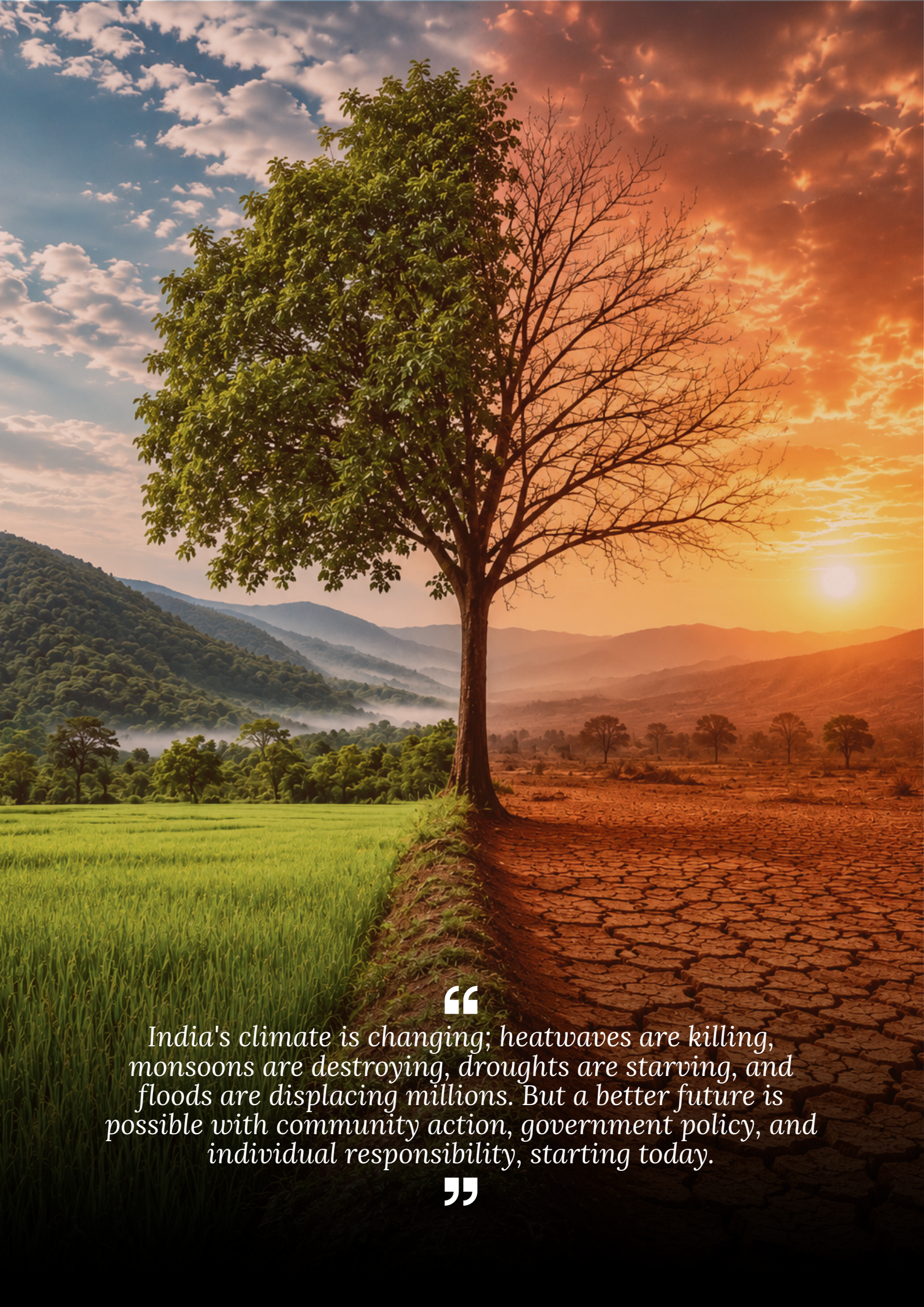


BUILDING A RESILIENT FUTURE

India's Roadmap for Climate and Disaster Resilience

INDUCTUS



India's climate is changing; heatwaves are killing, monsoons are destroying, droughts are starving, and floods are displacing millions. But a better future is possible with community action, government policy, and individual responsibility, starting today.

FOREWORD

India is at an important inflection point in its development journey. As the nation moves towards a more ambitious, globally integrated and sustainable economy, building resilience against disasters and climate-related risks is no longer a matter of preparedness alone; it is a fundamental requirement for sustainable growth.

The increasing frequency and intensity of extreme weather events, climate variability, urbanisation pressures and environmental stresses are creating new challenges for communities, infrastructure and public institutions. The economic and social consequences of these disruptions can be profound, particularly for vulnerable populations and regions. This makes **disaster and climate resilience an essential component of India's development roadmap.**

It is in this context that **"Building a Resilient Future – India's Roadmap for Disaster & Climate Resilience"** has been conceptualised. This report seeks to examine the evolving resilience landscape in India and, more importantly, initiate a conversation on what India must do differently to prepare for the risks of tomorrow.

India has made considerable progress in disaster management; however, the changing risk environment requires us to move beyond a predominantly response-oriented approach towards a **risk-informed, prevention-led and resilience-centric model of development.**

Moreover, the resilience agenda cannot be addressed by governments alone. It requires a **whole-of-society and whole-of-economy approach,** bringing together policymakers, industry, technology companies, academia, financial institutions, civil society and local communities. The private sector, in particular, has an important role to play by bringing innovation, investment, technology and execution capabilities into the resilience ecosystem.

The new-age technologies such as AI, satellite and geospatial technologies, predictive analytics, real-time data, digital platforms, and advanced communication systems can significantly strengthen risk assessment, early warning, emergency response, and recovery.

Investments in resilience & preparedness should not be seen merely as an expenditure. It is an investment in **protecting lives, safeguarding livelihoods, preserving economic assets and ensuring the continuity of development.**

The resilience requirements of coastal communities, Himalayan regions, arid landscapes, agricultural districts and rapidly expanding urban centres are fundamentally different. The roadmap must therefore combine national vision with decentralised planning, local knowledge and community-led action.

At **Inductus,** we believe that sustainable development and resilience are intrinsically linked. Our experience across consulting, technology-enabled solutions, infrastructure and development-sector engagements has reinforced our belief that complex national challenges require integrated thinking, strong partnerships and innovative execution. Resilience is not simply about responding better when a crisis occurs; it is about **designing systems that can anticipate risk, adapt to change, and continue to deliver even under stress.**

This report brings together perspectives on the challenges, opportunities and pathways available to India as it seeks to build a resilient future. We hope it will encourage policymakers, businesses, institutions and communities to move from discussion to action and from fragmented interventions to collaborative, long-term resilient strategies.

A resilient India will not merely withstand the challenges of a changing climate and an uncertain world; it will have the capacity to adapt, innovate, recover and emerge stronger.



Alouk Kumar

Alouk Kumar
Chief Executive Officer
Inductus Limited

Executive Summary

As per the global ranking, India ranks among the world's top ten most disaster-prone nations, with nearly **85%** of its land area exposed to one or more natural hazards. Accelerating climate change, rapid urbanization, environmental degradation, and emerging biological and industrial risks are increasing the frequency, complexity, and impact of disasters across the country. As one of the fastest-growing major economies, India's ability to strengthen disaster and climate resilience is central to safeguarding lives, protecting economic growth, preserving ecosystems, and achieving sustainable development.

This report assesses India's disaster-affected climate risk landscape, evaluates institutional preparedness, identifies key gaps, and outlines strategic priorities for strengthening resilience through 2035. It draws on government data, multilateral assessments, and academic research and includes case studies spanning India, and it is intended as a knowledge foundation for policy dialogue among government departments, disaster management authorities, and allied institutions.

Key Findings

85%
Land area exposed to one or more hazards

60,000+
Deaths, 2019 to 2025

Rs 0.8L to 1.5L Cr
Estimated annual economic loss

<5%
Disaster losses covered by insurance

250M+
People affected cumulatively, 2019 to 2025

3M+
Average annual displacement

90%+
Reduction in cyclone mortality since 1999

18x
Estimated return on resilience investment

Summary of the Case

Accelerating climate change:
India's average temperature has risen by about **0.7°C since 1901,** while extreme heat days are increasing. Himalayan glacial melt threatens water security for **500 million+** people, with glaciers potentially losing up to **80% by 2100.** In **2025,** extreme weather occurred on **331 of 334 tracked days.**

Mounting economic losses:
India incurs estimated annual disaster losses of **US$8 to 15 billion,** with less than **5% insured.** The **2025** monsoon affected crops and millions of farmers, while climate impacts could reduce GDP by **17% to 25% by 2070** without further adaptation.

