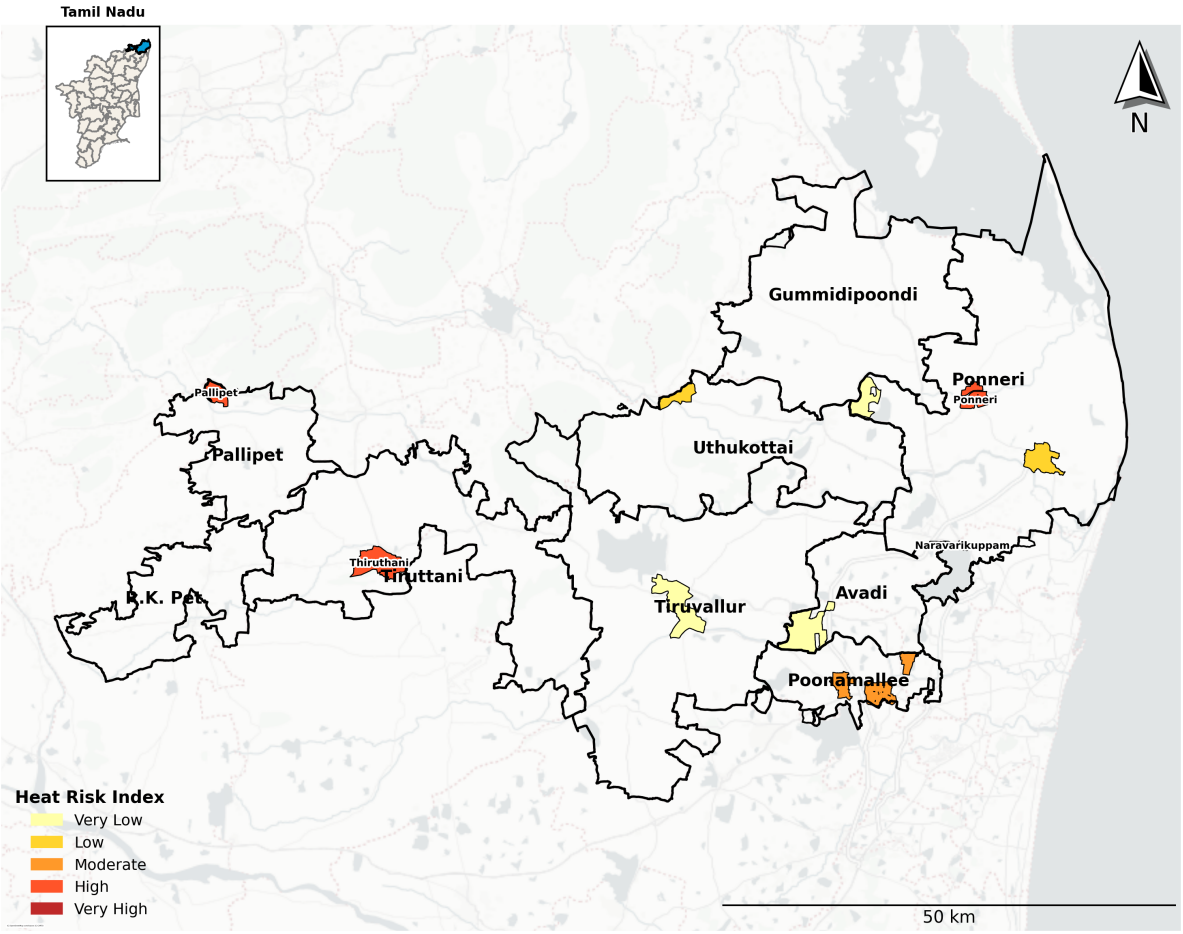


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure C: Heat Risk Index Map of Tiruvallur District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: [Tiruvallur]

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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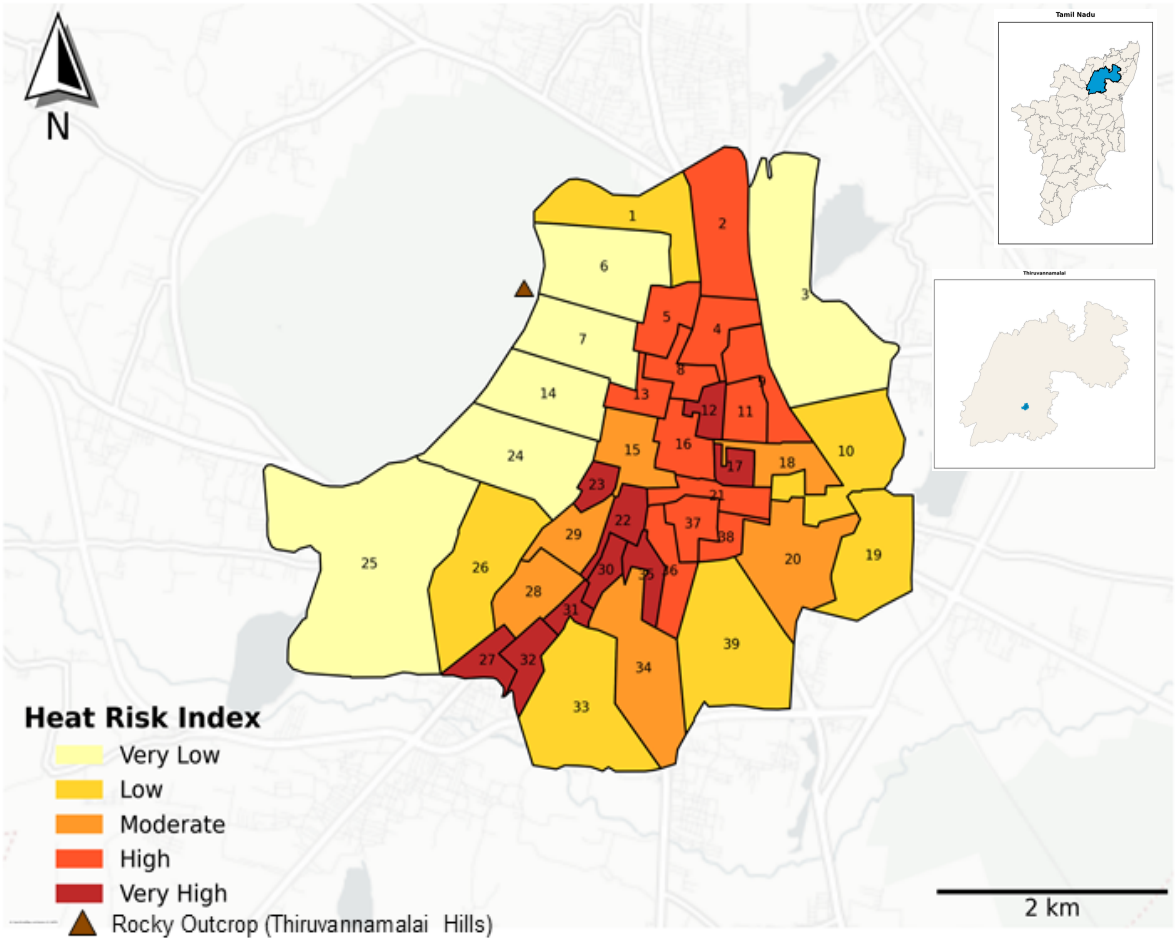
Tiruvannamalai District

Table 38: Tiruvannamalai Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Vembakkam	40°C	42°C	44°C
Cheyyar	40°C	42°C	44°C
Arni	40°C	42°C	44°C
Vandavasi	40°C	42°C	44°C
Chetpet	40°C	42°C	44°C
Kilpennathur	40°C	42°C	44°C
Polur	40°C	42°C	44°C
Tiruvannamalai	40°C	42°C	44°C
Thandrampet	39°C	41°C	43°C
Chengam	39°C	41°C	43°C
Jamunamarathoor	38°C	40°C	42°C
Kalasapakkam	38°C	40°C	42°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Tiruvannamalai	40°C	42°C	44°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

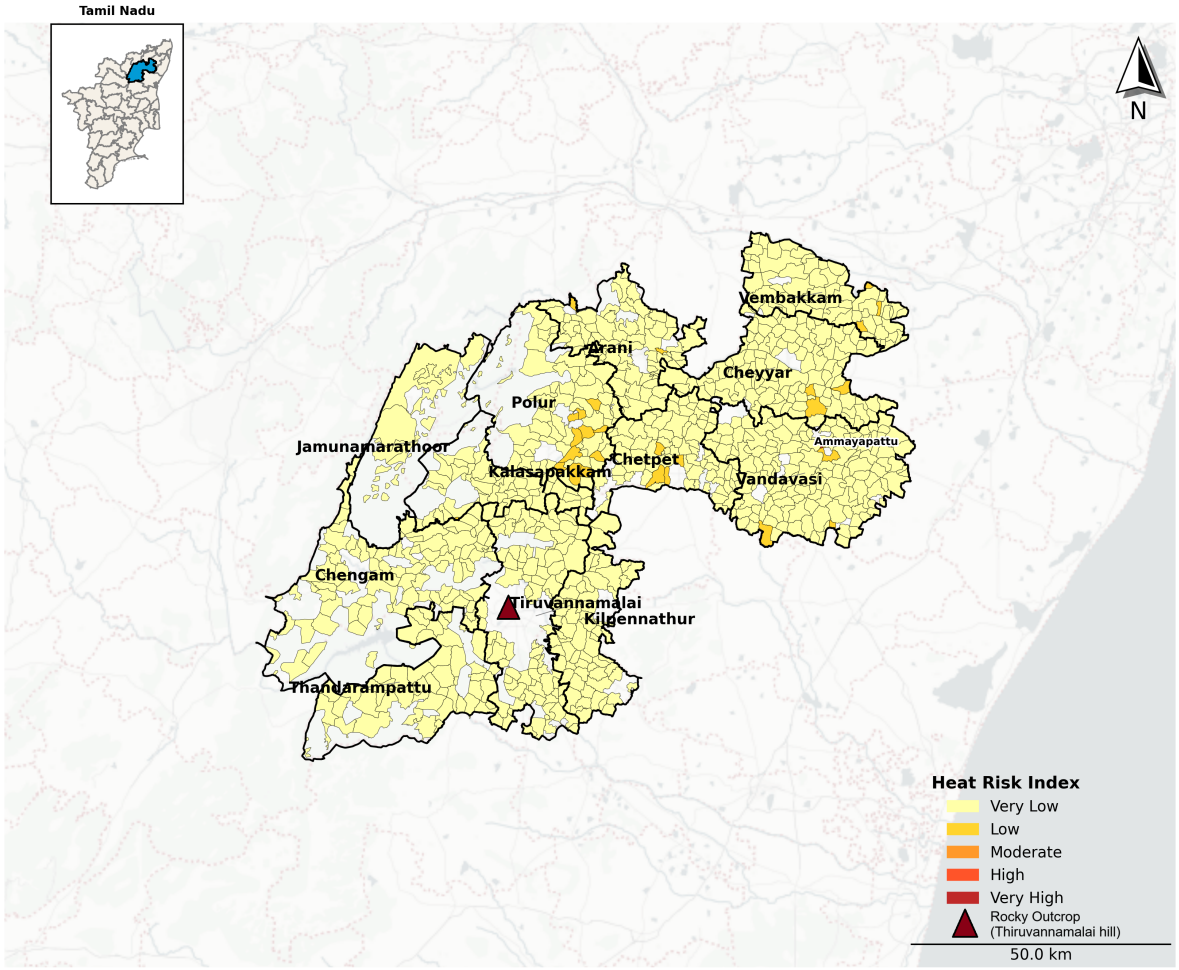
Figure A: Heat Risk Index Map of Tiruvannamalai City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Tiruvannamalai District at Village Panchayats level



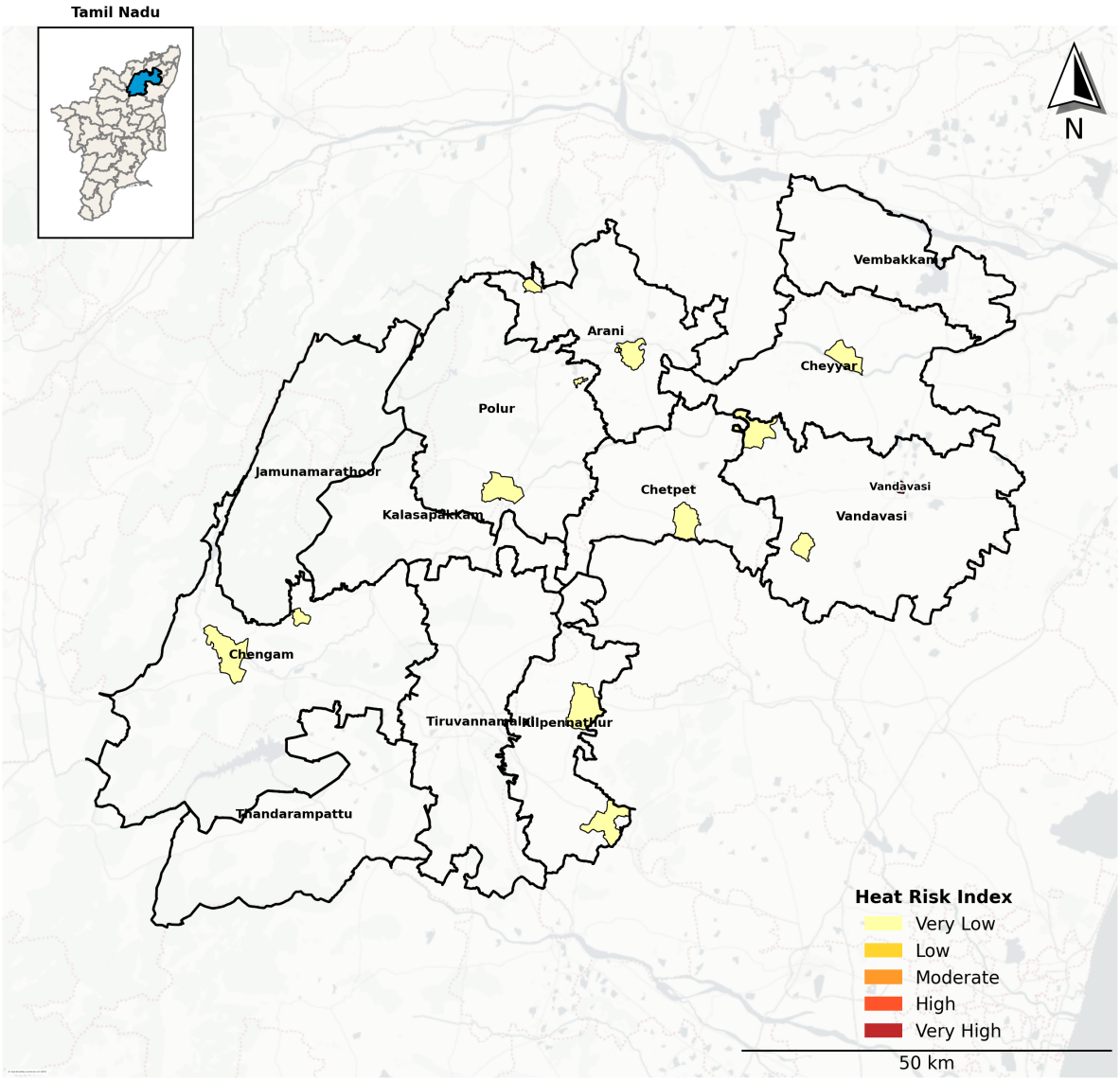
Disclaimer: Presence of bare rock/rocky hills can elevate surface temperature locally through heat reflectance, influencing mapped heat-risk levels.

Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure C: Heat Risk Index Map of Tiruvannamalai District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: [Tiruvannamalai]

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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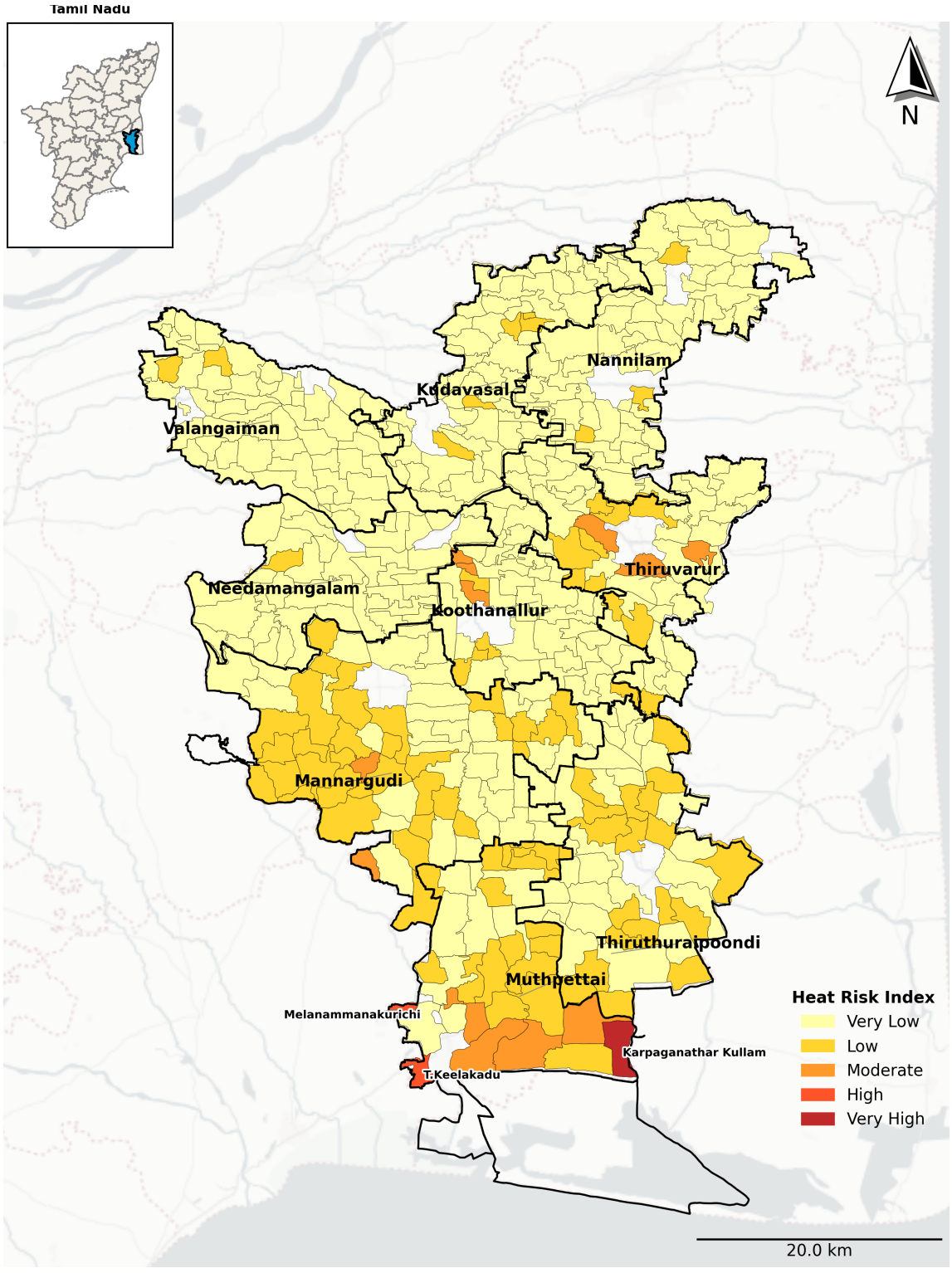
Tiruvarur District

Table 39: Tiruvarur Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Valangaiman	40°C	42°C	44°C
Koothanallur	40°C	42°C	44°C
Kudavasal	39°C	41°C	43°C
Needamangalam	39°C	41°C	43°C
Nannilam	39°C	41°C	43°C
Thiruvarur	39°C	41°C	43°C
Mannargudi	39°C	41°C	43°C
Thiruthuraipoondi	37°C	39°C	41°C
Muthupettai	37°C	39°C	41°C

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Figure A: Heat Risk Index Map of Tiruvarur District at Village Panchayats level

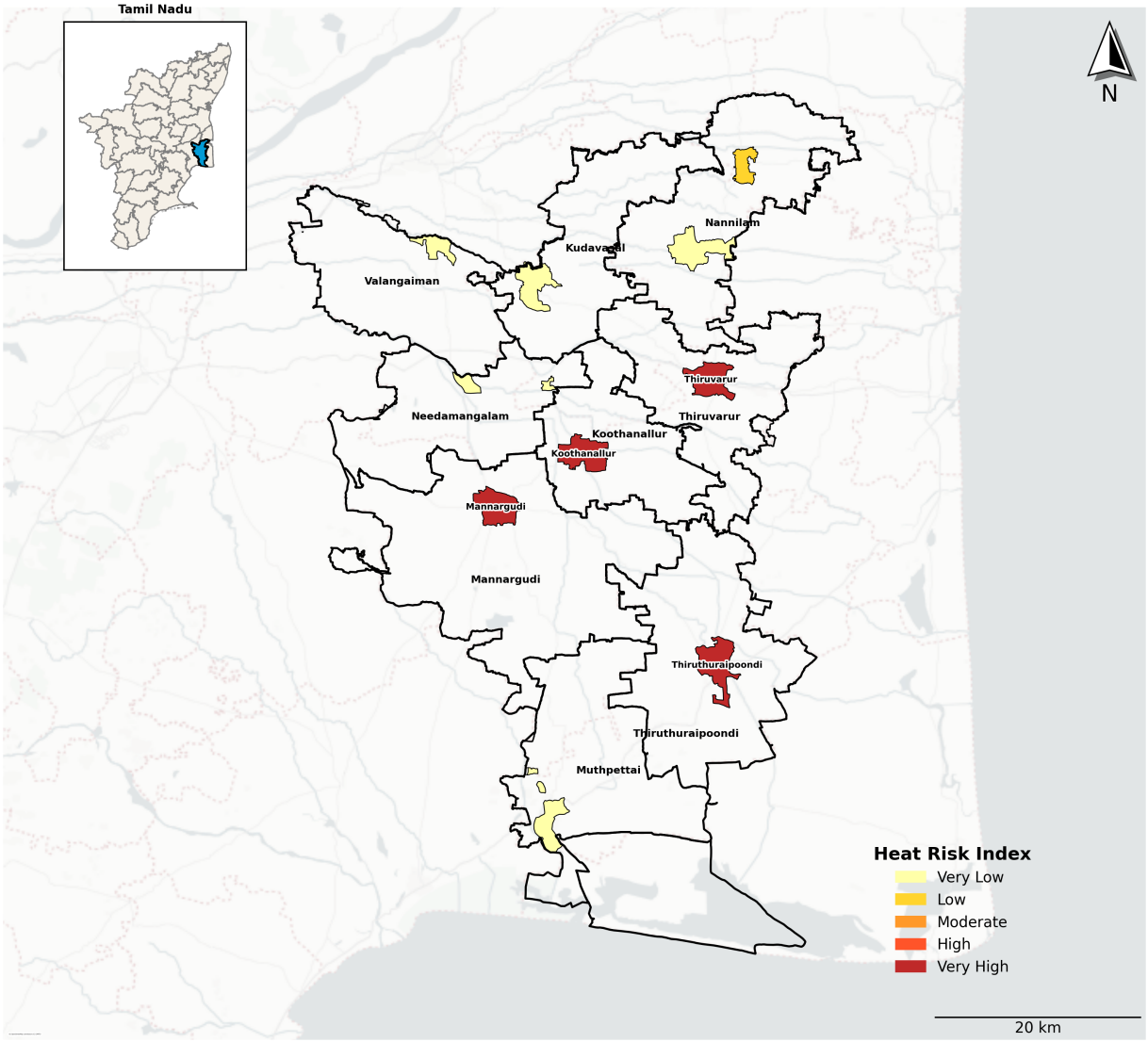


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure B: Heat Risk Index Map of Tiruvarur District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: [Tiruvarur]

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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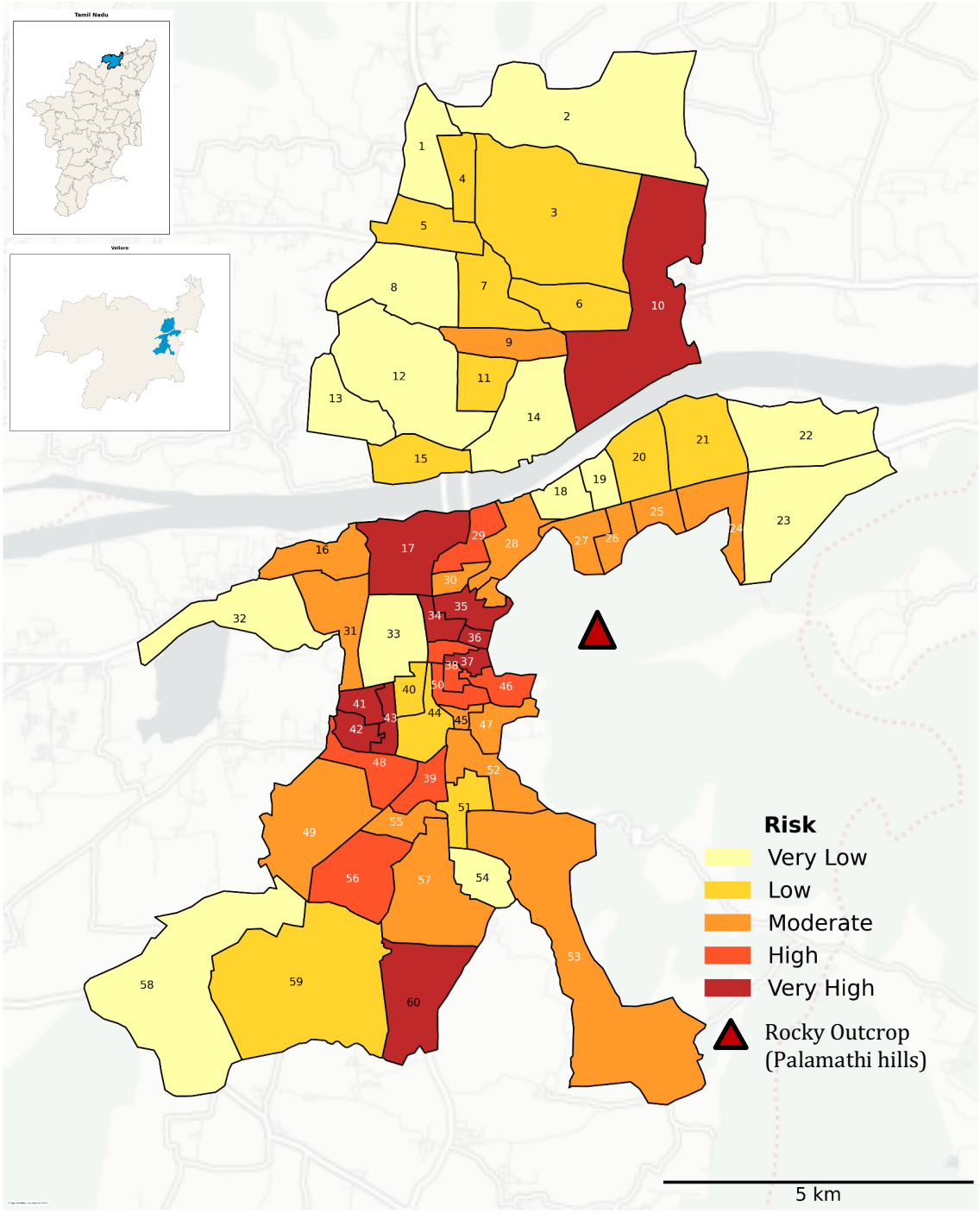
Vellore District

Table 40: Vellore Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Pernambut	40°C	42°C	44°C
Vellore	40°C	42°C	44°C
Gudiyatham	40°C	42°C	44°C
K V Kuppam	40°C	42°C	44°C
Katpadi	40°C	42°C	44°C
Anaicut	39°C	41°C	43°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Vellore	40°C	42°C	44°C

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

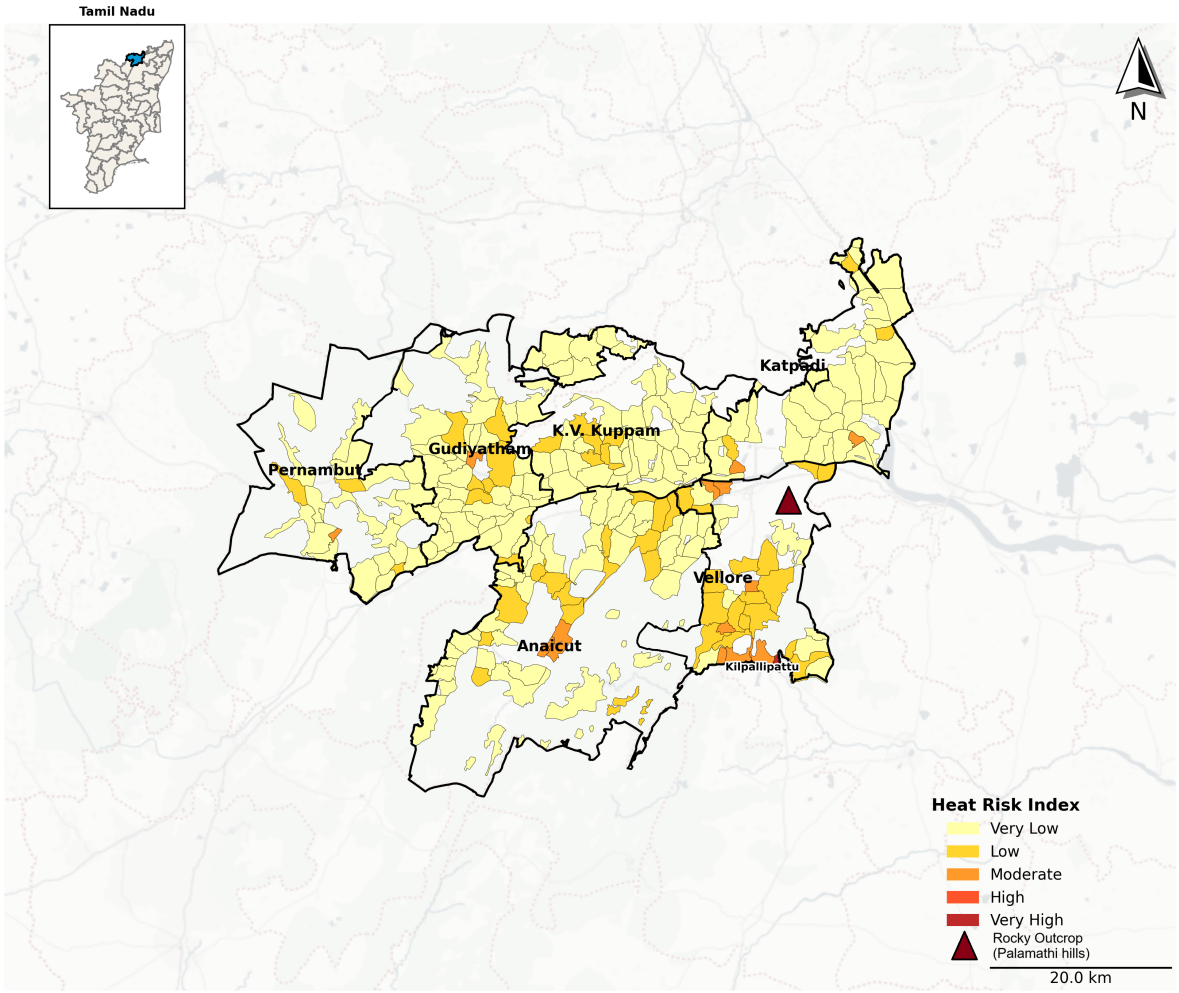
Figure A: Heat Risk Index Map of Vellore City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Vellore District at Village Panchayats level



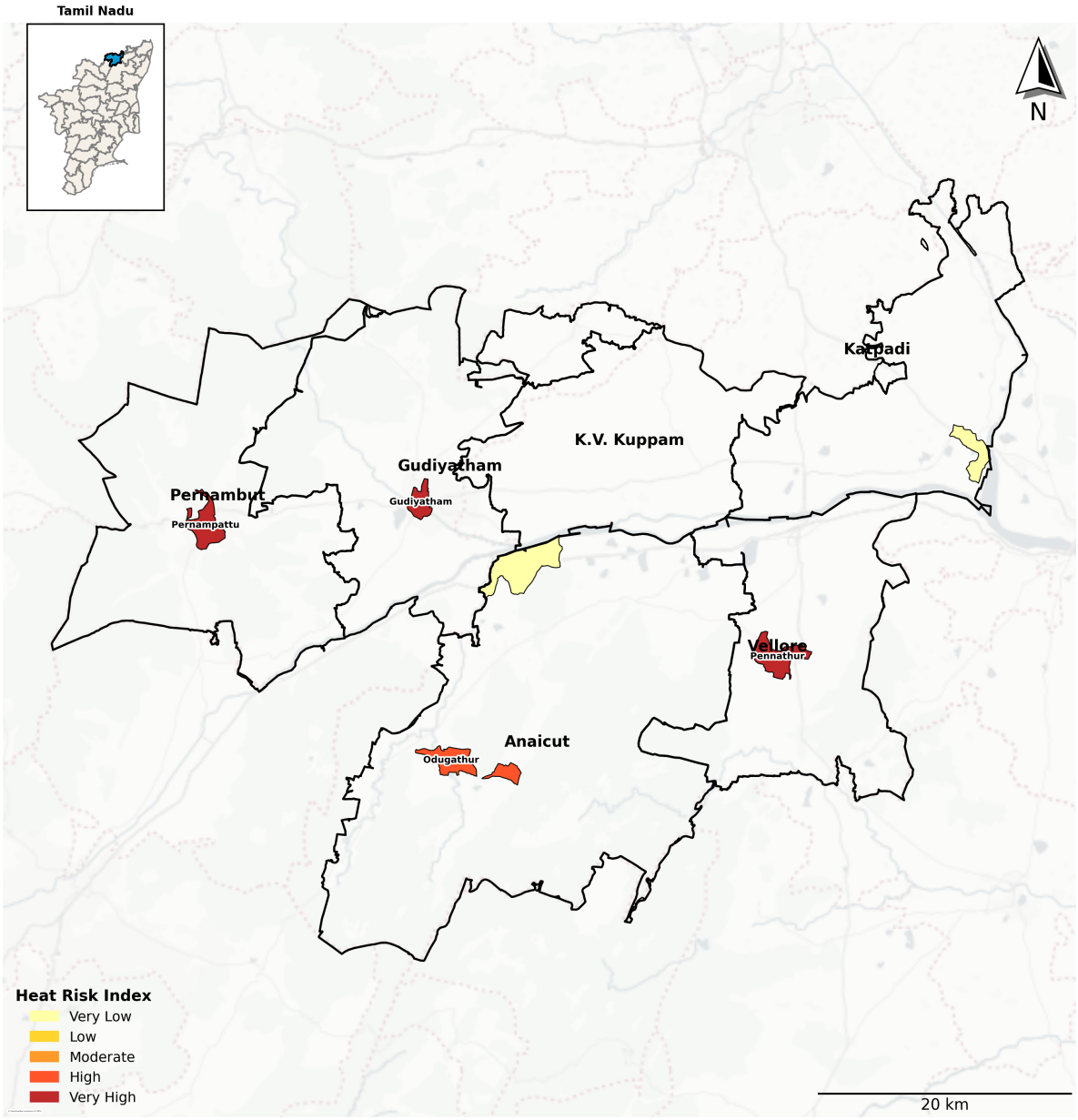
Disclaimer: Presence of bare rock/rocky hills can elevate surface temperature locally through heat reflectance, influencing mapped heat-risk levels.

Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

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Figure C: Heat Risk Index Map of Vellore District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Vellore

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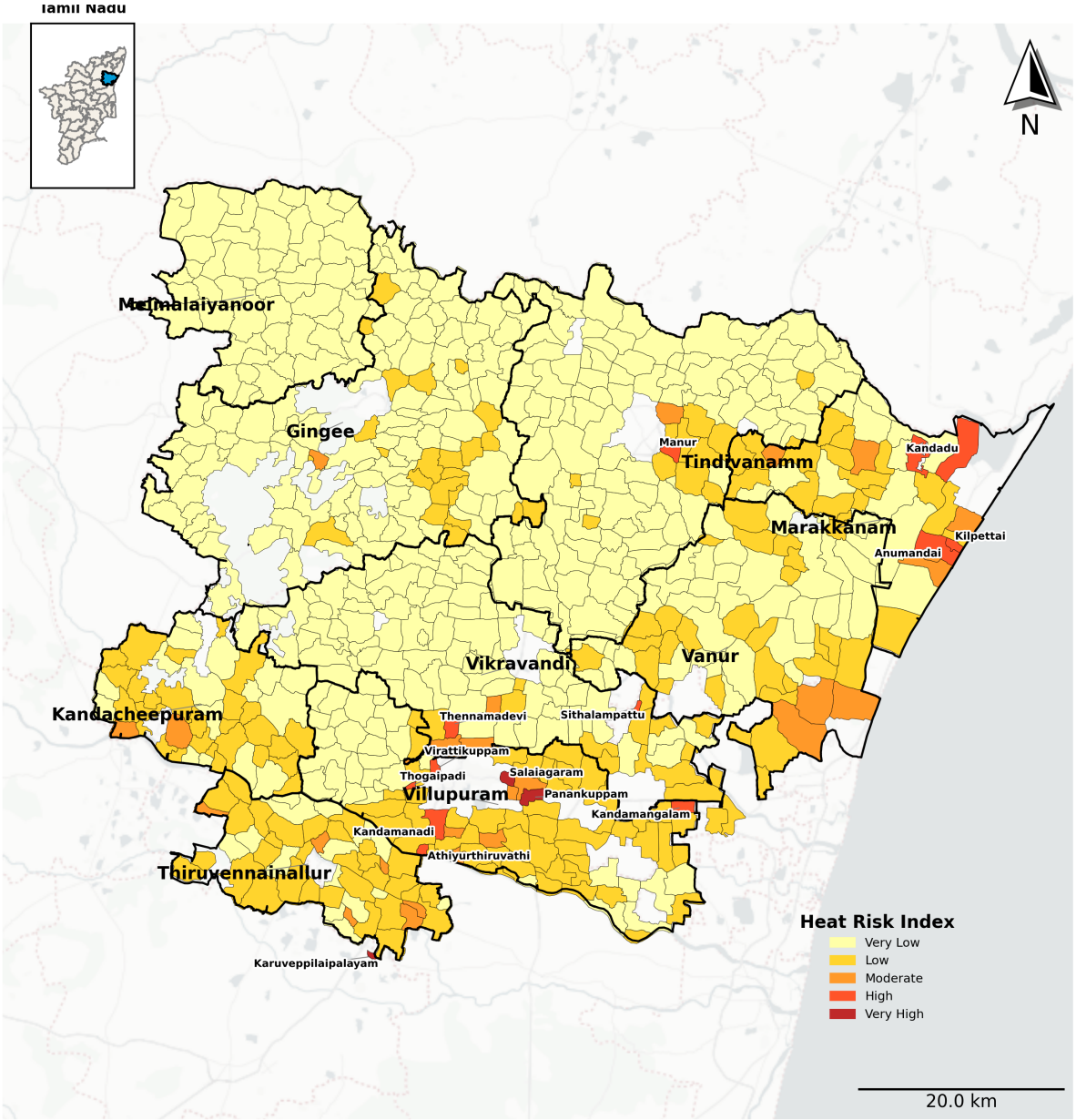
Villupuram District

Table 41: Villupuram Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Tindivanam	40°C	42°C	44°C
Gingee	40°C	42°C	44°C
Vikkiravandi	40°C	42°C	44°C
Kandachipuram	40°C	42°C	44°C
Villupuram	40°C	42°C	44°C
Thiruvennainallur	40°C	42°C	44°C
Melmalaiyanur	40°C	42°C	44°C
Vanur	39°C	41°C	43°C
Marakkanam	39°C	41°C	43°C

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Figure A: Heat Risk Index Map of Villupuram District at Village Panchayats level

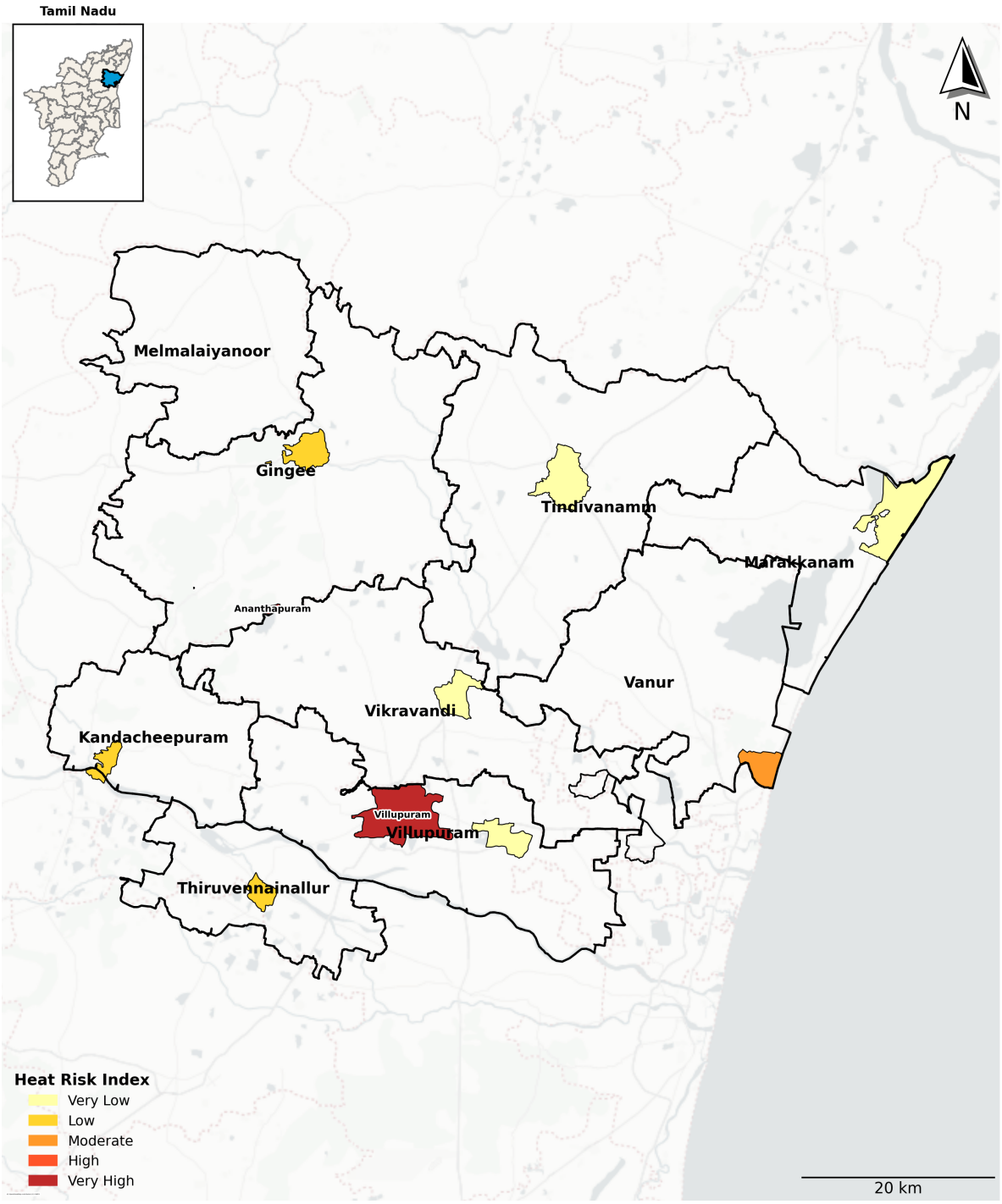


Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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Figure B: Heat Risk Index Map of Villupuram District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Villupuram

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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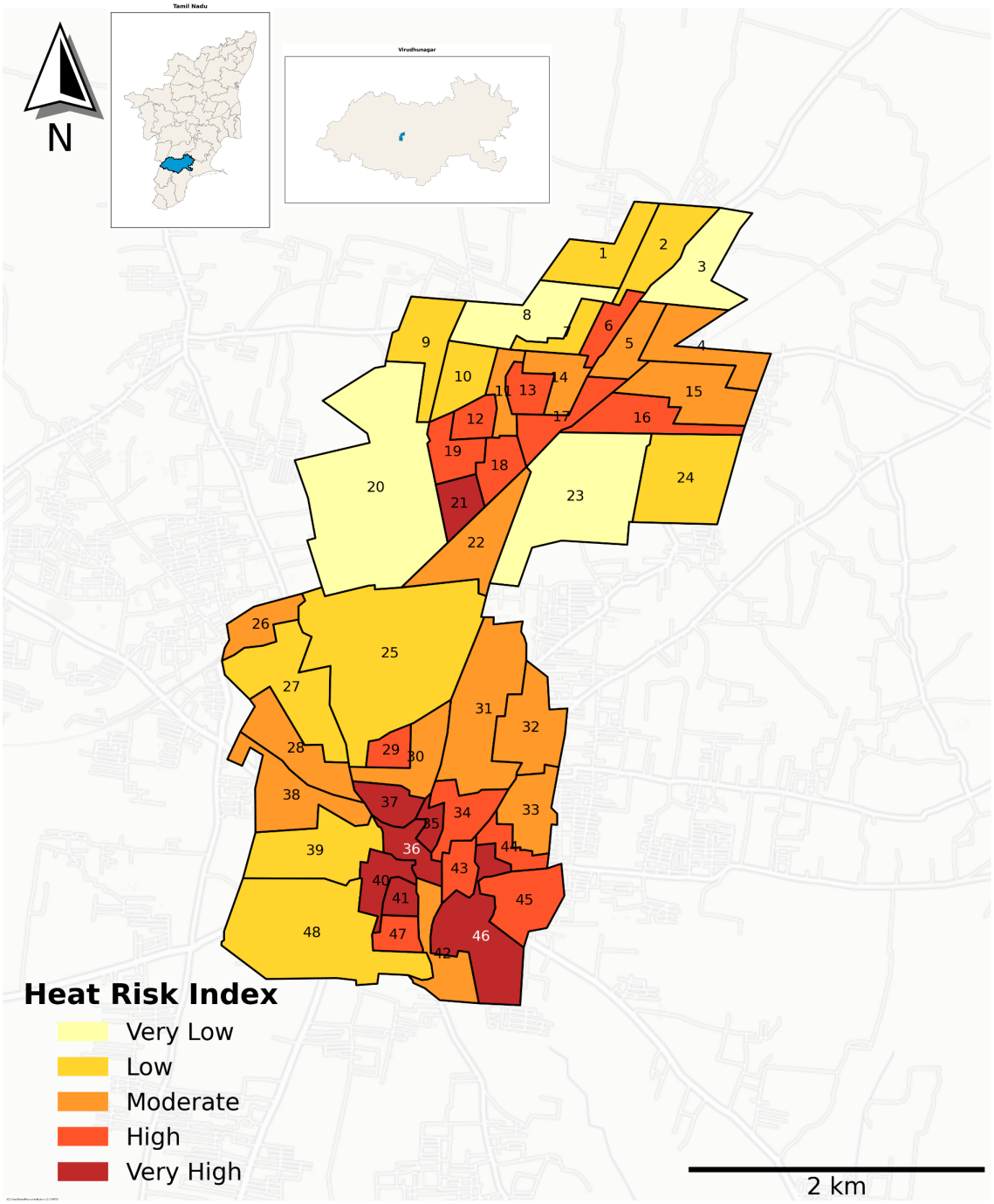
Virudhunagar District

Table 42: Virudhunagar Heat thresholds based on dry temperature for March-June (summer season)

Taluk	Yellow alert	Orange alert	Red alert
Vembakkottai	40°C	42°C	44°C
Virudhunagar	39°C	41°C	43°C
Sivakasi	39°C	41°C	43°C
Kariyapatti	39°C	41°C	43°C
Tiruchuli	39°C	41°C	43°C
Aruppukottai	39°C	41°C	43°C
Watrap	39°C	41°C	43°C
Sattur	39°C	41°C	43°C
Srivlliputhur	39°C	41°C	43°C
Rajapalayam	37°C	39°C	41°C
Corporation / City	**Yellow alert**	**Orange alert**	**Red alert**
Sivakasi	39°C	41°C	43°C

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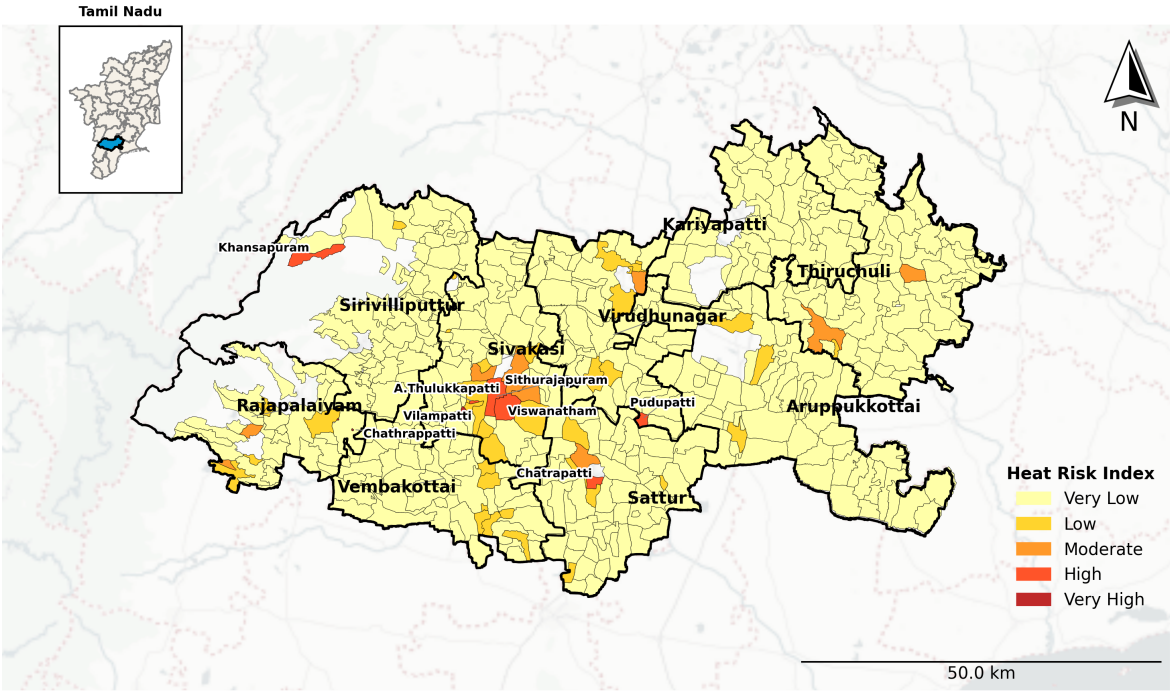
Figure A: Heat Risk Index Map of Sivakasi City at Ward Level



This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

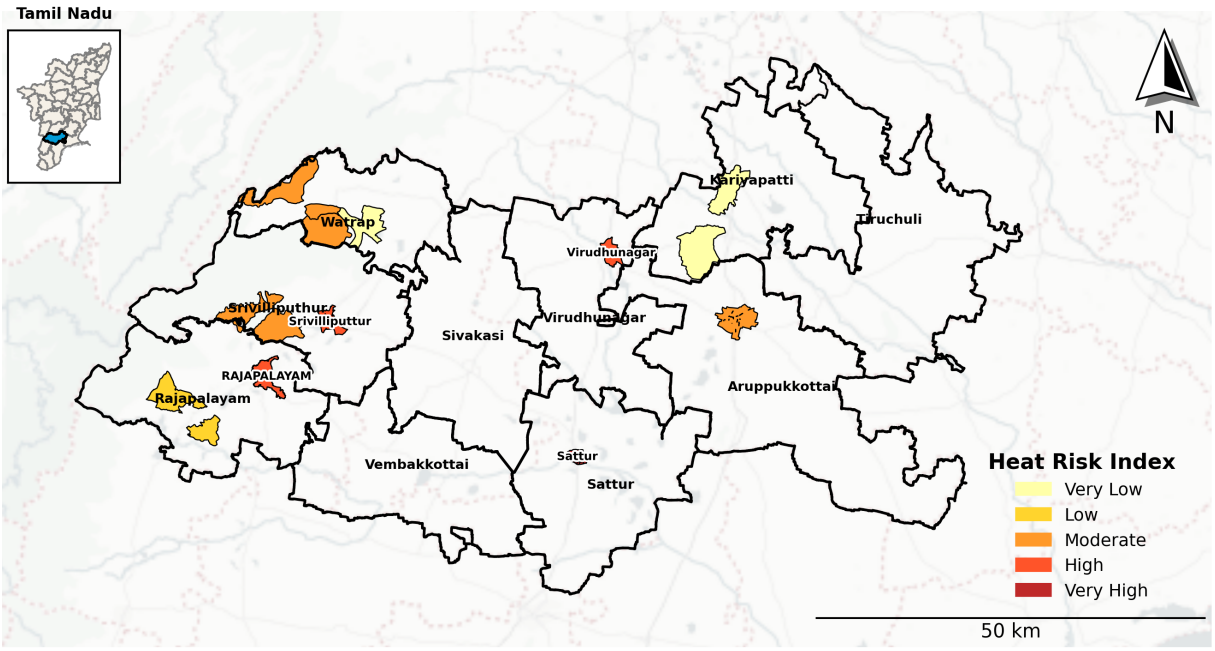
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Figure B: Heat Risk Index Map of Virudhunagar District at Village Panchayats level



Note: The white spaces are either urban areas or areas covered by vegetation, water bodies, barren land or marshy area.

Figure C: Heat Risk Index Map of Virudhunagar District at Town Panchayats and Municipalities level



Note: The white spaces are either rural areas or areas covered by vegetation, water bodies, barren land or marshy area.

For detailed contributing factors, refer here: Virudhunagar

This analysis is intended solely for initiating actions for the management of extreme heat events in the district/local body. Declaration of heatwave officially will be done only on the basis of IMD decisions in this report.

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The classification of wards in cities and village panchayats, town panchayats and municipalities in the very high risk category is based on a relative heat risk assessment for the cities and districts and does not necessarily indicate that these wards or village panchayats or town panchayats or municipalities are the hottest in terms of land surface temperature or air temperature. A state-level relative risk assessment was developed using a bottom-up approach, informed by these district-level assessments. Rather, these wards or village panchayats or town panchayats or municipalities exhibit a higher cumulative risk due to a combination of hazard, exposure and vulnerability parameters. During extreme heat events, these units are more susceptible to impacts than the other units.

Increased built-up area was a leading cause of heat risk in the cities owing to the Urban Heat Island Effect. This was exacerbated by other factors, such as the comparatively fewer green spaces and water bodies available to alleviate the heat risk.

This information was supplemented by the ground-truthing exercise with the district officials and city commissioners. The category of wards, village panchayats, town panchayats and municipalities was reassigned based on an understanding of the ground reality. This has been incorporated into the risk maps represented here. Several other factors, such as a floating population and increased humidity, were identified during these discussions.

The findings underscore the importance of interpreting heat risk as a multi-dimensional construct. It is not solely dependent on ambient temperature but is influenced by the interplay of form, infrastructure and social vulnerability. Targeted interventions in these villages and ULBs should therefore prioritise, but not be limited to, improving green cover, implementing cooling solutions and expanding health services during extreme heat events to build long-term resilience against heatwaves.

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6 Proposed Roadmap for Heat Risk Intelligence and Impact-Based Forecasting

This chapter presents a proposed Heat Risk Forecasting and Decision Support Framework for Tamil Nadu that seeks to integrate advanced weather forecasting, heat-stress indicators, sector-specific risk assessment, and multi-sectoral collaboration to strengthen heat preparedness and response. This chapter is the operational part of HAP report prepared by ARTPARK – IISc Bengaluru to set the ball rolling for the Daily Heat Report prepared by TNDRRA.

6.1. Executive Summary and Administrative Mandate

6.1.1 Background and Purpose

This Chapter proposes the establishment of a Predictive Forecast Modelling Engine (hereafter referred to as the Engine), a state-level, TNSDMA-coordinated platform that translates physical weather parameters into automated, department-level risk intelligence. The Engine is designed not as a standalone technical system, but as a data collaboration infrastructure: its thresholds, alerts, and predictions are only as strong as the sectoral data that feeds and continuously refines them.

This document is a proposed framework. The broader AI modelling architecture, multi-sectoral data pipelines, and co-developed threshold refinement processes described here represent the proposed build-out, to be delivered in phased collaboration with all line departments under TNSDMA's coordination.

6.1.2 The Core Proposition: Sector-Specific Data Drives Better Thresholds

A central principle of this framework is that heat-risk thresholds should be informed by local observations and observed impacts. While national guidelines, scientific literature, and sectoral standards provide an important starting point, the thresholds presented in this document are intended as interim operational values. As sector-specific datasets become available through participating departments, these thresholds may be periodically reviewed and refined using observed impacts, meteorological conditions, and departmental validation to improve their relevance under Tamil Nadu conditions.

6.1.3 Proposed Institutional Coordination Framework

Effective heat-risk management requires coordination across multiple departments, as the impacts of extreme heat affect public health, agriculture, water resources, electricity infrastructure (TNPDCL), labour, tourism, and other sectors. Accordingly, a coordinated institutional

framework is proposed to support heat-risk assessment, threshold development, and decision-making.

Under the proposed framework, TNSDMA may facilitate interdepartmental coordination through a Multi-Sectoral Data Collaboration Group (MSDCG) comprising nodal officers from participating departments. The MSDCG would support data sharing, threshold review, forecast validation, and the development of sector-specific advisories.

This approach seeks to promote a shared understanding of heat risks across departments and support coordinated preparedness and response actions.

6.1.4 Administrative Status

The framework presented in this Chapter is conceptual in nature and is intended to serve as a roadmap for the future development of heat-risk forecasting, impact assessment, and decision-support capabilities in Tamil Nadu. Any operational implementation, threshold adoption, data-sharing arrangements, or deployment of forecasting services would be subject to further technical evaluation, departmental consultation, and administrative approval by the Government of Tamil Nadu.

6.2. AI Modelling Architecture: Proposed Capability

6.2.1 Design Philosophy

The Engine's AI modelling architecture is designed around a principle of progressive refinement. It begins with the best available global weather prediction models and local calibration tools, then systematically narrows forecast uncertainty by ingesting sector-specific ground-truth data from Tamil Nadu's own departments. As additional observations, impact datasets, and operational records become available, forecast calibration and threshold development processes may be progressively refined to improve reliability and local relevance.

6.2.2 Stage 1: Hybrid AI and Numerical Weather Prediction Forecast Ingestion

The forecasting backbone of the Engine adopts a hybrid modelling approach that combines state-of-the-art AI weather prediction systems with established operational Numerical Weather Prediction (NWP) guidance.

AI Forecast Systems

The Engine will ingest forecasts from leading global AI weather prediction models, including:

- GraphCast
- GenCast

- Aurora
- AIFS
- FuXi
- Pangu-Weather
- FourCastNet

These models are trained on global atmospheric reanalysis and observational datasets and generate forecasts up to 14 days in advance while operating significantly faster than conventional numerical weather prediction systems. Their outputs form the foundational forecasting layer of the Engine and are subsequently subjected to local calibration, bias correction, quantile mapping, and spatial downscaling to improve their applicability to Tamil Nadu conditions. Model fine-tuning may be explored in later phases if sufficient local data become available and a clear improvement in forecast skill can be demonstrated.

Each AI forecasting system exhibits distinct strengths and limitations in representing different atmospheric processes and extreme weather conditions. By integrating forecasts from multiple AI models within an ensemble framework, the Engine leverages their complementary capabilities while reducing dependence on any single model.

Operational Numerical Weather Prediction Guidance

In addition to AI forecasts, the Engine will ingest operational guidance from established numerical weather prediction systems, including:

- ECMWF Integrated Forecasting System (IFS)
- Global Forecast System (GFS)
- Bharat Forecast System (BFS)
- Operational forecasts and advisories issued by IMD

These forecasts will serve as an independent source of meteorological guidance and expert reference during operational forecasting. NWP outputs will be used alongside AI forecasts to enhance situational awareness, improve forecaster confidence, and support expert interpretation of forecast uncertainty during heatwave events.

Multi-Model Forecast Synthesis

Forecasts from AI models and operational NWP systems will be synthesised within a multi-model forecasting framework. Initially, equal or expert-defined weighting schemes may be employed. As forecast archives and verification statistics are accumulated over successive seasons, adaptive weighting approaches may be introduced based on demonstrated forecast performance over Tamil Nadu.

The ensemble framework will generate forecasts of key meteorological variables including:

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- Maximum temperature (Tmax)
- Minimum temperature (Tmin)
- Relative humidity
- Wind speed
- Solar radiation
- Mean sea level pressure
- Other variables relevant to heat-risk assessment

6.2.2 Stage 2: Local Calibration Against Tamil Nadu Ground Truth

Global AI weather models can exhibit systematic biases. These biases may arise from challenges in representing local processes such as sea-breeze circulation, urban heat island effects, terrain-induced weather patterns, and regional land-atmosphere interactions. Accordingly, model outputs must be calibrated against local observations before being used for operational decision-making.

Ground Observation Integration: The Engine will ingest both real-time and historical observations from the regional network of Automatic Weather Stations (AWS) operated by the India Meteorological Department (IMD), together with state-owned AWS networks and other relevant observational datasets available through participating agencies. These observations will serve as the primary ground-truth reference for model evaluation, calibration, and forecast verification.

Statistical Recalibration: Bias-correction and statistical recalibration techniques, including quantile mapping, will be applied to align the probability distributions of AI model forecasts with Tamil Nadu's historical climate record. This process will reduce systematic warm, cool, wet, and dry biases and improve the representation of local climatic features, particularly in coastal districts where sea-breeze effects and humidity play a critical role in determining heat stress.

Continuous Learning Framework: As additional observational datasets become available over the course of implementation, the calibration framework will be periodically updated to improve forecast skill, reduce uncertainty, and enhance the reliability of district- and taluk-level heat-risk forecasts.

6.2.3 Stage 3: Taluk-Level Heat Risk Forecasting and Multi-Sectoral Data Integration

While meteorological forecasts provide the foundation for heat-risk assessment, effective heat action planning requires an understanding of how extreme heat translates into real-world impacts across different sectors. Accordingly, the proposed framework extends beyond weather forecasting by integrating meteorological information with sector-specific datasets through a structured multi-sectoral collaboration mechanism coordinated by TNSDMA.

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The forecasting system will generate taluk-level forecasts of key heat-risk indicators, including:

- Maximum Temperature (Tmax)
- Minimum Temperature (Tmin)
- Heat Index (Feels-Like Temperature)
- Wet Bulb Globe Temperature (WBGT)
- Excess Heat Factor (EHF)
- Heatwave duration and persistence

To improve the spatial relevance of forecasts, outputs from global AI weather models and operational numerical weather prediction systems will be refined using local observations, high-resolution datasets, and regional forecast guidance. Sector-specific datasets and threshold refinement processes are described in Section 6.3.

6.3. Multi-Sectoral Collaboration and Data Integration

The impacts of extreme heat extend across multiple sectors, including public health, agriculture, livestock, water resources, electricity infrastructure, labour, tourism, and public services. Accordingly, the proposed framework recognises the importance of collaboration among relevant departments and agencies to improve heat-risk assessment and preparedness.

While meteorological forecasts provide the foundation for heat-risk monitoring, sector-specific datasets can help improve understanding of how heat affects people, infrastructure, livelihoods, and services under Tamil Nadu conditions. Subject to availability and departmental participation, relevant datasets may include health surveillance records, electricity demand indicators, agricultural and livestock datasets, water-resource information, labour exposure data, tourism indicators, and demographic vulnerability information.

The integration of meteorological information with sector-specific observations can support the progressive refinement of heat-risk indicators, thresholds, and advisories. Over time, this collaborative approach may contribute to the development of more locally relevant heat-risk intelligence and decision-support capabilities for Tamil Nadu.

6.4. Progressive Development Roadmap for Tamil Nadu-Specific Heat Risk Intelligence

6.4.1 Phased Development Approach

The proposed Heat Risk Forecasting and Decision Support Framework adopts a phased approach that progresses from hazard forecasting to impact-based forecasting and, ultimately, to Tamil Nadu-specific heat-risk

intelligence. While the long-term objective is the development of locally calibrated thresholds and decision-support capabilities, the absence of comprehensive impact datasets should not delay the use of available science for heat-risk assessment and preparedness.

6.4.2 Phase I: Hazard Forecasting Using Best Available Science

The first phase focuses on establishing heat-risk forecasting capabilities using available meteorological forecasts, scientific literature, national guidance, and internationally accepted heat-stress indicators. Forecast products may include maximum and minimum temperature, Heat Index, WBGT, EHF, heatwave persistence, and district- and taluk-level heat-risk outlooks.

Initial advisories and risk assessments will be based on available scientific evidence and operational thresholds, providing an immediate foundation for heat-risk monitoring, preparedness, and response.

This phase enables Tamil Nadu to begin issuing enhanced heat-risk guidance while establishing a framework for future refinement and validation.

Key operational outputs during this phase may include:

- District- and taluk-level heat-risk forecasts;
- Operational heat-risk forecasts (1–3 days);
- Extended-range heat-risk outlooks and monitoring products (4–7 days);
- Heat Index, WBGT, and EHF monitoring products;
- Vulnerability hotspot maps;
- Early warning products to support departmental planning and response.

This phase enables Tamil Nadu to begin issuing advanced heat-risk guidance immediately while establishing a baseline framework for future refinement.

Initial Operational Thresholds for Heat Risk Assessment

Important Note: The thresholds presented below are indicative operational values derived from available scientific literature, national guidance, and internationally accepted heat-stress indicators. They are intended to support initial implementation and will be progressively reviewed and refined as Tamil Nadu-specific observations, sectoral datasets, and validation studies become available.

Table 43: Public Health and Vulnerable Populations – Interim Heat Risk Thresholds

Level	Heat Index (Feels-Like Temperature)	Extended Heat Forecast
Green (Low Risk)	Below 42°C	Zero or negative
Yellow (Moderate Risk)	42–48°C	Positive for 2 or more consecutive days
Orange (High Risk)	48–55°C	Above 3 for 2 or more consecutive days
Red (Extreme Risk)	Above 55°C	Above 6 for 2 or more consecutive days

Table 44:Livestock – Temperature Humidity Index (THI) Risk Thresholds

THI = 0.8 × T + RH × (T − 14.4) + 46.4 · Indigenous breeds have higher thermal tolerance — breed-specific thresholds to be calibrated during pilot phase.	
Level	**THI range**
Green (Low Risk)	Below 72
Yellow (Moderate Risk)	72–79
Orange (High Risk)	80–89
Red (Extreme Risk)	Above 89

Table 45: Agriculture – Crop-Specific Heat Stress Thresholds Agriculture — crops

Thresholds apply only during the specified vulnerable growth stage. Compound stress (Tmax breach + soil moisture deficit above 20% of field capacity) escalates advisory by one band.			
Crop	**Vulnerable stage**	**Threshold**	**Min. duration**
Paddy	Flowering and pollination	Above 35°C	2 consecutive days
Ragi	Grain-filling	Above 38°C	2 consecutive days

Sugarcane	Ratoon growth	Above 40°C	2 consecutive days
Banana	All stages	Above 42°C	1 day

Note: The crop list and thresholds presented below are indicative and intended to support initial operational planning. These thresholds, along with those for other crops cultivated across Tamil Nadu, will be further validated, refined, and operationalized through detailed studies in collaboration with the Agriculture Department of Tamil Nadu and Tamil Nadu Agricultural University (TNAU).

Table 46: Tourism and Public Gatherings – Heat Stress Thresholds

Level	WBGT	Heat Index
Green	Below 28°C	Below 35°C
Yellow	28–30°C	35–45°C
Orange	30–32°C	45–55°C
Red	Above 32°C	Above 55°C

Note: The thresholds presented are indicative operational values intended to support tourism activities, visitor safety, outdoor recreation, and public gathering management under heat-stress conditions. They are based on available scientific guidance and may be refined through future validation using Tamil Nadu-specific observations and impact data.

Table 47: Electricity and Critical Infrastructure – Heat Risk Thresholds

Level	Temperature trigger (Maximum Temperature, Tmax)
Green (Low Risk)	Tmax below 38°C
Yellow (Moderate Risk)	Tmax above 38°C
Orange (High Risk)	Tmax above 40°C or Tmin above 30°C for 2+ consecutive nights
Red (Extreme Risk)	Tmax above 42°C and/or Tmin above 32°C for 2+ consecutive nights

Note: Elevated night-time temperatures are included as an independent risk factor because they are associated with sustained cooling demand and reduced overnight recovery of electricity infrastructure.

6.4.3 Phase II: Impact Forecasting Through Multi-Sectoral Data Collaboration

The second phase focuses on linking forecast heat conditions with observed impacts using datasets contributed by participating departments. The objective is to improve understanding of how extreme heat affects people, infrastructure, livelihoods, and services across Tamil Nadu.

This phase supports the validation of heat-risk forecasts, identification of vulnerable populations and sectors, and the development of impact-based forecasting capabilities that move beyond hazard monitoring alone.

6.4.4 Phase III: Tamil Nadu-Specific Heat Risk Intelligence and Decision Support

The third phase focuses on developing Tamil Nadu-specific heat-risk intelligence using accumulated observations, impact records, and sectoral datasets. Statistical and data-driven analyses may be used to identify environmental conditions associated with observed impacts and to refine sector-specific thresholds, advisories, and decision-support tools.

Examples may include temperature and humidity conditions associated with increased heat-related illness, agricultural and livestock stress, electricity demand and infrastructure vulnerability, water stress, and thermal comfort impacts on tourism, labour, and public services.

Where sufficient evidence exists, district-specific and sector-specific thresholds may be developed to better reflect local climatic conditions, vulnerabilities, and operational requirements. This will support the generation of more targeted and actionable heat-risk advisories for departments, districts, and vulnerable populations.

6.4.5 Continuous Improvement and Seasonal Validation

The proposed framework is intended to be progressively refined through periodic review of forecast performance, observed impacts, and sectoral outcomes. As additional observations and impact datasets become available, thresholds and risk indicators may be updated based on scientific evidence and departmental validation.

Over time, this process may support the development of more locally relevant heat-risk intelligence and decision-support capabilities for Tamil Nadu.

6.5. Conclusion and Way Forward

The proposed framework provides a roadmap for strengthening heat-risk forecasting, preparedness, and decision-making in Tamil Nadu through the

integration of weather forecasting, heat-stress indicators, sector-specific risk assessment, and multi-sectoral collaboration.

