From Heatwaves to Cooling Futures: Maharashtra's Leadership in Climate Action in India

उष्णलाटांकडून शीतलतेकडे: भारतातील वातावरणीय बदल उपायांसाठी महाराष्ट्राचे नेतृत्व

Co-editors: Sujata Saunik and Mihir R. Bhatt

Photo: AIDMI.

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INTRODUCTION

Extreme Heat and Everyday Resilience: Maharashtra's Turning Point in 2025

*By **Sujata Saunik**, Former Chief Secretary, Maharashtra State Disaster Management Authority, Government of Maharashtra, India; and **Mihir R. Bhatt,** All India Disaster Mitigation Institute (AIDMI), India*

Maharashtra stands at the frontline of India's heat crisis. In 2025, the state faces a confluence of rising temperatures, erratic rainfall, and prolonged dry spells that threaten lives and livelihoods across both rural and urban landscapes. From the cotton belts of Jalgaon and Beed to the dense urban wards of Nagpur and Mumbai, the impact of extreme heat is no longer episodic—it is structural and accelerating each year.

This issue of *Southasiadisasters.net* titled "From Heatwaves to Cooling Futures: Maharashtra's Leadership in Climate Action in India" captures Maharashtra's evolving leadership in addressing extreme heat through science-based, locally led solutions. The contributions in this edition—ranging from reflective cool roofs and biomimicry in architecture to ocean-informed cooling and nature-based approaches—demonstrate the breadth of innovation emerging across the state. And there are many many more such innovations across Maharashtra.

The All India Disaster Mitigation Institute (AIDMI), in collaboration with the International Institute for Environment and Development (IIED), has contributed to this transformation through field-based research and community action. The joint 2024 study, *Building Resilience for Cotton Farmers in India: Evidence from Gujarat and Maharashtra* (IIED, 2024), documented how smallholder farmers—particularly women—are responding to extreme heat by diversifying crops, adopting water-efficient practices, and participating in community-managed Livelihood Resilience and Recovery Funds. These local financing mechanisms allow rapid, peer-assessed loans that help households recover without falling into debt.

Small businesses in Ahmedabad are facing the heat under an umbrella — everyday resilience in India's cities. Photo: AIDMI.

> *"Extreme heat is now a development issue for Maharashtra—affecting health, livelihoods, and dignity. Maharashtra's leadership shows that resilience can be built when local innovation meets public commitment."*

AIDMI's ongoing engagement in Maharashtra—with farmer-producer organisations, Panchayats, and DDMAs—bridges research with action. Its work supports the rollout of district heat action plans, promotes anticipatory finance for smallholders, and pilots affordable cooling technologies such as solar drying sheds, shaded market zones, and cool storage for cotton and perishable goods. Together, these actions underscore Maharashtra's growing recognition that cooling is not a luxury but a lifeline for its citizens — integral to human health, productivity, and equity, all of which lead to peace. ■

Co-editors: Sujata Saunik, Takemi Fellow, 2018, Harvard T.H. Chan School of Public Health, specialising in public health and heat policy, governance, and transformative administrative reforms.

Mihir R. Bhatt of AIDMI is a leading practitioner and thinker in disaster risk reduction and humanitarian action. He has pioneered community micro-insurance, anticipatory action for extreme heat, and locally-led pilots across South Asia.

Public Action for a Cooler Maharashtra: NDMA and Maharashtra Government Projects on Extreme Heat

By AIDMI, India

Maharashtra is facing some of India's most severe and recurring heatwaves. With temperatures rising beyond historical levels, accelerated coordinated public action between the **National Disaster Management Authority (NDMA)**, Government of India, and the **Government of Maharashtra (GoM)** has become critical to safeguarding lives, livelihoods, and public health. Together, NDMA–GoM initiatives are creating a robust framework for anticipating, managing, and reducing the growing impacts of extreme heat across the state.

At the national level, NDMA's *Guidelines for Heat Wave Management (2019)* remain the cornerstone of preparedness. These guidelines strengthen early warning systems, public communication, and emergency health protocols—especially for outdoor and informal workers. NDMA's collaboration with the **India Meteorological Department (IMD)** ensures Maharashtra receives five-day forecasts, district-level alerts, and colour-coded bulletins, enabling swift activation of **Heat Action Plans (HAPs)**. Regular NDMA training sessions further build capacity among state and district officers in heat illness management and coordinated emergency response.

Under NDMA guidance, Maharashtra's **State Disaster Management Authority (MSDMA)** has converted national directives into action through the *Maharashtra State Cooling Action Roadmap (2024–2025)*. This roadmap expands the use of cool roofs, boosts urban green cover, and integrates heat resilience into housing, education, and public health infrastructure. More than 20 districts—including Mumbai, Nagpur, Beed, Jalgaon, and Chandrapur—now implement localised HAPs with hydration stations, shade shelters, and mobile health units. More cities and districts are joining.

The state's **"Heat Ready Communities"** campaign spreads awareness in Marathi through schools and panchayats, while public cooling zones, tree-based microparks, and Miyawaki forests enhance nature-based protection.

Through the synergy, that is collaborative federalism, between NDMA's national leadership and Maharashtra's sub-national innovation, the state is advancing toward a vision of being **heat-ready, heat-resilient, and heat-smart**. This coordinated effort offers a model for India's response to the rising threat of extreme heat not only to other states of India but also to India's neighbours. ■

AIDMI Key Work of Four Decades in Maharashtra: 1984–2025

1984	Raigad District Watershed Management with Schools of Planning and Architecture (SPA) and the Government of Maharashtra.
1996	Successful recovery planning with the Government of Maharashtra, Tearfund UK, and EFICOR of Malcondji village following the 1993 Latur earthquake.
2006	Mumbai Voices Project: Voices of survivors of serial blasts in Mumbai with TISS, HHI Boston, and Red Cross.
2008	School Safety Audit: Towards Making Schools Safer with UNICEF.
2008	Mumbai Emergency Management Exercise (MEMEX) – India's first large-scale mock drill with the Government of Maharashtra and 20 CSOs.
2008	School Safety Trainings with district authorities and UNICEF.
2010	Mumbai Emergency Management Exercise (MEMEx II) with NDMA, TISS, and the Government of Maharashtra.
2017	Training on Preparation of School Safety Disaster Management Plan with UNICEF and the Government of Maharashtra.
2018	Understanding Uncertainty: Views from Kachchh, Mumbai, and Sundarbans with IDS, Sussex, IIT Mumbai, and Norwegian University of Life Sciences.
2020	Mumbai Coastal Patch: Working with fishing communities with IIT Mumbai and Varsova Fisher Community.
2022	National Roundtable on Pathways to Transformation: Coastal, Delta, and Desert Communities with IIT Mumbai and 20 leading CSOs of Maharashtra.
2024	Building Resilience for Cotton Farmers in India: Evidence from Maharashtra with over one lakh female farmers.
2025	Nature-Based Solutions in Maharashtra with city commissioners, CSOs, and Tata Trust in three towns.
2025	From Heatwaves to Cooling Futures: Maharashtra's Leadership in Climate Action in India with the Government of Maharashtra, government leadership and CSOs.

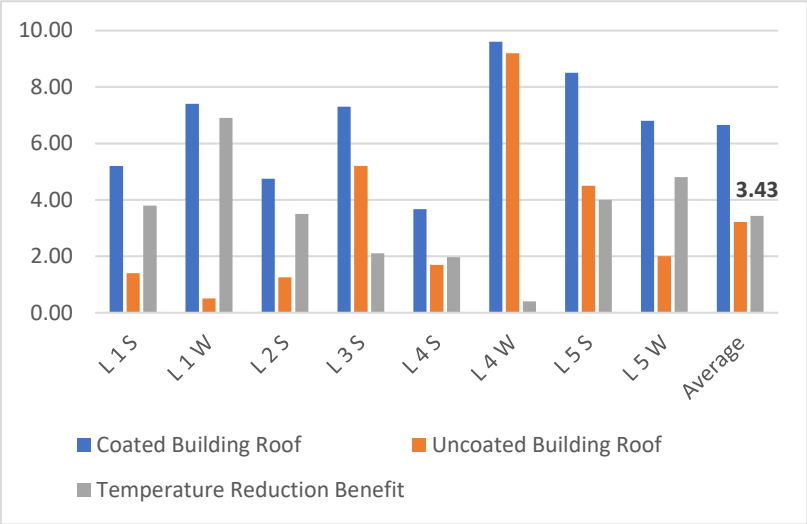
CLIMATE INNOVATION

The Green Project: Mitigating the Climate Risk Impacts in Maharashtra

*By **Anand Ghodke,** WASH-CCES Officer, **Yusuf Kabir,** WASH-CCES & DRR Specialist, UNICEF Maharashtra, and **Nilesh Mankar**, Dy Mechanical Engineer, GSDA, Nagpur, Maharashtra, India*

Background

Maharashtra continues to face acute challenges, including drought, intermittent power supply, and heatwaves, as climate change drives higher cooling demand. Rural communities, however, cannot afford individual solutions such as individual water supply systems, air conditioners, or coolers. To address these linked concerns of water, energy, and climate resilience, UNICEF and its partner SACRED, in collaboration with Zilla Parishad Nagpur, implemented "The Green Project" in seven locations of Nagpur district, introducing cost-effective, community-driven solutions.



Graph 1. Temperature Difference inside and outside for Coated & Uncoated Roof at 5 Locations (Summer and Winter).

Modus Operandi: The demonstration under "The Green Project" aimed to address water scarcity, energy shortages, and climate change resilience in Nagpur, Maharashtra, through the use of innovative mitigation technologies. The project integrated technologies to conserve natural resources and promote sustainability. It utilises existing borewells for water recharge, implements rainwater collection systems, applies reflective white paint to reduce indoor temperatures, and integrates solar-powered pumps to reduce grid dependency.