Uneven preparedness:
Cyclone mortality on India's east coast has fallen by more than **90% since the 1999 Odisha super cyclone** due to stronger early warning and evacuation systems. However, urban flooding, heatwaves, and Himalayan hazards remain major gaps.

Neglected man-made and biological threats:
The Bhopal gas disaster, Endosulfan exposure and COVID 19 exposed weaknesses in industrial safety and public health coordination. Biological preparedness remains distributed across multiple agencies, while industrial accidents continue to occur.

A policy framework exists:
The **Disaster Management Act 2005, the Disaster Management Amendment Act 2025,** and the **National Disaster Management Plan 2019** provide a comprehensive framework. Implementation remains constrained by fragmented coordination and inadequate resilience financing.

Greater investment in resilience:
The Fifteenth Finance Commission expanded disaster financing through dedicated mitigation funds alongside response funds, strengthening the shift from relief-focused spending toward disaster risk reduction.

Technology is strengthening preparedness:
AI-enabled forecasting, high-performance computing, and integrated early warning platforms are improving disaster preparedness, although adoption and implementation remain uneven across states.

Preparedness remains uneven:
India has achieved strong cyclone preparedness through advanced warnings and coordinated evacuation, but heatwaves, urban flooding and Himalayan hazards continue to present significant preparedness gaps.

Five strategic priorities emerge for the period to 2035:
Achieve universal early warning coverage by 2027, establish climate proof infrastructure standards, strengthen urban flood resilience across **100+ cities,** integrate man made and biological risks into national plans, and address the **US$24 billion+ annual resilience investment gap.**

India has made measurable progress in disaster preparedness, institutional capacity, technology-driven monitoring, and early warning. However, intensifying climate extremes, urban exposure, ecological degradation, and emerging biological and industrial risks require a shift from reactive response to long-term resilience planning. Achieving disaster resilience by 2035 will require a whole-of-government and whole-of-society approach that integrates risk reduction into development planning through sustained financing, technological innovation, and stronger institutional coordination. This will require coordinated action by central and state governments, industry, academia, research institutions, financial institutions, and communities, supported by sustained investment and stronger regional and international collaboration.

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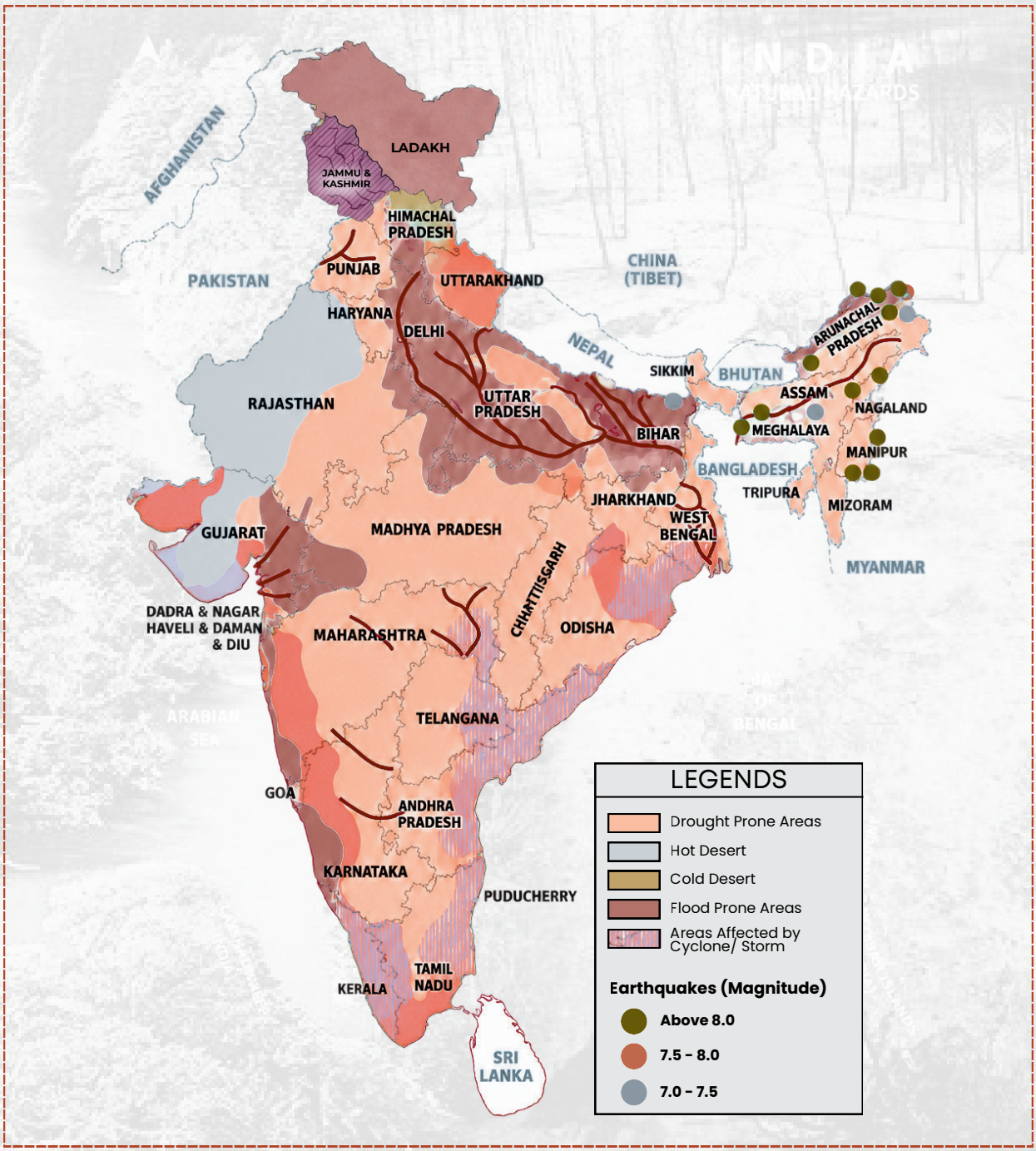
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Introduction

India's geography places it at the intersection of several major hazard systems. The Himalayan arc exposes northern states to **earthquakes, glacial lake outburst floods, and landslides.** The Bay of Bengal and Arabian Sea coastlines expose the eastern and western seaboards to tropical cyclones and storm surge. The Indo-Gangetic Plain and its river systems produce recurring floods, while the interior peninsula and western states are prone to drought and heat extremes. Rapid urbanization has added a further layer of exposure, concentrating population and economic assets in cities where drainage, housing, and health infrastructure often lag behind growth.

This report examines that risk landscape from four angles: the physical trends driving climate and disaster risk, the human and economic consequences of recent events, the institutional and legal framework built to manage those risks, and the technology now being deployed to close remaining gaps. It closes with a set of strategic priorities for the period to 2035.



Methodology & Sources

Findings are drawn from a combination of government sources, including the National Disaster Management Authority, the Ministry of Home Affairs, the India Meteorological Department, and the National Institute of Disaster Management, together with multilateral assessments from the World Meteorological Organization, the Asian Development Bank, and the United Nations Development Programme.

Academic literature on disaster mortality and economic loss in India, contemporary reporting on the 2025 monsoon season, and legislative records relating to the Disaster Management Act 2005 and its 2025 amendment were also reviewed. Where figures vary across sources due to differing time windows or measurement approaches, this report presents the range and identifies the source basis for each figure.

The purpose of this report is to provide a consolidated, decision-relevant overview for departments and agencies engaged in disaster and climate resilience planning and to support the knowledge exchange on disaster and climate resilience.



India's Disaster & Climate Risk Landscape

Vulnerability Profile



3.1 Hazard Profiling: Natural, Biological, and Man-Made Hazards

India's diverse geography, climatic conditions, rapid urbanization, expanding industrial base, and large population make it one of the world's most disaster-prone countries. The country is exposed to a wide range of natural, biological, and man-made hazards that vary significantly across regions. According to the National Hazard and Vulnerability Assessments, 27 of India's 36 states and union territories are classified as disaster-prone. States such as Odisha, Bihar, Gujarat, Uttar Pradesh, and West Bengal consistently experience high levels of multi-hazard events. vulnerability due to the combined impacts of floods, cyclones, droughts, earthquakes, heatwaves, and other climate-related risks. According to the National Institute of Disaster Management and the German development agency GIZ, India recorded 1,058 major floods, cyclones, droughts, cold waves, and heatwaves between 1995 and 2020. India ranked third globally in human mortality attributable to extreme weather events between 2000 and 2019, according to the Global Climate Risk Index.

