AI for a Climate-Resilient India

Dr Sanjay Kumar Srivastava

Abstract
India's climate risk landscape is rapidly evolving as anthropogenic warming intensifies extreme weather events across the subcontinent. Recent scientific assessments indicate that India has already warmed by nearly 0.9 °C relative to early twentieth-century levels, with further warming projected in the coming decades. This warming is accompanied by increasing heat extremes, intensified rainfall variability, accelerated ocean warming and cryospheric changes in the Himalayan region. These changes are transforming disasters from episodic hazards into systemic risks that interact with infrastructure networks, urbanization patterns and socio-economic vulnerabilities. Artificial Intelligence (AI) is emerging as a powerful enabler of anticipatory disaster risk reduction (DRR), capable of integrating Earth observation, predictive modelling and decision support systems. This research communication examines how AI technologies-particularly image analysis, large language models and agent-based optimisation models-can strengthen prevention and preparedness across India's evolving hazard landscape. Drawing on recent advances in remote sensing and climate services, the paper proposes an AI-enabled risk intelligence architecture linking observation, cognition and decision layers. Case studies from India's heatwave early-warning systems and Himalayan glacial hazard monitoring illustrate how AI can support anticipatory governance. The analysis suggests that AI's greatest contribution lies not in accelerating disaster response but in enabling earlier interventions that prevent losses before hazards translate into disasters.

Introduction

Climate change is reshaping the nature of disasters worldwide. Rising global temperatures are intensifying extreme weather events and increasing the probability of compound hazards that interact across environmental and socio-economic systems (IPCC, 2022). These changes are particularly pronounced in South Asia, where large populations and climate-sensitive livelihoods amplify vulnerability.

India represents one of the most complex

climate risk landscapes globally. The country spans diverse climatic zones including Himalayan cryospheres, monsoon-dependent river basins, semi-arid regions and densely populated coastal belts. Rapid urbanization and economic growth are increasing exposure to climate hazards by concentrating populations and infrastructure in risk-prone areas.
Recent scientific analysis presented in Dhara et al. (2025) provides an updated synthesis of observed and projected climate change in India. The study finds that India's mean temperature has already increased by approximately 0.89 °C compared with early twentieth-century conditions, with projections suggesting additional warming of 1.2–1.3 °C by mid-century under moderate emission scenarios.

These climatic changes are already affecting India's disaster risk profile. Heatwaves are becoming more frequent and severe, extreme rainfall events are intensifying and the Indian Ocean is warming rapidly. Glacier retreat in the Himalaya is increasing the risk of glacial lake outburst floods (GLOFs) and downstream water insecurity.

Such trends require a shift from reactive disaster management to anticipatory risk governance, where governments act before hazards translate into disasters. Artificial Intelligence (AI) provides powerful tools to support this transformation.
India's Emerging Climate Risk Landscape
Heat Extremes

India has experienced a significant increase in heatwave frequency in recent decades. Observations indicate that several regions are experiencing 5–10 additional heatwave days per decade (IMD, 2023). Heatwaves pose severe risks to public health, labour productivity and energy systems.

Rainfall Variability
While average monsoon rainfall may not decline significantly, climate change is increasing the intensity of extreme rainfall events across central India (Roxy et al., 2020). Such events contribute to flash floods, landslides and urban flooding.

Ocean Warming and Cyclones
The tropical Indian Ocean has warmed by approximately 0.12 °C per decade since 1950 (Dhara et al., 2025). Ocean warming is linked to increasing cyclone intensity in the Arabian Sea and Bay of Bengal.

Himalayan Cryosphere Changes
Glacier mass losses across the Himalaya have accelerated in recent decades, increasing risks of GLOFs and landslides (ICIMOD, 2023).

Together, these changes illustrate that India's future disasters will increasingly involve compound and cascading risks

Artificial Intelligence and the Risk Intelligence Stack
AI enables integration of diverse environmental datasets into decision-support systems capable of supporting anticipatory action.

"Climate change is reshaping the nature of disasters worldwide by intensifying extreme weather events and increasing compound hazards."

Image Intelligence
AI-based analysis of satellite imagery enables detection of early signals of environmental change. India's Earth observation capabilities through ISRO satellites and the Bhuvan platform provide valuable datasets for flood monitoring, coastal mapping and glacier observation (ISRO, 2022).

Machine learning algorithms can detect flood inundation patterns, identify urban heat hotspots and monitor glacier retreat.

Language Intelligence
Large Language Models can synthesize large volumes of scientific and operational information. In disaster contexts, such systems can integrate weather forecasts, disaster guidelines and socio-economic data to generate actionable advisories. For example, heatwave forecasts can automatically generate sector-specific advisories for hospitals, labour departments and urban administrations.

Decision Intelligence
Agent-based models simulate interactions between environmental hazards and human systems. These models can evaluate risk reduction strategies such as evacuation planning, infrastructure investment and land-use regulation.

Decision intelligence transforms climate data into actionable risk governance strategies.

Recent discussions at the India AI Impact Summit highlight the potential of artificial intelligence as a foundational component of national climate risk intelligence systems.