Key features of green technologies included:

- ***The Painted Roof:*** for harvesting rainwater, and the maximum potential is used to harvest by adding a parapet wall.
- ***Heat-resistant food-grade paint: The paint used is heat-resistant and of food-grade quality that provides an*** anti-dampness feature and absorbs heat.
- ***Self-Cleaning Filter:*** The filter works on the principle of centrifugal force and has a self-cleaning mechanism so that no dirt or dry waste blocks the flow of water.
- ***Storage Tank:*** The storage tank is installed either at the ground level or on the top of the premises to store the harvested water and to use it during the lean period as and when required.
- ***Recharge Shaft:*** The recharge shaft is a borewell of larger diameter, which is used to recharge shallow aquifers as the depth of these shafts is limited.
- ***Manually Operated Dual pump:*** It is a force lift type of pump that functions as a handpump and can also be used to pump water in the tanks installed on rooftops.
- ***Solar pump system:*** The solar pump system uses both submersible and other types of pumps to lift water from borewells to feed the water supply distribution system of the premises, wherever it is connected.

Results:

Result 1. Temperature Reduction and Cooling Impact

Table 1. Temperature Difference inside and outside for Coated & Uncoated Roof at 5 Locations (Summer & Winter)

Type of Roof	Average
Coated Building Roof - Average Temp	6.65
Uncoated Building Roof - Average Temp	3.22
Temperature Reduction - Cooling Impact	3.43

Result 2. Reduction in Energy Consumption

According to the study conducted under this approach, using a single 2 HP solar pump will result in a cost savings of Rs. 10,368 per year/year while reducing 1,071.36 kg CO2 emissions annually. The solar net metering indicates a reduction of approximately 60-70% in grid electricity consumption, resulting in an annual saving of approximately 10,000 INR. The details of the grid energy consumption is presented below:

Table 2. Nand Primary Health Cente, Bhivapur, Nagpur

Average Monthly Electricity Units before	Units Consumed During the month after
1100	388

Result 3. Reduction in Energy Consumption

In the case of water harvesting, the observation reveals that even if there is no significant increase in the water levels, the depletion is either reduced, constant or sustained.

Way Forward

Early results showed improvements in groundwater levels, reduced runoff, lowered room temperatures, and enhanced energy efficiency. This holistic approach not only addresses local water and energy issues but also contributes to achieving Sustainable Development Goals (SDGs) by fostering environmental sustainability and community resilience. The project showcases a scalable, cost-effective solution for rural and tribal areas affected by climate change. ■

उष्णलाटांकडून शीतलतेकडे वतावरणीय बदल उपायांसाठी महाराष्ट्राचे नेतृत्व

By AIDMI, India

Southasiadisasters.net चा हा अंक वातावरणबदलामुळे भारतासमोरील सर्वात गंभीर आव्हानांपैकी एक असलेल्या तीव्र उष्णतेला सामोरे जाण्यासाठी महाराष्ट्राने घेतलेले नेतृत्व अधोरेखित करतो.

या अंकात संरचना, विज्ञान, समुदाय लवचिकता आणि प्रशासनाला जोडणाऱ्या विविध नवोन्मेषी आणि स्थानिक अनुभवावर सिद्ध झालेल्या उपाययोजना सादर केल्या आहेत. UNICEF च्या नागपूरमधील योग्य खर्चातील व परिणामकारक "ग्रीन प्रोजेक्ट" व तसेच AIDMI आणि IIED यांच्या अभ्यासातून कापूस शेतकऱ्यांच्या उपजीविकेशी उष्णतेविरोधी लवचिकतेचा अनुभव सादर करण्यात आला आहे. या अंकातील प्रत्येक लेख स्थानिक स्तरावरील उपाय कसे ठोस परिणाम घडवतात हे दर्शवतो.

सदरील अंकात लेखकांनी शहरी उष्णता, उष्णता लवचिकतेसाठी प्रशासनातील सुधारणा, बायोमिमिक्री व पारंपरिक वास्तुशैली, समुद्रावर आधारित शीतकरण नवकल्पना, तसेच झोपडपट्ट्या आणि शेतांतील समुदाय-नेतृत्वाखालील रूपांतर याबद्दल विविध दृष्टिकोन मांडले आहेत. एकत्रितपणे, हे दृष्टिकोन दाखवतात की थंडकरण हे चैनीचे साधन नसून ते आरोग्य, उत्पादकता आणि समानतेची जीवनरेखा आहे.

कृषी, गृहनिर्माण आणि आपत्ती व्यवस्थापन यांसह संरचणा, उपजीविका, सेवा, आणि सुशासन इत्यादि सर्व क्षेत्रांमध्ये उष्णता-लवचिकता मुख्य प्रवाहात आणण्याचे आवाहन आहे. स्थानिक प्रयोगांना राज्यव्यापी उपक्रमांत रूपांतरित करून, महाराष्ट्र भारताचा पहिला "Cooling Transition" साध्य करू शकतो. पारंपरिक ज्ञान, तांत्रिक नवकल्पना आणि नागरिक नेतृत्व एकत्र येऊन वाढत्या उष्णतेपासून जीवन व हवामान सुरक्षित करू शकतात.

हा अंक विज्ञान, एकात्मता आणि शाश्वततेच्या आधारे लवचिकता निर्माण करण्याची मार्गदर्शक ठरू शकतो. ■

शहरी जोखिम शासन पर पुनर्विचार

By **Mihir R. Bhatt,** *AIDMI, India*

भारत के शहर आज विकास और संकट—दोनों के केंद्र बन चुके हैं। ये आर्थिक प्रगति को गति देते हैं, लेकिन साथ ही बाढ़, प्रदूषण और अत्यधिक गर्मी जैसी आपदाओं से सबसे अधिक प्रभावित भी होते हैं। ऐसे में शहरों की सुरक्षा और संरक्षा को केवल अपराध या क़ानून-व्यवस्था के नजरिये से नहीं, बल्कि जलवायु जोखिम, सामाजिक समावेशन और वित्तीय स्थिरता के दृष्टिकोण से भी समझना होगा।

आपदा जोखिम न्यूनीकरण और जलवायु लचीलापन पर दशकों के अनुभव से यह स्पष्ट होता है कि भारत को अपने शहरी शासन के ढांचे और सोच को बदलने की आवश्यकता है।

गेटेड कम्युनिटीज़ और नागरिक भागीदारी

गुड़गांव जैसे शहरों में गेटेड कम्युनिटीज़ का विस्तार नागरिकों को सार्वजनिक अवसंरचना की विफलताओं से अलग-थलग कर देता है। लेकिन जैसे ही बाढ़ आती है, यह भ्रम टूट जाता है। गुड़गांव की लगभग 40% आबादी अनौपचारिक बस्तियों या गांवों में रहती है। आप समुदाय को 'गेट' कर सकते हैं, लेकिन आप जोखिमों को 'गेट आउट' नहीं कर सकते।

नागरिक भागीदारी को वार्ड-स्तरीय मंचों के ज़रिये संस्थागत रूप देना होगा। अहमदाबाद का उदाहरण सामने है, जहाँ समितियों ने नालों, कचरे और हीट वेव योजनाओं में भागीदारी की। नागरिकों की भूमिका केवल योजना तक नहीं बल्कि निगरानी और मूल्यांकन तक होनी चाहिए।

साझेदारी और अर्बन चैलेंज फंड

शहरी शासन में लेन-देन से अधिक साझेदारी की ज़रूरत है। नागरिकों को

Invested in building sheds and storage boxes to protect stocks and improve storage, strengthening her business by offering cooler space to clients in Puri. Photo: AIDMI.

प्राथमिकताओं में शामिल करना होगा और निजी क्षेत्र—जो पहले से ही 70% शहरी निवेश करता है—को अनुबंधों में जल संरक्षण, समानता और लचीलापन जैसे तत्वों से बाँधना होगा।

अर्बन चैलेंज फंड का स्वागत हैं, लेकिन चेतावनी हैं कि इसका दायरा केवल कॉरपोरेट्स तक सीमित नहीं होना चाहिए। इसे छोटे उद्यमों, महिला समूहों और स्ट्रीट वेंडर्स तक भी पहुँचना चाहिए। असली परीक्षा यह होगी कि क्या यह संकट के समय सभी को जोड़ पाएगा और उन लोगों को शामिल करेगा जिन्हें अब तक बाहर रखा गया है।

ग्रेटर बेंगलुरु अथॉरिटी : संभावनाएँ और सीमाएँ

ग्रेटर बेंगलुरु अथॉरिटी एक दिलचस्प प्रयोग हैं। यह पानी, परिवहन और नालों जैसी एजेंसियों को जोड़ने का प्रयास है। लेकिन वे चेतावनी हैं कि वार्ड-स्तरीय निगरानी के बिना यह केवल एक और भारी संस्था बन जाएगी।

असली एकीकरण का मतलब है ऊर्ध्वाधर और क्षैतिज दोनों, और इसमें नागरिकों की भागीदारी दोनों स्तरों पर होनी चाहिए। सुरक्षा और संरक्षा को भी एजेंडे का हिस्सा बनाना होगा, क्योंकि शहरी शासन केवल अवसंरचना तक सीमित नहीं, बल्कि सुरक्षित और विश्वसनीय ढांचे का निर्माण भी है।

हीट पैटर्न और असंगठित श्रमिक

AIDMI के अध्ययनों से स्पष्ट है कि असंगठित श्रमिक सबसे अधिक प्रभावित होते हैं। अहमदाबाद में किए गए सर्वे के अनुसार, गर्मी के चरम दिनों में स्ट्रीट वेंडर्स की आय 20–25% तक गिर जाती है। रिक्शा चालक, निर्माण श्रमिक और सफ़ाई कर्मचारी लंबे समय तक धूप में बिना छांव, पानी या आराम के काम करते हैं।

हीट एक्शन प्लान अब स्कूलों और अस्पतालों तक पहुँचे हैं, लेकिन सवाल

है—क्या ये योजनाएँ परिवहन श्रमिकों और बेघर लोगों तक भी पहुँचती हैं?