The framework adopts a phased approach that begins with hazard forecasting using the best available scientific evidence, progresses towards impact-based forecasting through sectoral data integration, and ultimately supports the development of Tamil Nadu-specific heat-risk intelligence and decision-support capabilities.

The framework recognizes that effective heat-risk management requires both reliable forecasts and an improved understanding of how extreme heat affects people, infrastructure, livelihoods, and public services. Through collaboration, periodic review, and continued refinement, the proposed approach can support the gradual development of more locally relevant heat-risk thresholds, advisories, and preparedness measures.

This Chapter is intended as a roadmap for future development rather than a completed system, providing a foundation for strengthening heat resilience and climate adaptation efforts across Tamil Nadu.

Table 48: Objectives and Key output of this approach

Phase	**Objective**	**Data Requirement**	**Key Outputs**
Phase I	Hazard Forecasting	Meteorological forecasts and literature-based thresholds	Heat-risk forecasts, advisories, hotspot maps
Phase II	Impact Forecasting	Departmental impact datasets	Validation of impacts, sector-specific risk models
Phase III	Decision Intelligence	Multi-year impact database	Tamil Nadu-specific thresholds, district-specific triggers, decision-support systems
Continuous Improvement	Annual review and validation	Forecast and impact records	Refinement of thresholds and operational procedures

7 Potential Solutions and Financing the Implementation of Tamil Nadu State Heat Action Plan

7.1 Recommended Solutions for Heatwave Management

This section presents a structured table outlining heatwave mitigation, preparedness and responses. It identifies the primary department responsible for implementing each action and specifies a clear timeline for execution. To support a phased and effective rollout across the state, the actions are categorised into short-term (i.e. within a period of 18 months), medium-term and long-term interventions.

Table 49: Solutions identified for heatwave management

S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
1	H1	Strengthen Hospital Preparedness Plan with coordination mechanisms, protocols, and response measures for management of heat-related health illnesses.	Health and Family Welfare Department			
2	H2	Procure and supply basic equipment and essential medicines, IV fluids, ORS, cooling aids during the heat season to all Primary Health Centres, Community Health Centres, District Hospitals and Medical Colleges				
3	H3	Setting up dedicated Heatwave Wards in all Primary Health Centres and Urban Primary Health Centres to provide specialised care for heatstroke and other heat-related illnesses.				
4	H4	Installing rapid-cooling infrastructure such as tubs, portable pools, tarps, porous stretchers and misting arrangements in PHCs and UPHCs for efficient emergency cooling.				
5	H5	Address mental health treatment plans to cope with the heat stress for different groups				
6	H6	Conduct targeted training for healthcare workers on early				

S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
		identification, triage and treatment of Heat-Related Illnesses (HRIs).				
7	H7	Appoint experienced professionals or trainers to build the capacity of Health Centre staff on managing HRIs and emergency cooling techniques.				
8	H8	Implement community level awareness programmes through trained health workers on recognising HRIs and preventive behaviours during heatwaves.				
9	H9	Strengthen Heat Health Early Warning Systems (EWS) to issue timely advisories and public notices, enabling early preventive heat-related health risks				
10	H10	Set up First Aid and Medical Stations at prioritized high-risk areas to provide immediate relief and timely management of HRIs during extreme heat conditions				
11	H11	Ensure the availability of specialised healthcare services for individuals with chronic illness or any heatwave-triggered health condition				
12	H12	Ensure systematic reporting of heatwave-related cases and maintain digital lines across all health facilities to enable timely mobilisation of medical resources, optimise treatment capacity and strengthen responses during extreme heat events.				
13	H13	Compile data at district level on heatwave impacts to enable monitoring and targeted response measures and informed decision-making				
14	H14	Including gender responsive and inclusive approaches for capacity				

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S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
		building to address the heatwave management, protective measures and addressing vulnerabilities of different groups				
15	H15	Arrange regular health check-up camps in slums and vulnerable points to reach the at-risk population to address HRIs effectively				
16	DM1	Develop and annually update the state and sub-state Heat Action Plan in line with the national guidelines by NDMA	Revenue and Disaster Management			
17	DM2	Establishing the local thresholds for temperature specific to each city and district for precise early warning systems and provide alerts for heatwaves				
18	DM3	Conduct vulnerability and risk assessment at the finest resolution possible to identify priority hotspots				
19	DM4	Conduct state wide public awareness campaigns and develop IEC materials, with support to districts for community and vulnerable-group outreach.				
20	DM5	Issue directives on rescheduled working hours for outdoor workers during peak summer time				
21	DM6	Establish heatwave warning system with forecasting and issue warnings during summer season to take proactive heatwave management and informed decision makings				
22	DM7	Develop state guidelines for “Heat-Resilient Streets” (shaded bus stops, cool pavements, drinking water points, misting at major nodes).				
23	UD1	Encourage the widespread use of passive cooling surfaces such as cool roofs, green roofs, shaded façades,	Housing and Urban Development			

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S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
		and low-heat traditional roofing across public, institutional, and priority buildings through state guidelines and incentive programs.	Department / Public Works Department / Rural Development and Panchayat Raj / Municipal Administration and Water Supply			
24	UD2	Establish state wide Urban Cool Corridor networks by identifying and greening priority road stretches in major cities.	National Highways Authority of India / Rural Development and Panchayat Raj			
25	UD3	Provide guidelines for building infrastructure that incorporates heat-resilient materials, including thermal insulation, to reduce indoor temperatures and enhance comfort for individuals during extreme heat days.	Housing and Urban Development Department			
26	UD4	Mandate heat-resilient urban design guidelines for all Master Plans and Local Area Plans, including shading, ventilation corridors, and albedo standards.	Housing and Urban Development Department			
27	UD5	Guide all new developments to follow climate-responsive planning norms such as proper building orientation, adequate setbacks, connected ventilation corridors, and layouts that enable cross-ventilation.	Housing and Urban Development Department / Public Works Department			
28	MA1	Ensure the provision of safe drinking water facilities in all vulnerable areas on a priority basis to reduce heatwave risks and strengthen the adaptive	Municipal Administration and Water Supply /			

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S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
		capacity of individuals living or working in high-risk zones.	Greater Chennai Corporation (GCC) / Rural Development and Panchayat Raj			
29	MA2	Establish clean drinking water facilities in public locations such as railway stations, bus stops, commercial markets, parks and gardens and tourist attraction areas with frequent repair and maintenance to prevent disruptions and uninterrupted supply during extreme heat days				
30	MA3	Expand heat-resilient public spaces by installing shade structures along footpaths, transit areas and key pedestrian corridors across cities.				
31	MA4	Develop urban heat-mitigation nodes through urban acupuncture interventions such as pocket parks, shaded seating and local cooling points in dense neighbourhoods.				
32	MA5	Implement mandatory Tree Preservation & Plantation Rules for all urban development projects, ensuring minimum canopy cover thresholds.				
33	MA6	Implement urban heat mitigation measures through expansion of shaded public seating, shade structures and rejuvenation and protection of minor urban water bodies to improve thermal comfort and reduce heat stress.				
34	MA7	Protection of homeless or/and vulnerable populations through provision of shelter to reduce exposure and risk during extreme heat conditions.				
35	MA8	Provide shaded and cool bus stops with drinking water facilities for the community to manage the extreme heat during day time.				

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S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
36	ECCF 1	Develop and implement programs that raise environmental awareness and promote sustainable development in urban communities, with active participation from schools and local residents	Environment, Climate Change and Forests Department			
37	ECCF 2	Geo-tag and plant native seedlings in heat-stressed zones identified via high-resolution heat mapping.				
38	ECCF 3	Retrofitting the Rajiv Gandhi Government General Hospital and Stanley Government Hospital with high-efficiency cooling systems.	Health & Family Welfare/ Public Works Department			
39	ECCF 4	Implement a "Cool School" program to reduce classroom temperatures by 4°C via solar-reflective painting in schools while training teachers as Climate Ambassadors.	School Education Department (SED), Public Works Department			
40	ECCF 5	Implementing the Tamil Nadu Policy Cooling Guidelines to mandate passive cooling in new buildings and complete energy-efficient retrofitting in district hospitals	Public Works Department / Health & Family welfare Department			
41	ECCF 6	Implement a 15% green cover mandate for all Urban Local Bodies and expand mangrove/casuarina bio-shields across coastal districts to moderate local temperatures	Municipal Administration and Water Supply			
42	ECCF 7	Replace invasive heat-trapping species with native, shade-providing vegetation to improve local microclimates				
43	ECCF 8	Achieve 33% overall state green cover by institutionalising the 3-30-300 guideline (ensuring every citizen has high-quality, near-home access to trees and parks)	Environment, Climate Change and Forest Department /			

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S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
44	ECCF 9	Mature the Centre for Heat Excellence as the state's hub for bankable resilience projects and high-resolution heat-risk analytics to guide all future sectoral planning.	Rural Development and Panchayat Raj			
45	ECCF 10	Transition all public institutions into climate-resilient hubs using the Lifestyle for Climate certification framework for sustainable building envelopes.				
46	E1	Coordinate with the electricity department to ensure uninterrupted power supply, especially in high-risk areas and wards and facilitate the prompt restoration of electricity during outages.	Energy Department			
47	E2	Encourage energy-saving practices and promote the use of renewable energy sources, such as solar energy and wind energy to meet cooling and electricity demands.				
48	E3	Prioritize the integration of solar energy in cooling centres and other critical facilities to ensure sustainable and reliable power during extreme heat conditions.				
49	E4	Direct rooftop solar installations in individual homes and multi-story residential buildings through mandatory regulations for new constructions, integrated with the building approval or service connection process, to enhance energy resilience and reduce urban heat impacts				
50	A1	Ensure the provision of adequate sheds and shelters for livestock	Animal Husbandry, Dairying, Fisheries and			
51	A2	Guarantee that all veterinary hospitals are stocked with sufficient medicines				

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S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
		and fluids to address heat-related health issues in animals	Fishermen Welfare Department			
52	A3	Launch public awareness campaigns to educate farmers and communities on protective measures for livestock and poultry during prolonged heatwaves				
53	A4	Develop a system to assess and identify heat related illness and death of livestock resulting from extended heatwave conditions and provide insurance coverage for the same				
54	A5	Guide farmers on climate-resilient livestock management, including improved shed design, restricting grazing to cooler hours and adoption of practices to reduce heat stress in animals				
55	A5	Establish a fodder depot where dry fodder will be procured and distributed to farmers at a subsidised rate.				
56	A6	Supply of baled silage through departmental farms at a subsidised rate.				
57	A7	Establish silage banks at village/block level and also in departmental Farms.				
58	A8	Provide ex-gratia compensation for livestock deaths due to heatwave following State Disaster Response Fund (SDRF) norms				
59	A9	Guide farmers on climate-resilient livestock management, including improved shed design, restricting grazing to cooler hours, and adoption of practices to reduce heat stress in animals				

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S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
60	W1	Repair, renovate, restore and maintain farm-adjacent tanks, waterbodies and reservoirs to moderate local dry temperatures and ensure more reliable irrigation patterns for crops and to reduce the heat effect	Water Resources Department			
61	W2	Expand and restore urban water bodies (tanks, lakes, nalas) to enhance microclimatic cooling and support ecosystem services				
62	W3	Enhance the storage capacity and water availability of Water bodies to reduce heat effect				
63	T1	Encourage public transport, the use of electric vehicles to reduce emissions for a safer and sustainable environment	Transport Department			
64	T2	Provision of buttermilk twice daily (morning and evening) to drivers, conductors, and technical staff as a preventive health measure.				
65	T3	Supply of ORS pouches for passengers and staffin case of emergencies. Installation of cabin fans for Drivers				
66	T4	Drinking water facilities at STU-owned termini and bus stands				
67	S1	Modify school/college class break timings and restrict heat-exposed activities (outdoor sports, assemblies) during peak heat hours	School Education Department / Higher Education Department			
68	S2	Equip all institutions with functional cooling/ventilation, adequate drinking water, shaded waiting areas and basic first-aid protocols for heat illness				
69	S3	Include heat-risk awareness, prevention measures and emergency response training in the curriculum and campus activities				

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S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
70	S4	District Collectors and Chief Education Officers (CEOs) should have the power to change school timings or declare compensatory holidays during severe heatwaves				
71	S5	Schools are encouraged to use online classes or homework-based learning during these periods				
72	S6	All staff should undergo annual training to recognise heat exhaustion and heat stroke and provide immediate first aid; schools must stock ORS and maintain designated cooling/rest rooms.				
73	S7	The Mid-Day Meal menu should include hydrating foods, and meals should be prepared during cooler hours.				
74	S8	Heat safety lessons should be integrated into school assemblies and life skills/health education.				
75	S9	IEC materials in Tamil and English should be provided to students on dehydration, heat illness symptoms, and preventive practices.				
76	S10	Special attention must be given to primary students (Classes I-V), children with disabilities, and those with chronic illnesses, and attendance for these vulnerable groups should be made non-mandatory during severe heatwave warnings.				
77	L1	Facilitate heat-illness orientation for factory staff using IEC materials, to increase awareness on symptoms, risks and preventive actions to be taken during heatwave days	Labour Welfare and Skill Development Department			
78	L2	Ensure continuous access to safe drinking water, shaded areas and essential cooling measures at worksites				

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S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
		to maintain worker safety during extreme heat.				
79	L3	Issue directives on required breaks and/or rescheduled working hours for the workers who work at the furnace, in high heat zones and construction sites to reduce exposure during peak heat periods and safeguard worker's health.				
80	F1	Ensure adequate readiness of fire emergency services during summer by maintaining sufficient stocks of water and foam at critical locations to effectively combat fire incidents.	Tamil Nadu Fire & Rescue Services (TNFRS)			
81	F2	Keep emergency responders deployed in high floating populated areas during summer, especially during festivals across village panchayats, town panchayats, municipalities and corporations to ensure rapid fire response, effective mitigation and safe refuge during accidents.				
82	R1	Ensure the provision of safe drinking water facilities in all vulnerable areas on a priority basis to reduce heatwave risks and strengthen the adaptive capacity of individuals living or working in high-risk zones.	Rural Development and Panchayat Raj Department / Municipal Administration and Water Supply /Tamil Nadu Water Supply and Drainage Board & Chennai Metropolitan Water Supply and Sewerage Board			

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S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
83	R2	Establish clean drinking water facilities in public locations such as railway stations, bus stops, commercial markets, parks and gardens and tourist attraction areas with frequent repair and maintenance to prevent disruptions and uninterrupted supply during extreme heat days	Rural Development and Panchayat Raj Department			
84	R3	Identify and prepare shaded priority areas in high-risk locations for setting up safe drinking water points, green roofs and temporary cooling shelters				
85	R4	Conduct heatwave and HRI awareness campaigns through ASHA workers, SHGs and other panchayat-level community networks				
86	R5	Reschedule breaks and/or working hours for MGNREGS labourers during extreme heat days to reduce exposure to heat and minimise the risk of heat cramps and stroke				
87	R6	Issue advisories for outdoor workers to avoid peak heat hours and ensure access to shaded rest areas and drinking water facilities.				
88	R7	Public buildings and community assets should incorporate cool roofs, light-coloured and low heat-absorbing materials, along with adequate natural ventilation, roof vents, and proper airflow arrangements to improve indoor thermal comfort				
89	R8	All worksites must provide adequate drinking water, shaded rest areas, temporary shelters, protective gear (caps and cotton clothing), and First Aid Kits with ORS, basic medicines, and emergency contact details				

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S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
90	R9	Promote rehydration through ORS and traditional drinks *(buttermilk, lemon water, neeragaram*) at public spaces				
91	R10	Rejuvenate ponds, *ooranies*, and Minor Irrigation tanks under AGAMT and other schemes to enhance groundwater recharge, while integrating water conservation as a core long-term climate resilience strategy				
92	R11	Promote avenue tree plantation along rural roads through MGNREGS to reduce ambient temperatures and improve roadside microclimates				
93	R12	Ensure provision of drinking water, shaded shelters, and First Aid facilities at housing construction sites				
94	R13	Direct Chief and Superintending Engineers to assess and incorporate feasible heatwave mitigation measures within construction estimates for roads, bridges, and housing projects				
95	R14	Providing shaded and cool bus stops with drinking water facilities for the community to manage the extreme heat days during day times				
96	PWD 1	Provide shaded resting spaces and drinking water facilities in frequently visited public buildings to enhance thermal comfort for the public	Public Works Department / Police Housing Corporation / Tamil Nadu Urban Habitat Development Board/ Housing Board			
97	PWD 2	Develop and pilot cool roof coatings, high-reflectance pavements, low-heat construction materials and thermally efficient building systems in government buildings of the state				
98	PWD 3	Implement mandatory provision of drinking water and insulated Puff panel labour sheds at construction sites while				

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S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
		applying high-reflectance (SRI >90%) Solar Reflective Paint to existing roofs.				
99	PWD 4	Upgrade existing public buildings with solar-reflective ceramic tiles, double-glazed (Low-E) windows, and external shading (chajjas/fins) to reduce indoor temperatures by up to 3 degrees				
100	PWD 5	Standardize the use of Autoclaved Aerated Concrete (AAC) blocks and natural cross-ventilation in the conceptual design phase of all new public buildings to achieve a 30% reduction in heat transmission				
101	PD1	Ensure public safety during large gatherings by regulating crowd size, providing specific guidelines and SOPs	Tamil Nadu Police Department			
102	PD2	Reduce heat exposure for traffic police by providing solar hats, cooling glasses to personnel shaded booths and overhead canopies at major signals and junctions.				
103	PD3	Initiated a preparation of Tamil Nadu Police Heat Action Plan as an actionable framework designed to enhance occupational safety, reduce heat-related-morbidity and productivity loss, and institutionalise long-term resilience to extreme heat among police personnel				
104	AG1	Encourage drought-resilient crops and seed varieties to manage during water scarcity and drought period	Agriculture - Farmers Welfare Department			
105	AG2	Conduct field-level awareness on heat management, HRI risks, and adaptive agriculture practices to withstand rainfall and drought				
106	AG3	Develop a system to assess and identify crop damage resulting from				

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S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
		extended heatwave conditions and provide insurance coverage for the same				
107	AG4	Scale the use of drones for pesticides and foliar sprays to reduce the time farmers spend in direct sunlight during peak heat hours				
108	AG5	Implementation of TNAU Climate Resilience Villages and can be used as "living labs" to test drought-resilient crop cycles				
109	IS1	Issue directives to industries to reschedule breaks and/or working hours during peak heat periods to minimize worker exposure	Department of Industrial Safety and Health under Labour Welfare and Skill Development Department			
110	IS2	Ensure availability of safe drinking water, shaded rest areas and basic cooling measures (fans, coolers) at all industrial worksites				
111	IS3	Deliver heat-illness orientation programs for factory officers, supervisors and workers using IEC materials to improve recognition of symptoms and preventive practices				
112	IS4	Install efficient exhaust and ventilation systems to reduce heat build-up and protect workers from heat stress				
113	TO1	Installation of *Thaneer Pandhals* (water kiosks) and shaded rest areas at 10 priority sites along major roads / tourist circuits and tourist sites	Tourism Department			
114	TO2	Ensuring the availability of water refill stations at all properties (transitioning from plastic to glass bottles)				
115	TO3	Establishing coordination between tourist officers, local bodies and Health mobile units for HRI (Heat-Related Illness) recognition				

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S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
116	TO4	Launching Information, Education, and Communication (IEC) campaigns via digital signage and mobile apps to advise tourists on the best times to visit (to avoid heat stroke) and precautions to be taken				
117	TO5	Installing cool roofs and misting systems at Tamil Nadu Tourism Development Corporation (TTDC) properties				
118	TO6	Urban greening and vulnerability mapping for tourist trails to identify high-risk hotspots				
119	TO7	Implementing cooling walkways in locations where natural tree shade is unavailable				
120	TO8	Developing and institutionalizing early morning or late evening programs (nocturnal tourism) to disperse crowds and reduce daytime heat exposure				
121	TO9	Introducing electric shuttles to transport tourists between sites				
122	TO10	Formally integrating heat resilience measures and off-peak tourism promotion strategies into the official State Tourism Policy				
123	TO11	Restoring natural shade and reducing concrete lining in major tourist hubs to lower ambient temperatures				
124	HP1	Implement sufficient breaks or suspend all site activities if temperatures exceed local historical averages and provide light cotton uniforms, caps or hats; discourage synthetic or heavy clothing	Highways and Minor Ports Department			
125	HP2	Ensure safe, potable drinking water is available at all work sites and government offices and Erect				

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S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
		temporary, well-ventilated, shaded rest shelters near work areas and major highway junctions.				
126	HP3	Mandatory training for all workers and supervisory staff to recognise symptoms of heatstroke, headache, or dizziness.				
127	HP4	Provide first-aid kits at all sites and establish a protocol to immediately shift affected persons to the nearest government hospital.				
128	HP5	Design and provide cooling facilities under the Chief Minister's Road Infrastructure Development Program based on land availability.				
129	HP6	Active raising of avenue plantations on roadsides and medians to provide natural shade and reduce the "Heat Island" effect on asphalt.				
130	HP7	Implementation of specialized wayside amenities at sanctioned locations through Public-Private Partnerships (PPP).				
131	HP8	Entrusting major development works to the Tamil Nadu State Highways Authority (TANSHA) to ensure long-term climate-resilient road designs.				
132	HO1	Implementing mulching (50% assistance) and bunch covers for sensitive crops like banana to lower soil temperature and prevent sunburn and shade net houses to shield plants from direct solar radiation	Department of Horticulture and Plantation Crops			
133	HO2	Deploying Supplementary Water Management Activities (SWMA), including bore wells and tube wells, alongside existing micro-irrigation				

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S No	Code	Solutions	Responsible Department	Timeline		
				ST (within 18 months)	MT (18 months to 3 yr)	LT (above 3 years)
		systems to provide critical water sources during peak heat spells				
134	HO3	Facilitation of immediate enrolment and claim settlement under PMFBY and state insurance drives to help farmers recover input costs from yield losses caused by extreme heat				
135	HO4	Transition to automation-based micro-irrigation for precise water delivery and establish permanent supporting structures (*pandals*) to keep vegetable crops away from high-temperature soil				
136	HO5	Scaling up protected cultivation through World Bank-funded TNIAMP technologies, specifically focusing on energy-efficient cooling for nurseries and high-value crops.				
137	HO6	Mainstream the Integrated Farming System (IFS) approach by blending horticulture with livestock and agroforestry to spread climatic risk while shifting toward hardy, heat-tolerant traditional cultivars.				
138	HO7	Create long-term water harvesting structures, such as farm ponds and field bundling, to retain soil moisture during extended drought and heat periods.				

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7.2 Integrating the recommended Solutions to State Schemes

This table aligns the proposed solutions and actions with existing State programmes, policies and schemes to ensure the seamless integration of available resources. Each action is explicitly linked to a relevant government directive or scheme, fostering improved interdepartmental coordination and expanding the reach of heat-risk interventions. By leveraging established frameworks, this approach supports the efficient utilisation of existing financial allocations, ensuring that heat-risk mitigation is both cost-effective and structurally grounded in the state's administrative operations.

Table 50: Schemes linked with the solutions for heatwave management

Sr No	Programme	Directive/ Scheme	Code	Budget Allocation (cr) 2025 - 2026
Health and family welfare (HFW)				
1	National Health Mission	Urban Health and Wellness Centres (UHWCs)	H1, H2, H6	177
		Urban Polyclinics	H1, H2, H6	-
		Facility level Patient Welfare Societies	H2	
		Mahila Arogya Samiti (MAS)	H14, H6	-
		Health Management Information System (HMIS)	H12, H13	2.19
		Urban Mobile Medical Units (UMMUs)	H10/EMRI-108	-
		Prime Minister Ayushman Bharat Health Infrastructure Mission (PMABHIM)	H1,H2,H3, H4, H6	3001.29
		National Mental Health Programme	H5, H6	-
		School health and wellness programme	Potential schemes	-

		Rashtriya Bal Swasthya Karyakram (RBSK)	that can be linked to solutions	-
		Telemedicine/ e-Sanjeevani		-
		Tribal Mobile Medical Units	H15, H10	123
		Labour Mobile Medical Units- Occupational Health Services:	H15, H10, H6	-
		Health Melas, Nalam Kaakum Stalin(NKS)	H10	-
	State Specific schemes	Multi-speciality Clinics for Transgenders	H14	-
		Anaivarukum Nalavzhvu Thittam /Universal Health Coverage	H6, H7, H8,	96.27 Lakh
		Makkalai Thedi Maruthuvam - Home based NCD services:	Potential schemes that can be linked to solutions	681.64
		Village Health, Sanitation and Nutrition Committee (VHSNC)		10,000
		Dialysis Programme for Managing Chronic Kidney Disease		-
Housing and Urban Development Department				
2	Tamil Nadu urban habitat development board	Vada Chennai Valarchi Thittam	UD3, UD4	6,858
		Iyothee Thass Pandithar Habitation Development Scheme	UD3	50
Energy Department				
3	Tamil Nadu Power Distribution Corporation Limited (TNPDCL)	Mass Maintenance Programme	E1	-

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	Tamil Nadu Green Energy Corporation Limited (TNGECL)	Minnagam - 24X7 State Level Centralized Customer Care Centre	E1	-
		Renewable Energy Sources	E2	-
		Chief Minister's Solar Rooftop Capital Incentive Scheme	E3	3600
	Capital Incentive Scheme		E3, E4	10 (First Phase)
Animal Husbandry, Dairying, Fisheries and Fishermen Welfare Department				
4	Department of Animal Husbandry	Mobile Veterinary Unit scheme(MVU)	A2	-
		Vallalar Palluyir Kappagangal scheme	A1, A2	20
Rural Development and Panchayat Raj Department				
5	Anaithu Grama Anna Marumalarchi Thittam (AGAMT-II) to improve facilities in rural areas		R1	0.2/village
	Namakku Naame Thittam (Rural)		R1,R2, R3	100
	Kalaignarin Kanavu Illam		UD1, R3	3500
	MGNREGS		R3	-
	MP Local area development scheme		R1, R2, E2, A2	5/constituency
	Revamped Rashtriya Gram Swaraj Abhiyan		R2, R4	
	15th Finance Commission Grants		R1 to R6	
	State Finance Commission Grants			
	MP & MLA Grants			
Environment, Climate Change and Forests Department				
6	Tamil Nadu Urban Greening Policy 2026 (Green Tamil Nadu Mission)		ECCF6, ECCF7	

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	Tamil Nadu Wetlands Mission	ECCF6	
	Tamil Nadu Climate Change Mission	ECCF2, ECCF6, ECCF8	500 crores @for five years w.ef from 2022
	My TN Initiative - Nature Stewardship Programme	ECCF8	
	One Health Initiative	ECCF3	
	Tamil Nadu Cool School Initiative	ECCF4	
	Bio-Shield Programme		
	District Climate Change Missions		
	Environmental Information, Awareness, Capacity Building and Livelihood Programme (EIAC)	ECCF1	
Municipal Administration and Water Supply Department			
7	Kalaignar Nagarpura Mempattu Thittam	MA1, MA2	2000
	Namakku Naame Thittam (Urban)		150
	Smart Cities Mission	MA1, MA2, MA3	-
	National Urban Cooling Programme (NUCP)	UD1, UD2, MA3	-
	Shelter for Urban Homeless (SUH)	MA7	
	Chief Minister's Sanitation Workers Development Scheme	Potential schemes that can be linked to solutions	50
	Support to Urban Street Vendors(SUSV)		
	School Infrastructure Improvement Grant		
	Corporate Social Responsibility (CSR) Funds		
Revenue and Disaster Management			
8	Tamil Nadu State Disaster Management Authority/ TNDRRA	All the measures and directives will be directly taken by the State Disaster Management Authority coordination	DM1, DM2, DM3, DM4, DM5, DM6, DM7, H9, A3, T2, L1, L2, L3, UD2 , F2, PD1,

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		with all other line departments mentioned in the table		
Water Resources Department				
9	Tamil Nadu Irrigated Agriculture Modernization Project (TN-IAMP)		WR1, WR2	2292.48
	Kudimaramathu Works (TN WRD Community Waterbody Restoration)		WR1, WR2	-
	Inter linking of Rivers within the State	Cauvery-Agniyar-South Vellar-Manimuthar-Vaigai-Gundar Link Canal Scheme		-
		Thamirabharani-Karumeniyar-Nambiyar Link Canal Scheme		
	Lift Irrigation Scheme	Athikadavu-Avinashi Pumping Scheme		
		Mettur Sarabanga Lift Irrigation		
	Modernization of Common Area Development (M-CAD)	Palladam Extension Canal Cluster		99.03
School Education Department / Higher Education Department				
10	Green Campus Initiative (TN Colleges/Universities)		S2, S3	-
	Perasiriyar Anbazhagan School Development scheme		S1, S3	1000
Home, Prohibition and Excise Department				
11	Tamil Nadu Fire & Rescue Services (TNFRS)	Fire and Rescue Services Benevolent Fund		-
		15TH Finance Commission NDRF	F1	373
Public works department				
12	PWD Building Infrastructure Development Programme		PWD 1	-

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	Tamil Nadu Green Building & Energy Efficiency Initiative	PWD1, PWD2	-
Tamil Nadu Police Department			
13	Tamil Nadu Police Housing & Infrastructure Development Programme	PD2	
Agriculture - Farmers Welfare Department			
14	Kalaignarin Anaithu Grama Orunginaintha Velan Valarchi Thittam (AGOVT)	AG1	270
	Chief Minister's Dry Land Development Mission (CM-DLDM)	AG1	-
	TN Integrated Farming System (IFS) Programme	AG2	21
	State Crop Insurance Awareness & Enrollment Drive	AG3	841
	Tamil Nadu Millet Mission	AG1,AG2	
	Tamil Nadu Integrated Farming System	AG2	
	Ulavar Pathukapu Thittam	AG4	
	Chief Minister's Mannuyir Kaathu Mannuyir Kaappom Scheme	AG5	
Department of Industrial Safety and Health under Labour Welfare and Skill Development Department			
15	Tamil Nadu Occupational Safety, Health and Working Conditions Enforcement Program	IS1, IS4	-
	Industrial Hygiene & Health Risk Monitoring Program	IS2	-
	Safety Training & Capacity Building Program for Industrial Workers	IS3	
Highways and Minor Ports Department			
16	Chief Minister's Road Infrastructure Development Program	HP5, MA3	
Department of Horticulture and Plantation Crops			
17	Pradhan Mantri Krishi Sinchayee Yojana	HO1	1,140
	State Horticulture Development Scheme	HO1,HO2	46.92

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	Mission for Integrated Development of Horticulture	HO2,HO7, HO6	45.67
	National Agriculture Development Programme	HO2,HO6	41.67
	Rain fed Area Development	HO7	24.75
	TN Irrigated Agriculture Modernisation Project	HO5	
	Pradhan Mantri Fasal Bima Yojana	H03	

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8. Early warnings and alert mechanisms

India Meteorological Department (IMD), Ministry of Earth Sciences, is the nodal agency for providing weather information, including forecast and warnings for all weather-related hazards for optimum operation of weather-sensitive activities. It provides a warning against severe weather phenomena like tropical cyclones, squally winds, heavy rainfall/ snow, thunder-squall, hailstorms, dust storms, heat waves, warm nights, fog, cold waves, cold nights, ground frost, etc. It also provides real-time data and weather prediction of maximum temperature, heat wave warnings, extreme temperatures and heat alerts for vulnerable cities/ rural areas.

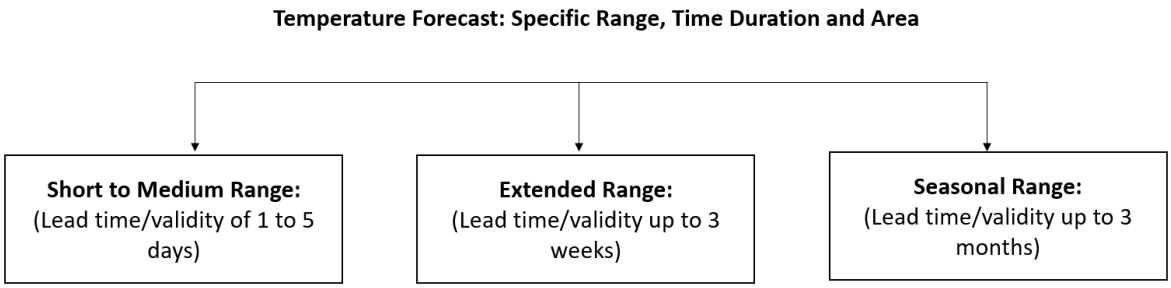
IMD issues forecasts and warnings for all weather-related hazards in short to medium range (valid for the next five days) every day as a part of its multi-hazard early warning system. These warnings, updated four times a day, are available on the link (http://www.imd.gov.in/pages/allIndiawxfcbulletin.php.)

A new system of exclusively heat-related warnings has been introduced with effect from 03 April, 2017. These warnings, valid for the next four days, are issued around 1600 hours IST daily and are provided to all authorities concerned (Departments of Health, Disaster Management, Indian Red Cross and Indian Medical Association, NDMA etc.) for taking suitable action at their end. A bulletin in extended range with an outlook for the next two weeks (for all hazards including heat waves) is issued every Thursday (http://www.imd.gov.in/pages/extended.php).

Furthermore, IMD website provides Climate Forecast System (CFS) based maps of daily maximum temperatures and their departures from normal for the next 21 days (also updated every Thursday) (https://nwp.imd.gov.in/gfsproducts12_all_mausam.php) and (https://nwp.imd.gov.in/gfsproducts_current_all_mausam.php). (https://mausam.imd.gov.in/)

The IMD also issues seasonal temperature outlooks for the next three months, with the first outlook valid from March to May and the second covering April to June each year. These seasonal perspectives are disseminated as press releases on the IMD website and distributed through electronic and print media. Additionally, these outlooks are also provided directly to all concerned Chief Secretaries, Disaster Managers and the health sector via the India Medical Association (IMA)) to support high-level policy planning and resource allocation.

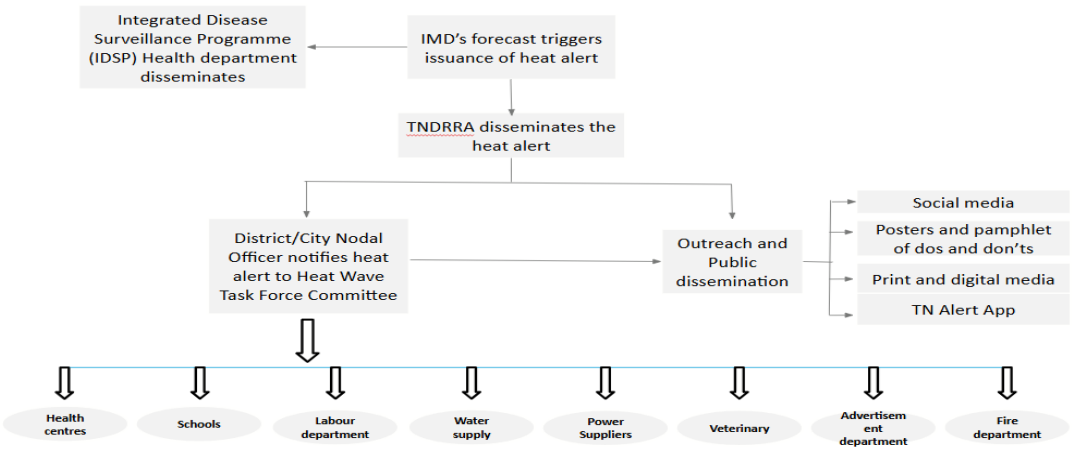
Figure 13: The operational system of weather forecasts and warnings



Source: IMD 2019

The District Disaster Management Authority (DDMA) will receive forecasts from the Tamil Nadu State Disaster Management Authority (TNSDMA) and the IMD Regional Meteorological Centre in Chennai. Tamil Nadu Disaster Risk Reduction Agency (TNDRRA) provides these on behalf of Tamil Nadu State Disaster Management Authority. These forecasts are then forwarded to the Nodal Officer of the District/ City Heatwave Taskforce Committee through the DDMA. Based on the heat thresholds established in this plan, the Nodal Officer will analyse critical meteorological variables, including temperature and relative humidity. Utilising this analysis, the Nodal Officer will issue color-coded heat alerts to the Heatwave Task Force Committee. These alerts will then be disseminated to relevant line departments and vulnerable populations to trigger coordinated response measures. Figure 14 illustrates the communication flow for the dissemination of these alerts.