India's disaster landscape can be broadly classified into three categories:

3.1.1 Natural Hazards

Natural hazards constitute the largest share of disasters in India and are primarily driven by climatic, hydrological, and geological processes.

Hydro-Meteorological Hazards: Floods, cyclones, heatwaves, cold waves, droughts, cloudbursts, lightning, and storm surges

Geophysical Hazards: Earthquakes, landslides, avalanches, and Glacial Lake Outburst Floods (GLOFs)

Approximately 85% of India's land area is exposed to one or more natural hazards, with climate change further increasing the frequency and intensity of extreme weather events.

Illustrative Examples:

Cyclone Fani (2019), Odisha	Cyclone Amphan (2020), West Bengal	Chamoli glacier burst (2021), Uttarakhand	Wayanad landslide (2024), Kerala	Sikkim GLOF (2023)



3.1.2 Biological Hazards

Biological hazards arise from infectious disease outbreaks and public health emergencies that threaten human health, livelihoods, and economic activity. These include pandemics, zoonotic diseases, vector-borne diseases, and waterborne outbreaks.

The COVID-19 pandemic (2020–2022) marked India's first large-scale biological disaster managed under the Disaster Management Act, exposing critical gaps in disease surveillance, healthcare capacity, emergency preparedness, and interagency coordination.



Illustrative Examples:

01 COVID-19 pandemic (2020–2022)

02 Nipah virus outbreaks in Kerala (2018, 2021, 2023)

03 Avian influenza (H5N1) outbreaks across multiple states



3.1.3 Man-Made Hazards

Man-made hazards result from industrial accidents, chemical releases, infrastructure failures, urban fires, transport accidents, hazardous waste incidents, and other human-induced events. Rapid industrialization and urban expansion have increased the exposure of people and critical infrastructure to such risks.

While India has established regulatory and institutional mechanisms to manage industrial and technological hazards, recurring incidents highlight the need for stronger enforcement, improved safety standards, and enhanced risk governance.

Illustrative Examples:

- **The Bhopal gas tragedy (1984)**—the world's worst industrial disaster
- **Endosulfan poisoning (Kerala)**—long-term health and ecological impacts
- **Morbi bridge collapse (2022),** Gujarat – infrastructure failure

3.2 Vulnerability Drivers

Several underlying factors amplify disaster risk across India:

Vulnerability Driver	Impact
Unplanned Urbanization	Urbanization without matching drainage and housing investment concentrates flood and heat exposure in cities.
Coastal Population Growth	Population growth in cyclone-prone states increases the number of people requiring evacuation during major storms
Agricultural Dependence	Agricultural dependence on monsoon timing leaves farm incomes exposed to both delayed and excessive rainfall.
Ecological Degradation	Deforestation and wetland loss reduce natural buffering against floods and landslides.
Insurance and Credit Gaps	Uneven access to insurance and formal credit slows recovery for lower-income households and small farmers after a disaster.

3.3 Climate Change as a Risk Multiplier

Climate change no longer acts as a standalone environmental issue but increasingly multiplies the frequency, intensity, and impact of natural hazards across India.

Climate Indicator	Observed Trend	Impact
Extreme Rainfall	Sharp increase in short-duration, high-intensity events	Frequent urban flooding (Chennai, Mumbai, Bengaluru, Pune)
Heatwaves	More severe and prolonged; 2024 is among the longest heatwave spells in history.	Health crises, productivity loss, water scarcity
Cyclone Intensity	Severe cyclones in the Arabian Sea are increasing (e.g., Tauktae 2021, Biparjoy 2023).	Higher wind speeds, greater damage potential
Glacial Retreat	Accelerated melting in Himalayas	Increased GLOF risk (Sikkim 2023)
Sea-Level Rise	3.1 mm/year (1993-2020) vs. 1.4 mm/year (1901-1990)	Coastal erosion, salinization, storm surge intensification

Economic and Social Impacts:

- **By 2050,** more than half of India's GDP is projected to be exposed to extreme weather, wildfires, and sea-level rise.
- **By 2070,** India could face up to **17 to 25% GDP loss** if no corrective climate actions are taken.
- **The IPCC AR6** identifies South Asia as a hotspot where climate risks intersect with poverty and high population density.

Implications for Disaster Management:

- Necessitates a shift from reactive relief to anticipatory, risk-informed planning.
- Requires integration of climate projections into disaster preparedness and infrastructure design.
- Demands strengthening of early warning systems, forecast-based financing, and ecosystem-based approaches to resilience.
- Multidimensional Impacts of Disasters: Current and Future Projections.

This section quantifies the impact of disasters and accelerating climate change across six dimensions relevant to India: human, agricultural, economic, ecological, financial, and **forward-looking projections to 2030 and 2050.**