शहरी जीवन की गुम होती विविधता

शहरों से सड़क पर दिखने वाली विविधता गायब हो रही है। स्ट्रीट वेंडर्स और छोटे व्यापारी लगातार कम हो रहे हैं। कुछ शहरों में इनकी संख्या 40% तक घट गई है।

यह परिस्थिति न केवल सांस्कृतिक बल्कि लचीलापन और सुरक्षा का भी नुकसान हैं। अनुमान है कि शहरी क्षेत्रों में लगभग 30% अनगिने 'लॉस एंड डैमेज' को वेंडर्स ही सोख लेते हैं। वे बाढ़ और हीटवेव के दौरान सस्ता भोजन और सामान उपलब्ध कराते हैं, जब औपचारिक प्रणालियाँ विफल हो जाती हैं।

तीन बड़ी चुनौतियाँ

हर शहरी नागरिक को तीन चुनौतियों पर ध्यान देना चाहिए :

1. जलवायु लचीलापन : भारत के 60% GDP शहरों से आते हैं। बाढ़, हीटवेव और प्रदूषण सीधा असर डालते हैं। सवाल यह है कि क्या शहर प्रकृति को नष्ट करने की बजाय उसे बहाल कर सकते हैं।
2. समानता और समावेशन : प्रवासी, महिलाएँ और वेंडर्स अभी भी योजना से बाहर हैं। समावेशन केवल न्याय नहीं बल्कि आपदा जोखिम न्यूनीकरण भी है।
3. वित्त और जवाबदेही : भारतीय शहरों में हर साल 100 अरब डॉलर का घाटा है। समाधान नीचे से ऊपर होना चाहिए। गर्मी से निपटने के 60% उपाय नागरिक पहले से ही कर रहे हैं। शहरों को इन्हें नियंत्रित करने की बजाय सुगम बनाना चाहिए।

निष्कर्ष

विकसित भारत का दृष्टिकोण साफ़ है—शहरी शासन को गेटेड हितों और अभिजात्य योजनाओं से आगे बढ़कर नागरिक-केंद्रित बनाना होगा। विशेष रूप से कमजोर वर्गों को इसमें शामिल करना होगा।

हमारी सुरक्षा और संरक्षा अवसंरचना की दृष्टि को अपने वर्तमान स्वरूप से कहीं आगे जाना होगा। क्या हम भविष्य के जोखिमों के लिए अतीत की अवसंरचना बना रहे हैं? यही असली सवाल है भारत के शहरी भविष्य के सामने। ■

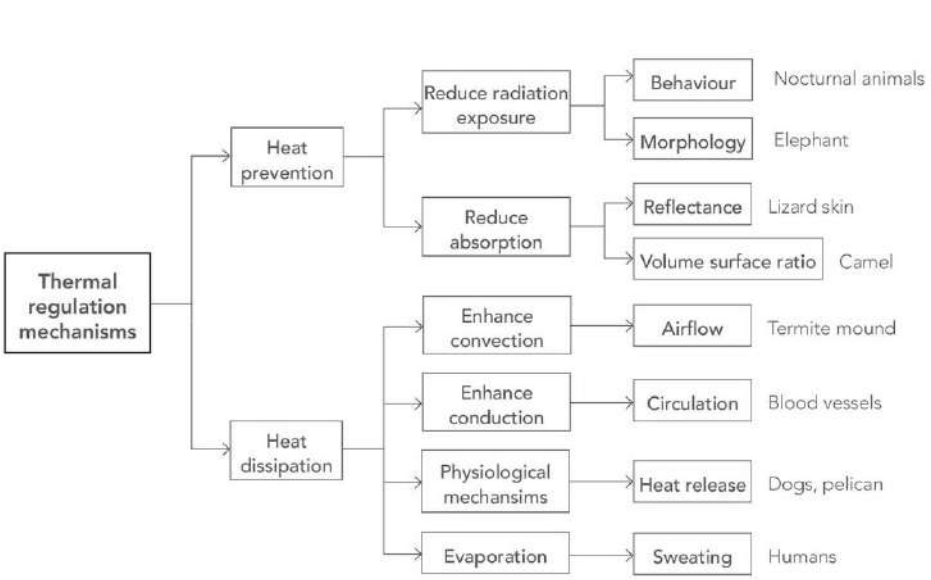
NATURE-INSPIRED DESIGN

Biomimicry for Thermal Comfort: Rethinking Urban Architecture for Extreme Heat in Maharashtra

*By **Ninad Shroff,** Architect and Researcher, Ahmedabad, Gujarat, India*

Traditionally, Indian architecture has been characterised by low-rise buildings, optimal shading and ventilation, and materials suited to the local climate. However, urbanisation today is driven by a desire for shiny steel-and-glass skyscrapers and wide highways —a development ill-suited to most Indian climates. Cities across the country are grappling with rising temperatures and increasingly frequent heat waves. To maintain indoor thermal comfort, most buildings rely on energy-intensive air-conditioning. According to the International Energy Agency, India is projected to have the second-largest stock of air conditioners globally by 2050. The sharp increase in air-conditioning units in recent years is already straining the electrical grid during peak hours. The heat released to the outdoors by these air-conditioning systems also contributes to the urban heat island effect.

Thermally efficient building design can substantially reduce, if not eliminate altogether, reliance on air conditioning. Buildings can be designed to better withstand extreme heat by drawing on strategies evolved by organisms to survive high temperatures. 'Biomimicry' is the emulation of strategies seen in the living world as a basis for design. Mimicry is not direct copying but rather the interpretation and adaptation of biological functions. Architects worldwide have utilised nature-inspired strategies in buildings to maintain indoor thermal comfort and reduce space cooling loads. Notable examples include the CH2 in Melbourne, where the building envelope has been designed as a protective 'skin' inspired by plants, featuring a kinetic facade and openings that respond to the sun's direction and intensity. A low-energy stack ventilation system cools the office spaces during the day, and an integrated passive ventilation system flushes out accumulated heat at night, capitalising on the diurnal temperature swings to drive air movement. The Eastgate Centre in Zimbabwe is another example, where the building's ventilation



Left: Thermal regulation mechanisms seen in nature. Credits: Author, based on Badarnah Kadri, 2012.
Top right: CH2 Building. Credits: Dianne Snape. Bottom right: Eastgate Centre. Credits: Mick Pearce.

system is derived from wind tunnels found in termite mounds that vent out heat. A high thermal mass and self-shading exterior further prevent excessive heat gain, inspired by cacti's skin.

Commercial buildings — typically fully air-conditioned and occupied throughout the day — are very energy-intensive. They are ideal for adopting such building-level thermoregulation strategies, as they have a central control system with regular day-night operation and a similar building typology. Modulating building form and orientation to reduce solar heat gain is an effective strategy for all building types and climates. In Maharashtra, coastal areas with a hot, humid climate can utilise cross-ventilation through permeable designs and dehumidification measures, while the hot, dry interior regions can employ insulation, night flushing, and evaporative cooling.

There is a need to rethink urban architecture's approach to climate resilience and responsiveness to local climate conditions, and biomimicry is just one possible solution. Energy efficiency and innovation must be incentivised through nationally mandated building codes and green rating systems, and the financial benefits of such measures should be effectively conveyed. Through advancements in design and technology, there is potential to fully realise buildings that are truly adaptive to environmental challenges. ■

COOLING LEADERSHIP

Cooling Maharashtra: A 2025 Plan for Survival and Leadership

*By **Ali Al Mokdad**, Strategic Senior Leader Specialising in Global Impact Operations, Governance, and Innovative Programming, Denmark*

Maharashtra's summers are no longer just hot—they're deadly. Climate change is driving heatwaves that threaten lives, strain infrastructure, and deepen inequality. Temperatures now regularly exceed 43°C in districts like Nagpur and Chandrapur, with annual heat-related deaths surpassing 120—likely far higher due to underreporting. Urban heat islands in Mumbai and shrinking green cover in Pune intensify impacts, especially for outdoor workers, slum residents, women, and children who often lack access to cooling or care. Economic losses from heat-related productivity alone exceed ₹ 5,000 crore annually. Without urgent action, deaths could rise 30% by 2025 as India's cities approach 600 million people by 2030.

A Plan That Saves Lives

The stakes are clear: cooling is not a luxury—it's a human right. Maharashtra's response can set a

new, actionable standard for climate resilience rooted in local knowledge, leadership, and community needs. In urban slums like Mumbai's Dharavi, permanent community cooling centres with solar-powered fans, water, and rehydration salts—funded through a ₹200 crore state budget and NGO partnerships—can offer lifesaving relief. In rural villages like Beed, mobile solar-powered cooling tents can be deployed to fields and markets where infrastructure is sparse. Shaded walkways with trees and misting systems can be piloted in Pune's crowded markets, while in Chandrapur, portable shade canopies and subsidised cooling vests for farmers can be scaled with support from the Green Climate Fund. To protect workers, enforceable heatwave breaks for construction and agricultural labourers should be supported by employer incentives of ₹50 crore, monitored by urban labour inspectors and rural cooperatives. Hyper-local heat alerts—sent via SMS and radio in Marathi, Hindi, and Urdu—can ensure even remote talukas like Washim are reached. These measures prioritise the most vulnerable—those without AC or shade—and should be co-designed through community workshops in places like Nagpur's slums and Beed's panchayats. With targeted implementation across both urban and rural settings, Maharashtra could prevent up to 50% of heat deaths, as modelled in Ahmedabad's Heat Action Plan.

Governing Heat as a Public Good

Heat is not just weather—it's a governance challenge. Maharashtra's departments must align to embed resilience into building codes, housing, and urban plans, targeting 30% tree cover by 2030. Public-private partnerships and incentives—like tax breaks and 'Heat Resilience Champion' awards—can mobilise private actors, from Pune developers to Mumbai startups and Nagpur businesses funding shaded markets. Cooling must be treated as a public service—subsidised, accessible, and equitably delivered. Achieving this requires political will, a dedicated budget of ₹1,000 crore, and civic momentum through a 'Cooling for All' campaign. A Heat Resilience Taskforce can fast-track action, while global partners like C40 Cities and the Green Climate Fund offer support—complementing, not replacing, local leadership. Heat is not just weather—it's a governance challenge. Maharashtra's departments must align to embed resilience into building codes, housing, and urban plans, targeting 30% tree cover by 2030. Public-private partnerships and incentives—like tax breaks and 'Heat Resilience Champion' awards—can mobilise private actors, from Pune developers to Mumbai startups and Nagpur businesses funding shaded markets. Cooling must be treated as a public service—subsidised, accessible, and equitably delivered. Achieving this requires political will, a dedicated budget of ₹1,000 crore, and civic momentum through a 'Cooling for All' campaign. A Heat Resilience Taskforce can fast-track action, while global partners like C40 Cities and the Green Climate Fund offer support—complementing, not replacing, local leadership.