Figure 14: Communication flow for sending out heat alerts



The outreach materials, structured as Information, Education and Communication (IEC) in Chapter 12, will be utilised by the Heatwave Task Force Committee to raise awareness among vulnerable populations. The focus will be on communicating essential "Do's and Don'ts," with priority actions emphasised in identified at-risk and vulnerable villages, town panchayats, municipalities and corporations.

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Table 51: Responsive actions to be taken by the State Departments during Heatwave alerts

S No	Department	Actions /Measures to be taken		
		Yellow	Orange	Red
1	Revenue and Disaster Management / TNDRRA	1. Issue an alert to all district and city officials to carry out effective actions in the respective districts 2. Disseminate the alert to the public and short messages of measures to be taken during yellow alerts	1. Issue an alert to all district and city officials to carry out effective actions in the respective districts 2. Disseminate the alert to the public and short messages of measures to be taken during orange alerts 3. Monitor the heatwave conditions with the case reports and admissions from PHC, UHCs, and with the State Health Department	1. Issue an alert to all district and city officials to carry out effective actions in the respective districts 2. Conduct regular meetings with community groups to communicate Red Alert conditions and emergency advisories 3. Disseminate urgent messages on staying cool and hydrated (adequate water intake, avoiding direct sun, wearing light clothing).
2	Health and Family Welfare Department	1. Communicate heat alerts to medical staff at PHCs and UHCs to ensure readiness of nursing staff, paramedics, essential medicines and precautionary materials, particularly in high-	1. Ensure continuous functioning of 108 / 104 Emergency Medical Services with adequate IV fluids and consumables.	1. Deploy mobile health teams at major bus stands, transport terminals, pilgrimage centres and tourist locations. 2. Arrange round-the-clock

S No	Department	Actions /Measures to be taken		
		Yellow	Orange	Red
		and very high-risk areas. 2. Conduct training on Information, Education and Communication (IEC) activities for public awareness on heat illnesses and physiological impacts of extreme heat and heatwaves. 3. Train medical professionals on the treatment of heat-related illnesses, including heat stroke, heat exhaustion and heat cramps. 4. Ensure hospitals maintain daily records of heat-related admissions, morbidity and mortality. 5. Ensure availability of emergency medical supplies for heat illness management, including cooling tubs, tarpaulin sheets and other cooling aids. 6. Verify inventories of medical supplies	2. Increase deployment of medical, nursing and paramedical staff in heatwave-affected wards during peak heat days, where feasible. 3. Coordinate with community health workers and Self-Help Groups (SHGs) to intensify outreach in high- and very high-risk areas. 4. Update heat-related case records every week and communicate consolidated reports to district headquarters. 5. Conduct field verification visits to PHCs and UHCs to assess preparedness and service readiness	treatment facilities for heat stroke and severe heat illness patients at hospitals and UHCs. 3. Ensure uninterrupted availability of IV fluids, cooling packs/ice, emergency medicines and cooling equipment. 4. Intensify deployment of mobile health teams and emergency medical services in severely affected areas. 5. Make special provisions for rapid emergency treatment and referral of heat stroke patients. 6. Generate frequent (weekly or more frequent, as required) reports on heat-related morbidity and mortality for submission to the District Health Officer.

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S No	Department	Actions /Measures to be taken		
		Yellow	Orange	Red
		(IV fluids, cooling packs/ice, ORS) at PHCs, UHCs and 108 emergency ambulances. 7. Display heatwave prevention and protection messages prominently at health facilities. 8. Ensure operational readiness of 108 / 104 Emergency Medical Services with adequate IV fluids.	during heatwave periods. 6. Coordinate with District Administration to prioritise uninterrupted power supply to hospitals and UHCs.	
3	Social Welfare Department/ School Education Department / Higher Education Department	1. Issue advisories to anganwadis, schools and colleges to minimise students' exposure to direct sunlight 2. Conduct child-friendly preventive education sessions on heat risks and distribute heat-protection materials in educational institutions 3. Train teachers and faculty members to disseminate heat-protection guidance and implement classroom-based heat-safety activities	1. Schedule examinations ahead of extreme heat days for the students 2. Ensure uninterrupted access to safe drinking water for students, teaching staff and non-teaching staff when institutions are operational 3. Disseminate advisories on staying cool and hydrated, including adequate water	1. Ensure closure of all schools and colleges during declared heatwave days, in accordance with government orders, meanwhile making arrangement to continue the meals for students from vulnerable sections 2. Ensure dissemination of Red Alert messages to all government and private educational institutions and

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S No	Department	Actions /Measures to be taken		
		Yellow	Orange	Red
		4. Implement Information, Education and Communication (IEC) activities on heatwave prevention and management within campuses 5. Promote tree plantation, green roofs including potted plants and the development of green campuses to enhance thermal comfort	intake and avoidance of direct sun exposure 4. Avoid, restrict or suspend physical education, sports and outdoor activities during school and college hours	communicate safety advisories to parents and guardians through bulk messaging systems 3. Advise teachers, faculty members and administrative staff on Red Alert protocols, emergency preparedness and student safety measures
4	Municipal Administration & Water Supply Department (MAWS) / Rural Development and Panchayat Raj Department / Urban Local Bodies (ULBs) / Tamil Nadu Water Supply and Drainage Board (TWAD) / Chennai Metropolitan Water Supply and	1. Ensure drinking water supply to all habitations 2. Local bodies shall identify the areas to provide shelters and drinking water during the heat alert period, such as bus depots/stops, markets, railway stations, pilgrimage, tourist, industrial areas, etc 3. Plan, install and maintain shaded waiting areas, drinking water facilities and fans at bus stops, terminals and passenger waiting areas	1. Keep parks open during afternoons and extend evening hours 2. Disseminate heat-protection tips and high-temperature warnings through local radio, FM channels, cinema theatres, print media and social media	1. Set up water kiosks, known as 'Thaneer Panthals,' at strategic locations such as bus depots, markets, and other gathering points. 2. Issue frequent and urgent public advisories on extreme heat risks and protective actions 3. Display heatwave prevention and protection measures prominently in public places

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S No	Department	Actions /Measures to be taken		
		Yellow	**Orange**	**Red**
	Sewerage Board (CMWSSB)- all should actively engage in Public Awareness and community outreach	4. Prepare and release advisory messages on heatwave do's and don'ts for the general public 5. Develop posters and pamphlets with guidance on protecting cattle and poultry during heatwave conditions 6. Arrange for water facilities for stray and wild animals to prevent/reduce human-animal conflict 7. Arrange for continuous relevant announcements in railway stations, bus stands and tourist spots every 10 minutes and whenever there are existing public announcement systems available		such as bus stands, railway stations, markets, hospitals, schools, and workplace areas through posters, digital screens and public announcements
5	Rural Development and Panchayat Raj Department	1. The Rural Development Department shall ensure that MGNREGS workers are sensitised on heat-related do's and don'ts, provided with	1. Organise training workshops and outreach sessions with community groups and mobilisers (Mahila Arogya	1. Scale up Thaneer Panthals,' at strategic locations in rural areas 2. Provide awareness and

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S No	Department	Actions /Measures to be taken		
		Yellow	**Orange**	**Red**
		adequate drinking water and shelter at worksites, and that accompanying children are safely cared for and protected from sun exposure 2. To collect information on the works sanctioned under the MGNREGS programme in high-risk areas to plan for mitigation efforts during the heat period	Samiti, SEWA, ASHA workers, anganwadis, municipal councils) to actively engage vulnerable communities in coordination with the health work personnel	issue warning to vulnerable groups
6	Animal Husbandry, Dairying, Fisheries and Fishermen Welfare Department	1. Create water reservoirs and small water-filled ponds or troughs at appropriate locations to ensure adequate drinking water for livestock and other animals during heatwave conditions	1. Ensure adequate livestock housing with improved ventilation and heat protection measures in villages 2. Advise farmers on heat stress management, nutrition and hydration for livestock through an IEC campaign coordinated with veterinary officers	1. Ensure immediate access to water, shade and cooling facilities to prevent heat stress–related morbidity and mortality in livestock 2. Support small and marginal farmers through intensified advisory services to protect livestock productivity and survival during extreme heat events
7	Department of Industrial Safety and	1. Conduct capacity-building workshops for	1. Enforce occupational safety	1. Intensify inspections of high-risk outdoor

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S No	Department	Actions /Measures to be taken		
		Yellow	Orange	Red
	Health / Public Works Department / Tamil Nadu Urban Habitat Development Board / Tamil Nadu Police Housing Corporation / Water Resources Department / Highways and Minor Ports Department / Municipal Administration and Water Supply Department / Rural Development and Panchayat Raj Department	employers, labourers and workers on the health impacts of extreme heat and preventive measures 2. Disseminate guidelines on heat-safe work practices, including hydration, rest breaks and early recognition of heat illness	measures at worksites, including provision of shaded rest areas, safe drinking water and bathing/washing facilities, in accordance with labour safety norms	worksites to ensure compliance with heat-safety requirements. 2. Regulate, restrict or suspend outdoor labour during peak heat hours, particularly between 12:00 PM and 4:00 PM. 3. Direct employers to modify work schedules by shifting outdoor work to early morning or evening hours or sufficient break 4. Conduct intensive publicity and awareness campaigns in high-risk areas and worksites on emergency heat-risk reduction measures. 5. Pilot initiatives to provide emergency ice packs, cooling aids and heat-illness prevention materials to labourers and workers in

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S No	Department	Actions /Measures to be taken		
		Yellow	**Orange**	**Red**
				severely affected locations.
8	Tamil Nadu Police Department	1. To educate Police personnel on duty in the open on precautionary measures to be taken during a heatwave. 2. To conscientise police personnel to help public and outdoor workers who are vulnerable to extreme heat events	1. Provide shaded shelters/cool vests for traffic personnel and checkpoint duty officers at their duty locations	1. To provide cool vests, cooling scarves, shaded rest areas, and adequate hydration 2. Innovative cooling solutions such as air-conditioned helmets / Straw hat (*Shola hats*) to reduce heat stress among frontline personnel.
9	Tamil Nadu Fire & Rescue Services (TNFRS)	1. Provide training and capacity building to schools, colleges and public places on heatwave preparedness, including preventive measures and basic first aid for individuals affected by heat-related illnesses such as heat stroke and heat cramps.	1. Ensure adequate availability of fire tenders, rescue vehicles and firefighting equipment	1. Ensure the uninterrupted functioning of communication systems to receive fire incident alerts and emergency messages 2. The Fire and Rescue Services Department has to ensure the readiness of vehicles and firefighting equipment to face any emergency
10	Transport Department/ Home department through RTOs	1. Display heat-safety precautionary messages (do's and don'ts) on buses, autos, and other	1. Provide ORS packets, ice packs and basic first-aid/medical support inside	1. Ensure uninterrupted availability of, drinking water, ORS packets, and cooling aids

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S No	Department	Actions /Measures to be taken		
		Yellow	Orange	Red
		vehicles, and distribute awareness pamphlets to passengers	buses and replenish them at major transit points 2. Intensify display of posters and distribution of information materials on prevention of heat-related illnesses inside buses and other vehicles 3. RTO may instruct all vehicles to arrange drinking water and buttermilk (Mor Pandhal) facilities for the general public inside all transport facilities carrying public	inside long-distance vehicles 2. Direct contractors and officers to suspend roadside and outdoor transport-related works between 12:00 PM and 4:00 PM 3. Ensure provision of drinking water and buttermilk (Mor Pandhal) for the public at all high-risk areas and places where floating population accumulates and which are serviced by private sector
11	Electricity Board/Energy Department	1. Issue heat-safety guidelines for the departmental workers engaged in outdoor and field operations	1. Ensure efficient, stable and continuous electricity supply, with priority to high-risk areas	1. Maintain an uninterrupted power supply to all critical facilities, prioritising very high and high-risk areas

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TN ALERT Mobile App

The TN-ALERT mobile application, launched by the Tamil Nadu State Disaster Management Authority (TNSDMA), serves as a centralized platform for real-time dissemination of disaster-related information. The app provides citizens with timely updates on disaster risks, early warnings, rainfall forecasts and safety advisories such as dos and don’ts. Notably, the application has been enhanced to include heatwave alerts, enabling users to receive heat advisories, precautionary measures and guidance on staying safe during extreme heat events. This initiative strengthens the state’s capacity for risk communication and supports proactive community response to both sudden and slow-onset climate hazards.

Scan code to download the TN ALERT Mobile App



iOS



Android

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9 Monitoring, evaluation and updating the Tamil Nadu State Heat Action Plan

This action plan integrates all the necessary components for an effective Heat Action Plan (HAP). Its successful implementation is crucial. Continuous monitoring, evaluation and revision are vital to its success. Evaluation is essential to assess whether the activities are achieving their intended effects (effectiveness), determining if they are cost-efficient (efficiency) and ensuring they are acceptable to the target population (social acceptability). It is vital that evaluation occurs at all stages of planning, development, implementation and review (WHO, 2008).

To ensure the effective and timely implementation of the HAP, both the process and outcomes must be monitored at designated intervals. Monitoring short-term strategies through quantitative, performance-based indicators will enhance the preparedness of officials and stakeholders while raising awareness and building the capacity of vulnerable groups. After the heatwave season, analysing the plan's outcomes and impacts will provide valuable insights into its effectiveness, highlight any remaining gaps and identify future needs for improving the plan's impact.

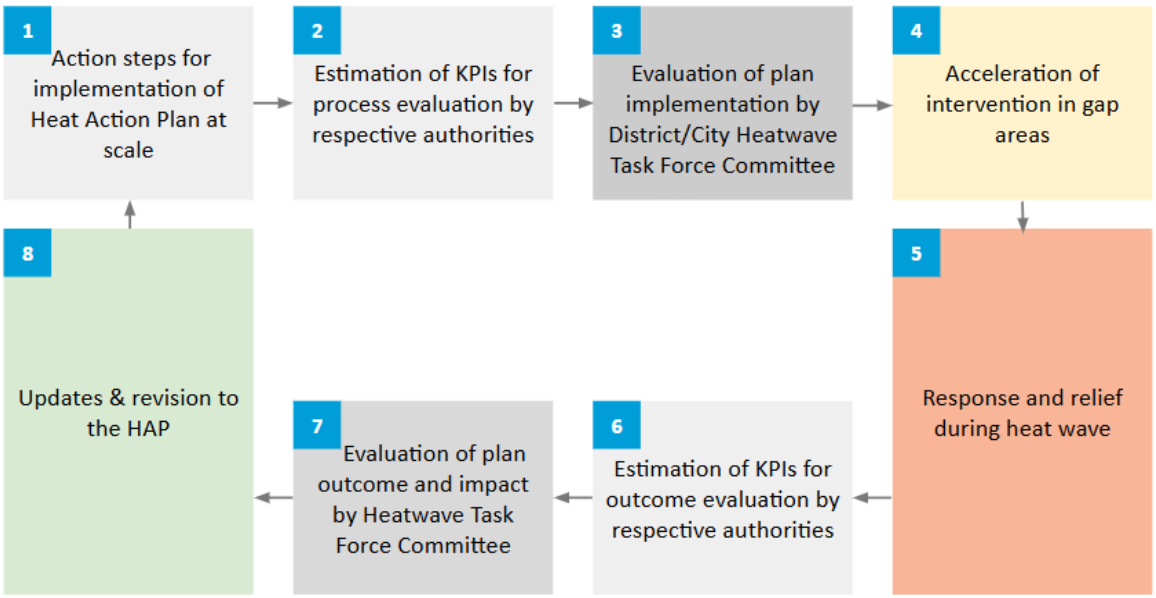
9.1 Monitoring and evaluation framework for the Tamil Nadu State HAP implementation

Key Performance Indicators (KPIs) aligned with each outlined strategy, spanning both for short-term preparedness and response and long-term heat risk mitigation will enable a quantitative evaluation of the plan’s performance. The KPIs aligned with each strategy for identified potential solutions will be developed in consultation with TNDRRA. The authority responsible for implementing each sub-theme will also be tasked with data collection, mapping and estimating the measurable KPIs against established minimum performance standards. This process will track progress and ensure alignment with the overarching goal of effectively mitigating heat risks and improving resilience.

9.2 Revising the HAP: Way Forward

Given the evolving and projected heat extremes in Tamil Nadu and recognizing this as the inaugural version of the Heat Action Plan (HAP) for the state, it is essential to revisit and revise the plan after the 2026 heatwave season. The revision process should be guided by the specific successes and challenges observed during the 2026 season. The heatwave management cycle, as illustrated in Figure 15, integrates monitoring, evaluation and plan updates into a continuous, year-round implementation framework. This cyclical approach ensures the plan remains adaptable and effective in addressing emerging heat-related challenges in Tamil Nadu, fostering long-term resilience and preparedness.

Figure 15: Heatwave management cycle for Tamil Nadu



In preparation for the next iteration of Tamil Nadu State Heat Action Plan (HAP), several key considerations should guide its development to ensure it remains a dynamic and science-based policy document:

Establishment of Evidence-Based Heat-Health Thresholds

While the current plan establishes local-level thresholds using biometeorological indices, it is crucial to enhance this by correlating mortality and heat illness data (as outlined in Chapter 13) with observed dry temperatures. The application of bio-statistical analysis techniques will allow for the establishment of more precise and accurate heat-health thresholds, significantly improving the plan's ability to predict and mitigate heat-related impacts.

Incorporation of Wind Speed and Meteorological Persistence

The current version of the plan relies on the Heat Index derived from daytime and night time relative humidity and temperature variables. Moving forward, it is essential to incorporate the India-specific Heat Index currently being developed by the India Meteorological Department (IMD). Integrating this data will provide a more comprehensive understanding of heat risks, accounting for variables such as wind speed and meteorological persistence, (the duration of the heat event), both of which play a critical role in heatwave intensity and its cumulative physiological impact. Weather stations across the state can be expanded to enhance threshold monitoring aligning with IMD guidelines.

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Development of Village, Town Panchayat and Municipality-Level Heat Risk Index

While the current plan utilizes sub-district level indices based on secondary data, it is essential to refine this approach to the village, town panchayat and municipality levels through targeted on-ground surveys. By collecting granular socio-economic data via field assessments, authorities can evaluate heat risk with significantly higher precision at the local level. This localized analysis will enable the strategic prioritization of mitigation and response measures, ensuring that resources are directed toward the specific areas with the highest heat vulnerability.

Development of Ward-Level Heat Risk Index

Similarly, the current plan includes a heat risk index at the sub-city level using secondary data. Moving forward, it is vital to refine this to the ward level. Implementing field surveys to collect local socio-economic and infrastructural data will allow for a more accurate assessment of heat risks in dense urban environments. This ward-level analysis will facilitate better prioritization of interventions, such as the placement of cooling centers or "green" zones, ensuring that resources are allocated effectively to protect the most vulnerable urban populations.

These key considerations aim to enhance the accuracy, relevance and effectiveness of future heat action plans for Tamil Nadu. By transitioning toward more granular data and sophisticated meteorological indices, the state can move from general awareness to informed, evidence-based decision making. This evolution ensures robust preparedness in the face of rising heat risks., ultimately safeguarding the lives and livelihoods of all citizens across the state's diverse landscapes

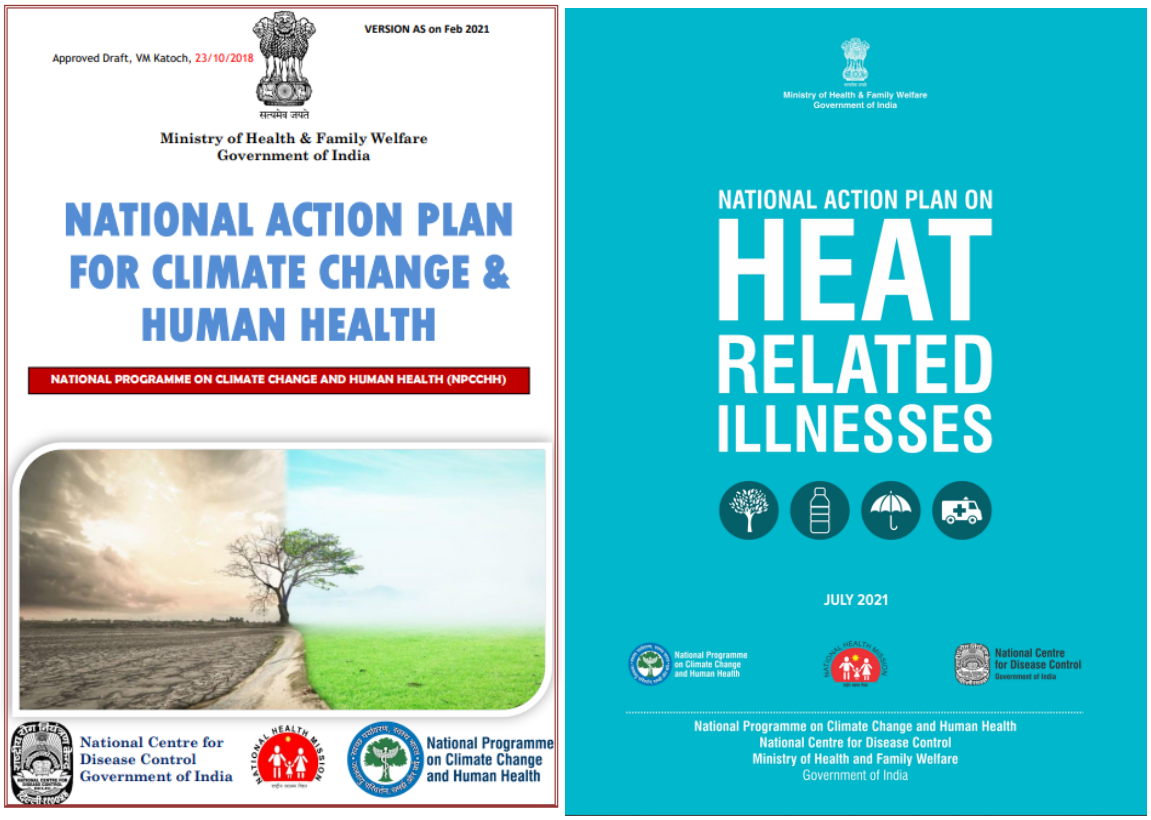
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10. Health sector preparedness and response plans

The health sector has to play one of the most crucial roles in advancing heat resilience. Effective health sector preparedness, timely response and long-term planning for risk reduction are crucial for minimizing the adverse impacts of extreme heat, particularly on vulnerable populations. This includes understanding the clinical manifestations of heat-related illnesses (HRIs), establishing protocols for their timely management and ensuring that health facilities are equipped with dedicated heatwave wards and robust response mechanisms. Integrating Heat Health Early Warning Systems is also a key component, allowing for timely alerts and coordinated interventions when extreme heat conditions are anticipated.

As part of a comprehensive Heat Action Plan (HAP), these measures form the foundation for a resilient public health response-one that can anticipate, manage and mitigate the health impacts of extreme heat through both preventive and reactive strategies. This chapter, based on the guiding documents provided by India's National Programme on Climate Change and Human Health, NCDC, MoHFW, outlines measures for health sector resilience.

Figure 16: Guiding documents provided by India's National Programme on Climate Change and Human Health, NCDC, MoHFW



Source: NPCCHH, NCDC, MoHFW

10.1. Understanding and managing heat-related illnesses

One of the most direct outcomes of extreme heat is Heat-related illnesses (HRI), which have now emerged as a significant public health concern, notably contributing to fatalities associated with extreme heat events (Savioli et al., 2022). In India alone, reports presented in the Lok Sabha in 2024 revealed that there were more than 67,637 suspected cases of heatstroke between March and July due to severe heat waves in the same year (Vasudha Mukherjee, 2024). A global systematic review indicates that for every degree rise in temperature from the baseline, there is an associated increase of 18 percent in morbidity and a staggering 35 percent in mortality related to heat illnesses (Faurie et al., 2022).

10.1.1 Pathophysiology

Human beings maintain a core body temperature of 37°C through four primary heat dissipation mechanisms:

- Conduction: transfer of heat through direct contact with a cooler object or air.
- Convection: heat transfer through direct contact with fluid.
- Evaporation: loss of heat through sweat or water on the skin.
- Radiation: Heat is transferred from the skin tissue to the surrounding air.

It's important to note that, except for evaporation, the effectiveness of the other three pathways diminishes at temperatures above 35°C. Additionally, when relative humidity exceeds 75 percent, evaporation becomes inefficient too (NPCCHH, 2024). As the thermoregulatory system becomes overwhelmed due to the inability to dissipate body heat, individuals may experience a range of heat-related illnesses (HRI). These can range from non-fatal conditions such as heat cramps, exhaustion, rashes and edema to the more severe and potentially fatal heat stroke. If non-threatening conditions are not addressed on time, they can progress into heat stroke

Table 52: The range of heat-related illnesses

Heat-Related Illnesses	Description	Treatment
Severe illness		
Heat stroke	A multisystem, life-threatening illness characterised by elevation of the core body temperature (>40°C) and CNS dysfunction	Move the patient to a cool environment; manage airway, breathing and circulation; administer rapid cooling with cold-water or ice water immersion or other means; administer

		intravenous rehydration; and evacuate to the emergency department after on-site cooling is performed. ICU admission is warranted for the management of end-organ sequelae.
Moderate illness		
Heat exhaustion	Profound fatigue, weakness, nausea, headache or dizziness or a combination of these symptoms resulting from a decrease in body water content or blood volume due to water or salt depletion from heat exposure; mild elevation (<40°C) in body temperature may be present, but not altered mental status	Remove the patient from the hot environment; treat with rest in supine position, evaporative cooling and intravenous or oral rehydration; monitor mental status. A delayed response to treatment warrants further evaluation
Mild illness		
Heat syncope	Brief loss of consciousness due to vasodilation and pooling of blood in the limbs as a result of physiological compensation to heat exposure	Remove the patient from the hot environment; treat with rest in supine position, passive cooling and intravenous or oral rehydration. Prolonged recovery or a medical history or physical examination arousing concern for a cardiac cause, if the patient has cardiac risk factors, should prompt further evaluation
Heat edema	Swelling of limbs caused by peripheral vasodilation and interstitial pooling resulting from physiological compensation in response to heat exposure	Remove the patient from the hot environment and elevate the legs. Diuretic agents are not indicated
Heat cramps	Painful muscle spasms in the abdomen, arms, or legs during or after activity in the heat, which often occur when excessive amounts of salt are lost during sweating from physical exertion	Remove patient from the hot environment, treat with rest, oral electrolytes and fluid repletion

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Heat rash	An inflammatory disorder of the epidermis that results from blockage of sweat glands; may be followed by superimposed bacterial soft-tissue infection	Remove patient's clothing; treat with evaporative cooling and glucocorticoid and antibacterial cream as needed, but avoid topical emollients; monitor for cellulitis. Advise the patient to avoid hot environments and to wear loose clothing.

Source: Sorensen et al., 2022

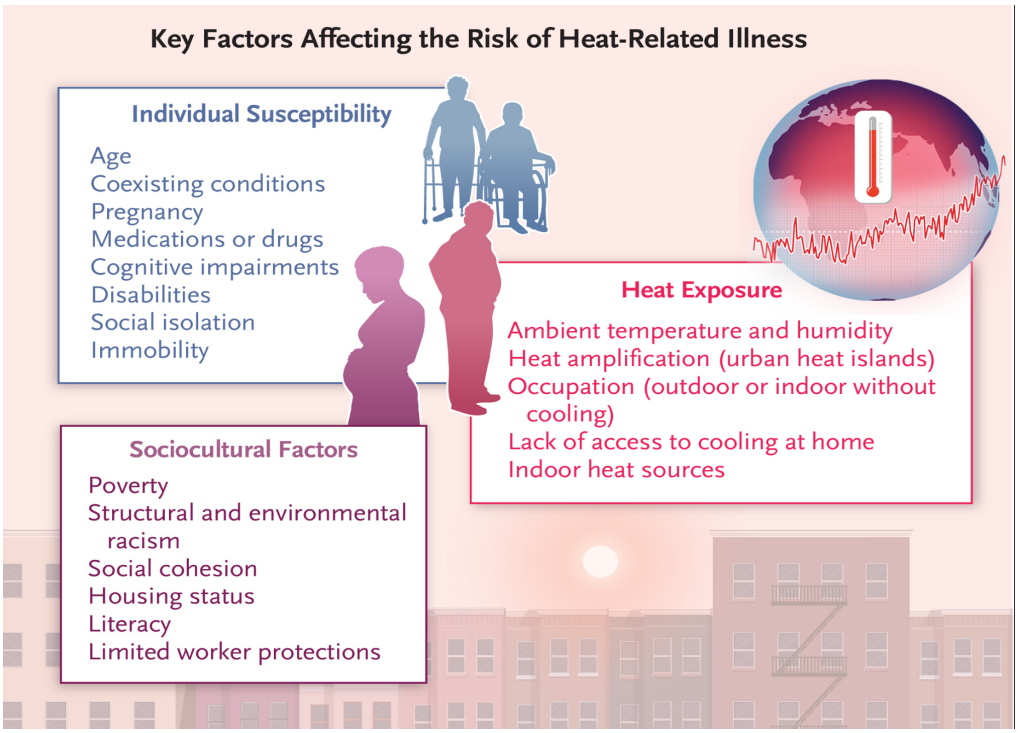
10.1.2 Risk factors for HRI

Increasing frequency and intensity of extreme heat events predispose certain groups to HRI. This risk is an amalgamation of 3 factors (Sorensen et al., 2022):-

- Heat exposure: a combination of ambient temperature, humidity and bodily metabolic heat generated
- Individual vulnerability: age, sex, gestational status and pre-existing illnesses
- Socio-cultural factors: income status, healthcare access, working and living conditions

The risk factors have been quantified in chapter four of this heat action plan, where a ward-level heat risk map has been developed.

Figure 17: Risk Factors of Heat-Related Illness



Source: Sorensen et al., 2022

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10.1.3 Heat stroke

On the spectrum of HRI, Heat strokes are considered a catastrophic emergency requiring immediate medical assistance. It is characterised by an increased core body temperature of 40°C and above associated with neurological dysfunction such as convulsions, delirium and in severe cases like coma. There are two types of heat strokes:

- Classical Heat Stroke (CHS): Occurs periodically in vulnerable groups at increased risk to HRI in extreme heat and humid environments
- Exertional Heat Stroke (EHS): Individuals engaged in high physical activity levels in extreme heat and humid conditions are predominantly at risk. Occupations such as athletes, outdoor manual workers and military personnel are particularly vulnerable to these environmental stresses.

The primary distinction between EHS and CHS are described in the table below. However, the clinical manifestations of both conditions remain the same, irrespective of the cause.

Table 53: Features of EHS and CHS

Feature	Exertional Heat Stroke	Classic Heat Stroke
Occurrence	Sporadic (any time of year)	Epidemic (heat waves)
Exposure	. Athletic event . Working in high heat stress conditions	A. High environmental heat with/ without high humidity
Acute risk factors	• Dehydration • Concurrent Illness • Obesity • Wearing too much clothing • Poor cardiovascular fitness	• Lack of adequate ventilation/ cooling • Confined places • Physical exertion not a prerequisite
Heat equilibrium	Overwhelmed: heat gain> heat loss • Heat gain from environment with/ without an increase in internal heat production	Impaired: reduced heat loss capacity • Internal heat loss mechanism impaired • Restricted/ inadequate ventilation
Heat injury development	Quick rise in core body temperature (over minutes/hours)	Slow rise in core body temperature (over hours or days)
Sweating	Usually present (wet skin)	May be absent (dry skin)
CNS dysfunction	Common	Common
Pathophysiological changes	• Metabolic acidosis • Hypoglycaemia • Rhabdomyolysis: Frequent	• Respiratory alkalosis • Liver dysfunction: mild • DIC: Mild

	• Liver dysfunction: Severe • Renal failure: Common • DIC: Severe • Hypocalcaemia, Hyperkalemia	• Volume and electrolyte abnormality is common
Risk factors		
Physiological	• Healthy, active adult	• Elderly • Children • Pregnancy • Obesity • Chronic illness • Poor physical or psychological health
Medication/ drug use	Amphetamines and amphetamine like agents, MDMA, cocaine, PCP and LSD, synthetic stimulants of the cathinone class, alcohol	Antihypertensives, laxatives, anticholinergic drugs, salicylates, thyroid agonists, benztropine, trifluoperazine, butyrophenones, tricyclic antidepressants, SSRIs
Socio-economic (individual/ institutional)	Occupation/ physical exertion linked: work time, duration, adequate time to rest, lack of cooling and hydration facilities	• Social isolation • Living on higher floors • Unventilated and non-air conditioned living space • Inability to care for oneself

Source: NPCCHH, 2024

10.1.4 Clinical manifestation

The signs and symptoms of heat stroke are:

- Warm skin with or without sweating
- Hypotension: A condition characterized by low blood pressure, often defined as a systolic blood pressure below 90 mmHg.
- Tachycardia: A heart rate that exceeds the normal resting rate, generally defined as more than 100 beats per minute in adults.
- Tachypnea: Abnormally rapid and shallow breathing, typically defined as a respiratory rate greater than 20 breaths per minute in adults.
- Anhidrosis: The inability to sweat normally, either in one specific area or over large areas of the body. This condition prevents the body from cooling down, which can lead to dangerous, life-threatening overheating.

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The liver and brain are particularly vulnerable to the effects of hyperthermia and the prognosis is influenced by both the severity and duration of the hyperthermic episode. However, if cooling measures are implemented promptly and completed within 30 minutes of the onset of symptoms, the chances of death can be reduced to zero. This emphasises the critical importance of rapid intervention in preventing severe health outcomes in hyperthermic patients (Savioli et al., 2022).

10.1.5 Severe Heat-related Illness Management

Heat-related illnesses are largely preventable, but if not promptly identified and managed, they can lead to severe health complications and, in critical cases, even death. The clinical manifestations of heat stroke can closely resemble those of various other conditions, including sepsis, metabolic disorders, cerebrovascular events, neuropathic emergencies and potential toxicological exposures. Therefore, it is always essential to record the core body temperature and rule out other causes of hyperthermia. Simultaneously, prompt initiation of heat stroke treatment is critical to avoid adverse health outcomes. A comprehensive set of routine investigations should be conducted for patients suspected of heat stroke. These include:

- Complete blood count (CBC)
- Arterial blood gas (ABG) analysis
- Liver function tests (LFTs)
- Kidney function tests (KFTs)
- Blood glucose levels
- Electrolyte panel
- Toxicological screening
- Urinalysis
- Additionally, a chest X-ray should be performed if the patient exhibits respiratory symptoms. This thorough assessment helps guide appropriate treatment and management of heat stroke.