Multidimensional
Impacts of Disasters

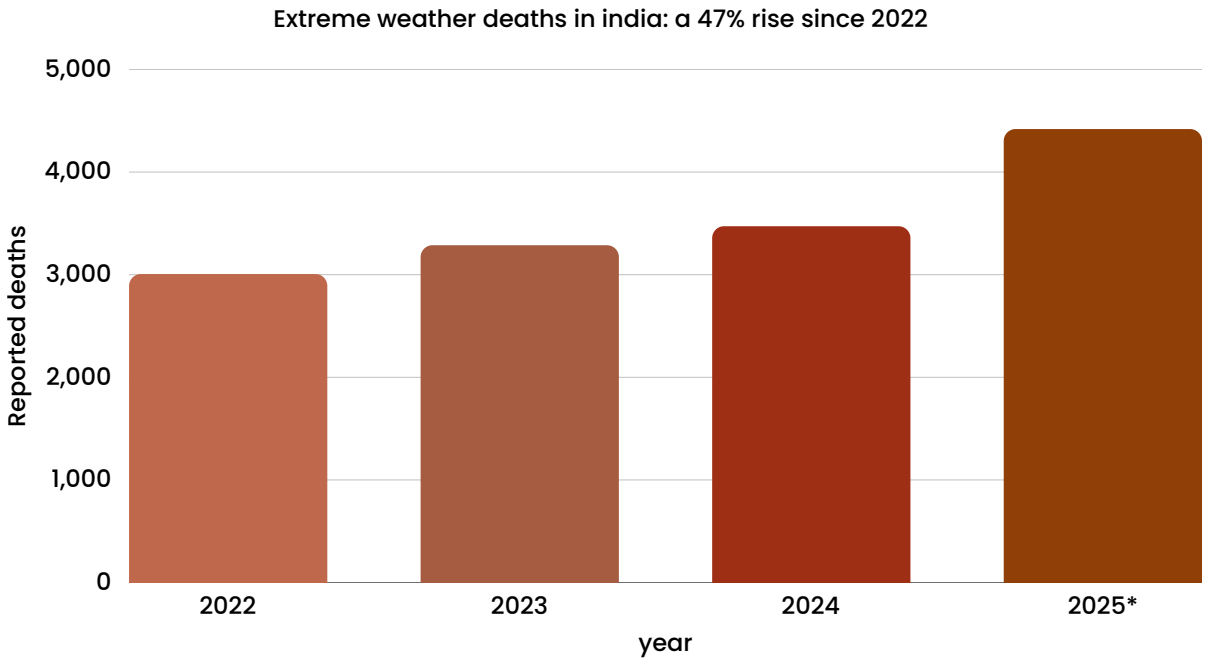
Current and Future Projections

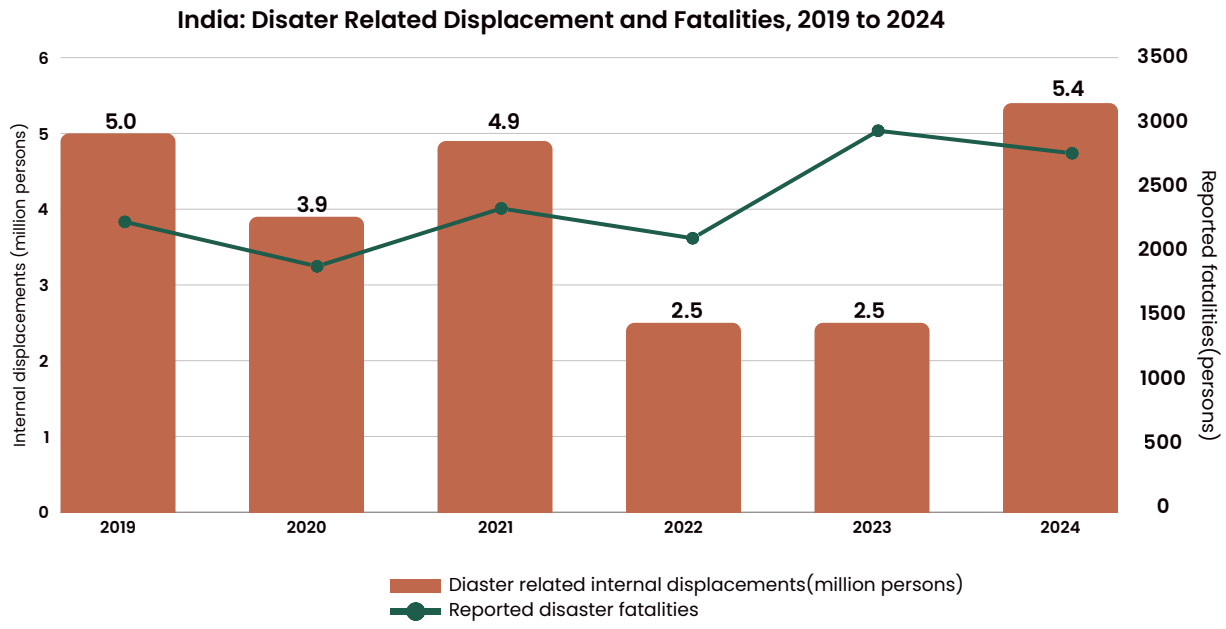
This section quantifies the impact of disasters and accelerating climate change across six dimensions relevant to India: **human, agricultural, economic, ecological, financial, and forward-looking projections to 2030 and 2050.**



4.1 Human Impact: Mortality, Morbidity, and Displacement

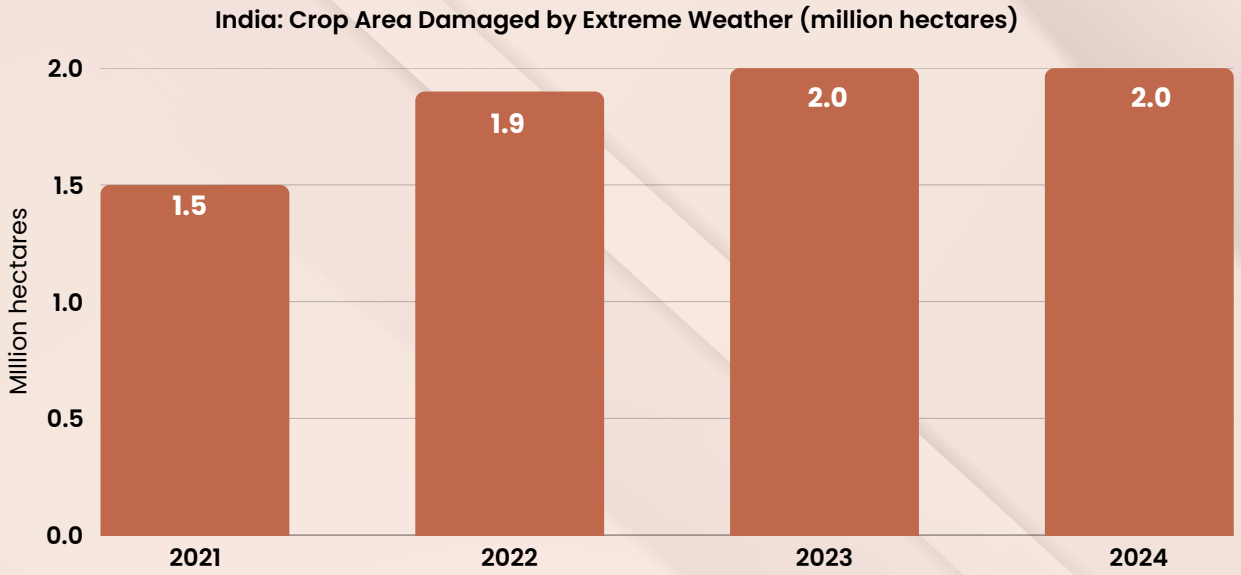
India recorded an average of 3 **million disaster-related internal displacements annually,** with 2024 marking a **12-year high of 5.4 million,** driven largely by floods. **Between 2015 and 2024,** cumulative disaster displacement reached **32 million people,** placing India among the five most affected countries globally. Mortality is also rising, with extreme weather occurring on **322 days in 2024 and 270 of 273 days** during January to September 2025. Deaths increased from **2,755 in 2022 to 4,064 in 2025,** reflecting a **47% rise.** Climate impacts are further affecting public health and productivity, with **55% more heat-related deaths** among older adults, **247 billion labor hours lost in 2024,** and an estimated **4.5% of GDP at risk by 2030 due to extreme heat and humidity.**

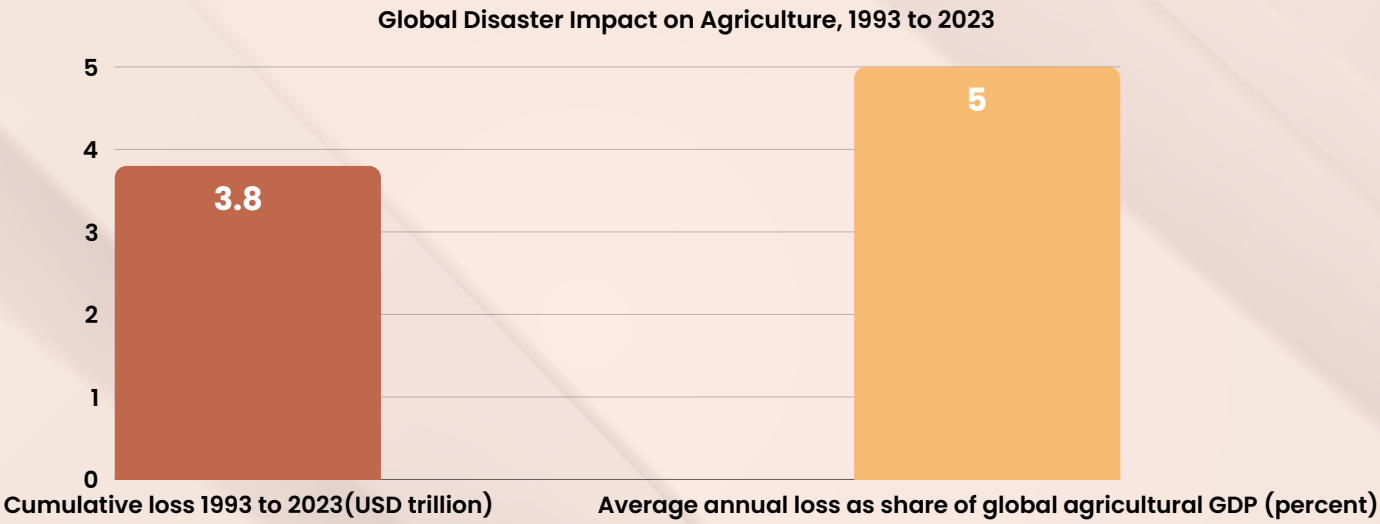




4.2 Agricultural Impact: Crop Loss, Food Security, and Rural Livelihoods

Agricultural losses continue to threaten rural livelihoods across India. **From 2024 to 2025,** hydro-meteorological disasters damaged **10.23 lakh hectares of cropped area,** with Uttar Pradesh recording the highest losses. **In 2024 alone, an estimated 3.2 million hectares of crops and 9,400** livestock were lost. Globally, disasters have caused **USD 3.8 trillion** in agricultural losses over the past three decades. In India, where agriculture supports nearly half the workforce, extreme heat alone resulted in an **estimated USD 194 billion** in **agricultural income losses in 2024,** increasing risks to rural livelihoods and food security.