"Maharashtra's 2025 plan makes cooling a human right—turning urgent heat action into a model of inclusive, climate-smart governance."

Final Thoughts: A Global Imperative

Maharashtra's crisis echoes a global pattern—from Nigeria's 2022 heatwave worsening food insecurity for millions, to refugees enduring over 40°C in Cox's Bazar camps, Pakistan's 2022 heatwave claiming at least 90 lives, and Texas's 2025 heatwave reaching 111°F, straining power grids and causing fatalities. Wildfires driven by extreme heat displaced thousands in Syria and Lebanon in 2025, while Europe's 2023 heatwave claimed over 47,000 lives—proving that no region is immune.

Yet Maharashtra can lead by shaping a locally grounded, globally relevant model. Cities like Seville and Melbourne demonstrate the effectiveness of targeted cooling measures. Maharashtra's own pilots—such as Dharavi's shelters, Pune's shaded markets, and multilingual alerts—offer a scalable path forward.

Climate financing, civic momentum, and private-sector incentives are all within reach. A Heat Resilience Taskforce could bridge the gap between policy and delivery with transparency and trust.

The foundation is in place. Whether Maharashtra becomes a blueprint or a cautionary tale depends on how this moment is met. Cooling alone won't solve everything. However, without it, the cost of inaction will only continue to grow. ■

CLIMATE PREPAREDNESS

Strengthening Heat Governance: From Emergency Response to Long-Term Cooling Strategies

*By **Aditya Valiathan Pillai,** Visiting Fellow, Adaptation and Resilience, Sustainable Futures Collaborative (SFC), New Delhi, India*

Extreme heat is not a static problem. It is a moving target, shaped by a warming climate that is pushing temperatures higher, for longer, and with greater humidity. This means that the solutions we design today will not hold tomorrow. India's heat governance cannot afford to be reactive; it must anticipate a future that is predictably hotter and far more dangerous. That requires a framework that evolves as the hazard intensifies, one that moves beyond saving lives during the next heatwave to reducing structural risk over the long term.

Our recent assessment of the implementation of heat actions in nine of India's most heat-vulnerable cities reveals that short-term measures—such as hydration points, work breaks, and hospital readiness—are more prevalent than long-term actions, which are inconsistent and rarely targeted at the most vulnerable populations. This imbalance will leave cities more vulnerable to higher mortality as temperatures rise. Fixing this requires progress on three fronts.

First, finance. The real gap is not in funding emergency measures but in securing predictable public finance for structural risk reduction. Frequent calls for heat-specific funding are beside the point. Extreme heat is not a major political priority, and many hazards have equally legitimate claims on the public purse. It is important to realise that there are several national and state schemes that can finance heat resilience, from urban tree-planting programmes to water works funds, which can be creatively tapped to finance India's heat resilience. Heat finance is as much about creativity as it is about brute-force provisioning. Philanthropies and CSR funding are useful in the breach but are unlikely to sustain systemic change.

India has opened an important door by allowing states to draw on the National and State Disaster Mitigation Funds for heat mitigation projects. This window must be widened through a multi-state national long-term heat resilience programme by the central government to create cutting-edge demonstration projects that can be replicated.

Second, cooling. As the gap between peak day and nighttime temperatures and human tolerance widens, low-income households and outdoor workers will turn to cheap, inefficient air conditioners, locking in higher emissions and energy bills. A targeted public programme can avert this trajectory. Governments should subsidise or bulk-procure efficient ACs for the hottest, highest-risk zones identified by vulnerability assessments, while continuing to invest in passive cooling—shade, reflective roofs, ventilation retrofits—that reduce the need for active cooling. Decentralised renewable energy must be invested in to power these ACs for the at-risk where possible. Pragmatic, early action can reduce the risk of major maladaptation in the future.

> *"India's response to heat must evolve from saving lives today to securing livelihoods tomorrow – through finance, science, and sustained, equitable cooling."*

Third, science. Policy today is flying half-blind. Only two of 42 city-level officials we asked had access to climate projections, and just three cities had installed local weather stations. A national programme to stimulate decentralised scientific capacity for climate change is essential. Maharashtra's efforts to create a framework for heat action, which relied on scientific data on vulnerability, heat islands, and solutions, and partnerships with expert organisations, are a model other cities should adopt. This knowledge infrastructure should be funded by public budgets and supplemented by philanthropy and CSR, with civil society partners helping translate data into action and hold the system to account.

The pivot we need is clear: from reactive relief to durable, equity-centred cooling—financed publicly, delivered by trained institutions, and guided by local science. The sooner we start, the better our chances of staying ahead of a predictably hotter future. ■

Smart Cooling for Hot Summers: Everyday Climate-Smart Living

*By **Dr. Milind Mujumdar,** Retired Senior Scientist, CCCR–IITM, Pune, Maharashtra, India*

Until a few decades ago, rising per capita energy consumption was seen as a symbol of development, but it is now clear that fossil fuel–based energy and industrial processes drive greenhouse gas emissions, disturb Earth's radiation balance, and accelerate global warming. With rapid urbanisation and the expansion of "concrete jungles," the need for sustainable energy practices is more urgent than ever. Climate change is increasingly perceptible, especially through the steady rise in evening and night-time temperatures. A long-term IITM study (Krishnan et al., 2020) confirms this warming trend will persist for decades.

For urban residents, stored heat in roofs and walls prevents homes from cooling at night, reducing the effectiveness of fans or coolers and prompting households to rely on energy-intensive air conditioning (AC). However, every 1°C drop in indoor temperatures may raise outdoor temperatures by nearly 2°C, exacerbating the urban heat island effect. Overdependence on AC also weakens the body's natural adaptability, which Ayurveda explains through seasonal balancing of Vata, Pitta, and Kapha. Moreover, glass-heavy buildings exacerbate indoor heat and humidity, while high-speed ceiling fans circulate discomfort rather than ventilating. Running fans slowly aids ventilation, while higher speeds should be reserved for tasks like drying floors. Ultimately, sustainable, science-based practices are essential for long-term comfort and resilience.

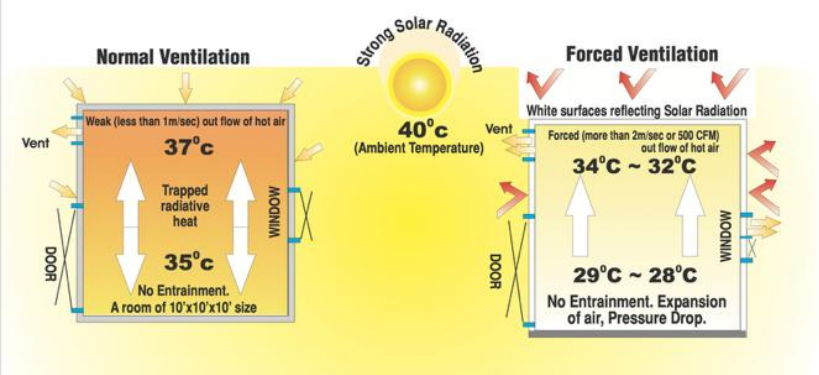


Figure 1: Eco-friendly, energy efficient indoor ventilation

The question, then, is whether we continue down the path of ecological degradation or choose to live in harmony with nature. The solution lies in applying science, especially meteorology, to everyday life.

A practical solution for indoor cooling lies in using two strategically placed exhaust fans along with an understanding of how air circulates inside a room.

Meteorology in day-to-day life, understanding daytime and night-time airflow and effective use of cross-ventilation.

Forced cross ventilation: Warm air, being lighter, naturally rises and accumulates near the ceiling. While ceiling fans running at high speed push this hot air downwards in a cone-shaped flow, circulating the heat instead of removing it. To overcome this, one exhaust fan should be placed in a window where the outdoor inflow is stronger, so that cooler external air is drawn inside. Meanwhile, a second fan, ideally positioned opposite and closer to the ceiling, should be used to expel the hot indoor air. Sealing the outlet fan's edges can further improve efficiency. Depending on the time of day, the system can be

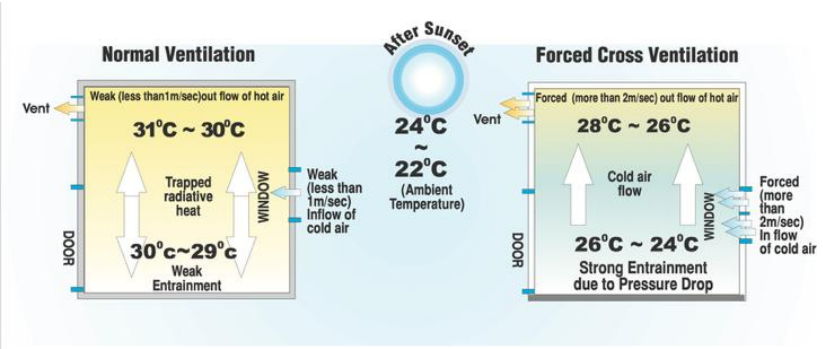


Figure 2: Does wet, cold air circulates faster than dry, hot air?

adjusted: for instance, during the cooler late evenings and nights, fresh air should be drawn in, while during the hot afternoons, the focus should be on expelling warm air. Under strong daytime solar radiation, normal ventilation yields weak air exchange (<1 m/s), which traps radiative heat and maintains indoor temperatures comparable to the ambient temperature. In contrast, forced (crossed) ventilation actively expels hot air (>2 m/s; Givoni, 1994), aided by reflective surfaces, thereby reducing indoor temperatures. After sunset, indoor spaces cool slowly under normal ventilation, remaining slightly warmer than ambient due to weak inflow and poor heat removal. Forced cross ventilation enhances entrainment through pressure-driven airflow, lowering indoor conditions to much closer to ambient. The effectiveness of this system can be enhanced by incorporating an electronic timer to automate hourly intake and exhaust cycles. Additionally, inlet air filters may be used if necessary.