The foundation for effectively treating HRI lies in quickly recognising heat as a causative factor, implementing rapid cooling techniques and relocating the patient to a cooler environment. Rapid cooling is the most effective treatment for suspected HRI cases, reducing the risk of mortality from more than 50 percent to as low as 5 percent (U.S. Customs and Border Protection). The technique adopted should be completed within 30 minutes of the onset of symptoms, ultimately maintaining a core body temperature between 38 to 39°C.

10.2. Rapid cooling

Heat-related illnesses, particularly heatstroke, require immediate cooling to prevent severe organ damage or fatal outcomes. Rapid cooling treatments help lower the body temperature as quickly as possible to

prevent complications like brain swelling, kidney failure and cardiovascular stress.

10.2.1 Managing principles when considering Rapid Cooling in heat stroke suspected cases

- Assess competency of airway, breathing, circulation, disability and exposure before treatment initiation and monitor them throughout the procedure, particularly in CHS patients.
- A temperature gradient must be created between the skin and the surroundings, leveraging the body's thermoregulatory mechanisms.
- Cooling rates between 0.784 to 0.154 Deg C/min are efficient in preventing further organ dysfunction complications.
- The primary aim of managing heat stroke patients in emergencies is to *"Cool first, Transport second "*(NPCCHH, 2024)
- Depending on the scene of the collapse, appropriate cooling techniques should be undertaken to complete cooling within 30 minutes of clinical presentation.
- It is not required to differentiate a case between EHS and CHS, as the treatment line remains the same.
- Cooling is not advised when the body temperature is normal or low.
- Avoid prescribing antipyretics such as Paracetamol, Aspirin, Ibuprofen, etc.
- The use of Dantrolene, a skeletal muscle relaxant, is also not recommended in EHS.

10.2.2 Challenges

- Shivering may be triggered by rapid cooling even after persistent hyperthermia and is more commonly seen in the elderly and children. In such cases, wet bedsheets, water spray and fans are used to cool the patient down. If shivering persists, seek pharmacological support.
- Monitoring of vital signs is crucial through electrodes, especially for severely ill patients presenting with CHS, as they are at an increased risk of cardiovascular decompensation. In cases of rapid cooling methods such as cold water immersion, it is not possible.

10.2.3 Appropriate rapid cooling techniques for heat strokes

10.2.3.1 For Exertional Heat Stroke

i. Ice/ Cold water immersion

The use of cold water immersion is widely recognized as the gold standard for cooling patients with exertional heat stress (EHS) who are otherwise physically healthy. Due to its high thermal conductivity, cold water facilitates efficient and rapid cooling compared to alternative methods.

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Resources required: Tub/ Portable pool/ Tarpaulin, cold water, ice buckets with ice, rectal thermometer, lubricating gel, 3-4 towels, tarpaulin for shade, if outdoors, 3 to 4 trained personnel for stirring the water, recording vitals, managing patient vitals and monitoring rectal temperature.

Mechanism: In this technique, a vessel filled with ice slurry or cold water is maintained at a temperature between 2 to 10°C. The patient should be exposed as much as possible to the cool medium and immersed up to the torso with hands outside the vessel. A cold cloth should also be placed on the head for additional cooling. The patient should be securely positioned with a cloth under the axilla and stabilised by personnel to prevent any risk of drowning. The immersion should last between 15 to 20 minutes, with the water being vigorously stirred to enhance heat transfer. This process should continue until shivering occurs or the patient reaches a target temperature of 38°C to 39°C. Following successful cooling, the patient should be transported to the nearest emergency department for further monitoring and evaluation. Continue cooling in the best possible way if temperatures are not met during transportation.

Cooling time: 15 minutes

Challenges: Effective pre-planning is essential for managing heat stroke incidents in the field, necessitating the allocation of appropriate resources, both material and personnel. This requires thorough preparation and coordination to ensure a timely and effective response.

Figure 18: Cold Water Immersion in the field



Source: NPCCHH, 2024

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ii. Tarpaulin-Assisted Cooling with Oscillation (TACO)

This method is designed for use in resource-limited settings.

Resources required: Instead of a traditional tub or pool for cold water immersion, a tarpaulin is utilized.

Mechanism: First, the tarpaulin is filled with ice and the patient lies on their back in the centre of the tarp. The corners of the tarp are then lifted, allowing cold water to be added until the patient's chest is fully submerged. To enhance the cooling effect, the tarp is gently moved back and forth to mix the ice and water, facilitating effective cooling.

Challenges: It requires dedicated staff just for lifting patients. For obese patients, more people may be needed.

Cooling time: 10 to 15 minutes

Figure 19: TACO in the field



Source: NPCCHH, 2024

iii. Cold water dousing with ice massage

Also known as Water Ice Therapy.

Resources required: Utilises the same resources as cold water immersion; additionally, a porous stretcher is used.

Mechanism: The patient is placed on the porous stretcher inside the tub/ portable pool and multiple personnel drench the patient entirely except the

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head in the ice-cold water from the tub. Simultaneously massage muscles of the chest, abdomen, thighs and legs with icepacks.

Cooling time: 12 to 24 minutes

10.2.3.2 For Classical Heat Stroke

i. Body bag immersion

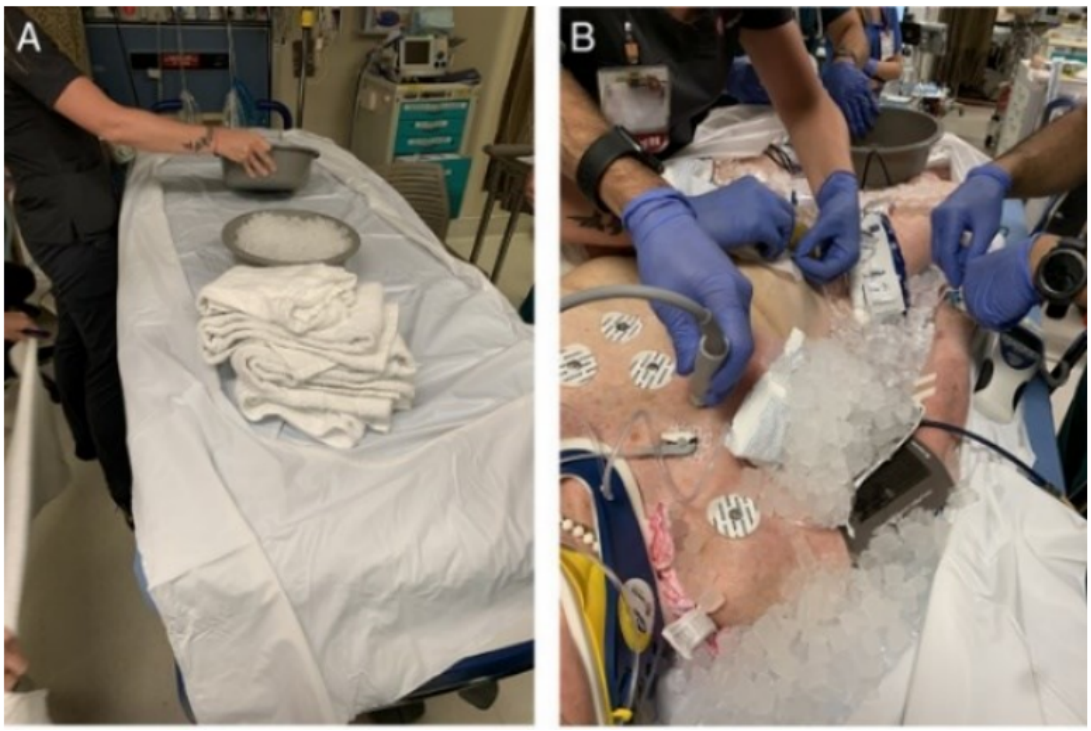
The technique has similar cooling rates as that of cold water immersion but allows for continuous monitoring of the patient as the chest is exposed. Hence, it is the ideal treatment mode in CHS patients. This technique can be used in the field, in an ambulance, or the emergency room of a hospital.

Resources required: Utilizes the same resources as cold water immersion, except for a tub, a waterproof, leakproof body bag is used and other medical equipment such as monitor, chest and limb leads.

Mechanism: Place the patient into the body bag filled with ice and cold water, baring the chest. Attach the monitor to assess ABCDE. Once the initial assessment is completed, close the body bag until the rectal temperature reaches 38 to 39°C.

Cooling time: 15 mins

Figure 20: Cold water immersion using a body bag in the emergency department



Source: NPCCHH, 2024

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ii. Water spray and Directed Fan

This technique effectively utilizes the body's evaporative and convective thermoregulatory pathways, making it particularly beneficial in cases of CHS, especially for children and older adults.

Resources required: Spray bottle, fan

Mechanism: Once the initial assessment is complete, carefully expose the patient and lightly spray them with cold water while turning on the fan to enhance the cooling effect. If the patient begins to shiver, switch to using room temperature water to ensure their comfort.

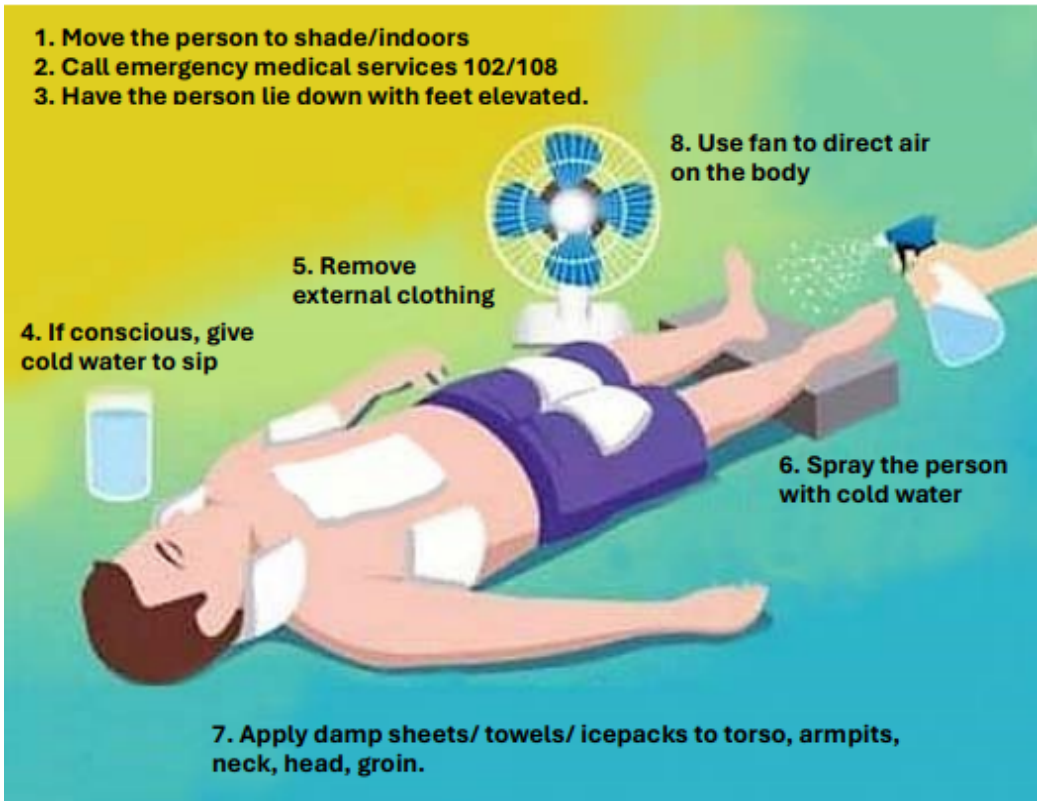
Challenges: It requires access to ample amounts of water and takes longer to cool down when utilizing water at room temperature.

iii. Water-soaked bedsheets and Directed Fan

Soak bed sheets in cool water and apply them over the patient's exposed skin while positioning a fan to blow air at a high speed. This method is particularly effective for children and elderly patients, as it helps to lower body temperature quickly and safely.

iv. Ice pack/ Crushed Ice, Water spray and directed fan

Figure 21: Multiple methods implemented at a time for rapid cooling



Source: NPCCHH, 2024

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10.3. Hospital initiatives towards heat wave preparedness

Heatwave Ward: Specialised Hospital Care for Heat-Related Illnesses (Anumeha Yadav, 2024)

A heatwave ward is a dedicated hospital space designated for the treatment of patients suffering from mild and severe heat-related illnesses. These wards are especially crucial in regions experiencing extreme heat conditions due to climate change and rising global temperatures, leading to an increased frequency of hot days and nights.

Owing to the sudden rise in heat-related mortality in 2024, hospitals like Safdarjung, AIIMS (All India Institute of Medical Sciences) and RML (Dr. Ram Manohar Lohia Hospital) in Delhi have established specialised heatwave units to provide dedicated care for patients affected by extreme heat. These wards feature well-ventilated, air-conditioned rooms equipped with life-saving drugs, expert HRI-skilled medical staff, ORS, IV fluids, ice and cold water, along with advanced cooling technologies to stabilize patients and prevent life-threatening complications. (Ankita Upadhyay, 2024)

Benefits of Heatwave Wards

- Prevents Fatal Heatstroke Cases: Rapid cooling interventions reduce mortality rates drastically, using evidence-based rapid cooling techniques to lower core body temperature.
- Reduces Heatwave-Related Hospital Admissions: Early intervention prevents complications and shortens hospital stays.
- Enhances Climate Resilience in Healthcare: These wards facilitate hospital preparedness for the rise in climate change-associated heat waves.
- Protects Vulnerable Populations: This is critical for elderly patients, outdoor workers, pregnant women and those with chronic illnesses.

Figure 22: Inflated pools and Ceramic Tubs for Heat Wards



Source: Upadhyay, Ankita. 2024. "Battling 107°F fever with ice and water: Inside RML Hospital's heat stroke unit".

10.4. Hospital Preparedness Measures for Managing Heat-related Illness

The hospital preparedness plan developed under the NPCCHH serves as a foundational guide for states to design, implement, coordinate and assess heatwave response measures within health facilities.

It outlines planned activities across three seasonal phases: pre-heat season, heat season and post-heat season. These activities are categorized into three main areas: infrastructure and logistics, capacity building and information and education and communication (IEC)/awareness. The plan is tailored for three tiers of healthcare institutions: Primary Health Centres (PHCs), Community Health Centres (CHCs) and District Hospitals (DHs)//medical colleges (MCs).

Table 54: Hospital Preparedness Chart- Pre-heat, during and post-heat Season

PHC	CHC	DH/MC
A. Pre-heat Season		
INFRASTRUCTURE AND LOGISTICS		
1. Check inventories for basic equipment and medicines required. 2. Ensure adequate arrangement of staff 3. Explore the creation of ice pack dispensaries to increase access to vulnerable communities 4. Adopt long-term measures such as cool roofs and improving the green coverage of health facility 5. Identify a Rapid Response Team (RRT) to respond to any exigency call outside the hospitals 6. Try to establish outreach clinics at various locations easily accessible to the vulnerable population		
CAPACITY BUILDING		
1. Prepare a detailed action plan to tackle HRI (updated annually). 2. Organize fresher/refresher targeted training course—maintaining hospital records, improve expedience of recording of cause of death, heat illness examination procedures 3. Community involvement of trained staff to create awareness.		
• Map susceptible villages (identify areas/populations that are vulnerable)	• Map susceptible PHCs (identify areas/populations that are vulnerable)	• Map susceptible blocks (identify areas/ populations that are vulnerable)
IEC/AWARENESS		

PHC	CHC	DH/MC
1. Prepare targeted IEChoardings, banners, posters, leaflets, factsheets, information cards, media, mic announcements, rallies, song/drama activities and street plays. 2. Plan for dissemination as per assessment of vulnerable area/ communities. 3. Conduct sensitisation meetings. 4. Prepare handouts for health staff about heat illness 5. Ensure the availability of funds for the above activities		
B. Heat Season		
INFRASTRUCTURE AND LOGISTICS		
1. Ensure adequate medical supplies are available 2. Identify surge capacities and mark the beds dedicated to treating heatstroke victims and enhance emergency department preparedness to handle more patients		
• Increase ASHA/ANM/ MPHW outreach in at-risk villages during a heat alert, if feasible.	• Increase ASHA/ ANM/MPHW 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. • Organize DNO-CC/ SNO-CC visits to CHCs to confirm proper preparation has been made for HRI and conduct case audits during the heat season.
CAPACITY BUILDING		
1. Ensure reporting of HRI cases daily 2. Adopt HRI treatment and prevention protocols 3. Expedite recording of cause of death due to HRI		
• Referral of patients to the higher facility only after ensuring adequate stabilization	• Prepare weekly reports of health impact for nodal officer	• Prepare weekly reports of health impact for nodal officer • Conduct case review

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PHC	CHC	DH/MC
and basic definitive care (cooling and hydration)	• Conduct case review during heat season	during heat season
IEC/AWARENESS		
1. Ensure IEC dissemination 2. Target the vulnerable area/communities followed by other areas. 3. Plan activities as per the Heatwave alert issued by IMD		
C. Post-heat Season		
A. INFRASTRUCTURE AND LOGISTICS		
• Review to assess/identify gaps, if any, e.g., ► Any shortage of equipment, medicine, staff. ► Any long-term measures adopted and maintained • Enlist/document the lessons learnt for the next season		
CAPACITY BUILDING		
• Review to assess/identify gaps, if any, e.g., ► Any flaw/fault in reporting channel/format/ efficiency ► Number of deaths reviewed • Enlist/document the lessons learnt for the next season		
IEC/AWARENESS		
• Review to assess/identify gaps, if any, e.g., ► IEC messages ► Dissemination area/community ► Efficient use of resources • Enlist/document the lessons learnt for the next season		

Source: National action plan on heat-related illnesses (HRIs) by NPCCHH, 2024

10.4.1. Basic equipment and medicines required as a part of Hospital preparedness for heat season

Primary Health Centre (PHC), Community Health Centre (CHC), District Hospital (DH) and Medical Colleges should ensure the following requirements before the start of heat season:

- Dedicated bed for HRI patients in cooler area of hospital
- Thermometer, ORS packets, ice packs, BP apparatus
- Silver sulphadiazine cream, Calamine lotion, Chlorhexidine in a light cream or lotion base
- Cold IV normal saline (0.9%), dextrose 50% in water solution (D50W)
- Glucometer and testing strips

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- ECG equipment: ECG machine, Gel, electrodes, ECG paper
- Cooling equipment: AC, cooler, fan as per requirement
- Water cooler
- Medicines: Lorazepam, diazepam
- Ambulance with ice packs and cold water.

The director/In-charge of Hospitals CHCS and PHCS in all States/Districts should ensure that the following measures are in place:

- 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 (CSD).
- Need to update heat health action plan and issue advisories for hospital preparedness, surveillance and weekly monitoring, including capacity building.
- Promoting strategic media coverage of climate and health linkages at the State level in regional languages to increase support for climate mitigation and adaptation responses.
- Long-term measures such as adopting cool roofs, improving green/forest coverage and analysing health impacts in urban planning.
- Standard Operating procedures should be established to tackle all levels of heat-related illnesses. Capacity-building measures for doctors, nurses and other staff should also be undertaken.
- Cases with suspected heat stroke should be rapidly assessed using standard Treatment Protocols.
- Identify surge capacities and mark the beds dedicated to treat heat stroke victims and enhance emergency department preparedness to handle more patients.
- Identify RRTs (Rapid Response Teams) to respond to any emergency call outside the hospitals.
- Ensure adequate arrangements of Staff, Beds, IV fluids, ORS, essential medicines and equipment to cater to the management of volume depletion and electrolyte imbalance.
- May try to establish outreach clinics at various locations easily accessible to the vulnerable population to reduce the number of cases affected. Health Centers must undertake awareness campaigns for neighborhood communities using different means of information dissemination.
- Primary health centres must refer the patients to the higher facility only after ensuring adequate stabilization and basic definitive care (cooling and hydration).
- Hospitals must ensure proper networking with nearby facilities and medical centres to share the patient load that exceeds their surge capacities.

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All cases of heat-related illnesses (suspected or confirmed) should be reported to the IDSP (Integrated Disease Surveillance Programme) unit of the district.

10.5. Heat Health Early Warning Systems (EWS)

Heat Health Early Warning Systems (EWS) utilize climate and weather forecasts, along with predefined heat stress thresholds, to issue public advisories and activate health interventions aimed at minimizing heat-related health risks before, during and after extreme heat events. These systems are essential decision-support tools, typically developed and maintained through collaboration between public health experts and meteorological agencies. As a core element of broader Heat Action Plans (HAPs), Heat Health EWS plays a vital role in informing health and social service protocols, ensuring timely and appropriate preparedness, prevention and response measures during heatwaves.

Local heat thresholds for early warning systems can be developed using the following methods:

A. Biostatistical methods: The thresholds for temperature are prepared by IMD in India and can be coupled with impact indicators of health. These two can be used in combination to send out alerts and can be used to plan for preparedness as well.

   To establish a correlation between temperature and health impact (outcome) variable, which may include-

   - All cause daily mortality count data
   - Cause-specific daily mortality count data
   - Hospital daily admissions count data
   - Emergency ambulance (108) services daily call count data

B. Meteorological (Bio-meteorological) method: The 2015 WMO WHO Heatwaves and Health: Guidance on Warning-System Development suggests that "In situations where there is basic meteorological information but no health data, a percentile-based threshold (90th, 95th) could be contemplated as a warning trigger value."

   Establishing of percentile thresholds based on thermal and bio-meteorological variables-

   - Tmax, Tmin and Tmean
   - Humidex
   - Wet Bulb Globe Temperature (WBGT)
   - Universal Thermal Climate Index (HTCI)
   - Heat index

NDMA recommends using the 75th, 85th and 95th percentile for Indian context

Extreme heat goes beyond just high daytime temperatures-it also involves factors like humidity and how well people are acclimatised. For early warning systems to be effective, they must account for these variables. This means combining weather forecasts with historical health and climate data to better anticipate the actual health impacts. Without this integrated approach, the true danger of extreme heat events can be missed. For example, many heat-related illnesses are triggered by persistently high night time temperatures, even when daytime highs don't seem extreme

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11 Agriculture sector preparedness and response plans

Heat stress has a significant impact on health, productivity, and the economy, particularly among agricultural workers. It reduces productivity, reduces the physical working capacity of outdoor workers, increases the time required to complete tasks, increases rest periods due to dehydration, and leads to absenteeism, thereby lowering overall agricultural output and household income. The most prevalent health outcomes include Heat-Related Illnesses (HRI). It ranges from mild symptoms such as excessive sweating, dizziness, fatigue, headache, and muscle cramps to life-threatening conditions like heat stroke and death, primarily due to prolonged occupational exposure to high temperatures throughout the year and intensified exposure during heatwave periods. Furthermore, heat stress significantly reduces work capacity, with projections indicating that the agricultural sector could account for nearly 60% of global working hours lost due to heat stress by 2030 (ILO 2019).

The following section outlines potential short- and long-term measures for heat-stress management, drawing on traditional knowledge, climate-responsive cultural practices, and sustainable resource management approaches. These interventions try to enhance farm resilience, strengthen community preparedness, improve water security, and protect both human and livestock systems from the adverse impacts of extreme heat.

11.1 Short-term actions for Heat Stress Management

A. Climate-responsive agricultural practices

1. Adjusting sowing dates

Adjusting sowing dates is a vital climate-smart adaptation strategy in crop diversification and intercropping systems, enabling farmers to align critical growth stages such as flowering, grain filling, and root establishment with optimal temperature, rainfall, and solar radiation windows, thereby distributing environmental risks and enhancing resilience amid shifting monsoon patterns and heat stress prevalent in regions like India.

By shifting planting 10-20 days earlier or later from traditional timings (e.g., advancing kharif maize from mid-June to early May in rainfed savannas or delaying wheat post-rice harvest to escape terminal heat above 34°C), farmers can avoid coinciding reproductive phases with peak heatwaves or dry spells, boosting yields by 10-25% through improved pollination success, reduced spikelet sterility (down 15-30%), and better

water use efficiency as crops escape peak evapotranspiration periods (Ji et al., 2024)

2. **Intercropping and diversified production**

Intercropping involves growing complementary crops (e.g., soybean–maize, cotton with mung bean) to improve land use efficiency and resource utilization. It enhances soil moisture retention, reduces fertilizer and water requirements, suppresses pests through crop diversity and trap cropping, and improves soil organic matter and biodiversity. Especially in water-scarce regions, intercrops conserve irrigation water and support residue-based mulching.

Figure 23: Representative of an Intercropping System in Agriculture



Source: Tamil Nadu Agricultural University

Crop diversification and intercropping distribute risks, resources, and pests across multiple species, fundamentally enhancing agricultural resilience and sustainability by breaking monoculture vulnerabilities. In crop diversification, shifting from single-crop dominance, such as rice-wheat in India's Indo-Gangetic plains, to varied rotations or mixes spreads market price fluctuations, weather extremes, and disease pressures while stabilizing farmer incomes through multiple harvest windows and value-added outputs.

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Figure 24: Representation of Crop Diversification Practice



Source: Unicrop Biochem

3. Mulching

Mulching and residue management are effective practices for moderating soil temperature and conserving moisture. Plant residue spreading involves leaving crop materials such as straw, stubble, husks, or leaves directly over the soil after harvest or planting to protect and enrich the soil. It reduces soil evaporation, enhances water-use efficiency, suppresses weed growth, stabilizes root-zone temperature, and protects roots from thermal damage (Chand et al., 2024).

Figure 25: Representation of Stubble Mulching in Agricultural Fields



Source: TNAU Agritech Portal, Tamil Nadu Agricultural University.

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B. Water Management Interventions

Water management interventions play a crucial role in mitigating heat-induced stress. It involves targeted strategies to optimize water use, reduce waste, and enhance crop resilience amid scarcity. These practices are crucial for sustainable farming, especially in water-stressed regions.

1. Drip irrigation

Drip irrigation supplies water directly to the crop root zone through tubes and emitters, achieving high water-use efficiency. It reduces evaporation, runoff, and deep percolation losses while maintaining optimal soil moisture, improving nutrient uptake, reducing fertilizer requirements, and increasing crop yields.

Figure 26: Representation of a Drip Irrigation System



Source: Welldrip Irrigation Industries

2. Sprinkler irrigation

Sprinkler irrigation simulates artificial rainfall by pumping water through overhead pipes and nozzles that disperse it as fine droplets over crops, providing uniform coverage on medium-textured soils and row crops such as wheat, maize, potatoes, and pulses in undulating terrain, where drip systems are challenging.

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Figure 27: Representation of a Sprinkler Irrigation System



Source: ACCESS IRRIGATION

3. Farm ponds

Farm/community ponds are cost-effective structures with the potential to significantly improve rural livelihoods by enhancing water control and supporting agricultural intensification. They are not merely for intermediate storage, as it would lead to greater groundwater depletion and inequitable water distribution. It can also serve as a storage tank for harvested rainwater from neighborhood households and furthermore, ponds can be built across the village. It can be used for irrigation and livestock drinking water during the peak summer season.

Figure 28: Farm Pond as a water Conservation structure in an Agricultural Landscape



Source: Vikalp Sangam, 2019

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C. Community heat resilient alternatives

1. Shaded public/high footfall spaces

Most rural festivals take place during peak summer when large numbers of villagers gather. These common spaces can be equipped with shaded areas and arrangements for safe drinking water or buttermilk. Shaded structures can be constructed with reflective and cool roofing materials to reduce heat absorption. These shelters may be integrated with rainwater-harvesting systems, enabling rooftop water collection while also maintaining cooler community spaces. This approach ensures both thermal comfort during heatwave days and sustainable water conservation, and is used during water scarcity periods.

2. Tanker Water Supply

While long-term water security should focus on sustainable sources such as rainwater harvesting and waterbody restoration, tanker supply can play an important role in ensuring timely water availability for households and livestock and providing scheduled distribution to households when required. There should be planned, regulated supply mechanisms to help it function effectively during the summer season.

Figure 29: Tanker based Water Supply System



Source: Scroll.in

3. Information Dissemination Mechanism for Local Communities

- Early heat warnings can be communicated through public loudspeakers and through entities such as Milk Producers' Cooperative Societies, where farmers regularly gather. These locally

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trusted platforms ensure the timely dissemination of alerts to farmers and agricultural labourers in a simple, effective manner.

- Based on warning information, farmers can reschedule fieldwork to early morning or late evening hours to avoid peak noon exposure.
- Agricultural labourers can shift tasks to shaded areas during high-heat periods, and livestock can be grazed and tied in shaded areas during midday, thereby protecting farmers, workers, and animals simultaneously.

4. Public Health Emergency Systems

- All Primary Health Centres (PHCs) in villages should ensure 24×7 ambulance connectivity with nearby District or Sub-district Government Hospitals in case of emergency cases of HRI (Town Panchayat or District Headquarters) to facilitate timely referral and advanced medical care.

11. 2 Potential long-term actions for Heat Stress Management

1. Conservation tillage

Conservation tillage paired with residue retention represents a cornerstone of sustainable agriculture, minimizing soil disturbance to less than 30% inversion while maintaining at least 30% ground cover from crop residues like wheat straw, rice husks, or maize stover to foster soil health and ecosystem services (Li et al., 2019)

Figure 30: Strip Till Cultivation Method in Agriculture



Source: Pandi et al., 2025

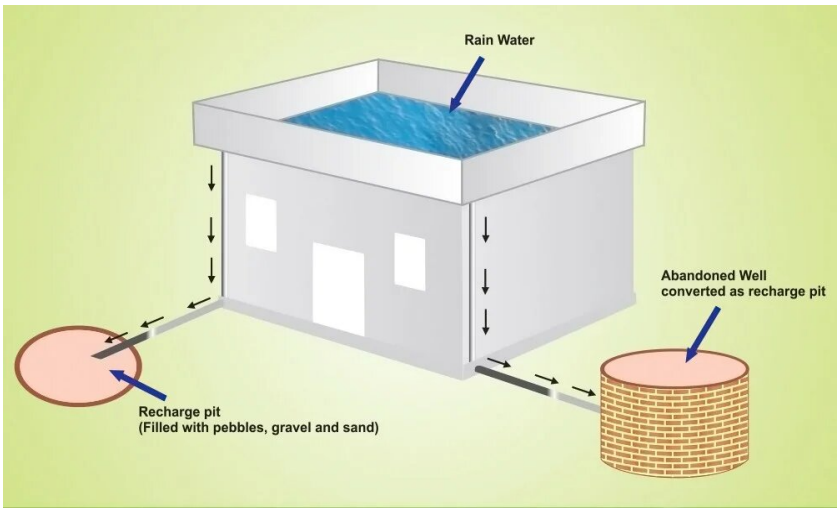
2. Rainwater Harvesting

Rainwater harvesting is a sustainable, long-term solution for water security, crucial during periods of scarcity. It helps maintain the water table, providing a reliable source for irrigation, livestock, and even drinking water when other supplies are severely depleted.

- **Pits**: Recharge pits are constructed to recharge the shallow aquifer. These are constructed 1 to 2 m wide and up to 3 m deep, which are backfilled with boulders, gravels, and coarse sand.

Figure 31: Image of recharge pits for rainwater harvesting



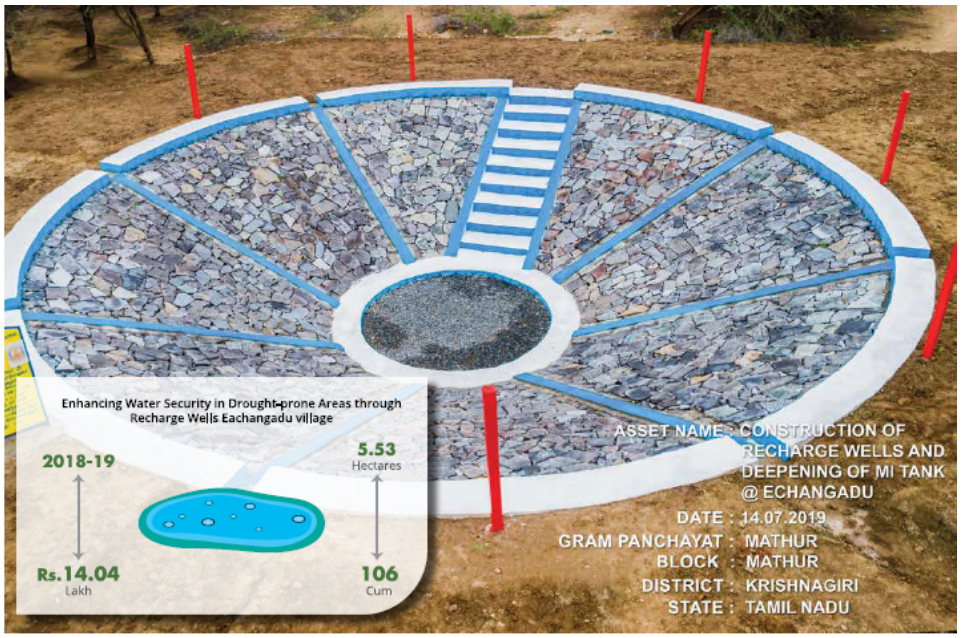


Source: Sankalpa Rural Development Society, 2018

- **Recharge wells:** Recharge wells of 100 to 300 mm diameter are generally constructed for recharging the deeper aquifers and water is passed through filter media to avoid choking of recharge wells.

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Figure 32: Reviving Aquifers through Recharge Wells



Source: Team MyGov, 2019

- **Recharge Shafts**: For recharging shallow aquifers beneath a clayey surface, use recharge shafts 0.5 to 3 m in diameter, 10 to 15 m deep, constructed and backfilled with boulders, gravel, and coarse sand.

Figure 33: Recharge shaft, Kiliyanur, Tamil Nadu



Source: Richard-Ferroudji et al. , 2018

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3. Restoration of waterbodies

The restoration efforts involved several key actions, such as removing invasive weeds, desilting the ponds, and strengthening and rebuilding the embankments. These initiatives will restore the ponds to a healthy, sustainable state, underscoring their importance to the region's agricultural productivity and groundwater recharge.

Figure 34: Rejuvenation of traditional water bodies for conservation



Source: EFI, Tamil Nadu, 2025

4. Climate-proof Overhead Tanks

Overhead water tanks are built at elevated points to take advantage of gravity to maintain sufficient water pressure. This elevation facilitates the

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efficient and rapid distribution of water, minimizing the need for extensive mechanical pumping. With the OHTs, it can be proven with climate-resilient materials such as reflective materials and cool roof paints, whereas the rainwater harvesting mechanism can also be installed along with the dug well to store more water and reduce maintenance.

5. Avenue plantation

- Avenue plantings offer a sustainable, traditional method for moderating temperatures, providing significant cooling benefits. These plantings, installed along long routes in collaboration with state highway departments or in rural areas utilizing MGNREGA workers, counteract the heat reflected by roads.
- The shade from avenue trees is crucial, as it naturally lowers air and surface temperatures, making the area notably cooler than nearby open spaces. Furthermore, this natural shading eliminates the need for additional, heat-absorbing concrete seating, providing comfortable resting spots for the community.