India AI Impact Summit: AI for Disaster and Climate Resilience

The India AI Impact Summit (2026)

emphasized the growing role of artificial intelligence in addressing climate and disaster risks. Participants highlighted that AI should evolve from a technological capability into a component of national resilience infrastructure, supporting early warning, risk analysis, and anticipatory decision-making.

Several key insights emerging from the summit are particularly relevant for disaster risk reduction in India.

AI as a Climate Risk Intelligence System
The summit underscored the need to integrate AI with India's Earth observation infrastructure, meteorological networks, and digital public platforms. Such integration would allow continuous monitoring of climate hazards such as heatwaves, floods, cyclones, and landslides.

"India represents one of the most complex climate risk landscapes globally, spanning Himalayan cryospheres, monsoon river basins, semi-arid regions, and densely populated coastal belts."

GeoAI for Impact-Based Forecasting
Advances in geospatial AI (GeoAI) enable hazard forecasts to be translated into impact assessments by combining satellite imagery, geospatial data, and socio-economic vulnerability indicators. This approach can support impact-based forecasting, which focuses not only on predicting hazards but also on identifying populations and infrastructure at risk.

AI for Anticipatory Action
AI models can help governments move beyond reactive disaster response toward anticipatory risk management. Early warning systems linked to decision algorithms can trigger preventive actions such as evacuation planning, pre-positioning of relief supplies, and activation of social protection mechanisms.

Responsible AI for Public Decision-Making
The summit also highlighted the importance of responsible AI frameworks to ensure transparency, accountability, and ethical governance of AI systems used in disaster management.

Overall, discussions at the summit reinforced the idea that AI's greatest value lies in enabling earlier and better-informed decisions, reducing losses before hazards translate into disasters.

AI-Enabled Heatwave Early Warning in India
The evolution of heatwave preparedness in India, exemplified by the Ahmedabad Heat Action Plan, illustrates how early warning systems combined with emerging AI capabilities can support anticipatory climate risk management.

Heatwave Early Warning in India: Lessons from Ahmedabad
Extreme heat represents one of the fastest growing climate risks in India. Heatwaves have increased significantly in frequency and intensity in recent decades, posing serious risks to public health, labour productivity, and urban infrastructure (IMD, 2023; Dhara et al., 2025).

The Ahmedabad Heat Action Plan, first implemented in 2013, represents one of the earliest examples of anticipatory climate risk management in India. Developed through collaboration between municipal authorities, public health researchers, and meteorological agencies, the plan uses temperature forecasts to trigger graded response measures.

Key components include:
- Early warning alerts are issued several days in advance
- Public communication campaigns

advising citizens on heat protection
- Cooling shelters and water distribution points
- Health system preparedness for heat-related illnesses

Recent advances in AI and satellite-based Earth observation provide opportunities to further strengthen such systems. AI analysis of thermal satellite imagery can identify neighbourhood-level urban heat hotspots, allowing authorities to target vulnerable communities more effectively.

"India's mean temperature has already increased by approximately 0.89 °C, with projections indicating further warming by mid-century."

For example, combining satellite temperature data with demographic and land-use information enables city administrations to identify areas where heat exposure overlaps with social vulnerability-such as informal settlements or areas with limited green space.

These developments illustrate how AI can enhance traditional early warning systems by enabling localized risk intelligence and targeted interventions.

Extreme heat represents one of India's fastest-growing climate risks. Several cities have implemented Heat Action Plans supported by improved forecasting and data analytics.

Ahmedabad's Heat Action Plan, developed with support from public health researchers and meteorological agencies, uses temperature forecasts to trigger graded response measures, including public advisories and cooling shelters.

AI-driven analysis of satellite thermal imagery can further enhance these systems by identifying neighbourhood-level heat hotspots. Such insights enable targeted interventions for vulnerable communities, including outdoor workers and informal settlements.

These approaches demonstrate how AI can strengthen anticipatory public health responses to extreme heat.

AI-Supported Monitoring of Himalayan Glacial Hazards

Advances in GeoAI and satellite monitoring are enabling early identification of glacial hazards in the Himalaya, supporting anticipatory risk management strategies

Monitoring Himalayan Glacial Hazards with GeoAI

The Hindu Kush–Himalaya region is experiencing rapid warming and glacier retreat. Accelerated glacier melt has led to the formation and expansion of glacial lakes, increasing the risk of glacial lake outburst floods (GLOFs) (ICIMOD, 2023; Dhara et al., 2025).

Monitoring these remote high-mountain environments has traditionally been difficult due to challenging terrain and limited observational infrastructure. Advances in satellite remote sensing and AI-based image analysis are transforming this capability. Institutions such as ICIMOD, ISRO, and NASA's SERVIR program are using Earth observation data combined with machine learning algorithms to detect changes in glacier area, snow cover, and glacial lake expansion.

Key applications include:
- Automated detection of glacial lakes using satellite imagery
- Monitoring glacier retreat and moraine stability
- Early identification of potentially dangerous glacial lakes
- Risk mapping of downstream