Simple measures such as reflective rooftops, efficient appliances, smart AC use, and sensor-based lighting can reduce heat load and save energy. Passive cooling methods—such as misting, managing humidity, or even placing cold-water-soaked socks — offer low-cost relief. Innovative eco-friendly technologies worldwide show that comfort need not harm the planet. If households adopt such practices, the collective impact can ease climate stress. In a warming world, small, mindful actions help us live comfortably, sustainably, and in closer harmony with nature.

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ARCHITECTURAL RESILIENCE

Mitigating Extreme Heat in Maharashtra (2025): Evaluating Wada Architecture as a Sustainable Cooling Measure

*By **Aniket Sawargaonkar,** M.Sc. in Disaster Management, Jamsetji Tata School of Disaster Studies, Tata Institute of Social Sciences (TISS), Mumbai, India*

These high temperatures characterise Maharashtra, as it is one of the Indian states that has been exposed to excessive heat, most recently in cities such as Nagpur, Chandrapur, Jalgaon, and Pune (Government of Maharashtra, 2025). Even though air conditioners and desert coolers provide temporary relief, they are not affordable for the majority of the population due to energy costs and infrastructure limitations. It has brought back interest in indigenous, climate-sensitive and community-based architectural responses, one of the brightest of which is the ancient Wada.

Wadas were large houses and administrative buildings built during the Maratha and Peshwa periods (17th-19th centuries). They were built with locally available materials—stone, brick, and mud — and designed to withstand the hot, semi-arid climate prevalent in the area. Wadas had ventilated corridors, central courtyards, and thick thermal-mass walls, which provided natural air conditioning and thermal comfort when electricity and cooling were far away (Vakharia & Joshi, 2024).

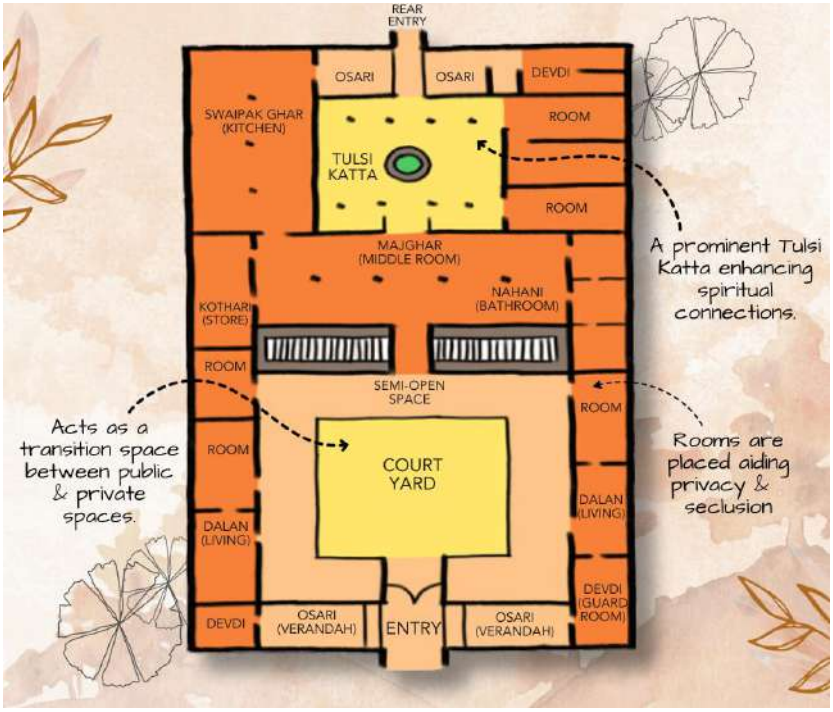
The centre courtyard of the Wada is the core that serves as the natural cooling and heating unit. It helps with vertical airflow: hot air rises and exits through the open courtyard, while cool air flows into the shady rooms. The masonry walls are also thick and maintain moderate temperatures by keeping out the violent afternoon sunlight and gradually dissipating stored heat in the evening. These conventional materials are effective in conferring insulation, unlike modern concrete structures that entrap and heat up (COEP Tech & SPA Bhopal, 2024).

The transitional zones are composed of verandahs and shaded corridors to avoid direct sunlight and keep the

interior cooler. Semi-open spaces allow residents to perform their household activities during the hottest hours of the day. Cross ventilation through strategically located small windows and latticed screens (jaalis) helps reduce heat gain while maintaining privacy with minimal material use. Mud or plaster floors are cool, and some Wada even have small fountains which help to cool by evaporation. Roofs are usually made of clay tiles, and timber beams are used, along with ventilation gaps, to allow heat to escape. Sun exposure is also reduced by the east-west orientation of buildings (Vakharia & Joshi, 2024).

These conventionally recognised design benefits have been supported by scientific review. In this study, Vakharia and Joshi (2024) found that the indoor temperatures of Wadas were maintained 4ºC to 6ºC below the outside temperatures, serving as thermal sinks. The temperature of the Wada walls was also found to be significantly lower than that of the adjacent concrete buildings. In their 2022 study, the authors of the present research reported that Wadas used 40 per cent less energy to cool their home than modern row houses and apartments.

Wadas are also creatures of climate resilience in addition to architecture. Areas such as verandahs enhanced not only thermal comfort but also social interaction between people. Several Wadas are still populated by local people, who also maintain them. Sensitively retrofitted, these buildings would be an essential component of modern climate adaptation planning, while also preserving cultural heritage. Instead of considering Wadas as relics of a bygone era, they should be viewed as culturally rooted, ecologically sustainable problems that are adaptable to present and foreseeable climate scenarios.



Traditional layout of a Wada courtyard house. Source: Kaarwan. "Wada Architecture of Maharashtra." Retrieved from kaarwan.com

Wada architecture shows how tradition meets innovation – keeping homes 4–6°C cooler and communities resilient. Reviving these designs can inspire Maharashtra's path toward sustainable, climate-smart living. These timeless structures prove that heritage can be a powerful solution to modern heat challenges.

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EVIDENCE-BASED COOLING

Keeping Maharashtra's Slums Cool: What the Evidence Says

*By **Akash Yadav**, AIDMI, India*

Maharashtra's urban heat strategy has primarily focused on tree cover, public awareness campaigns, and the use of indoor fans. However, in slum homes with tin roofs and limited airflow, these measures address only the real risk in part. During pre-monsoon weeks, indoor temperatures routinely exceed safe physiological limits, even at night. This isn't just discomfort; it's a public health emergency playing out in slow motion across millions of homes. Yet some of the most effective solutions require no power, no machinery, and minimal cost.

Drawing on 10 peer-reviewed studies and large-scale pilots, the table below highlights passive cooling approaches — such as reflective coatings, simple insulation, and improved ventilation — that deliver measurable relief. Crucially, they are light enough for fragile structures, cheap enough for informal budgets, and scalable enough for policy.

Below is the same evidence table shared earlier; it lists the source, the intervention tested, headline results, and why each matter in the Maharashtra context.

Table: Literature Review of Cool-Roofing Solutions in India

S. N.	Source (year, journal)	What was tested	Key data-driven results	Why it matters for Maharashtra
1.	Vellingiri et al. 2020, Indian J. Occup. & Environ. Med.	Solar-reflective paint, Thermocol false-ceiling and ModRoof panels on tin/asbestos roofs (16 Ahmedabad slum homes, 7-h data-logger runs)	• Paint only: peak indoor 1 °C cooler than bare tin. • Thermocol: 2.5 °C cooler. • ModRoof: up to 4.5 °C cooler vs tin at 13:00.	Tin and asbestos are still the main roofing sheets in Mumbai & Pune slums; even the "cheapest first step" (paint) buys 1 °C, while panel replacement buys ≥4 °C.
2.	Mahila Housing Trust 2024. Hot Take: Cool Roofs + Times of India (Chintan 2025 Delhi trial)	Five-layer "eco-roof" stack (tarpaulin + tin + 10 mm waste-cardboard/ bamboo-jute) in five waste-picker colonies (n = 60 sensor runs)	Indoor maximum 6 °C below ambient and 13 °C below unmodified tin during the May heatwave; materials cost: ₹55/ft².	All layers are available in Dharavi scrap markets, with the cost falling within state slum-upgrade ceilings.
3.	IIT-Bombay 2025 "Keep It Cool" tech page	High-IR acrylic coating on metal/concrete roofs (lab & 2-house pilots, roof set-points 65 – 80 °C)	Roof-to-room gradient ≈ 20 °C; steady-state room ≤ 47 °C when roof hits 80 °C.	The product originated in Mumbai; the MMRDA has earmarked it for transit camp retrofits.
4.	IIT-Bombay Tech-note 2024 – Near-IR dark-colour cool coating	Pigmented water-based film (100 µm DFT) on RCC/tile roofs	Roof surface drops 15 – 20 °C and indoor drops to 37–39 °C; typical AC power bills cut 25 – 30 %.	Works on black-tar felt common on chawl terraces – proves "cool" needn't be white
5.	Sarkar & Jana 2023, Cities 143	Survey + Energy Plus scenarios for Mumbai slum & SRA blocks (ACH 0.4 →	The model shows that overheating hours (>32 °C operative) fall by 22% when cross-ventilation and light-	Simple design tweaks can be baked into SRA redevelopment guidelines before occupation.