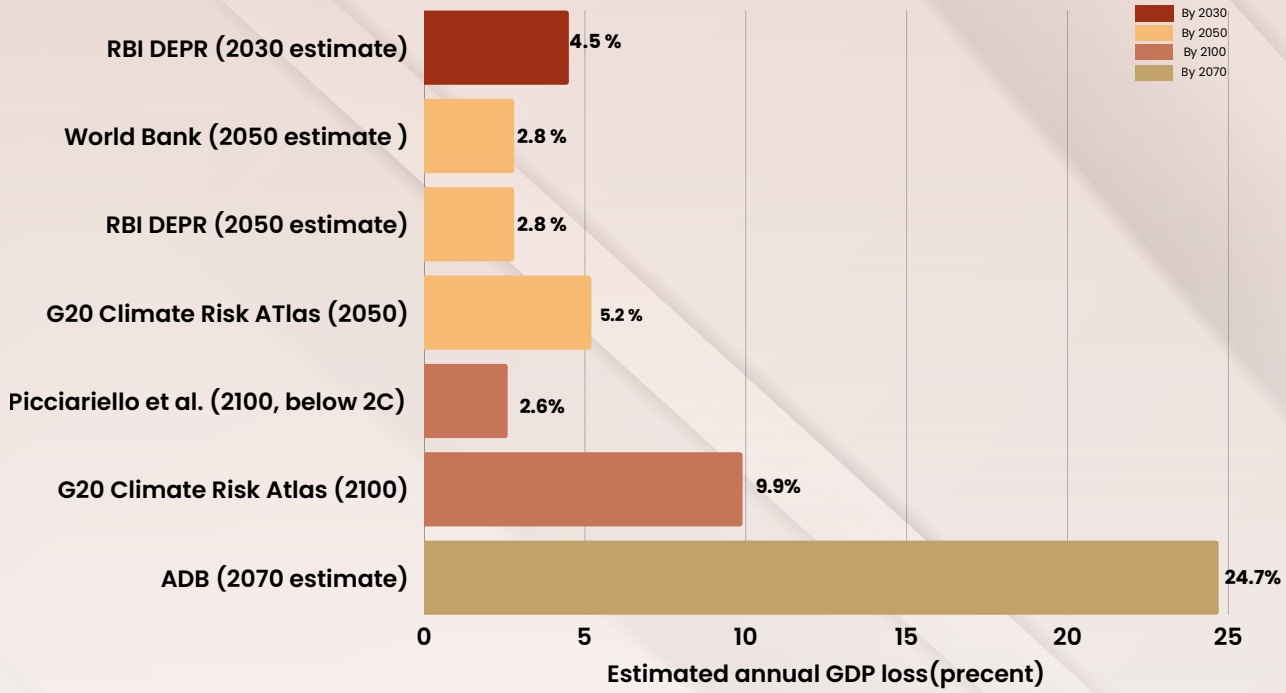


Source: Ground Report and Ministry of Home Affairs Provisional State data 2024 to 2025;FAO, The Impact of Disasters on Agriculture and food Security

4.3 Economic Impact: GDP Loss, Infrastructure Damage, and Productivity Decline

India incurs average annual disaster-related economic losses of **0.4% of GDP,** with floods and landslides accounting for the largest share. Infrastructure losses are estimated at **USD 31.6 billion annually,** particularly across roads, power, and rail. Climate-related disruptions can reduce government revenues by up to **12% and GDP by up to 2% in affected years.** Rising heat stress is expected to place up to **4.5% of GDP** at risk by 2030 through lost labor productivity, highlighting the growing economic cost of climate change.

India: Comparative Estimate of Climate Linked GDP Loss Across Institutions and Time Horizons



Source : RBI DEPR Report on currency and finance 2022 to 23; World Bank 2018; G20 Climate



4.4 Biological Impact: Public Health, Disease Outbreaks, and Health System Resilience

Biological disasters have become an increasingly important component of India's disaster risk landscape. **The COVID-19 pandemic** recorded over **4.5 crore confirmed cases** and **more than 5.3 lakh** officially reported deaths, placing unprecedented pressure on healthcare systems, livelihoods, education, and supply chains. Recurrent outbreaks of Nipah virus, Zika virus, and avian influenza highlight the growing risk of emerging infectious diseases, driven by climate change, urbanization, and increased human-animal interaction. Strengthening disease surveillance, laboratory capacity, genomic sequencing, and coordination under the One Health approach will be essential to improve India's preparedness and resilience against future biological disasters.

Biological Disaster Snapshot: India (2006 to 2025)

COVID-19 Pandemic

Key Statistics

- 4.5+ Crore confirmed cases
- 5.3+ lakh officially reported deaths

Implications

Largest public health emergency in Independent India. Widespread disruption to healthcare and the economy, highlighting the need for immediate and rapid surveillance and outbreak containment.

NIPAH VIRUS

Key Statistics

- Multiple outbreaks since 2001
- case fatality rate 40 to 75 percent

Implications

Highlights the need for rapid surveillance and outbreak containment.

AVIAN INFLUENZA (H5N1)

Key Statistics

- Recurrent outbreaks affecting poultry and wildlife

Implications

Significant economic losses and strengthened animal disease surveillance.

Zika and Vector-Borne Diseases

Key Statistics

- Periodic outbreaks across multiple states

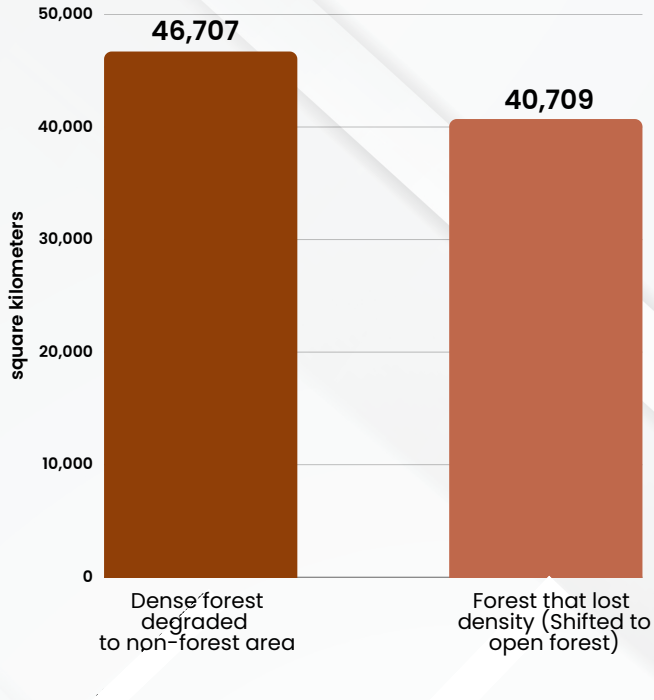
Implications

Increasing climate and environmental risks require stronger vector surveillance and public health preparedness.

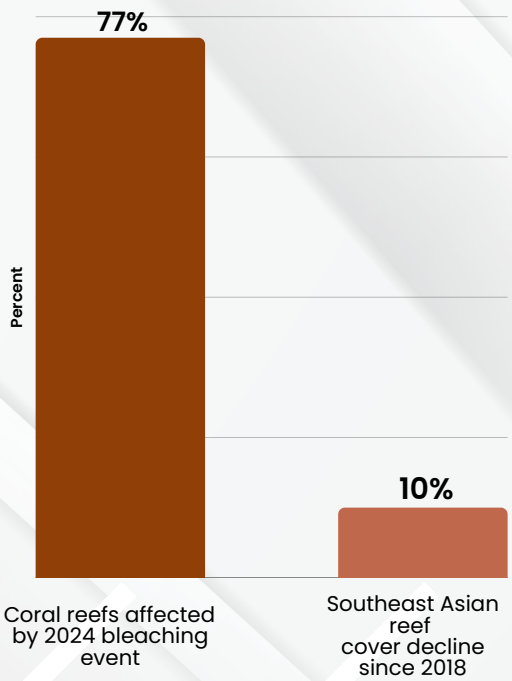
4.5 Ecological Impact: Ecosystem Degradation and Biodiversity Loss

India's forest and tree cover increased marginally to **25.17%** of the country's geographical area, but forest quality continues to decline. Over the past decade, **46,707 sq km of forests** were converted to non-forest land, while **40,709 sq km** experienced canopy degradation, particularly in the Western Ghats, the Himalayan region, and the Andaman and Nicobar Islands. Coastal ecosystems are also under growing stress, with record global coral bleaching affecting **77% of reefs in 2024,** posing significant risks to India's coral reefs, marine biodiversity, fisheries, tourism, and coastal protection.