Figure 35: Example of Avenue Plantation along the roadside



Source: MGNREGA Success, 2018

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6. Agroforestry

- Agroforestry can be promoted by incorporating native species and establishing permanent green cover across villages through a subsidy method. With the native species requiring very little water won't impact crop productivity and also provide shade to the agricultural labors during the summer. This method would also keep the area cooler, thereby aiding the widespread growth of green cover. The specific species for agroforestry must be carefully selected according to the local conditions as the geography varies from place to place.
- The United Nations Food and Agriculture Organization (FAO) states that integrating trees into rice-production landscapes in Southeast Asia enhances adaptability and resilience for farmers, communities, and their environments. It helps lower temperatures, improves soil water infiltration, increases carbon storage, and diversifies farm production, which effectively reduces both climate and market risks.

Figure 36: Agroforestry practice adopted by farmers in Tamil Nadu



Source: The Better India, 2017

7. Sacred groves

- Sacred groves are an integral part of the Indian village environment, embodying a form of nature worship. These groves shelter a wide variety of flora, including trees, shrubs, herbs, and climbers. The state has two main types: natural sacred groves, where existing vegetation is protected, and locally established sacred gardens.

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- The significance of human-environment connections throughout India is underscored by initiatives such as 'Sacred Groves of India,' which showcase the diverse conservation methods employed by various communities to safeguard the country's rich, biodiverse forests.

Figure 37: Representation of Kasampatty Sacred Grove, Dindigul District, Tamil Nadu



Source: The Hindu, 2025

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12 Recommended mitigation efforts for the protection of livestock against heat stress

Livestock adaptation and mitigation measures focus on reducing thermal load, improving animal comfort, ensuring feed and water security, and safeguarding natural resources. Adaptation extends beyond human health to livestock and ecological systems.

12.1. Community-Based Protective Measures

Community-led practices play an important role in protecting livestock during extreme heat conditions.

- The construction of straw sheds (chappras) provides low-cost shading that reduces direct solar exposure and helps maintain cooler resting spaces for animals.
- Tree-planting drives further lower surrounding temperatures by creating natural shade and improving the local microclimate.
- In addition, communities establish temporary shelters and water sources to ensure livestock survival during prolonged heat events, reflecting locally evolved socio-ecological adaptation strategies.

Figure 38: A calf sheltering from the sun under a shelter laden with straw, Kurua village, Assam, India



Source: Getty Images, 2024

12.2. Improved Livestock Housing and Microclimate Regulation

Improved livestock housing is a key technological intervention for mitigating heat stress.

- The construction of cattle sheds with enhanced ventilation promotes air circulation and facilitates heat dissipation from animal bodies.
- Proper shelter design helps regulate internal microclimatic conditions, preventing excessive heat accumulation within sheds. Maintaining cooler housing environments reduces physiological stress, improves animal comfort, and supports sustained livestock productivity during high-temperature periods.

Figure 39: Cattle shed with enhanced ventilation



Source: Tamil Nadu Agricultural University

Overall, the recommended mitigation measures help regulate shelter microclimates, secure feed and water resources, and reduce physiological stress in livestock during periods of elevated temperatures. By integrating housing improvements, feed and water management, and adaptive strategies, these interventions collectively strengthen the resilience of mixed farming systems under conditions of heat stress (Shanmugasundaram et al., 2023; Singh et al., 2024; Sarkar, 2023; Chand et al., 2024).

12.3 Recommended strategies and action by The Tamil Nadu Cooperative Milk Producers' Federation LTD for Animal Husbandry

A) Mitigation Strategies by Alert Level

Alert Level	Action Items & Key Strategies
Yellow Alert	**Ensure Shade & Shelter:** Offer natural or constructed shade (minimum 4 m² per cow) to reduce solar load **Providing Ample Clean Water:** Ensure unrestricted access to cool, clean water at multiple points. Cows may double their water intake during heat stress. Ensure multiple clean water points; check/refill frequently, especially mid-day **Feeding Management:** Offer most feed early morning and late evening when cooler; cows eat better then **Monitor Early Signs:** Watch for increased respiration, reduced grazing, and drooling to initiate corrective steps **Behavior Monitoring:** Check for increased breathing rates and reduced grazing; adjust management early
Orange Alert	**Ventilation Enhancements:** Install or increase fans/ventilators in housing areas to improve airflow (cross-ventilation) **Water Sprays & Misting:** Intermittent misting/sprinklers reduce body heat via evaporation - ensure good airflow so humidity doesn't build up **Cooling Drinking Water:** Cool water (e.g., around 10 °C where feasible) encourages drinking and lowers internal body temperature **Electrolytes & Supplements:** Provide electrolytes and consider feed additives/buffers to support rumen stability during stress **Reduce Animal Handling:** Avoid moving cows during the hottest hours
Red Alert	**Ventilation:** Ventilation with high-speed fans wherever possible **Sprinkler Cycles:** Frequent sprinkler cycles with correct timing **Shade & Roofing:** Shade nets + reflective roofing

	Wet Gunny Bags: Hanging wet gunny bags around the shed **Medical Monitoring:** Check rectal temperature/respiration (normal cows ~101.5-102.5 °F; higher indicates stress). If cows show open-mouth panting, drooling, lethargy, veterinary intervention is required **Reduce Animal Handling:** Avoid moving cows during the hottest hours

B) Monitoring Indicators for Milch Animals

Animal signs of heat stress:

- Increased respiration rate (> 60 breaths/min)
- Open-mouth breathing/drooling
- Reduced feed intake & milk yield
- Standing more than lying (trying to lose heat)
- Dehydration (dry gum, sunken eyes)

C) Monitoring Card for Milch Cows

Symptom	Meaning	Action
Panting	Moderate stress	Increase air flow
Open-mouth breathing	Severe stress	Immediate cooling
Drooling	Heat overload	Spray + shade
Standing continuously	Trying to dissipate heat	Improve resting area cooling
Milk drop > 10%	Ongoing stress	Review THI log & cooling system

D) Practical Recommendations for Tamil Nadu Farms

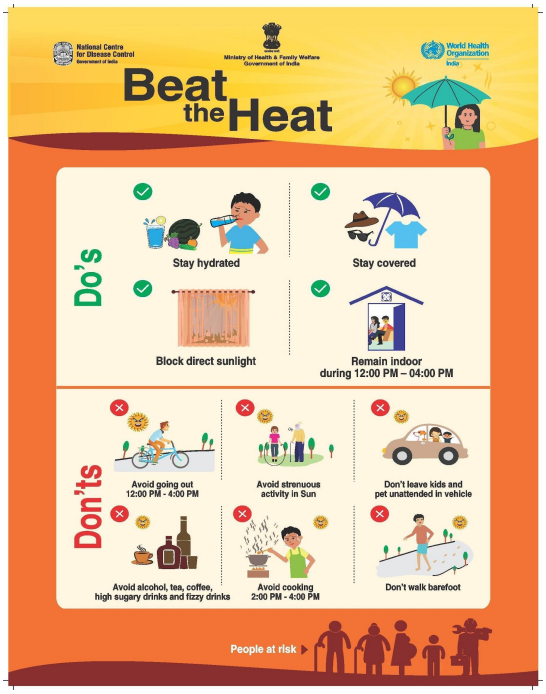
- Roof insulation or white reflective paint - wherever possible
- 10-12 feet shed height for better airflow
- East-West shed orientation is advisable to avoid direct sunlight penetration
- Minimum 60 liters of water/cow/day (may increase to 100+ liters in peak heat)
- Tree plantation around the farm boundary

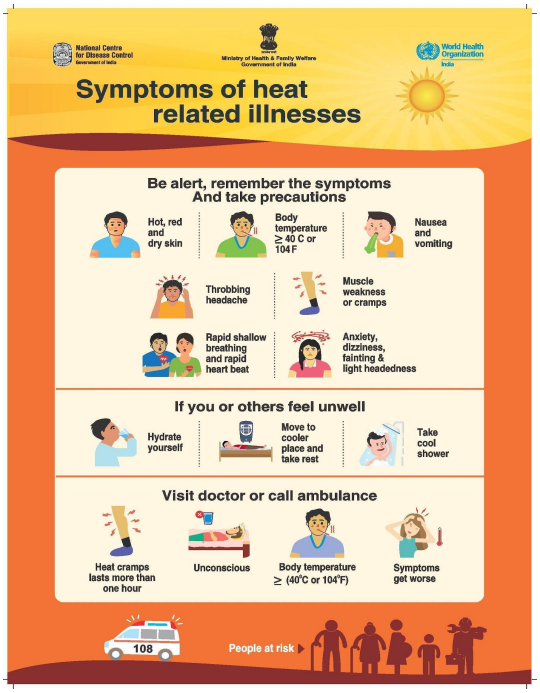
Note: Added based on consultation with the TNCMPF LTD

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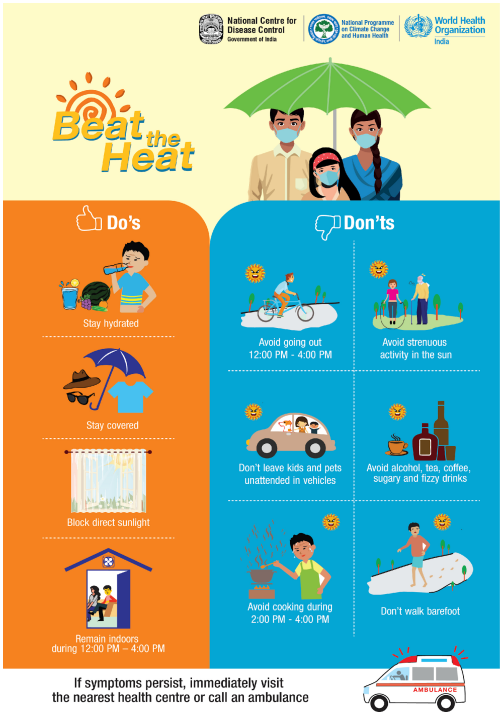
13 Information, Education and Communication (IEC)

Figure 40: IECs Issued by NPCCHH for Heat wave warning and management









Source: National Programme on Climate Change & Human Health (NPCCHH), NCDC

Figure 41: IECs Issued by TNSDMA for Heat wave warning and management



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தமிழ்நாடு மாநில பேரிடர் மேலாண்மை ஆணையம்

நம்பகமான தகவல்களுக்கு TNAlert கைப்பேசி செயலியை பதிவிறக்க

அரசாங்கத்தின் அதிகாரப்பூர்வ வழிமுறைகளைப் பின்பற்றுங்கள் - அமைதியாக இருங்கள்!

வெப்ப அலையின் போது
பணியாளர் மற்றும் வெளிப்புற தொழிலாளர்களுக்கு



சுத்தமான குடிநீர், நிழல் மற்றும் ஓய்வு இடைவெளி வழங்கப்பட வேண்டும்.



பணியிடங்களில் ORS, மோர், முதலுதவி பெட்டி, ஐஸ் ஒத்தடப் பைகள் ஆகியவற்றை வைத்திருங்கள்.



வெப்பம் அதிகமில்லாத அதிகாலை அல்லது மாலையில் கடுமையான வேலைகளைத் திட்டமிடுங்கள்.



அதிக வெப்பத்தின் போது தொழிலாளர்கள் அடிக்கடி ஓய்வு எடுக்க அனுமதிக்கவும்.



புதிய தொழிலாளர்கள் வெப்பத்திற்கு பழக்கப்படும் வரை அவர்களுக்கு இலகுவான பணிகளை ஒதுக்குங்கள்.



கர்ப்பிணிகள் மற்றும் மருத்துவ குறைபாடுள்ளவர்களுக்கு சிறப்பு கவனம் செலுத்துங்கள்.



வெப்ப அலை எச்சரிக்கைகளை தொழிலாளர்களுக்கு முன்கூட்டியே தெரிவிக்கவும்.

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மாவட்ட அவசர கட்டுப்பாட்டு அறை: 1077

பொதுமக்கள் கருத்தி வெளியிடுவோர்

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Tamil Nadu State Disaster Management Authority

For reliable information Download the TNAlert* mobile App

Follow official government advisories — Stay calm!

DURING HEATWAVE
For Employee and Outdoor Workers



Provide clean drinking water, shaded areas, and rest breaks.



Keep ORS, first-aid kits, ice packs, and buttermilk available at worksites.



Schedule heavy labour for early morning or late evening.



Allow workers to take more frequent breaks during high heat.



Assign lighter duties to new workers until they adapt to the heat.



Give special attention to pregnant workers and people with medical conditions.



Notify workers early when heatwave alerts are issued.

For Emergency Assistance:
State Emergency Control Room: 1070
District Emergency Control Room: 1077

Published in the interest of public safety

Tamil Nadu Disaster Risk Reduction Agency
Commissionerate of Revenue Administration and Disaster Management
Ezhilagam, Chepauk, Chennai – 600 005.

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வெப்ப அலையின் தாக்கத்தினை தணித்திட வீடுகள் மற்றும் கட்டிடங்களில்



பிரதிபலிப்பு கூரை பெயிண்ட் பயன்படுத்தவும் அல்லது குளிர் கூரை தொழில்நுட்பத்தைப் பயன்படுத்துங்கள்.



சன்னல் பிரதிபலிப்பான்களை நிறுவவும்.



சூரிய ஒளியைத் தடுக்க அடர் வண்ண திரைச்சீலைகள், கண்ணாடி அல்லது மூங்கில் திரைச்சீலைகளைப் பயன்படுத்தவும்.



இரவில் வெப்பநிலை குறையும் போது காற்றோட்டத்தினை உண்டாக்குங்கள்.



வீட்டை இயற்கையாகவே குளிர்விக்க உட்புற தாவரங்கள் அல்லது கூரை தாவரங்களை வளர்க்கவும்.



மின்சாரத்தைச் சேமிக்கவும் வெப்பச் சுமையைக் குறைக்கவும் குளிர்சாதன வெப்பநிலையை 24°C அல்லது அதற்கு மேல் பராமரிக்கவும்.

அவசர உதவிக்கு:
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மாவட்ட அவசர கட்டுப்பாட்டு அறை: 1077

பொதுமக்கள் கருத்தி வெளியிடுவோர்

தமிழ்நாடு பேரிடர் அபாய குறைப்பு முகமை
வருவாய் நிர்வாகம் மற்றும் பேரிடர் மேலாண்மை ஆணையரகம்,
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DURING HEATWAVE
For Homes and Buildings



Use reflective roof paint or cool-roof technology where possible.



Install temporary window reflectors (e.g., foil-covered cardboard).



Use dark curtains, tinted glass, or bamboo blinds to block sunlight.



Ventilate at night when temperatures drop.



Grow indoor plants or rooftop vegetation to naturally cool the home.



Maintain AC temperatures at 24°C or higher to save energy and reduce heat load.

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தமிழ்நாடு மாநில பேரிடர் மேலாண்மை ஆணையம்

நம்பகமான தகவல்களுக்கு TNAlert கைப்பேசி செயலியை பதிவிறக்க

அரசாங்கத்தின் அதிகாரப்பூர்வ வழிமுறைகளைப் பின்பற்றுங்கள் - அமைதியாக இருங்கள்!

வெப்ப அலையின் போது கால்நடைகள் மற்றும் விலங்குகளுக்கு



கால்நடைகளை நிழலான இடங்களில் வைத்து, குளிர்ந்த, சுத்தமான தண்ணீரை வழங்குங்கள். காலை 11 மணி முதல் மாலை 4 மணி வரை அவற்றை வேலை செய்ய வைக்காதீர்கள்.



ஓலைக்கூரை, மண்பூச்சு, வெப்பம் தணிக்கும் வெள்ளை பெயிண்ட் மற்றும் நீர்தெளிப்பான் ஆகியவற்றை பயன்படுத்தி கால்நடை கொட்டகையினை குளிர்விக்கவும்.



கால்நடை கொட்டகைகளில் மின்விசிறிகள், அல்லது தண்ணீர் தெளிப்பான்களைப் பயன்படுத்துங்கள்.



அதிக வெப்பத்தின் போது, விலங்குகளின் மீது தண்ணீரை தெளிக்கவும் அல்லது பாதுகாப்பான நீர்நிலைகளில் குளிர்விக்கவும்.



பசுந்தீவனம், கனிம கலவைகள் மற்றும் உப்பு ஆகியவற்றை வழங்கவும்; வெம்மை குறைந்த நேரங்களில் மேய்ச்சலுக்கு அனுப்பவும்.

அவசர உதவிக்கு:
மாநில அவசர கட்டுப்பாட்டு அறை: 1070
மாவட்ட அவசர கட்டுப்பாட்டு அறை: 1077

பொதுமக்கள் கருத்து வெளியிடுவோம்

தமிழ்நாடு பேரிடர் அபாய குறைப்பு முகமை
வருவாய் நிர்வாகம் மற்றும் பேரிடர் மேலாண்மை ஆணையரகம்,
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DURING HEATWAVE
For Cattle and Animals



Keep animals in shaded areas and provide cool, clean water. Do not make them work between 11 a.m. and 4 p.m.



Reduce shed temperatures using thatched roofs, whitewash, mud plaster, or sprinklers.



Use fans, foggers, or water sprayers in cattle sheds when available.



During extreme heat, spray animals with water or allow them access to safe water bodies.



Provide green fodder, mineral mixtures, and salt; allow grazing during cooler hours.

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தமிழ்நாடு மாநில பேரிடர் மேலாண்மை ஆணையம்

நம்பகமான தகவல்களுக்கு TNAlert கைப்பேசி செயலியை பதிவிறக்க

அரசாங்கத்தின் அதிகாரப்பூர்வ வழிமுறைகளைப் பின்பற்றுங்கள் - அமைதியாக இருங்கள்!

வெப்ப அலைக்கு பிறகு



சாதாரண வெப்பநிலை திரும்பும் வரை திரவங்களை பருகுவதைத் தொடரவும்.



நன்றாக ஓய்வெடுங்கள், ஒன்று அல்லது இரண்டு நாட்களுக்கு கடுமையான செயல்களைத் தவிர்க்கவும்.



தனியாக வசிக்கும் வயதானவர்கள், வெளிப்புற வேலை செய்பவர்கள் மற்றும் அண்டை வீட்டாரின் நலனை சரிபார்க்கவும்.



கால்நடைகளுக்கு வெப்ப அழுத்தத்தை பரிசோதித்து, அவற்றிற்கு முறையாக நீர்ச்சத்து கிடைப்பதை உறுதிசெய்யவும்.



அறைகளில் வெப்பம் அதிகரிப்பதைத் தடுக்க உட்புற காற்றோட்டத்தைப் பராமரிக்கவும்.



நீர்சத்துள்ள பொருள்களின் பயன்பாடு மற்றும் சுகாதார முன்னெச்சரிக்கை நடவடிக்கைகளுக்கான அரசாங்க ஆலோசனைகளைப் பின்பற்றவும்.

அவசர உதவிக்கு:
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AFTER HEATWAVE



Continue drinking fluids until normal temperatures return.



Rest well and avoid strenuous activity for a day or two.



Check on elderly people, outdoor workers, and neighbours who live alone.



Inspect livestock for heat stress and ensure they rehydrate properly.



Maintain indoor ventilation to prevent heat build-up during the next day.



Follow government advisories for water usage and health precautions.

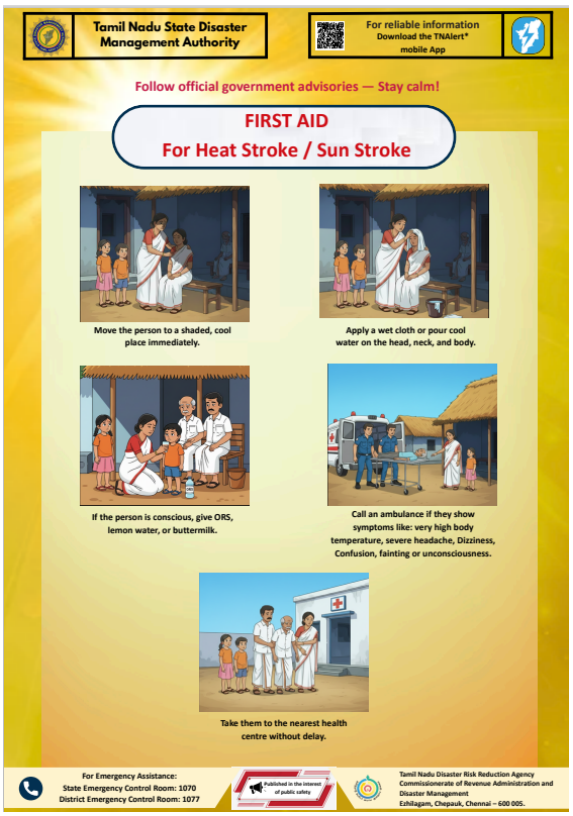
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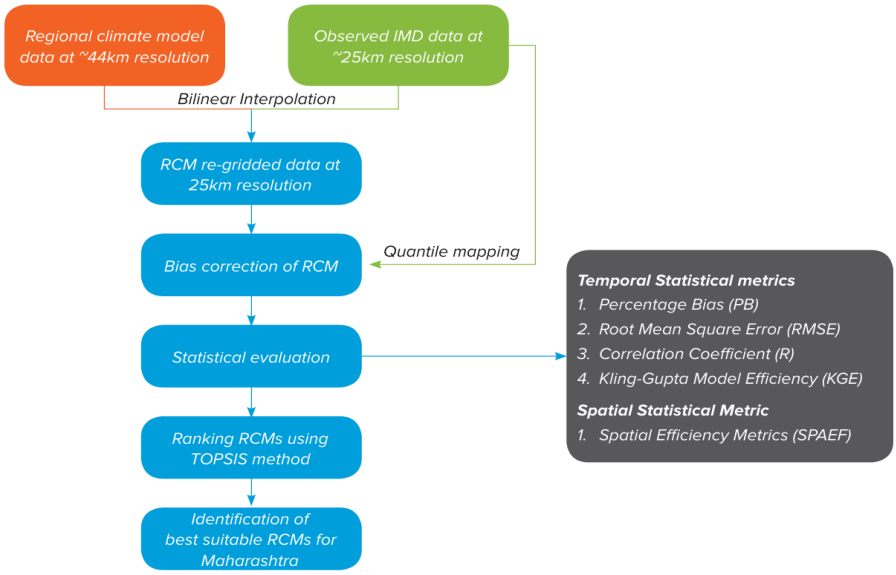
Source: State Disaster Management Authority, Tamil Nadu

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Annexure 1: Detailed Methodology and Datasets used for undertaking climatological projections over Tamil Nadu, A study carried out by Anna University, Tamil Nadu.

To grasp future climatic patterns, the detailed downscaled projections from the Coordinated Regional Climate Downscaling Experiment (CORDEX) South Asia program, overseen by the Centre for Climate Change Research (CCCR) at the Indian Institute of Tropical Meteorology (IITM), Pune have been used in this plan. These projections stem from the CMIP5 (Coupled Model Intercomparison Projects, 5th generation) climate models, a collaborative platform showcased in the IPCC's fifth assessment report (AR5). Under CORDEX, regional models driven by CMIP5 data portray scenarios for Representative Concentration Pathways (RCPs) - specifically, RCP 4.5 (mid-range emissions) and RCP 8.5 (high-end emissions). These scenarios depict a time series of emissions, concentrations of greenhouse gases, aerosols and land-use changes. While temperature projections are considered with high or moderate confidence, rainfall projections bear lower confidence, prompting the use of robust statistical methods for model selection and bias correction. Despite such corrections, the inherent variability in the Indian climate and coarse model resolution introduces some level of uncertainty. Evaluating the bias-corrected Regional Climate Model (RCM) outputs involved temporal and spatial metrics, ultimately leading to the ensemble of top-performing models, specifically the CanESM2 and CSIRO-Mk3.6 for temperature.

Figure A1: Methodology for developing climatic projections



Source: Authors' analysis

Table A1: List of models chosen for projection analysis

Driving CMIP5 GCM	Contributing CMIP5 Modelling Centre
CCCma-CanESM2	Canadian Centre for Climate Modelling and Analysis (CCCma), Canada
NOAA-GFDL-GFDL ESM2M	National Oceanic and Atmospheric Administration (NOAA), Geophysical Fluid Dynamics Laboratory (GFDL), USA
CNRM-CM5	Centre National de Recherches Me´te´orologiques (CNRM), France
MPI-ESM-MR	Max Planck Institute for Meteorology (MPI-M), Germany
IPSL-CM5A-LR	institut Pierre-Simon Laplace (IPSL), France
CSIRO-Mk3.6	Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia

Source: Authors' compilation

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Annexure 2: Detailed Methodology and data used for calculating satellite based indices

Calculating satellite derived Indices: For mapping the urban heat islands and various other landscape indicators, a combination of satellite based data obtained from the Landsat-8 and Sentinel 2 has been used. Landsat-8 data is particularly useful for calculating various indices, such as the Normalised Difference Vegetation Index (NDVI), Modified Normalised Difference Water Index (MNDWI), etc. These indices utilise the spectral information captured by Landsat-8 to derive meaningful insights about land cover, vegetation health and water bodies.

Normalised Difference Vegetation Index (NDVI): The NDVI is a widely used vegetation index calculated from Sremotely sensed data, in this case-Landsat-8 data. It quantifies the presence and health of vegetation by measuring the difference between near-infrared (NIR) and red (RED) bands of the electromagnetic spectrum (Sha Huang 2020). The formula for NDVI is:

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

NDVI values range from -1 to 1, where higher values indicate healthier vegetation and lower values indicate sparse or stressed vegetation. It provides insights into vegetation density, distribution and health over large spatial scales.

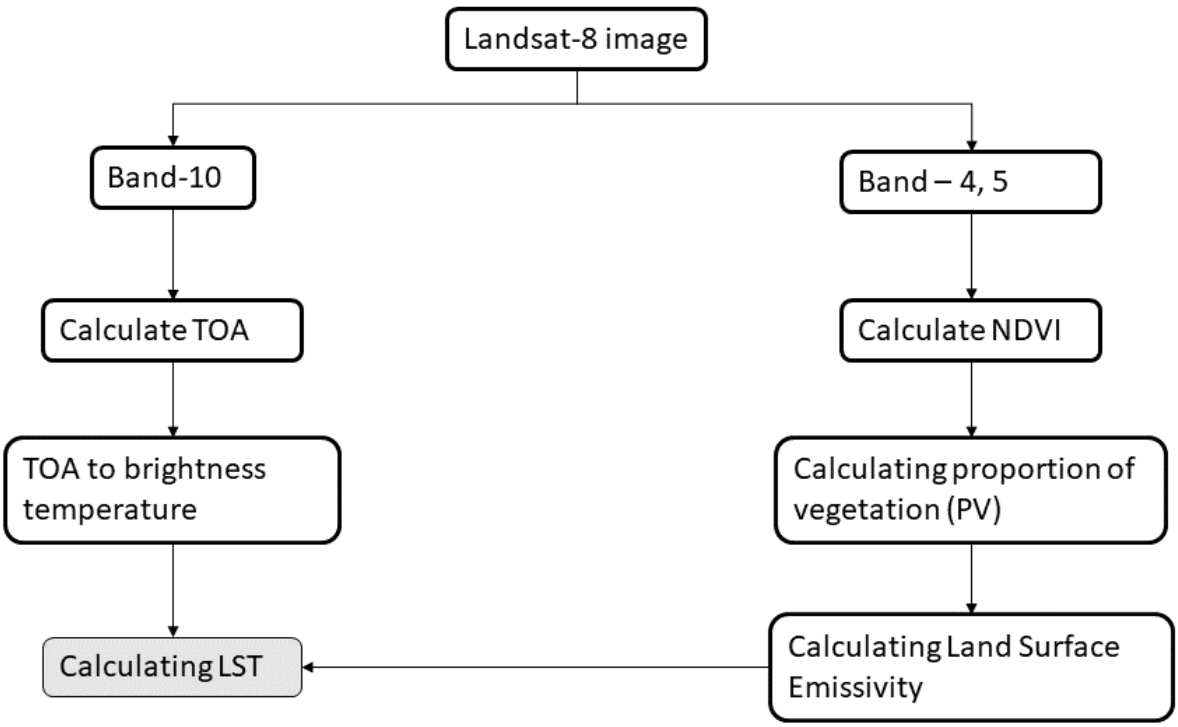
Modified Normalised Difference Water Index (MNDWI): The MNDWI is designed to detect the presence of water bodies in remotely sensed imagery. It is particularly effective at distinguishing between water and non-water features, such as built-up areas or vegetation. MNDWI calculated using the green (Green) and shortwave infrared (SWIR) bands of the electromagnetic spectrum (Liwei Chang 2022). The formula for MNDWI is:

$$MNDWI = \frac{Green - SWIR}{Green + SWIR}$$

MNDWI values typically range from -1 to 1, where higher values indicate the presence of water and lower values correspond to non-water features.

Land Surface Temperature (LST): Land Surface Temperature (LST) refers to the temperature of the Earth's surface as measured from a satellite or other remote sensing platform. It is a crucial parameter which provides insights into surface energy fluxes, Urban Heat Island Effect s and land-atmosphere interactions. Landsat-8 is equipped with the Thermal Infrared Sensor (TIRS), which enables the estimation of land surface temperature (Ridho 2023), (Anandababu D 2018).

Figure A2: Methodology for computing Land Surface Temperatures from Landsat-8



Source: Authors' analysis

Land Use/Land Cover: The land use/ land cover data was taken as the direct product of Sentinel 2A derived indices from the ESRI's Living Atlas as a raster data of the year 2023 (most recent available data at the time of analysis). This data underwent initial categorization into various classes, subsequently refined into six distinct categories tailored for our specific analysis. These categories include: Water, Vegetation, Crop, Build, Swampy region and Bare.

Building Density: Utilising Google's Open Building dataset, an assessment of building density was conducted. Following this, a spatial join operation was executed, integrating the building data with the wards, villages and blocks. As a result, each administrative unit acquired a count of total buildings within its boundaries, facilitating the calculation of building density across the analysed region. This methodological approach ensures a detailed understanding of the spatial distribution and concentration of buildings within the study area.

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Annexure 3: Climate Risk assessment and adaptation plan of Tamil Nadu- Report 2024

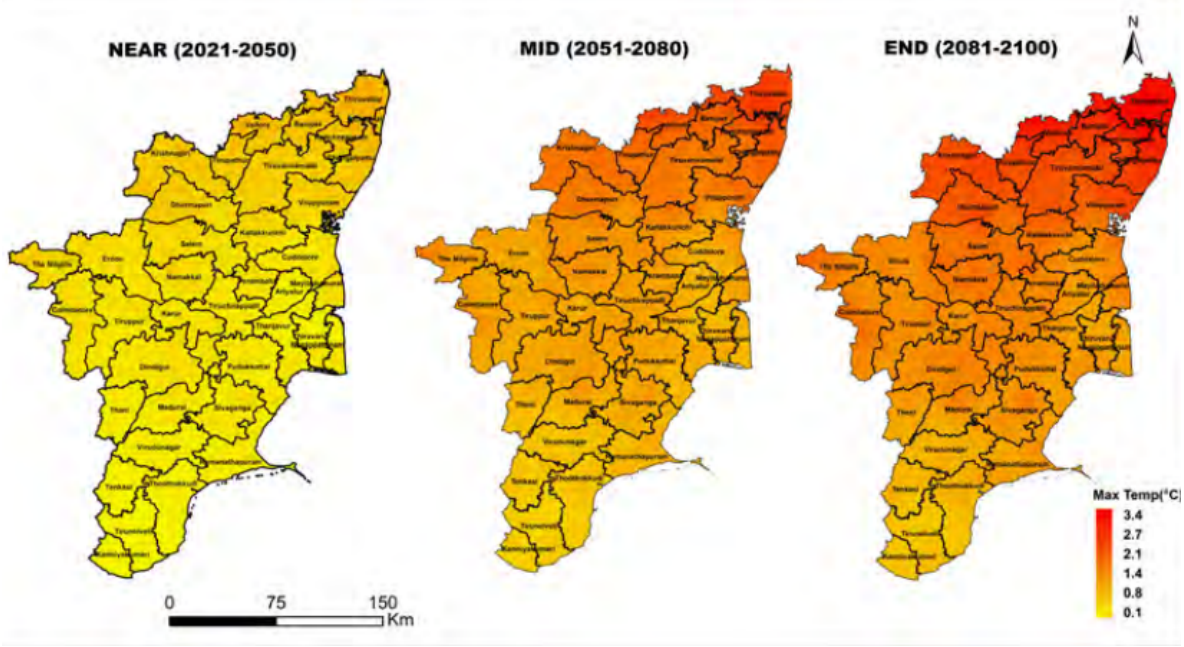
The 2024 Climate Risk Assessment and Adaptation Plan of Tamil Nadu, prepared by the Centre for Climate Change and Disaster Management, Department of Civil Engineering, Anna University, Chennai, with support from the Department of Environment and Climate Change, Government of Tamil Nadu, provides a scientific assessment of observed climate conditions and future heatwave risks across the state. The study analyses long-term meteorological data and climate projections to examine historical climate variability and projected changes in extreme temperature events, with the aim of informing adaptation strategies and heat action planning.

Observed climate analysis was carried out using high-resolution gridded data from the India Meteorological Department (IMD), including 0.25° × 0.25° daily gridded rainfall data covering 184 grids across Tamil Nadu and 1° × 1° daily gridded maximum and minimum temperature datasets covering 23 grids. These datasets span a 30-year baseline period from 1985 to 2014 and were used to establish normal climate conditions and understand spatial variability across the state.

In the assessment the climate profile indicates that the mean annual maximum temperature of Tamil Nadu during 1985-2014 is 32.5°C, with a spatial range from 29.5°C to 33.4°C. Higher mean maximum temperatures are recorded in districts such as Chennai, Kancheepuram, Chengalpattu, Thiruvallur, Tiruvarur and Cuddalore, while the Nilgiris district records the lowest values owing to its higher elevation and hilly terrain. The mean annual minimum temperature for the same period is 22.6°C, with values ranging from 19.4°C to 24.1°C. The highest minimum temperatures are observed in Tiruvarur, followed by Cuddalore, Mayiladuthurai and Nagapattinam, whereas the Nilgiris district shows the lowest minimum temperatures. These patterns demonstrate pronounced spatial temperature variability across the state, influenced by coastal proximity, elevation and topography.