S. N.	Source (year, journal)	What was tested	Key data-driven results	Why it matters for Maharashtra
		3.9 with added vents; high-albedo finishes)	coloured roofs are combined, outranking small room AC units on both cost and equity.	
6.	Sutar et al. 2017, Build. & Environ. 44(9)	Double-skin roof with 50 mm air-gap + pergola shading (Nagpur test cell)	Peak indoor 3.6 °C lower; cooling-degree-hours cut 28%	Ready-made details useful for AMRUT-funded slum redevelopment sites in Nagpur.
7.	Hindustan Times 20 Nov 2020 (WRI re-analysis of Landsat-8 + in-situ loggers)	City-wide thermal map of Mumbai (pre-monsoon afternoon)	The largest slum patch averaged 6°C hotter than the adjacent formal housing.	Provides a quantified baseline risk against which any cool-roof rollout can be measured.
8.	Nutkiewicz et al. 2022, Renew. Sustain. Energy Rev. 159	Meta-analysis & modelling of 27 cool-roof assemblies for informal settlements (23 m² prototype dwelling)	Heat-stress exposure time decreases by up to 91%; mean electricity savings are approximately 0.7 kWh/day⁻.	Confirms that cool roofs are the single biggest low-tech heat-risk reducer for dense tropical settlements.
9.	Wang et al. 2024 (in Clim. Policy) & city-scale energy-climate model for Ahmedabad	Scenario: coat 20 % of the city's roof area by 2030	Cooling-energy demand falls 0.21 TWh yr⁻¹; mesoscale CFD indicates ~0.6 °C daytime ambient drop; prior epidemiology links 0.6 °C to ≈ 800 avoided heat deaths per decade	Suggests Mumbai could reap similar city-wide gains if it hits the state target of 20 % cool-roof coverage
10.	Meade et al. 2024, Lancet Planetary Health 8:e256-269 (critical review of electric fans)	Biophysical modelling of fan use under 30 – 50 °C, 10 – 90 % RH	Fans are beneficial ≤ 35 °C (any RH); become net heat-gainers ≥ 39°C in very hot-dry air.	Explains why passive cooling (e.g. reflective roofs, ventilation) must keep rooms below ~ 37 °C before fans are safe and effective.

Take-home Lessons for Practitioners

1. **Paint first, then insulate.** Field trials across four Indian cities show that a single lime-based or acrylic reflective coat typically cools rooms by 1 – 4 °C (with rare peaks up to 5 °C). Adding a thin Thermocol or bamboo-jute layer roughly doubles the relief, delivering 6–13 °C lower highs compared with bare tin, depending on whether you benchmark against outdoor air or an unmodified roof.
2. **Design for air.** Energy Plus simulations and spot monitoring in Mumbai's Dharavi show that introducing true cross-ventilation or leaving a modest 15 cm pergola gap above the roof can reduce overheating hours by approximately one-quarter to two-fifths (≈ 22 – 39 %), with zero electricity input.
3. **Fans need context.** After a basic cool-roof retrofit, peak indoor temperatures in Ahmedabad tin-roof homes stay below 35 °C. Electric fans remain helpful up to that threshold but can increase heat strain once the air exceeds ≈ approximately 39 °C in hot, dry conditions. In the cooled rooms, the fan is therefore both safe and effective.
4. **Scale multiplies gains.** City-scale modelling for Ahmedabad shows that coating just 20 % of roof slices 0.21 TWh yr⁻¹ off projected 2030 cooling demand and nudges daytime neighbourhood air temperatures down by ~0.6 °C, enough to push several "danger" heat-index days back below public-health thresholds. ■

COASTAL COOLING

Ocean-Informed Cooling: MSP and UDA Interventions for Addressing Extreme Heatwaves

*By **J Cathrine,** Maritime Research Center, Pune, India*

In 2025, India is experiencing unprecedented heat, highlighting the intensifying impacts of climate change. The India Meteorological Department (IMD) issued its first heatwave alert on April 7, forecasting above-normal temperatures from April through June. February was the hottest in 125 years, with an average mean temperature of 22.04°C and rainfall less than half the usual levels. Between February 11 and 23, thirty-one states and union territories recorded night-time temperatures above normal, with many regions exceeding typical values by 3 °C to 5 °C. These patterns align with projections from the Intergovernmental Panel on Climate Change (IPCC), which anticipates more frequent and severe heatwaves in India.

Extreme heat poses significant threats to health, livelihoods, and ecosystems. High temperatures contribute to heatstroke, dehydration, cardiovascular and kidney disorders, and mental health strain, particularly among outdoor workers, the elderly, and women in agrarian communities. Heatwaves exacerbate water scarcity, reduce soil moisture, and impact agricultural productivity, livestock, and fisheries. Food security, biodiversity, and public health are directly affected. While Heat Action Plans (HAPs) address emergency responses, they remain insufficient for mitigating systemic vulnerabilities or long-term climate risks.

Addressing these challenges requires strategies that harness the ocean's cooling potential. Marine Spatial Planning (MSP) and Underwater Domain Awareness (UDA) provide integrated frameworks capable of long-term heat adaptation. MSP offers governance to balance ecological integrity with development. It enables the restoration of mangroves, seagrasses, and coral reefs, enhancing natural cooling, buffering urban heat, and increasing carbon sequestration. MSP also facilitates sustainable marine renewable energy, such as offshore wind and ocean thermal energy conversion, which can support cooling technologies while reducing greenhouse gas emissions. By guiding coastal urban design and regulating waterfront development, MSP preserves ventilation corridors that mitigate heat stress in densely populated areas.

UDA complements MSP by providing technological and monitoring capabilities to implement interventions effectively. Acoustic and oceanographic mapping allows real-time assessment of thermal stress, salinity, and ecosystem health in coastal waters. This information enables early prediction of marine heatwaves and their impacts on fisheries, agriculture, and urban heat. UDA also informs underwater noise regulation to protect

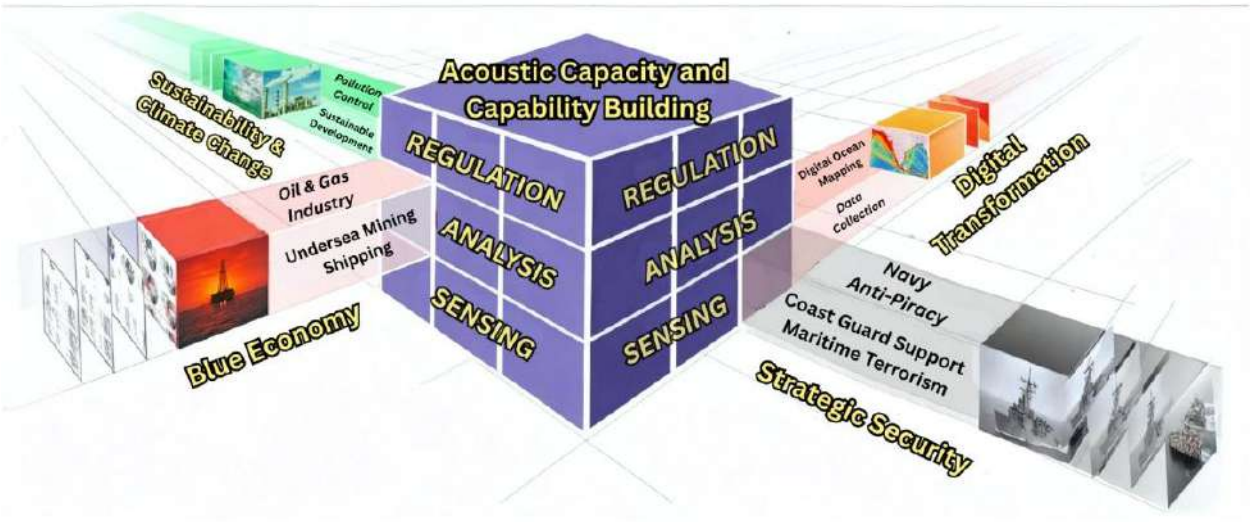

Figure 1: Comprehensive Perspective of the UDA Framework.

ecosystems and maintain natural cooling functions. Digital twins of coastal environments enable the simulation of interactions between marine and terrestrial heat events, optimising infrastructure placement, such as seawater air-conditioning systems, with minimal ecological disruption.

The integration of MSP and UDA creates a robust system in which governance and environmental intelligence reinforce each other. Conventional HAPs address immediate heat impacts but fail to mitigate underlying drivers. Ocean-informed cooling strengthens resilience by integrating land- and marine-based strategies, safeguarding vulnerable communities, and promoting sustainable economic activity. It also aligns with India's Sustainable Development Goals, particularly climate action, sustainable cities, and life below water, while incorporating Environmental, Social, and Governance (ESG) principles for climate-smart investment.

Ocean-informed cooling through MSP and UDA represents a paradigm shift in climate adaptation. By leveraging the ocean as an active regulator of heat, we can implement a scientifically grounded, socially equitable approach to extreme heat. This integrated model positions the state as a leader in climate-smart governance within the Indian Ocean Region, offering lessons for other coastal areas confronting rising temperatures, ecosystem stress, and socio-economic vulnerability.

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EXTREME HEAT SOLUTIONS

Extreme Heat-related Cooling Measures in Maharashtra, India: Building Resilience in 2025

*By **Vishal Pathak**, AIDMI, India*

Maharashtra, one of India's key cotton-producing states, continues to grapple with the intensifying impacts of extreme heat. In 2025, smallholder cotton farmers—especially women—face increasing vulnerability due to rising temperatures, longer dry spells, and more frequent heatwaves. These conditions have contributed to significant crop losses, exacerbating the socioeconomic fragility of rural households that depend on agriculture.

A recent study[1] IIED and AIDMI reveal that nearly 84% of cotton farmers in Maharashtra perceive a sharp increase in average temperatures over the last five years. Heatwaves are now an almost annual occurrence, with over half of the surveyed farmers reporting complete or major crop losses due to droughts and floods, which are further exacerbated by erratic rainfall. This heat-induced stress not only affects crops but also reduces milk yield, impacts children's nutrition, and increases health-related expenditures.

Despite the growing threat, adaptive cooling measures remain limited. Few farms have access to irrigation—only about 50%—making them particularly vulnerable to heat and water scarcity. As a coping strategy, farmers often resort to savings, borrowing, or reducing household expenditures, such as withdrawing children from private education or avoiding healthcare costs. However, these measures are reactive and not sustainable in the long term.