India: Forest Quality Decline Over the past Decade (square kilometers)



Marine Ecosystem Stress Indicators Relevant to Indian Coastal Waters

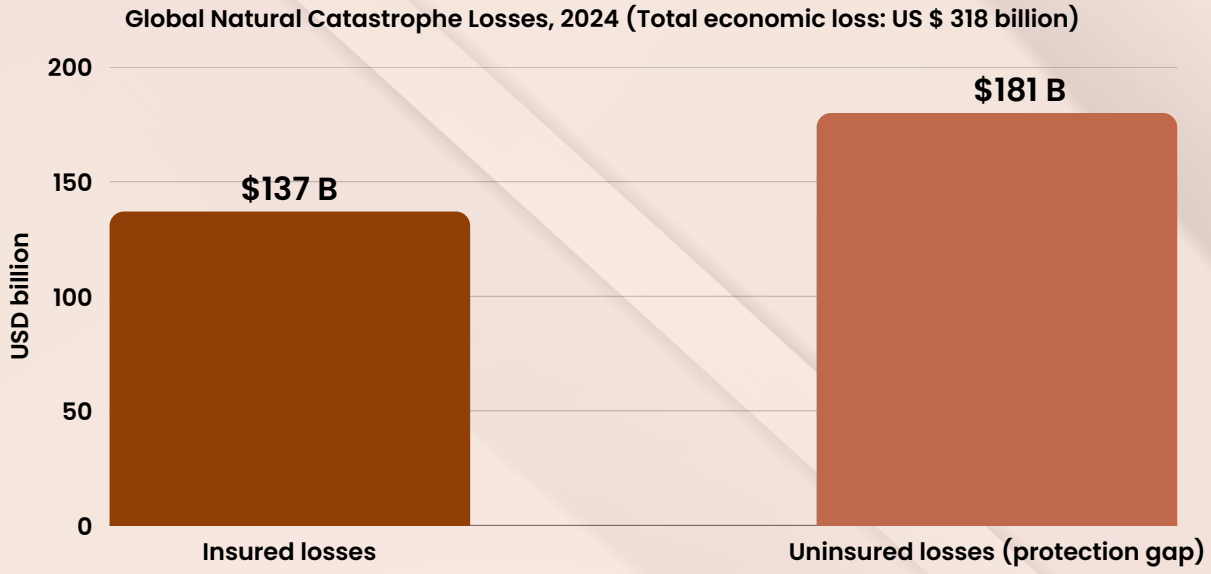


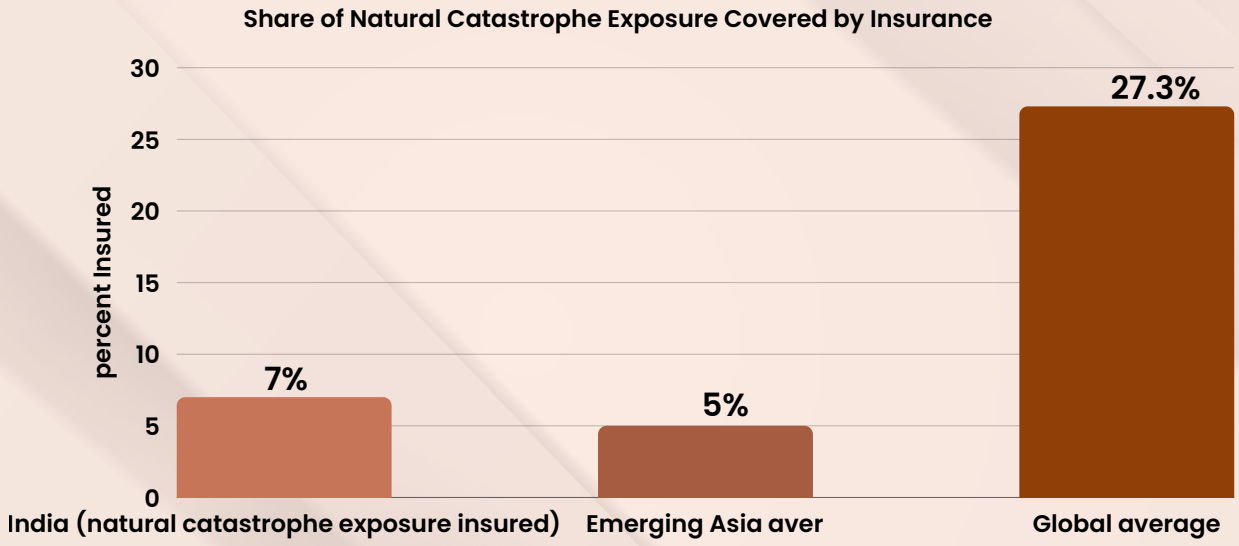
Source: Forest Survey of India, 18th India State of Forest Report; ADB, Oceans and Coral Reefs in Asia and the Pacific, 2025; Statista Biodiversity Loss compendium.



4.6 Financial Impact: Fiscal Burden, Insurance Gap, and Uninsured Losses

The global disaster protection gap remains significant, with **USD 181 billion in uninsured losses in 2024, widening to an estimated USD 424 billion in 2025. India is among the most underinsured countries, with 93% of natural catastrophe exposure and around 95% of disaster losses remaining uninsured.** This limited insurance coverage places a greater financial burden on governments, delays recovery, and highlights the need for stronger disaster risk financing and insurance penetration.



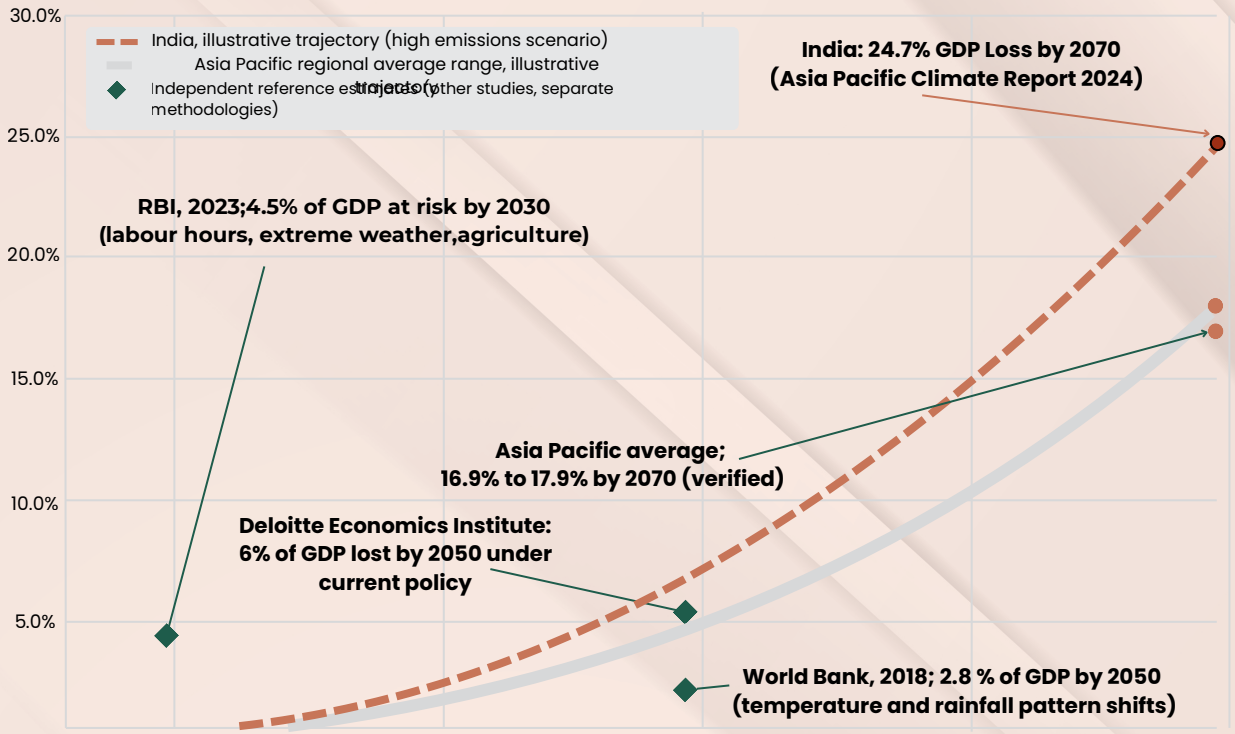


Source: Swiss Re Institute, sigma 1/2025 and sigma 1/2026 Natural Catastrophes reports; Swiss Re, India's Insurance Market: Growing Fast, 2024 to 25.