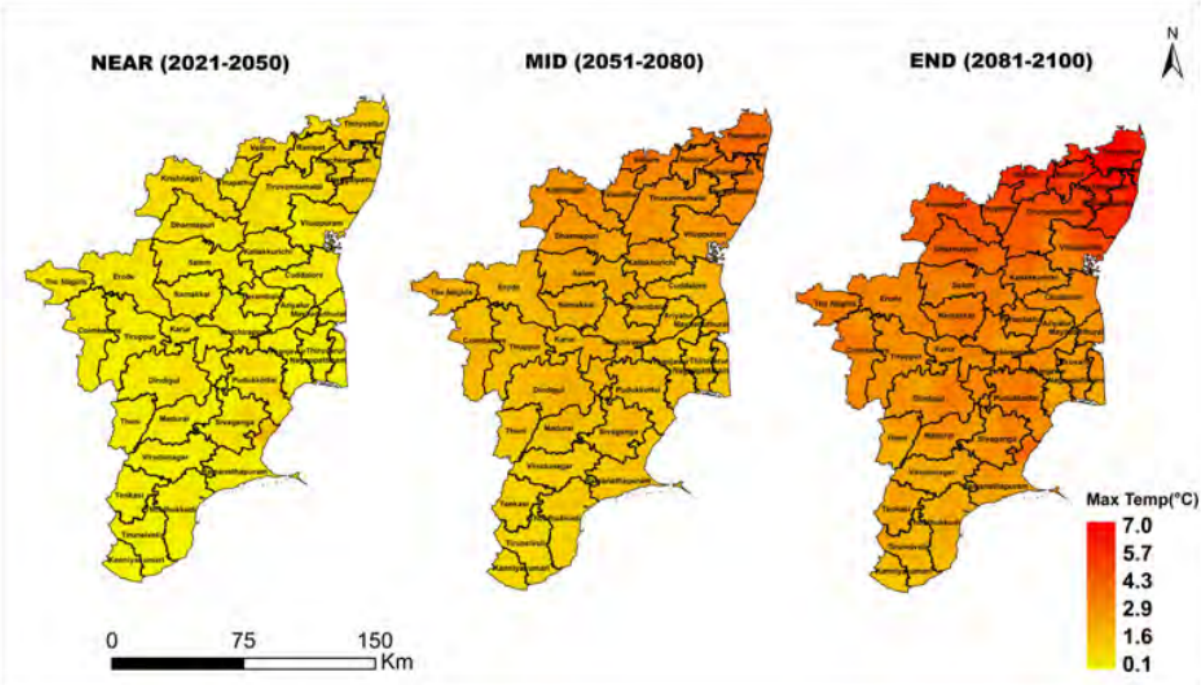
Along with the spatial analysis, the study analysed nearly century, mid-century and end century climate projections relative to the 1985-2014 baseline indicating a steady rise in annual mean maximum temperature across Tamil Nadu. Under the SSP2-4.5 scenario, temperatures may increase by about 0.4°C (2021-2050), 1.3°C (2051-2070) and 1.7°C (2081-2100). Under the high emission SSP5-8.5 scenario, the rise is projected to be higher at 0.6°C, 1.7°C and 3.5°C for the same periods.

Figure A3: Changes in Annual Maximum Temperature under SSP2-4.5 projected till 2100



Source: Climate Risk Assessment and Adaptation Plan of Tamil Nadu, CCCDM, 2024

Figure A4: Changes in Annual Maximum Temperature under SSP2-8.5 projected till 2100



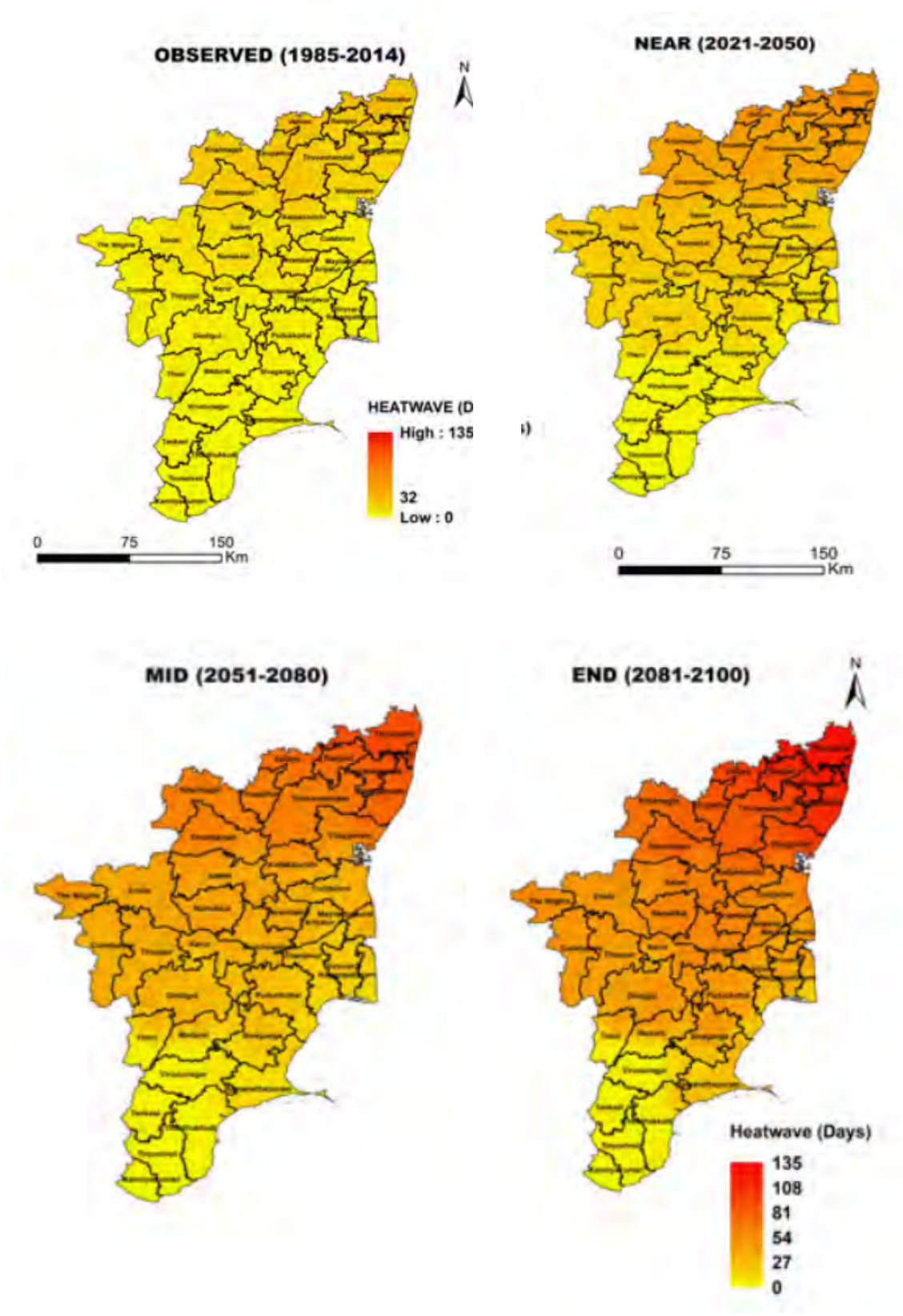
Source: Climate Risk Assessment and Adaptation Plan of Tamil Nadu, CCCDM, 2024

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The historical analysis of extreme temperature events shows that Tamil Nadu experienced an average of 12 heatwave days per year during 1985-2014, with a range from 0 to 28 very hot days annually. And the future climate projections indicate a substantial rise in heatwave exposure across the state, with average heatwave days projected to increase to about 22 days per year during 2021-2050, 40 days per year during 2051-2070 and 55 days per year during 2071-2100. This represents a significant escalation compared to the historical baseline and suggests that heatwave frequency could increase several fold by the end of the century.

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Figure A5: Heatwave days under SSP2-4.5 projected till 2100



Source: Climate Risk Assessment and Adaptation Plan of Tamil Nadu, CCCDM, 2024

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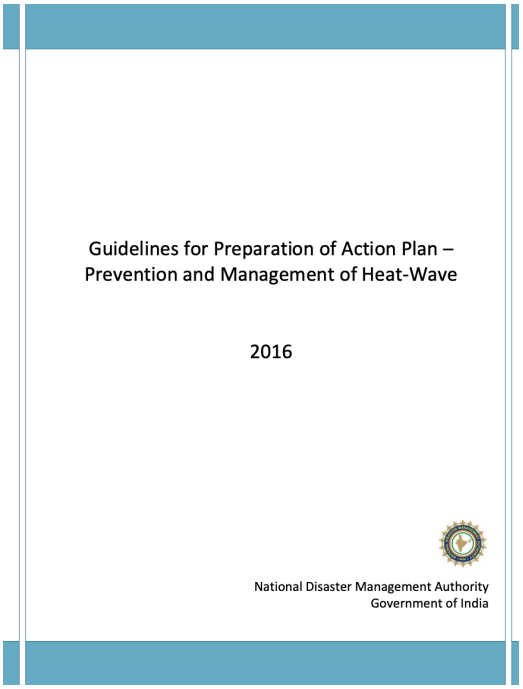
The 2024 assessment shows that Tamil Nadu already experiences notable spatial temperature variability. With the observed data (1985-2014) it establishes a high-temperature baseline, particularly in coastal and low-lying districts, while projections under SSP2-4.5 and SSP5-8.5 indicate steady rises in annual maximum temperatures through the century. This warming is closely associated with a sharp increase in heatwave frequency, with projected heatwave days rising several fold compared to historical levels.

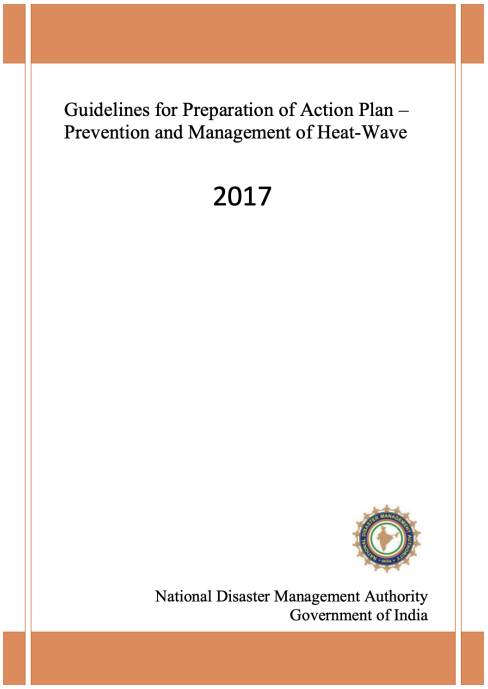
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Annexure 4: National Guidelines for preparation of action plan - prevention and management of heat wave

Recognising the growing severity of heat as a hazard, the National Disaster Management Authority (NDMA) first issued the National Guidelines for the Preparation of Action Plan - Prevention and Management of Heat Wave in 2016. The guidelines were subsequently revised in 2017 and again in 2019 to further strengthen state capacities for risk assessment, forecasting, preparedness, response and long-term mitigation. The 2019 revision notably introduced a dedicated section on the "Built Environment," emphasising infrastructure resilience and climate-sensitive urban planning.

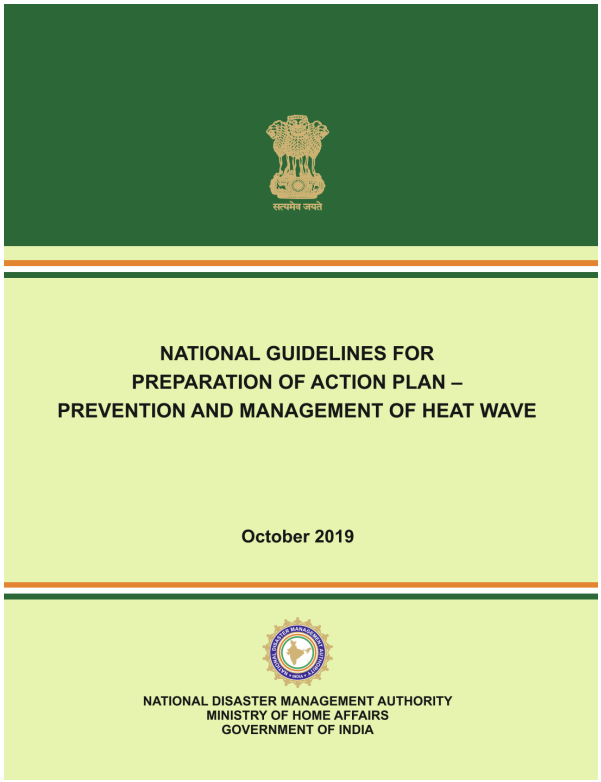
Figure A6: NDMA guidelines launched in 2016, 2017 and 2019





National Guidelines for preparation of Action Plan - Preventive and Management of Heat Wave, 2016 - Download

National Guidelines for preparation of Action Plan - Preventive and Management of Heat Wave, 2017 - Download



National Guidelines for preparation of Action Plan - Preventive and Management of Heat Wave, 2019 - Download

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Annexure 5: Factors affecting the table for villages/town panchayats/municipalities and wards falling in very high, high and moderate risk categories

The indicators of each component of hazard, exposure and vulnerability that showed a very high score (equal to or more than 8 out of 10) have been identified in this section. The hyperlink below provides complete information on the factors affecting each village/town/municipality, along with ward information for municipal corporations, enabling government stakeholders to address potential heat risk factors in specific wards. This enables targeted actions for enhancing heat resilience.

Table A2: Hyperlink to the contributing factors for cities and districts of Tamil Nadu

S NO	Description	Hyperlink
1	Contributing factors for cities at the ward level analysis	Attached link
2	Contributing factors for district at the village level analysis	Attached link
3	Contributing factors for district at the urban local body (except municipal corporation) level analysis	Attached link

These findings underscore the importance of interpreting heat risk as a multi-dimensional construct. **It is not solely dependent on ambient temperature but is influenced by the interplay of urban form, infrastructure and social vulnerability.** Targeted interventions in these wards should therefore prioritize, but not be limited to, improving green cover, implementing cooling solutions and expanding health services during extreme heat events, to build long-term resilience against heatwaves

Annexure 6: Heat Risk Assessment Score for the State of Tamil Nadu

This annexure presents the district- and city-wise Heat Risk Assessment Score for all 38 districts of Tamil Nadu, undertaken as part of the Tamil Nadu State Heat Action Plan. The assessment is organised district-wise and city wise.

For district the scores are presented at village, town panchayat and municipality level. For city, the scores are presented at ward-level.

The detailed Heat Risk Assessment Score for all districts and cities can be accessed through the link provided here: Heat Risk Assessment Score Link

Together, these tables provide a granular evidence base that enables planners and administrators to identify areas where heat risk is most acute and understand the underlying drivers of risk, thereby supporting targeted, prioritised, and localised heat action planning across the State.

Annexure 7: Case studies on urban greening solutions and infrastructure modifications

This chapter provides details of the proposed solutions based on selected case studies of their implementation across multiple countries. The following solutions have been proposed, catering to multiple thematic areas mainly infrastructure and urban greening.

Table A3: Contents of the proposed solutions

Name of the solution	Theme and scale of the solution		
	Infrastructure	Public health	Sustainable urban planning
Green Roof			
Cool Roof			
Green Facade			
Cooling Shelter			
Shade Structure on Footpaths			
Urban Greenery			
Cool Pavements			
Development of Urban Acupuncture			
Thatch / Palm leaves roofing.			
Hollow Concrete / Terracotta Tiles			

1. **Name of Solution - Green Roofing Systems**

Location - Open Roofs with direct exposure

A green roof is a layer of vegetation planted over a waterproofing system installed on top of a building. It helps mitigate urban heat by cooling the environment, reducing building temperatures and improving overall thermal comfort.

Types of Green Roof System

Green roofs come in three main types: **extensive, intensive and semi-intensive**, each varying in design, vegetation, maintenance and structural requirements.

Intensive Green Roof

Intensive green roofs are **heavier and more complex** due to their deeper soil layer, often exceeding **6 inches**. This allows them to support a variety of plant species, including shrubs, perennials and even small trees, creating a park-like setting. Due to their weight, these roofs require regular irrigation, maintenance and structural reinforcement. They significantly contribute to urban cooling by absorbing and retaining heat, preventing temperature spikes in buildings and improving air quality through excellent plant coverage.

Semi-Intensive Green Roof

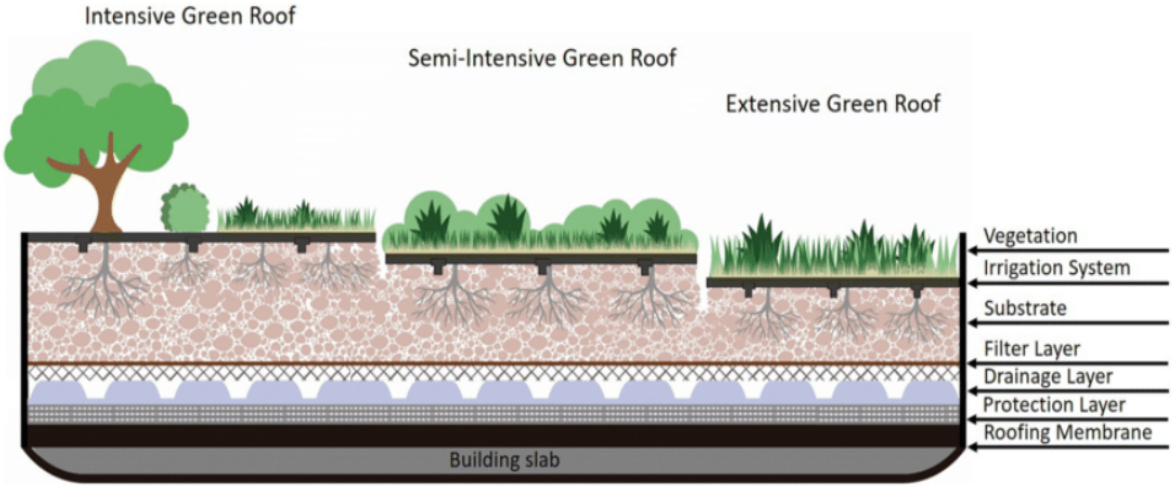
Semi-intensive green roofs combine elements of both extensive and intensive systems. They can support a mix of grasses, ground covers and small shrubs with a moderate soil depth. They require **intermediate levels of maintenance and irrigation** compared to intensive green roofs. These roofs are commonly used in commercial and institutional buildings where a balance between ecological benefits and functional aesthetics is needed.

Extensive Green Roof

Extensive green roofs are the lightest and most low-maintenance type. They have a shallow soil depth, typically between **2 to 6 inches** and support hardy, drought-resistant plants such as sedums, grasses and mosses. These roofs are designed primarily for environmental benefits rather than aesthetic or recreational purposes. Because they require minimal irrigation and upkeep, they are ideal for retrofitting buildings with limited structural capacity.

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Figure A7: Cross Section of Green Roof



Source: Calheiros, Cristina, Stefanakis, Alexandros. 2021. Green Roofs Towards Circular and Resilient Cities. Circular Economy and Sustainability.

How green roofs help in reducing heat

Green roofs play a vital role in **reducing urban heat** through various natural cooling mechanisms:

1. **Evapotranspiration & Cooling:** Plants absorb and release water as vapor, naturally lowering surrounding air temperatures.

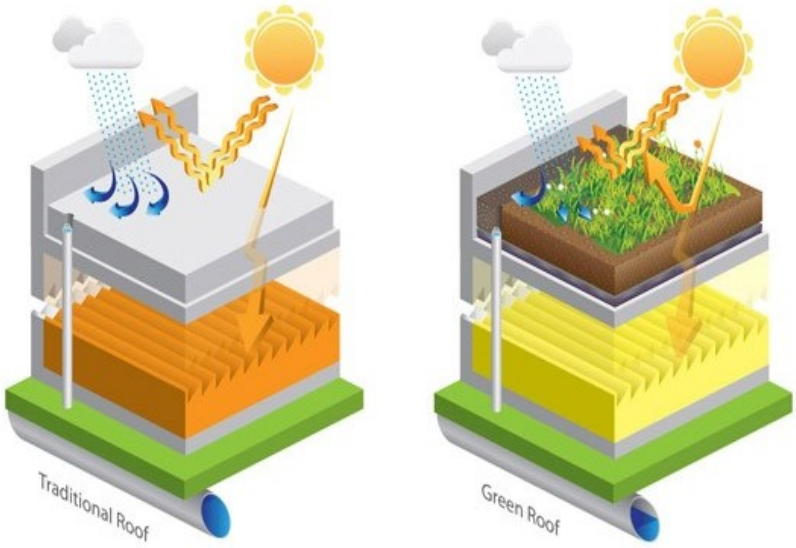
2. **Thermal Insulation:** The soil and vegetation act as a barrier, reducing heat transfer into buildings, leading to **lower indoor temperatures in summer** and **heat retention in winter**.

3. **Reduction of Urban Heat Island (UHI) Effect:** Several studies demonstrate that green roof temperatures can be 16–22°C (60.8–71.6°F) lower than that of conventional roofs. When transforming 80–90% of the roofs in a city to green roofs, they may reduce the average ambient temperature between 0.3°C and 3°C (32.5°F and 37.4° F) (Santamoursi 2014). Research conducted in Lagos , Nigeria, showed that a green facade reduces internal air temperatures by an average of 2.3°C (36.14°F) (Akinwolemiswa et al. 2018) and reduces the temperature of the facade itself between 2°C and 10°C (35.6°F and 50°F) compared to the natural stone (Eisenberg and Polcher 2020).

4. **Heat Absorption & Delayed Heat Release:** Green roofs absorb solar radiation and release it slowly, preventing temperature spikes during the day and stabilizing nighttime temperatures.

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Figure A8: Heat Dissipation in Green Roof in contrast with Conventional Roof



Source: Heidarinejad, Ghassem and Arash Esmaili.2016. "Assessment of Green Roof Energy Savings compared to Conventional Roof.", Environmental Science, Engineering.199603023

Figure A9: Thermal Map of Roofs with green roof and conventional roof



Source: Heidarinejad and Esmaili 2015

Potential Location of Implementation of Green Roof Systems



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2. Name of Solution - Cool Roof Systems

Location - Open Roofs with direct exposure

A **cool roof system** is a heat-mitigating solution designed to reduce urban temperatures by reflecting more sunlight and absorbing less heat compared to conventional roofs. It plays a crucial role in **mitigating the urban heat island (UHI) effect**, lowering indoor temperatures and improving energy efficiency. Ahmedabad, a city in India known for its extreme summer heat, has successfully implemented **cool roof strategies** to combat rising temperatures and enhance thermal comfort for its residents.

How Cool Roof Systems Work

Cool roofs utilize **high-albedo (reflective) materials** or **coatings** that reduce heat absorption and improve energy efficiency. These roofs can be categorized into:

1. **Reflective Coatings & Paints** – These are applied to existing roofs with high solar reflectance, reducing surface temperatures.
2. **Cool Roofing Sheets & Membranes** – Prefabricated sheets with reflective properties that minimize heat absorption.
3. **High-Albedo Tiles & Roofing Materials** – Light-colored, heat-reflective tiles that help keep rooftops cooler.

Conventional roofs can reach temperatures of 150°F or more on a sunny summer afternoon. Under the same conditions a reflective roof could stay more than 50°F (28 °C) cooler**.**

Implementation of Cool Roofs in Ahmedabad

Ahmedabad, one of India's hottest cities, experiences summer temperatures exceeding **45°C (113°F)**. The city adopted **cool roof solutions** to address extreme heat conditions under its **Heat Action Plan (HAP)**. The initiative focused on:

1. **Pilot Cool Roof Program (2017)**
    - Ahmedabad Municipal Corporation (AMC) launched a **pilot project** covering **3,000 low-income houses** with white reflective coatings, reducing indoor temperatures by **2–5°C** (NRDC 2017)
    - The project focused on **slum areas, informal settlements and public buildings**, where people were most vulnerable to extreme heat.
2. **Scaling Up in 2019**
    - The **cool roof program expanded** to include more households, commercial buildings and public infrastructure based on successful pilot results.

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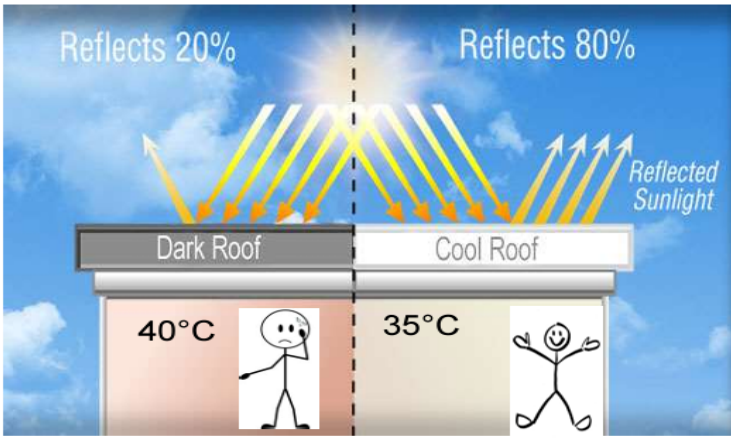
- The initiative encouraged **private developers** and homeowners to adopt cool roofing materials.

3. **Integration into Urban Planning (2020–Present)**
   - AMC made cool roofs part of **building by-laws and urban heat resilience strategies**.
   - Government and private agencies partnered to **subsidize** cool roofing solutions for low-income communities.
   - Roof cooling materials such as **white lime coatings, solar-reflective paints and cool tiles** were promoted citywide.

Benefits of Cool Roof Implementation in Ahmedabad

1. **Reduction in Indoor Temperatures**
   - Cool roofs **lower indoor temperatures by 2–5°C**, improving thermal comfort, especially for vulnerable populations (NRDC 2017)
2. **Energy Savings & Reduced Cooling Costs**
   - A cool roof can reduce the amount of energy needed for air conditioning by up to 15 per cent on a single-story building, leading to substantial savings on energy bills (EESI 2012).
3. **Mitigation of the Urban Heat Island (UHI) Effect**
   - Large-scale implementation of cool roofs helps **reduce citywide temperatures**, making Ahmedabad more **resilient to heat waves**.
4. **Improved Public Health & Heat Resilience**
   - Reduced indoor heat exposure minimises **heat-related illnesses and deaths**, particularly for low-income communities and elderly populations.
5. **Scalability & Affordability**
   - The Cool Roof program is **cost-effective**, requires minimal investment and can be **easily implemented on new and existing buildings**.

Figure A10: Difference between Dark Roof and Cool Roofs



Source: S. Himmelstein. 2017. "California Study: Cool Roof Technology impacts Air Quality

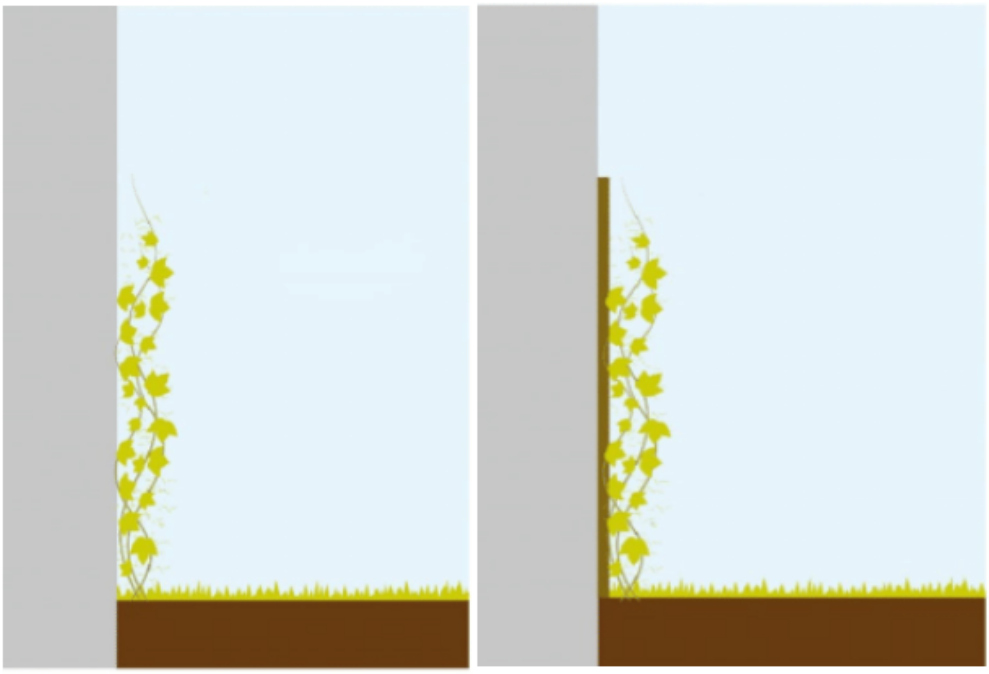
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3. Name of Solution - Ground-Based Green Facade and Facade Bound Greening

Location - Building Facade, Periphery of Building

Ground Based - Ground-based green facades are green walls with climbing plants rooted in ground planters. With adhesive pads as part of their anatomy, the climbing or self-clinging plants can grow directly on the wall or in a unique frame connected to the wall. The plants extract water and nutrients from the soil at ground level, grow very tall and adjust to climate fluctuations and lighting conditions. Many flowering and evergreen species can add aesthetic experience to exterior walls, calm and freshen the air

Figure A11: Ground-based green facades, either self-climbing or with support structure

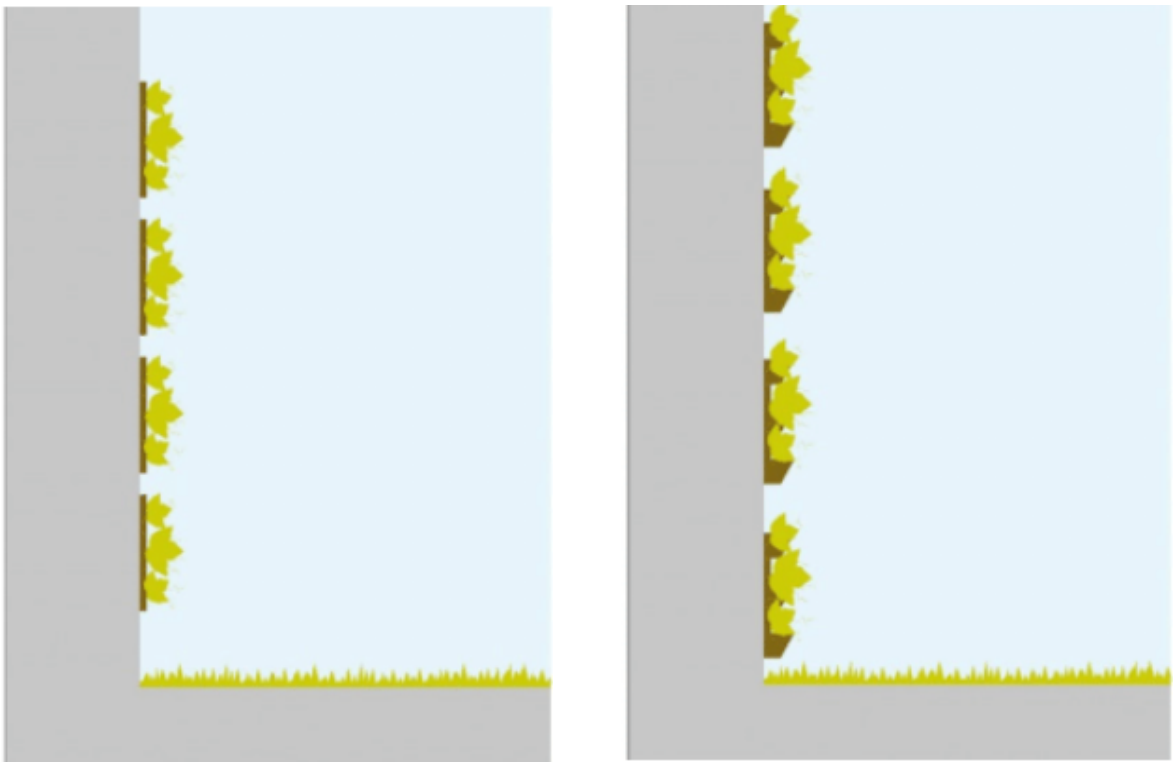


Source: Closing Water Cycles in the Built Environment through Nature-Based Solutions: The Contribution of Vertical Greening Systems and Green Roofs Water, 2021.

Facade Bound Greening - Facade-bounded greening is a type of green wall using irrigation technology and unique substrates to reduce the weight of green facades. They are more expensive than ground-based greening and require higher use of resources in construction and maintenance. Facade-bounded greening allows for a combination of 10–15 plant species, most often mosses and perennials and grows fast and uniform. The thin layer of soil inhibits their suitability in cold, temperate regions.

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Figure A12: Wall-based green facades, either with panels attached to the wall or as stand-alone systems



Source: Closing Water Cycles in the Built Environment through Nature-Based Solutions: The Contribution of Vertical Greening Systems and Green Roofs. Water. 2021.

Heat Regulation

- The vegetation layer of the green facade absorbs solar radiation through photosynthesis, protects the heat transmission into the building and provides shade if trees are planted. It reduces building temperature and cools the surrounding air.
- Research conducted in Lagos, Nigeria, showed that a green facade reduces internal air temperatures by an average of 2.3°C (36.14°F) and reduces the temperature of the facade itself between 2°C and 10°C (35.6°F and 50°F) compared to the natural stone (World Bank 2021)

Potential Location of Implementation of Green Facade Treatment



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4. Name of Solution - Cooling Shelter

Location - Places of high footfall and pedestrian-intensive location

Cooling shelters in cities serve as **climate-resilient spaces** designed to provide relief from extreme heat, particularly during heatwaves. These shelters are strategically located in **high-footfall areas such as bus stops, markets, parks and transport hubs**, offering shaded and ventilated spaces for public use.

They incorporate **passive cooling techniques**, including **green roofs, bamboo or perforated structures, solar-reflective materials and evaporative cooling systems**. Some shelters also integrate **water dispensers, misting systems and vegetation** to enhance cooling further.

Cooling shelters help protect vulnerable populations, improve urban thermal comfort and contribute to a city's **heat action plan by reducing** heat exposure and offering a comfortable resting place.

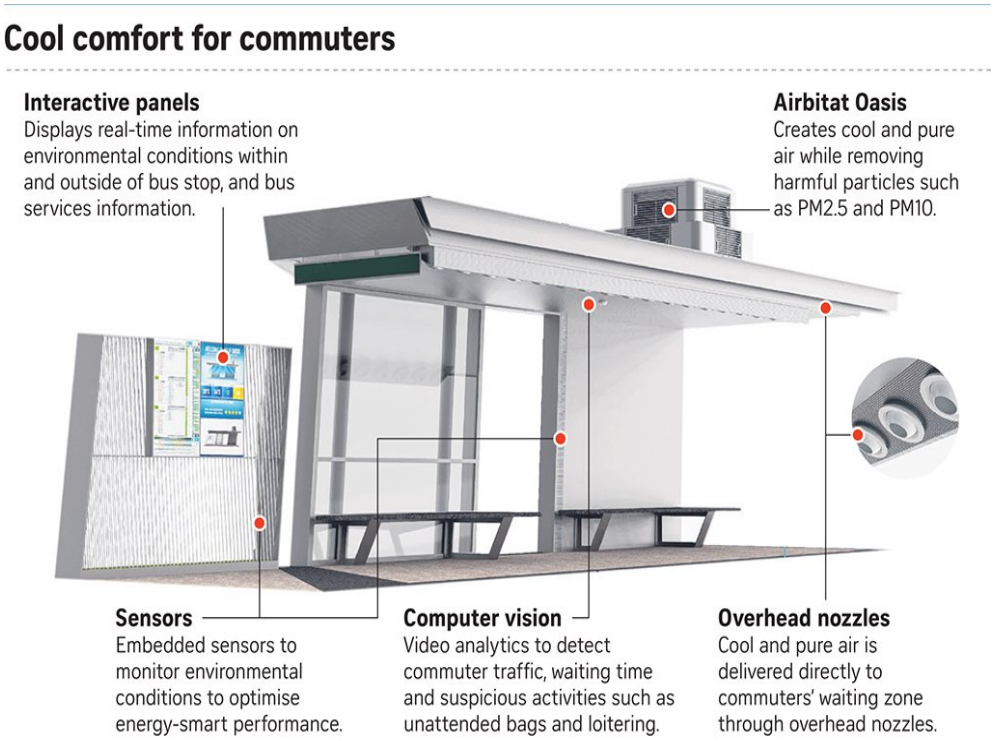
Figure A13: Cooling Shelter



Source: Freepik

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Figure A14: Components of Cooling Shelter



Source: Ilyas Sholihyn. 2018. "Singapore trials 'smart' bus stop that tracks commuter detects shady activities and blows cool air".