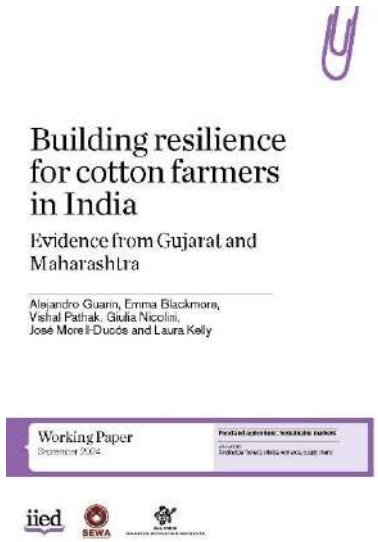
Adaptation efforts such as crop rotation, intercropping, and tree planting are practised by many farmers. These methods not only improve soil health but also act as natural buffers against extreme weather. Yet, economic cooling mechanisms like crop insurance

[1] Guarin, A., Blackmore, E., Pathak, V., Nicolini, G., Morell-Decos, J. and Kelly, L. (2024). Building resilience for cotton farmers in India: Evidence from Gujarat and Mahrashtra. IIED and AIDMI. https://www.iied.org/22481iied.

remain underutilised. While uptake in Maharashtra is relatively higher than in other states—driven by the national PMFBY scheme—farmers still face challenges related to affordability, limited awareness, and bureaucratic hurdles in the claims processing process.

In response to these growing challenges, the Government of Maharashtra has stepped up its heat-related planning and interventions. Through the State Climate Change Action Plan (SAPCC), the state has prioritised extreme heat management, with special provisions for climate-resilient agriculture. District Disaster Management Authorities (DDMAs) in hotspot districts have begun incorporating heatwave risk into their seasonal planning, with support from the state's Department of Agriculture. In addition, the Maharashtra State Disaster Management Authority (MSDMA) is coordinating the rollout of localised Heat Action Plans, modelled on national guidelines, to ensure better early warning, public awareness, and coordination with local health and irrigation departments.

The government has also partnered with civil society and farmer-producer organisations to scale up access to heat-resilient seed varieties and micro-irrigation systems through the PMKSY (Pradhan Mantri Krishi Sinchayee Yojana), as well as to improve farmer advisories via Krishi Vigyan Kendras (KVKs). These advisories include agro-meteorological bulletins and climate-resilient farming tips disseminated through SMS in local languages. Moreover, Mahatma Phule Renewable Energy and Infrastructure Technology (MAHAPREIT) is exploring cooling-as-a-service pilots in rural storage and post-harvest facilities, in collaboration with NABARD and private cooling entrepreneurs.



Read more: https://aidmi.org/building-resilience-for-cotton-farmers-in-india-evidence-from-gujarat-and-maharashtra/

Community-driven solutions such as the Livelihood Resilience and Recovery Fund offer an alternative model. This fund enables quick, interest-free loans based on peer assessment and has been praised for its responsiveness and accessibility, critical features absent in formal insurance schemes.

Looking ahead, Maharashtra's approach to cooling must continue integrating infrastructural upgrades (such as affordable irrigation), inclusive insurance products, and localised climate services. Government action must be complemented by stronger awareness campaigns, gender-sensitive interventions, and support for trusted community institutions. State-level convergence across departments—including Agriculture, Energy, Health, and Rural Development—is vital to align heat adaptation efforts under one coordinated resilience framework.

Extreme heat is no longer a seasonal anomaly—it is a structural challenge. Addressing it requires systemic solutions that prioritise environmental, economic, and social resilience at the grassroots. With the combined momentum of state-led policies, civil society innovation, and community action, Maharashtra can chart a path towards a heat-resilient rural future. ■

AIDMI's contribution to the IUCN World Conservation Congress, held in Abu Dhabi from October 9–15, 2025 — sharing India's perspectives on urban resilience, risk governance, and inclusive development. Photo: AIDMI.

Maharashtra's Leadership in Disaster Management: Building Systems, Science, and Resilience

By AIDMI, India

In 2025, the Maharashtra State Disaster Management Authority (MSDMA) stands out as a national leader in disaster risk governance. From modernising operations and scaling mitigation projects to strengthening community preparedness, MSDMA is shaping a holistic, evidence-based approach to resilience—building systems that combine innovation, coordination, and climate-smart development.

Cooling Achievements of Maharashtra in 2025

1. **Modernised State Emergency Operations Centre (SEOC):** Inaugurated in April 2025 at Mantralaya, Mumbai—enhancing real-time coordination, inter-departmental communication, and data-driven disaster response across the state.
2. **Establishment of the State Institute of Disaster Management (SIDM), Nagpur:** Cabinet approval of ₹ 184 crore for a new training and research institute—marking a milestone in building state-level capacity and advancing applied disaster-risk research.
3. **Implementation of Large-Scale Mitigation Works:** Over 1,600 mitigation projects worth more than ₹ 5,000 crore launched across coastal and inland Maharashtra—addressing floods, landslides, and heat impacts through structural and non-structural measures.
4. **Launch of the Statewide Landslide Management Plan:** Maharashtra's first comprehensive plan prioritising high-risk zones and detailing engineering, ecological, and community-based strategies for slope stability and safety. Though not a cooling measure per se, it made people safe.
5. **Comprehensive Pre-Monsoon Preparedness Drive:** A state-wide readiness campaign requiring 24×7 officer availability, remapping 249 landslide sites, and conducting mock drill protocols across the Mumbai region and other vulnerable districts and small towns during summer 2025.

Actions for the Future of a Cooler Maharashtra

1. **Institutionalise Cooling within Development and Disaster Planning:** Embed cooling targets and indicators into District Disaster Management Plans (DDMPs), Smart City Missions, housing schemes, and health programmes—making heat resilience a core policy goal across departments.
2. **Invest in Community-Centred Cooling Infrastructure:** Expand **low-cost cool roofs, shade corridors, and green shelters** in cities and small towns. Prioritise public spaces—schools, markets, and transport hubs—as local cooling anchors accessible to all.
3. **Strengthen Climate Data, Early Warning, and Decision Systems:** Integrate heat forecasts, real-time temperature data, and health alerts into the State Emergency Operations Centre (SEOC) to guide anticipatory action and protect outdoor workers and vulnerable groups.
4. **Mobilise Cooling Finance and Private Sector Engagement:** Create a **"Cool Maharashtra Fund"** leveraging CSR, climate finance, and local governance budgets to scale heat adaptation innovations, particularly for small businesses, informal workers, and rural women entrepreneurs.
5. **Advance Education, Research, and Citizen Awareness on Heat Resilience:** Empower institutions such as **SIDM Nagpur, YASHADA Pune, and TISS Mumbai** to lead interdisciplinary research, youth training, and community awareness on cooling futures and urban resilience.

Lessons from Maharashtra for Other States of India

1. **Treat Cooling as a Core Development Priority, Not a Luxury:** Maharashtra reframed cooling from a comfort issue to a public health and development necessity. By embedding cooling into its State Disaster Management Plan and Climate Action Framework, the state demonstrated that "cooling saves lives, livelihoods, and productivity."
2. **Build Institutional Muscle for Climate Governance:** Establishing a modernised State Emergency Operations Centre (SEOC) and approving the State Institute of Disaster Management (SIDM) in Nagpur have created a backbone for evidence-based decision-making and training — a model other states can emulate to professionalise disaster governance for greater impact.

3. **Scale Local Innovations Through Partnerships:** From cool-roof pilots in Nagpur and Beed to community shade corridors in Jalgaon, Maharashtra, showed how local innovations—backed by NGOs, academia (TISS, YASHADA), and agencies like UNDP and UNICEF—can be scaled through coordinated government action.
4. **Integrate Finance and Community Action:** The state pioneered anticipatory and micro-finance tools such as the Livelihood Resilience and Recovery Fund, enabling rapid, peer-assessed loans to small farmers and workers. This approach shifts disaster finance from compensation to resilience-building before crises strike.
5. **Champion Cross-Sector Collaboration for Cooling Futures:** Maharashtra's "Cooling for All" approach united departments of health, energy, housing, and urban development, alongside civil society and the private sector. This whole-of-government and whole-of-society model can guide other states to align disaster risk reduction, climate adaptation, and social equity goals, making each Indian cool.

Disaster Risk Research and Publications on Maharashtra

Recent research offers valuable insights for policy, planning, and local action under Maharashtra's disaster risk reduction and heat resilience agenda.

1. **Assessment of Heat Wave Risk in Maharashtra State: A Sub-District Level Analysis** *(Shinde et al., 2025, SSRN)* — Maps 32 years of temperature and socioeconomic data across 358 talukas, providing the most updated evidence for heat-resilience strategies under the **State Disaster Management Plan (SDMP) 2023**.
2. **Enhancing Disaster Resilience: A Comprehensive Analysis of the SDMP 2023** *(Chothe & Garudkar, 2024, IJAR)* — Reviews Maharashtra's disaster management framework against the **Sendai Framework and NDMP 2019**, highlighting institutional gaps and the need to integrate climate-specific hazards like extreme heat.
3. **Heat Stress: Vulnerability, Health Impacts, and Coping Strategies in Rural Maharashtra** *(Pradyumna et al., 2018, ASSAR–CARIAA)* — A field-based study revealing how heat stress affects health, livelihoods, and gendered vulnerability, forming the evidence base for **locally led cooling and adaptation efforts**.
4. **Estimating Indoor Heat Stress of Low-Socioeconomic Households** *(Tasgaonkar et al., 2025, Heliyon Climate)* — Demonstrates the importance of **cool-roof and ventilation solutions** through measurements of indoor temperature and humidity in low-income settlements.
5. **Framework for Assessing Climate Risk in Maharashtra** *(Water Policy Journal, 2024)* — Proposes a **multi-dimensional risk assessment model** linking environmental, social, and economic indicators, offering scalable applications for **district-level early warning and resilience planning**. ■

INVESTING IN NATURE

Investing in Biodiversity and Nature in India: Building Climate Resilience and Securing Development

By AIDMI, India

India's vast biodiversity—home to over 90,000 animal and 45,000 plant species—is central to its resilience and prosperity. Yet this natural wealth is under threat from land degradation, extreme weather, and intensifying heatwaves. Investing in nature is therefore not only an environmental imperative but also an economic and social necessity.