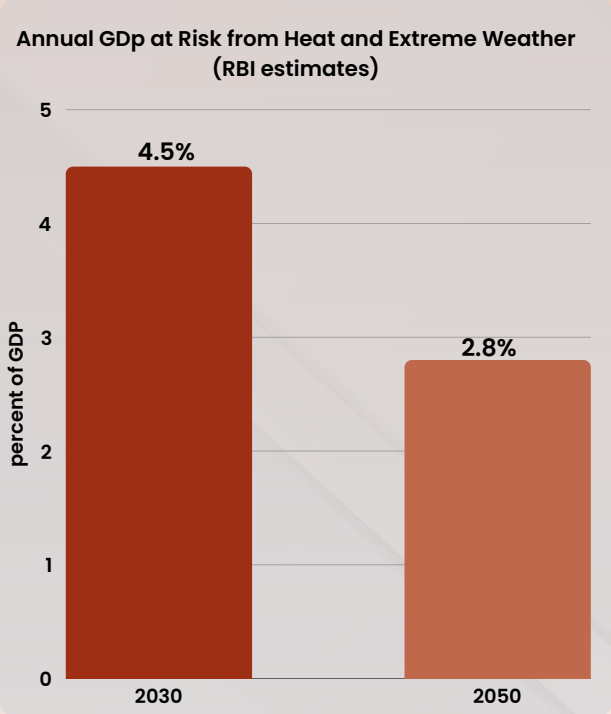
4.7 Future Impact Projections for 2030 and 2050

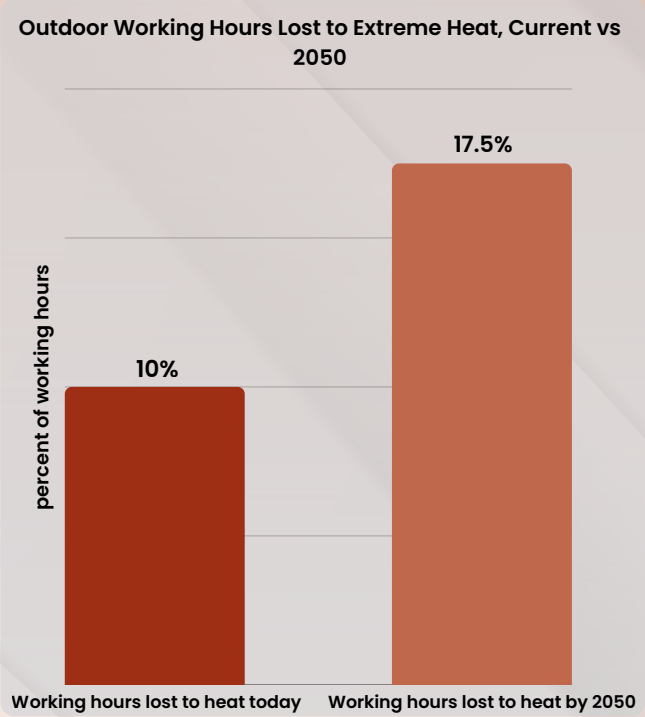
By 2030 and 2050, India is expected to face rising climate risks through higher heat-related productivity losses, greater population exposure, and widening economic vulnerability. **Up to 4.5% of GDP** could be at risk by 2030 due to heat stress, while **15 to 20%** of working hours may be lost by 2050 in heat-exposed sectors such as agriculture and construction. Climate change could expose **148.3 million** people to severe climate hotspots by 2050, push **45 million** additional people into poverty by 2030, and increase risks for **18.1 million** people living in low-lying coastal areas.

Projected GDP Loss For India Due To Climate Change and Disaster, 2026 to 2070

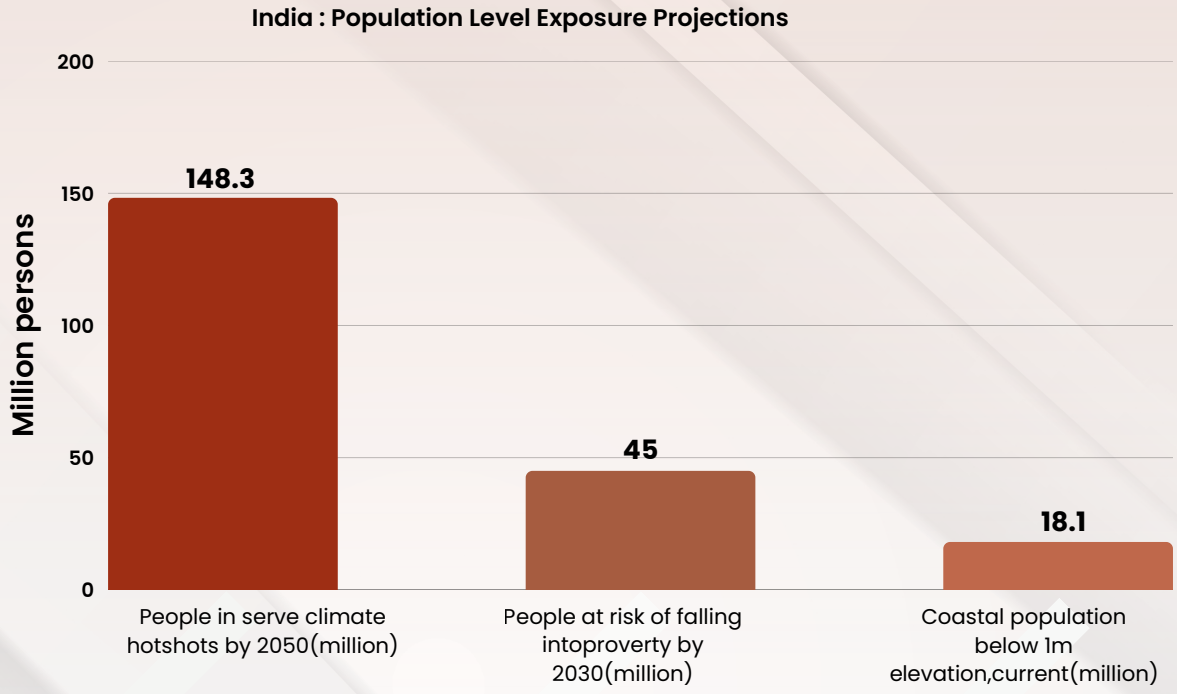








Source: RBI, Report on Currency and Finance 2022 to 23; McKinsey Global Institute, Climate Risk and Response; World Bank, 2018.



Source: Mani et al. 2018, World Bank South Asia Hotspots; World Bank 2018 poverty projections; Lancet Countdown 2024 India Data Sheet.

India's financial protection gap is expected to widen as climate risks intensify. With an insurance resilience index of **just 5 to 7%,** most disaster losses are likely to remain uninsured, increasing the fiscal burden on governments and households. Strengthening disaster risk financing, parametric insurance, catastrophe risk pooling, and contingency funding will be essential to improve resilience by 2030.



Accelerating Trends

Climate Change and Disaster Dynamics in India

5.1 Shifting Precipitation Patterns and Glacial Instability

Climate change is fundamentally altering India's hydrological systems. Monsoon rainfall has declined by approximately **10% since the 1950s,** with projections indicating a further **15-20% decline by 2100.** This reduction is accompanied by increasing variability; short-duration, high-intensity rainfall events are replacing steady monsoon showers, contributing to both flash floods and prolonged dry spells.

The Himalayan glacier system is experiencing variability-affected melt. The International Centre for Integrated Mountain Development (ICIMOD) reports that the Himalayas could lose up to **80% of glaciers** by the end of this century under current emission trajectories. Over 500 million people across the Indus, Ganges, and Brahmaputra river basins depend on glacier-fed rivers for water security. Accelerated melt threatens both near-term flood risk—through Glacial Lake Outburst Floods (GLOFs)—and longer-term water scarcity as glacial mass diminishes. The 2023 Sikkim GLOF, which claimed approximately 100 lives and caused extensive damage to the Teesta River basin, underscores the urgency of this threat.