With more than 900 plus multi-purpose cyclone shelters, already established in the state, it provides a good opportunity to also leverage the existing infrastructure for a combination of passive cooling (green roofs, cool roofs) and active cooling solutions (misting, AC, fans).

Example of Jodhpur Cooling Shelter (NRDC 2024) and Ahmedabad Cool Bus-Stop

Figure A15: Jodhpur Cooling Shelter





Source: NRDC 2024

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Figure A16: Ahmedabad Cool Bus Stop



Source: Ahmedabad Cool Bus Stop, AMC, AMTS, MHT

5. Name of Solution - Shading Structures on Footpaths

Location - Pedestrian Pathways

Shading infrastructure is crucial in **enhancing pedestrian comfort, reducing heat exposure and improving walkability** in urban areas. Shading is an effective method of improving microclimate conditions in cities and shading structures such as canopies and covered walkways can improve pedestrians' thermal comfort in open urban spaces (Hsing-Yu Ou et.al 2023). By integrating shading solutions, cities can create **cooler, more comfortable and safer pedestrian environments** while mitigating the **urban heat island (UHI) effect**.

Fabric Canopies & Tensile Structures(Latifa Sultana et.al 2019)

- Lightweight, **fabric-based shading systems** (e.g., tensile fabric canopies) offer **flexibility and easy installation**.
- Reflective or light-colored fabrics help **reduce heat absorption**.
- Ideal for **temporary events, public plazas, or narrow streets where trees cannot be planted**.

Bamboo & Wooden Shade Structures (Renwu Wu et al. 2023)

- **Sustainable materials** like bamboo and wood create **eco-friendly and visually appealing shading elements**.
- These can be used as **arched walkways, pergolas, or modular canopy designs**.
- Suitable for **urban promenades, cultural districts and heritage sites**.

Benefits of Shading Infrastructure in Urban Areas

- **Enhances Pedestrian Comfort & Walkability:** Encourages people

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to **walk and use public spaces**, reducing car dependency.

- **Mitigates Urban Heat Island (UHI) Effect:** Reduces heat absorption from roads, buildings and sidewalks.
- **Improves Public Health:** Lowers risks of **heat exhaustion, dehydration and heat-related illnesses**.
- **Supports Sustainable Urban Design:** Integrating greenery and shading promotes **climate-adaptive city planning**.

Figure A17: Pedestrian Shelter



Source: Adele, Peters. 2021. "What US Cities can learn from Abu Dhabi about surviving record heat"

6. Name of Solution - Urban Greenery

Location - Locations in cities with exposed pavements, exposed roads and locations with less green covers

Urban greenery modifies shade provision, evapotranspiration and albedo. Combining these three mechanisms reduces sensible heat gain, lowering heat gain and surface temperatures. Red boxes indicate warming mechanisms and blue boxes indicate cooling mechanisms.

How Urban Greenery Reduces Heat (Nyuk Hien Wong et al. 2021)

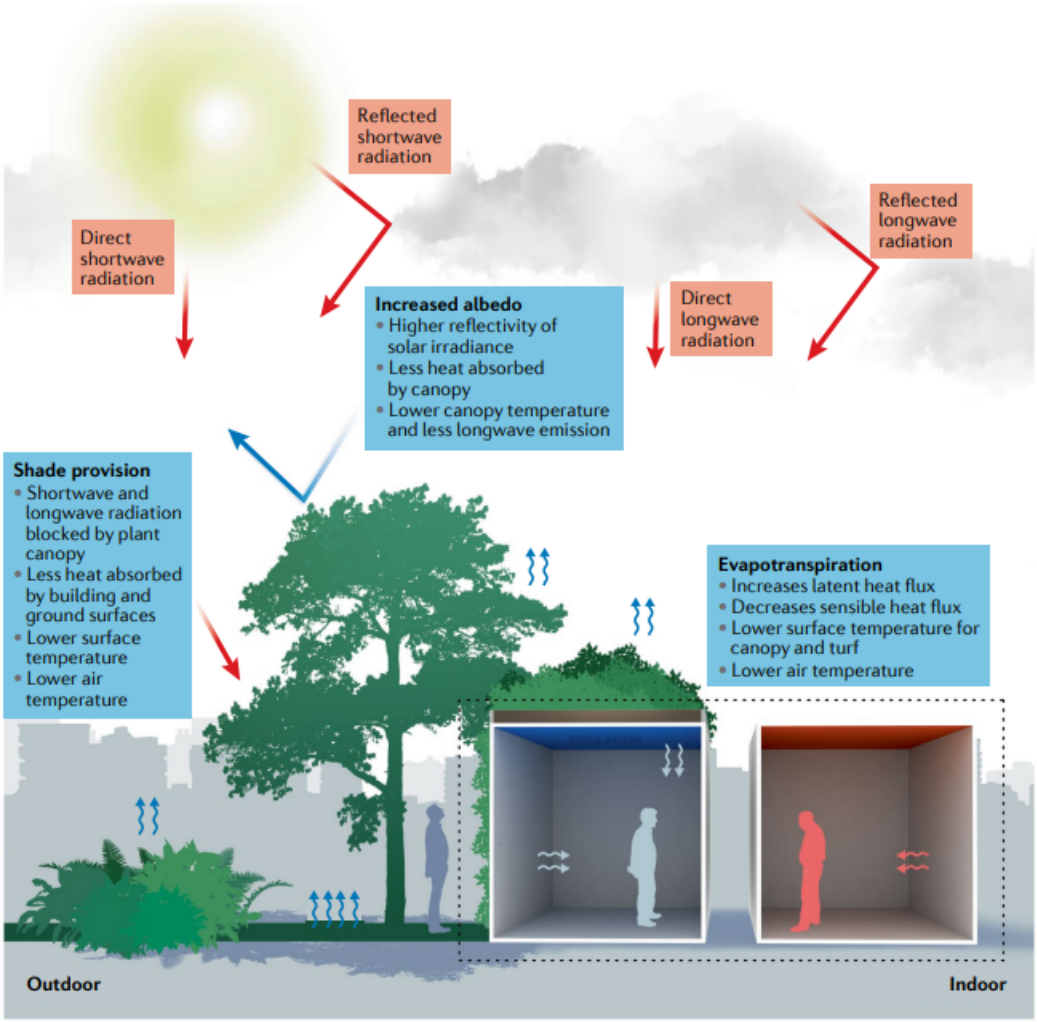
1. **Shade Provision**
    - Trees and vegetation block direct solar radiation, reducing the heat absorbed by buildings, roads and ground surfaces.
    - This leads to lower surface temperatures and cooler

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surrounding air, creating shaded microclimates that enhance pedestrian comfort.

2. **Increased Albedo Effect**
    - Green canopies reflect more sunlight than dark urban surfaces, reducing heat absorption.
    - Lower canopy temperatures result in less longwave radiation emission, which helps cool the environment.
3. **Evapotranspiration Cooling**
    - Plants absorb water through their roots and release moisture through evapotranspiration, increasing humidity and reducing surrounding air temperature.
    - This process also lowers surface temperatures of green spaces, rooftops and walls, preventing excessive heating of urban structures.

Figure A18: Factors contributing to UHI in cities



Source: Nyuk Hien Wong, Chun, Liang Tan, Dionysia, Denia Kolokotsa and Hideki Takebayash. N.d. "Greenery as a mitigation and adaptation strategy to urban heat".

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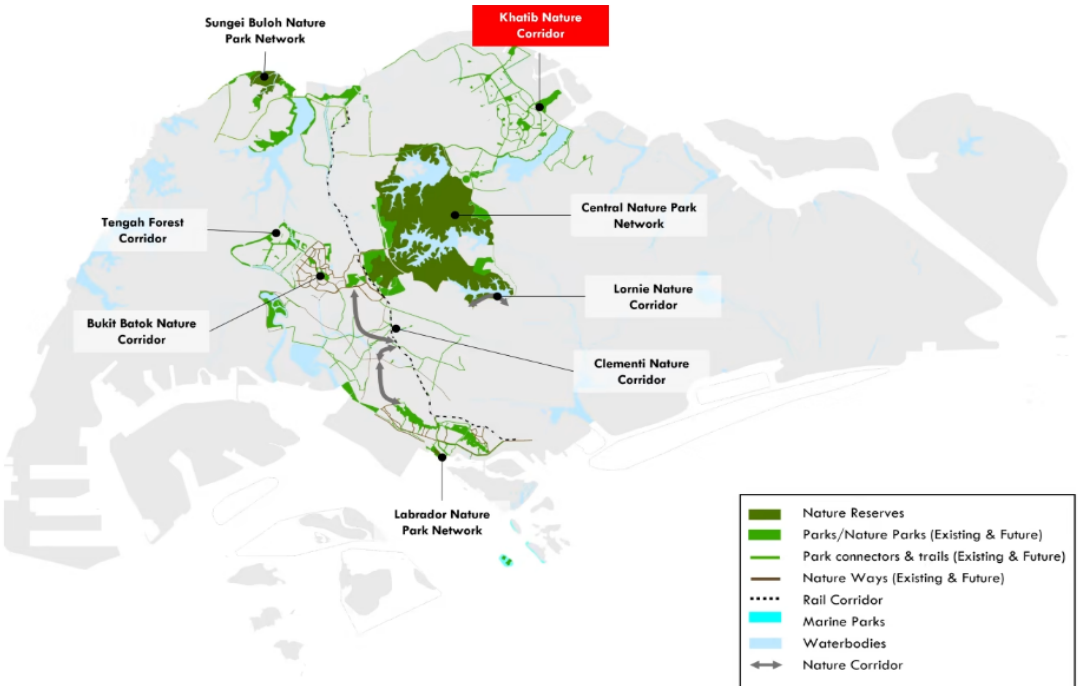
Case Studies - Singapore Green Plan (2030)

The **City in Nature program**, launched in 2020, was a key initiative under **Singapore's Green Plan 2030.** It aimed to transform the country into a green, livable and sustainable home for its citizens by 2030 (Green Plan Singapore 2023).

By 2030, Singapore intends to introduce **200 hectares of skyscraper greenery and plant over 170,000 more trees in industrial areas**, bringing nature into the city's dense urban fabric.

To improve accessibility to green spaces, Singapore committed to strengthening connections between green spaces by constructing **300 kilometres of Nature Ways and 500 kilometres of park connectors**. This would ensure that every household was within a 10-minute walk of a park.

Figure A19: Layout of Green Singapore



Source: Singapore Green Plan, 2023

Singapore Therapeutic Garden

- These gardens are designed based on scientific research to **encourage interaction with nature**, **enhancing the overall well-being** of visitors and residents (Green Plan Singapore 2023).
- These gardens are carefully planned spaces that provide a **calm and natural environment to promote relaxation, reduce stress and improve mental and emotional health**. They aim to offer a restorative experience for individuals of all ages.

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Figure A20: Therapeutic Garden





Source: Singapore Green Plan, 2023

7. Name of Solution - Cool Pavements

Location - Pedestrian Pathways and locations with high footfalls

Cool Pavements and Their Implementation in Urban Areas

Cool pavements are specially designed surfaces that reduce heat absorption and **lower urban temperatures** than conventional asphalt and concrete pavements. These pavements are essential in mitigating the **urban heat island (UHI) effect**, as traditional dark-colored roads and sidewalks absorb and retain heat, increasing surface and air temperatures.

Cool pavements use materials and technologies that **reflect more sunlight, absorb less heat and enhance cooling**. They are categorized into:

1. **High-Albedo Pavements** – These pavements have **light-colored or reflective surfaces** that reduce heat absorption and increase solar reflectance (albedo), keeping temperatures lower.
2. **Permeable Pavements—**Made of materials like porous asphalt, permeable concrete, or interlocking pavers, permeable pavers allow water to seep through, reducing surface temperatures through evaporative cooling.
3. **Evaporative Pavements** contain water-retaining materials that **absorb and release moisture through evaporation**, cooling the pavement surface.

Benefits of Cool Pavements and Evaporative Pavements Work

Cool Pavements

1. **High reflectivity (Albedo Effect):** They reflect more sunlight rather than absorbing it as heat (Taha H et al. 2002).
2. **Lower surface temperatures:** Studies show they can be **10-20°C cooler** than traditional asphalt (Sophia Kappou et al. 2022).
3. **Durability & Sustainability:** Many superb pavement materials are designed to be **longer-lasting** and reduce energy costs.

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Evaporative Pavements

1. **Moisture retention:** These pavements contain hydrophilic materials that **store water and gradually release it** through evaporation.
2. **Heat dissipation:** The evaporative cooling effect lowers surface temperatures, making surrounding areas more comfortable.
3. **Permeability:** They allow rainwater infiltration, reducing runoff and improving groundwater recharge.

Actionable Implementation of Cool Pavements in Urban Areas

1. **Public Spaces & Sidewalks** – Applying cool pavement coatings to pedestrian pathways and public squares reduces surface heat and improves walkability.
2. **Roadways & Parking Lots** – Using high-reflectivity materials in parking areas prevents excessive heat accumulation.
3. **Playgrounds & Sports Courts** – Implementing cool pavement surfaces in schools and parks enhances thermal comfort for children and athletes.
4. **Bus Stops & Transit Hubs** – Applying permeable and evaporative pavements in transportation areas lowers heat stress for commuters.
5. **Residential & Commercial Driveways** – Using permeable concrete or reflective coatings in driveways improves local cooling and storm water management.

Figure A21: Types of cool pavements and their uses

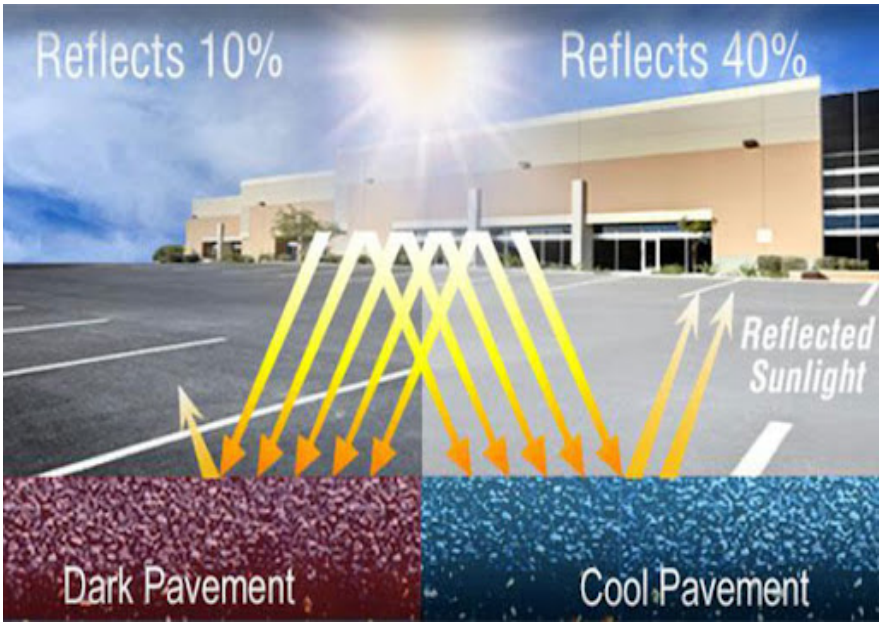
Pavement type	Solar Reflectance (SR)	Uses	Pavement surface life
Clear Resin Binders	Depends on aggregate	New construction & maintenance for streets, sidewalks, parking lots, etc.	20 years
Coatings (e.g., cementitious coating, elastomeric coating)	New: 35–55%	Coatings for preventive maintenance for streets, driveways, parking lots, etc.	1 to 5
Light-Colored Aggregates (e.g., chip seal)	Depends on aggregate	Overlay for preventive maintenance for highways, streets, parking lots	2 to 5 years
Light-Colored Cement (e.g., slag, white cement)	New: 70–80%	New construction & maintenance for highways, streets, sidewalks, parking lots, etc.	40 years
Porous Asphalt Cement (AC), Pervious Portland Cement Concrete (PCC), & Reinforced Grass Pavements	Depends on pavement type	New construction, to aid with stormwater management	varies
Portland Cement Concrete (PCC)	New (gray cement): 35–50% Aged (gray cement): 20–35%	New construction & maintenance for highways, streets, sidewalks, parking lots, etc.	40 years

Source: Global Cool Cities Alliance 2012

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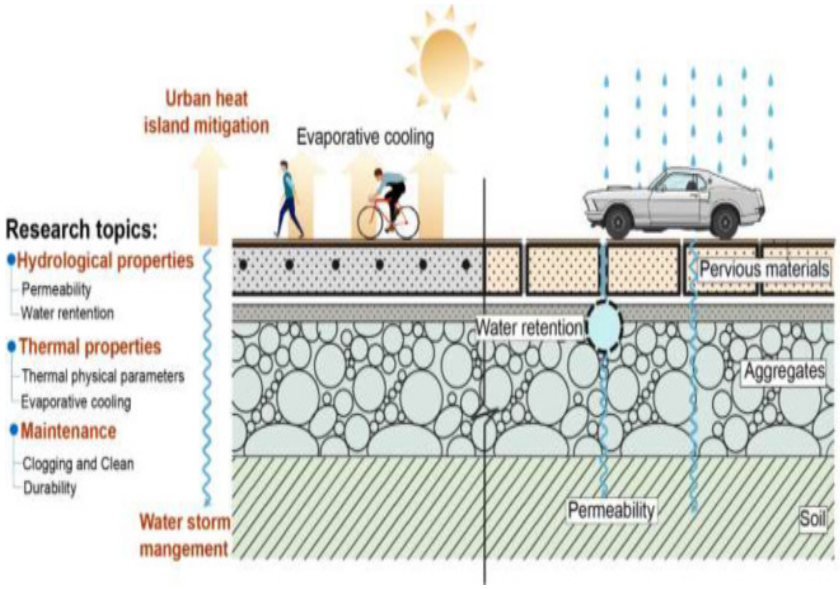
Cool pavements are **cost-effective, environmentally friendly and improve urban resilience** against extreme heat. Their integration with **green infrastructure**, such as **tree-lined streets and shaded pedestrian pathways**, further enhances city cooling benefits.

Figure A22: Dark Pavements v/s Cool Pavements



Source: Lui, Hui, John, Harvey, Arash, Saboori, Ali, A Butt. 2017. "Development and Application of LCA Tool for Cool Pavement". University of California

Figure A23: Evaporative Cooling



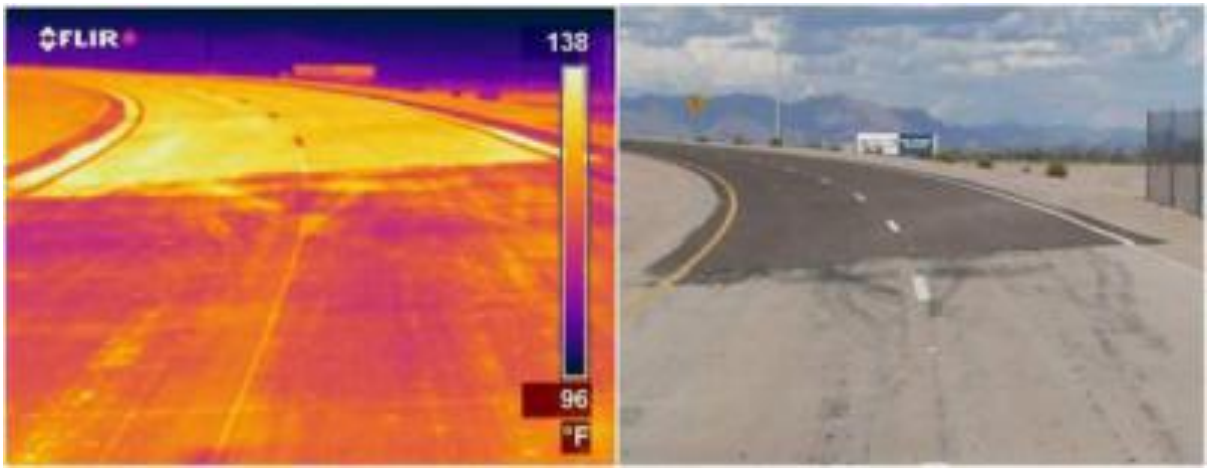
Source: Performance synergism of previous pavement on stormwater management and urban heat island mitigation: A review of its benefits, key parameters and co-benefits approach. Water Research. 2022

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The UHI effect is due to the materials used in the construction of urban areas, which absorb and store more heat during the daytime than rural areas, later releasing it and boosting afternoon and night-time temperatures.

Reflective pavements (RP) r**educe the amount of light** and, therefore, heat absorbed by pavements. Reflective materials can be used to coat existing pavements or to construct entirely new ones.

Figure A24: Thermal Infrared Vision of cool pavements compared to a normal asphalt road



Source: Heat Island Group

Thermal infrared (left) and visible (right) images of a road with light and dark segments. The infrared image shows that the light segment (bottom) is about 17°C (30°F) cooler than the dark segment (top). (Image courtesy of Larry Scofield, APCA)

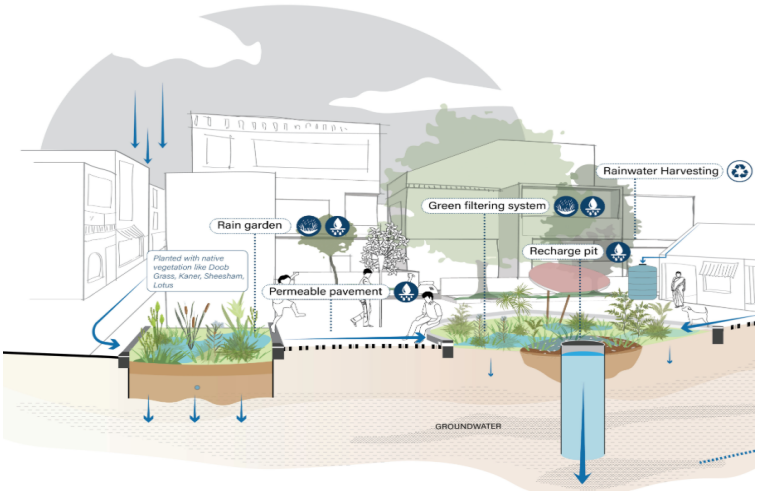
8. Name of Solution - Development of Urban Acupuncture

Location - Urban Voids, Pocket Parks, Kitchen Gardens in Hospitals

Areas with high public activity levels can be used to incorporate the Disaster Risk Reduction (DRR) concept. These public spaces can also leverage the **small niches, corner greens/buffers and neighborhood parks to be holistically developed into blue-green acupunctures of varying scales**. Multiple acupuncture can also be designed in conjunction. For example, recharge wells can be part of a stormwater park that can help improve the overall livability of the area. If the groundwater level is shallow, water collected into these wells can be treated using native plants. In cases where it's deep, the water can retain and recharge naturally.

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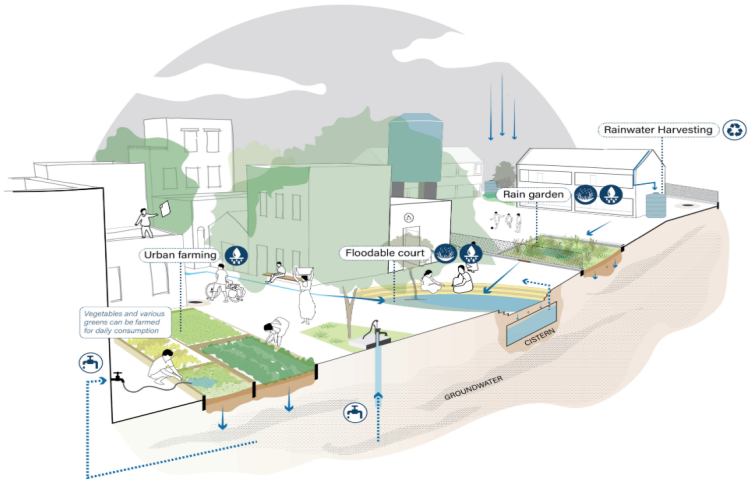
Figure A25: Development of Urban Blue-Green Acupuncture



Source: *WRI India. 2021, "Creating a flood resilient Indian "Sheher" through Water Sensitive Urban Design"*

In cities, the marginalised neighborhoods are adversely affected by flooding and are further crippled with challenges such as inadequate access to WASH and the right to healthy spaces. These urban settlements are highly dense, organic and lack open spaces; the blue-green acupunctures will have multi-functional and circular values. Small pockets of open spaces (community kitchen gardens, wetlands) will be carved up, which can be synergistically designed to provide clean water, livelihood and public green spaces. Efficient rainwater harvesting and recharge wells can ensure access to safe, clean water for the community.

Figure A26: Leveraging small open spaces to act as temporary ground for water



Source - WRI India. 2021, "Creating a flood resilient Indian "Sheher" through Water Sensitive Urban Design"

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9. Name of Solution - Thatch / Palm Leaves for roofing

Location - Rural and Peri-Urban Areas

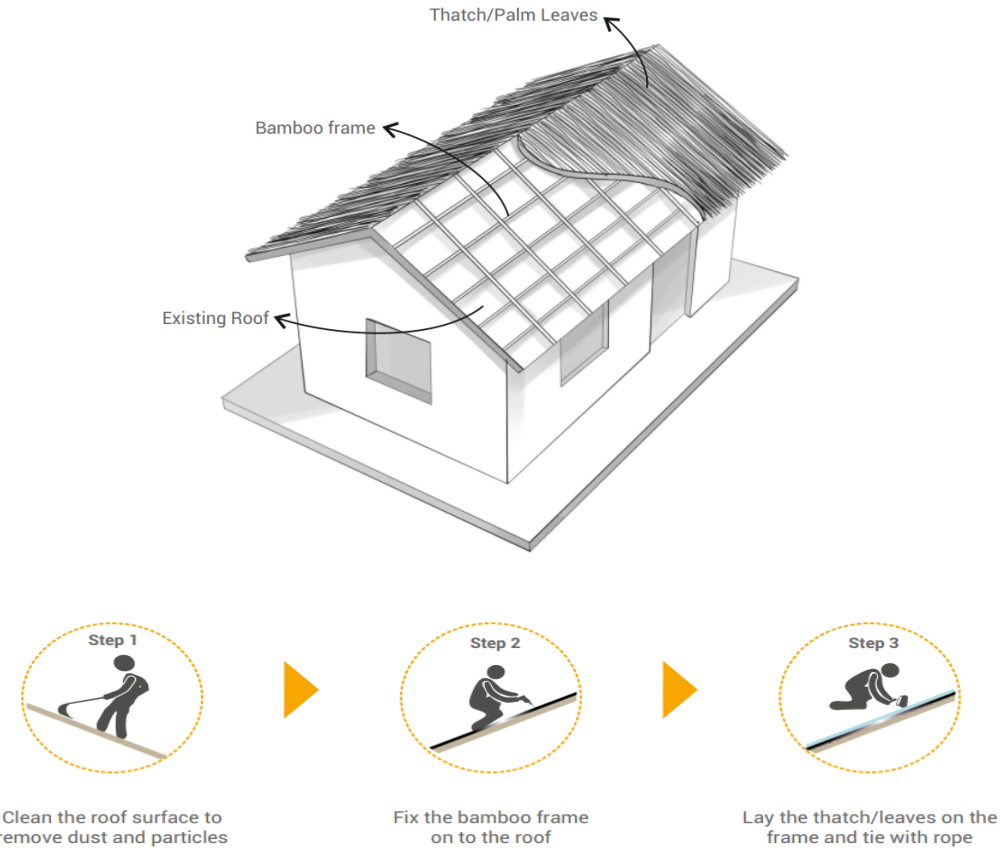
Bamboo, Thatch and palm leaves are locally available across India and can be installed as a secondary roof screen, reducing the heating effect. Traditional materials like bamboo, thatch and palm leaves offer excellent heat mitigation and solar reflectance benefits, making them ideal for sustainable architecture.

With natural light tones, thatch and palm leaves reflect some solar radiation while providing effective insulation due to the trapped air within their fibers, keeping interiors cooler. When used in slatted or woven forms, bamboo creates a semi-permeable barrier that allows light and air to pass through, reducing heat buildup.



Method for Installation

Figure A27: Deployment of Thatch / Palm leaver over roofs



Source: *NDMA 2021 "House Owners' Guide to Alternate Roof Cooling Solutions," New Delhi*

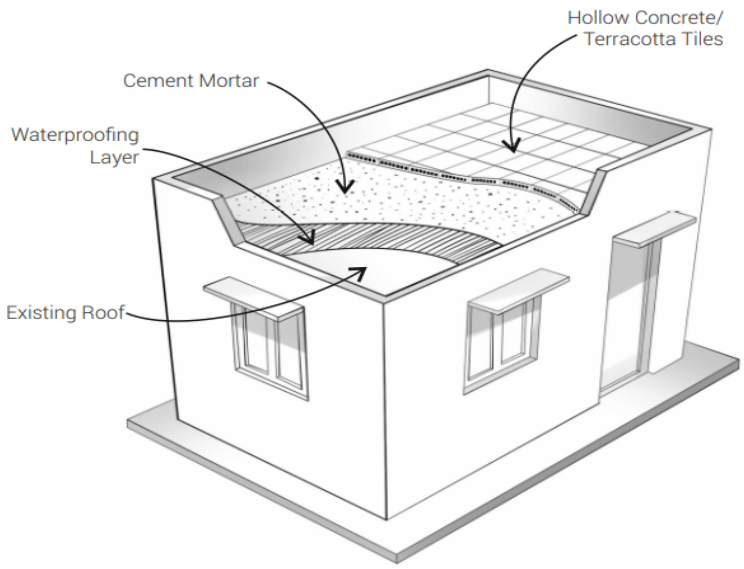
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10. Name of Solution - **Hollow Terracotta/ Concrete Tiles**

Location - Exposed Rooftops

- Hollow concrete/terracotta tiles have high thermal and sound insulation properties, limiting heat flow. The air inside the cavities provides the insulation to heat.
- Hollow concrete tiles contribute to heat mitigation by enhancing thermal insulation and reducing heat absorption. Their **hollow cores trap air as a natural insulator, slowing heat transfer and cooling surfaces**.
- Unlike solid concrete, which retains heat and radiates it back into the surroundings, hollow tiles minimize thermal mass, reducing the urban heat island effect.
- Additionally, their design allows for **better airflow, further aiding in cooling by dissipating trapped heat**.
- Hollow concrete tiles can significantly lower surface temperatures, creating a more comfortable microclimate, especially in hot and humid regions when used in pavements, roofs, or facades.
- Their ability to accommodate **water-permeable designs also supports cooling through evaporative effects**, enhancing their role in sustainable urban development.

Figure A28: Deployment of Hollow Concrete / Terracotta Tiles on existing roofs



Source: *NDMA. 2021 "House Owners' Guide to Alternate Roof Cooling Solutions," New Delhi*

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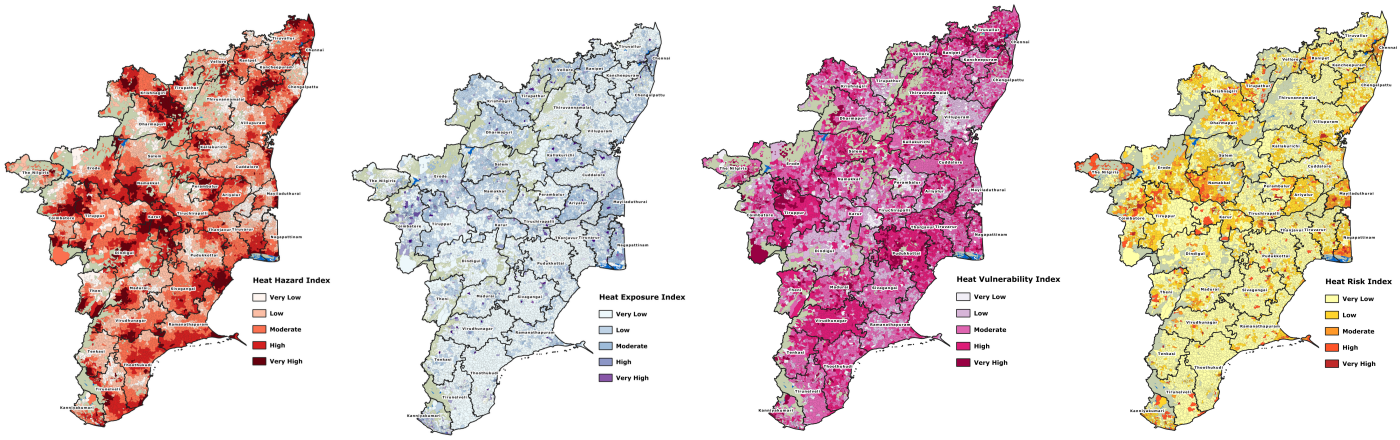
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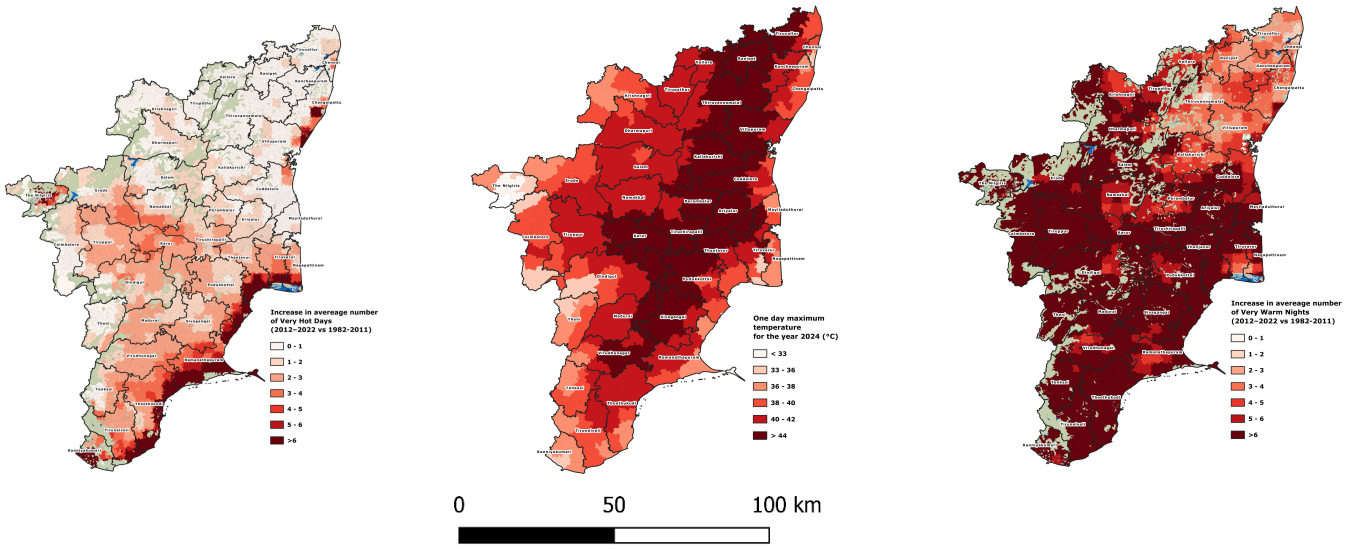
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Hazard (Climatic events)	**X**	**Exposure** (Population, infrastructure, etc.)	**x**	**Vulnerability** (Population sensitivity, systemic adaptive capacity)	**=**	**Risk**

Note: In the hazard, exposure, vulnerability and risk maps , the values and associated colour categories are only comparable within a district



Change in frequency of very hot days	One-day maximum temperature (2024)	Change in frequency of very warm nights

Note: The Land Use Land Cover categories of vegetation, water bodies and barren land have been represented as green, blue, and grey, respectively

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