Forests, wetlands, mangroves, and grasslands act as **critical natural infrastructure**, regulating local temperatures, storing carbon, and protecting communities from floods and droughts. These ecosystems sustain millions of livelihoods, especially for women, Indigenous peoples, and rural communities. Strengthening this human–nature connection through **community-led conservation** ensures both ecological protection and equitable growth.

Nature-based Solutions (NbS)—like mangrove restoration, watershed management, and urban green corridors—offer cost-effective, long-term resilience. Maharashtra's watershed restoration and Odisha's mangrove regeneration show how local action can deliver climate and development benefits simultaneously.

To accelerate progress, India must prioritise NbS in climate finance, align policies with biodiversity missions, and expand blended finance models that engage public, private, and community sectors. Empowering institutions such as Panchayats, women's collectives, and youth networks will help make conservation inclusive. ■

Partners in Cooling Maharashtra: Institutions, Governance, and Communities Against Extreme Heat

By AIDMI, India

As Maharashtra confronts intensifying and recurring extreme heat events, a unique coalition of institutions, governance leaders, and civil society is shaping the state's response. The **Tata Institute of Social Sciences (TISS)**, **Yashwantrao Chavan Academy of Development Administration (YASHADA)**, and a broad network of **civil society organisations (CSOs) and NGOs** are together redefining what climate resilience means for one of India's most heat-exposed states. Their work demonstrates how science, policy, and community leadership can converge to make Maharashtra *cool, inclusive, and climate-smart*.

Knowledge Action: The Role of TISS

The Tata Institute of Social Sciences (TISS) has emerged as a knowledge and action partner at the heart of Maharashtra's heat resilience efforts. Through its **Jamsetji Tata School of Disaster Studies (JTSDS)**, TISS has studied how heat stress affects livelihoods, health, and work across cities such as Mumbai, Nagpur, and Beed. This research has generated crucial evidence for inclusive **Heat Action Plans (HAPs)** that reflect the needs of informal workers, women, and children.

TISS also plays a leading role in **capacity building**, training state and municipal officers, NGOs, and community organisations on *urban heat risk and social resilience*. These modules integrate early warning systems, occupational safety, and cool infrastructure into disaster management plans—supporting the Maharashtra State Disaster Management Authority's (MSDMA) goal to make "every district heat ready."

In collaboration with **AIDMI**, TISS has helped identify and promote **community-level cooling solutions** such as cool roofs, green corridors, and shaded public spaces. Its approach combines traditional building knowledge with modern design, demonstrating how academic research can be transformed into tangible community benefits. Beyond implementation, TISS experts contribute to **policy dialogues** with MSDMA, NDMA, and the Ministry of Earth Sciences, ensuring that heat resilience is embedded in urban planning, CSR investment, and local governance frameworks.

Perhaps most inspiring is TISS's effort to mobilise **youth and academia**. By turning its campuses into "living laboratories" for climate action, it is cultivating a new generation of citizens who view cooling not merely as comfort—but as a right and a shared responsibility.

> *"Cooling is the new measure of development. Maharashtra's institutions are proving that local leadership can make climate resilience real."*

Governance Leadership: The Role of YASHADA

The **Yashwantrao Chavan Academy of Development Administration (YASHADA)**, Pune, provides the governance backbone for Maharashtra's climate adaptation mission. Through its **Centre for Disaster Management (CDM)**, YASHADA trains administrative officers, municipal staff, and disaster managers to integrate heatwave preparedness into daily governance. Its programmes for IAS and State Civil Service officers emphasise aligning **District Disaster Management Plans (DDMPs)** with NDMA's *Guidelines on Heat Wave Management* and Maharashtra's evolving *Cooling Roadmap*.

YASHADA serves as a **convergence platform**, linking departments such as health, urban development, agriculture, energy, and labour. This cross-sector coordination ensures that the social and economic dimensions of heat are fully understood and addressed. As the state's apex training institute, YASHADA is also developing **knowledge resources** on urban heat, rural livelihoods, and green cooling to support the **Maharashtra Climate Action Plan**.

Field documentation—ranging from cool roofs in Beed to green cover restoration in Nashik and

market shade structures in Nagpur—helps connect local innovations to state policy. By partnering with **AIDMI, UNDP, and the World Bank**, YASHADA has initiated projects that explore financing mechanisms for local cooling interventions, the inclusion of heat awareness in Panchayati Raj and ULB trainings, and the use of sustainable materials in housing.

True to its motto of *"Building Competent and Compassionate Governance,"* YASHADA promotes **leadership for climate resilience**. It encourages officials to innovate and replicate community-based cooling practices, nurturing a governance culture that acts early, plans locally, and cools inclusively.

Community Power: The Role of Civil Society and NGOs

While research and governance set the framework, it is **civil society** that brings heat resilience to life in Maharashtra's villages, towns, and markets. NGOs such as **AIDMI**, **SEWA**, **Prayas**, and **WOTR** have been instrumental in ensuring that the lived experience of vulnerable workers—vendors, farmers, construction labourers—is reflected in policy.

Through grassroots documentation, these organisations have provided evidence that informs **Heat Action Plans** and contributes to the **Maharashtra State Cooling Roadmap**. Their advocacy ensures that heat resilience remains centred on the poor and informal workforce, especially women.

Civil society has also led **on-ground innovations**: installing cool roofs and shade shelters, promoting tree-based micro-parks, and reviving traditional materials like clay tiles and white lime coatings. These low-cost methods have shown measurable success, reducing indoor temperatures by 2–4°C in pilot areas.

> *"Resilience begins with capable governance, informed science, and empowered citizens."*

At the same time, NGOs have driven **awareness campaigns** across schools, health centres, and municipal wards under the banner of *"Heat Ready Communities."* Localised training materials in Marathi and participatory communication ensure that life-saving information reaches everyone.

Crucially, NGOs have connected **corporate social responsibility (CSR)** with local adaptation. Projects such as **Afat Vimo** (micro-insurance for extreme heat) and **market shade initiatives** channel CSR and municipal funds toward cooling solutions. These partnerships are helping integrate heat management into district plans and municipal budgets.

By collaborating with institutions like TISS and YASHADA, NGOs are also creating **knowledge partnerships** that bridge community experience and academic rigour—forming a statewide learning ecosystem for resilience.

Cooling Maharashtra Together: The Way Ahead

The synergy among **TISS, YASHADA, and civil society organisations** offers Maharashtra a model of institutional cooperation against climate extremes. Together, they represent three essential pillars of resilience:

- **Knowledge Action** – producing science-based understanding through research and education.
- **Governance Leadership** – transforming policy and planning into responsive administration.
- **Community Power** – translating ideas into local impact and inclusion.

As the state faces longer and more frequent heatwaves, this partnership demonstrates that cooling Maharashtra is not merely a technical challenge—it is a social and governance mission. By connecting classrooms, government offices, and community spaces, Maharashtra is showing India how to build resilience from the ground up.

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WAY AHEAD

Cooling the Future: Maharashtra's Roadmap for Inclusive Climate Resilience

*By **Sujata Saunik** and **Mihir R. Bhatt**, India*

The road ahead for Maharashtra requires bridging innovation, investment, and inclusion without doubt. The following are five areas for its road map:

1. **Institutionalise Cooling in Development Planning of Maharashtra:** Cooling must be mainstreamed within state and district disaster management plans, urban missions, and agricultural policies. The Maharashtra State Disaster Management Authority (MSDMA) can spearhead a coordinated "Heat and Cooling Resilience Mission" that brings together the departments of health, agriculture, and energy under a single convergence framework by 2030.
2. **Fund Resilience, Not Disasters:** As AIDMI's work with IIED demonstrates, locally managed recovery funds and micro-insurance are faster, more trusted, and more inclusive of gender. Embedding such financial mechanisms into climate budgets and CSR investments will ensure that resilience funding reaches the most exposed communities before crises unfold. Leadership corporate initiatives in Maharashtra can develop such a mechanism of Rs. 100 crores for the state.
3. **Scale Community Cooling Solutions:** Pilots in Nagpur, Beed, and Jalgaon have demonstrated measurable reductions in temperature through the use of low-cost cool roofs, shade structures, and passive ventilation. These should now move from demonstration to district-wide programmes supported by urban local bodies and the private sector to at least 50 cities and towns by 2030.
4. **Build a Cooling Economy:** Extreme heat adaptation can generate green jobs—from the local manufacturing of reflective paints and bamboo-jute panels to retrofitting schools and Anganwadis with climate-smart cooling solutions. Linking such initiatives to state skill missions can make resilience economically rewarding. Develop a concept proper for the cooling economy with multi-stakeholder consultation and the Maharashtra Planning Board by March 2026.
5. **Strengthen Research and Policy Linkages:** Continuous collaboration among AIDMI, IIED, IITM, TISS, and state agencies can refine evidence, monitor impacts, and develop replicable models for all districts of Maharashtra under a 5-year programme.

> *"The way ahead is to finance resilience, not disasters—by empowering small businesses, farmers, and cities of Maharashtra to design their own cooling futures, supported by science and solidarity."*

In essence, Maharashtra's "cooling transition" is both an adaptation and a development opportunity. Grounded in community finance, guided by data, and driven by inclusive governance, the state can chart a new national pathway—where protecting citizens from extreme heat becomes central to sustainable growth and social justice. ■

Climate and Health Reception: Solutions for a Sharper Future

All India Disaster Mitigation Institute (AIDMI) was honoured to join the Climate and Health Reception hosted by The Rockefeller Foundation on September 24, 2025, during Climate Week NYC. The gathering highlighted how the global health and climate communities are coming together amid rising challenges, including the worsening impacts of extreme heat. We were inspired by community-led solutions from Rio de Janeiro and the Southern United States, demonstrating how locally tested and adapted approaches can be scaled to protect lives, strengthen resilience, and deliver health benefits in climate-vulnerable settings.

At AIDMI, we learn that these lessons are vital for advancing locally led adaptation and building the resilience of vulnerable communities across South Asia and beyond. We thank The Rockefeller Foundation for convening this important dialogue and look forward to collaborating with global partners to bridge health and climate action to every Indian. *(Source: AIDMI)* ■

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ISSN: 3048-7978 (Print), Volume 20, Issue 7, Pages 24, November 2025 (Total Issue No. 226)