5.2 Urban Heat Islands and Intensifying Extreme Weather Events

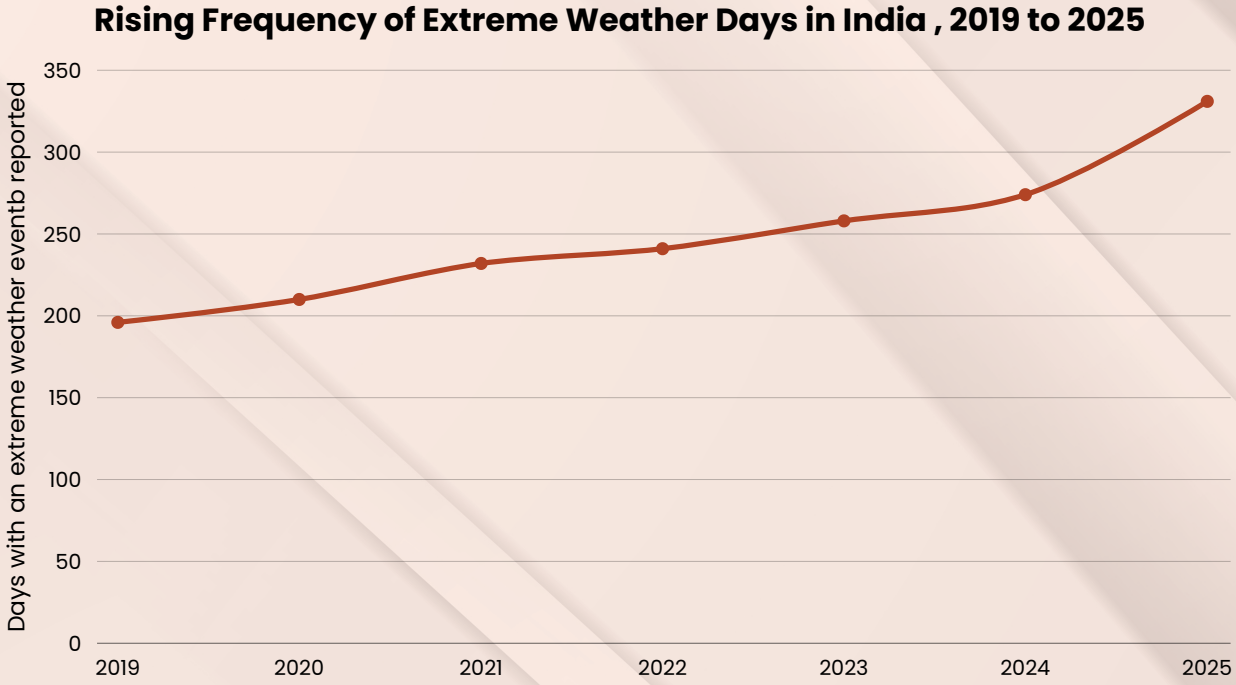


- **Temperature Rise and Heat Extremes**

Average temperatures across India have risen by **approximately 0.7°C since 1901,** with the rate of warming accelerating in recent decades. The number of extreme heat days has doubled over the same period. In 2024, India recorded **554 heatwave days** across the country—the highest on record—placing sustained stress on agriculture, labor productivity, and public health systems. Northern and central states now regularly experience summer temperatures exceeding **45°C.**

- **Extreme Weather Frequency**

The period from 2019 to 2025 has witnessed a dramatic escalation in the frequency and intensity of extreme weather events:



Source: Centre for Science and Environment annual Extreme weather assessments, 2019 to 2025

Over **1,600+ extreme weather events** were recorded between 2019 and 2024, averaging 270 per year. In 2023, India recorded extreme weather on **318 of 365 days,** affecting all **36 states and union territories.** 2025 saw extreme weather on **331 of 334 days,** with February heatwaves recorded in western India for the first time in history.



5.3 Ecological Degradation and Systemic Feedback Loops

Land Degradation

Approximately **30%** of India's land area **(96.4 million hectares)** is degraded or facing desertification. Deforestation and wetland loss are reducing natural buffering against floods and landslides, creating feedback loops that amplify disaster risk.

Biodiversity and Ecosystem Loss

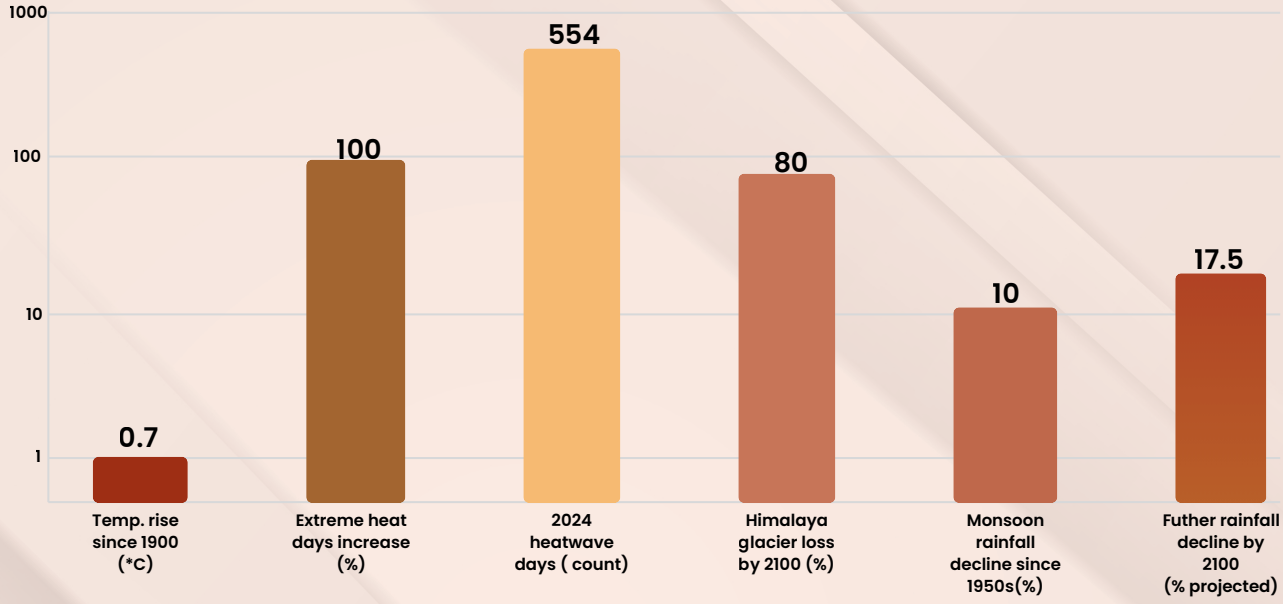
Ecological degradation manifests through multiple pathways: forest fires, wetland shrinkage, and coastal ecosystem loss. India's wetlands—covering **15.26 million hectares,** are shrinking at **2-3% annually,** reducing natural flood buffers. Coastal ecosystems, particularly mangroves in the Sundarbans, have lost significant area, compromising storm surge protection for millions of coastal residents.

Systemic Feedback Loops

Ecological degradation and climate change create reinforcing feedback loops:

1. Deforestation → Reduced rainfall → Increased drought risk → Further vegetation loss
2. Wetland loss → Reduced flood absorption → Increased flood damage → Infrastructure destruction
3. Glacial melt → Initial flood risk → Long-term water scarcity → Migration and conflict
4. Land degradation → Reduced agricultural productivity → Increased vulnerability → Displacement

Climate Change Indicators for India





- **Drivers of Rising Temperatures**

The increase of approximately **0.7°C** in India's average surface temperature since 1901 is primarily driven by rising concentrations of greenhouse gases, including carbon dioxide, methane, and nitrous oxide, resulting from fossil fuel combustion, industrialization, transport, agriculture, and land use change. Rapid urbanization has further intensified warming through the urban heat island effect, while deforestation and wetland loss have reduced the natural capacity of ecosystems to absorb carbon and regulate local temperatures. Together, these factors have accelerated climate change, increasing the frequency and intensity of heatwaves, extreme rainfall events, glacier retreat, and other climate-related hazards across India.

- **Carbon Emissions and Disaster Risk**

Carbon emissions are a major driver of climate change and the increasing frequency and intensity of disasters. India is the world's third-largest carbon dioxide emitter, accounting for approximately 8% of global CO_2 emissions, while its per capita emissions remain around 2.3 tonnes, less than half the global average of about **4.8 tonnes per person.** This reflects India's lower historical contribution to cumulative emissions despite its growing economy and population.

Rising greenhouse gas concentrations are increasing average temperatures, altering precipitation patterns, intensifying heatwaves and extreme rainfall events, strengthening tropical cyclones, and accelerating Himalayan glacier retreat. According to the International Centre for Integrated Mountain Development (ICIMOD), the Hindu Kush Himalayan region could lose up to 80% of its glacier volume by 2100 under high emission scenarios, threatening water security, agriculture, hydropower, and the livelihoods of nearly two billion people dependent on major river basins across Asia.

Reducing India's carbon footprint through renewable energy deployment, energy-efficient infrastructure, sustainable transport, industrial decarbonization, and ecosystem restoration will not only support the country's climate commitments but also reduce long-term disaster risks by limiting future climate impacts and strengthening resilience.



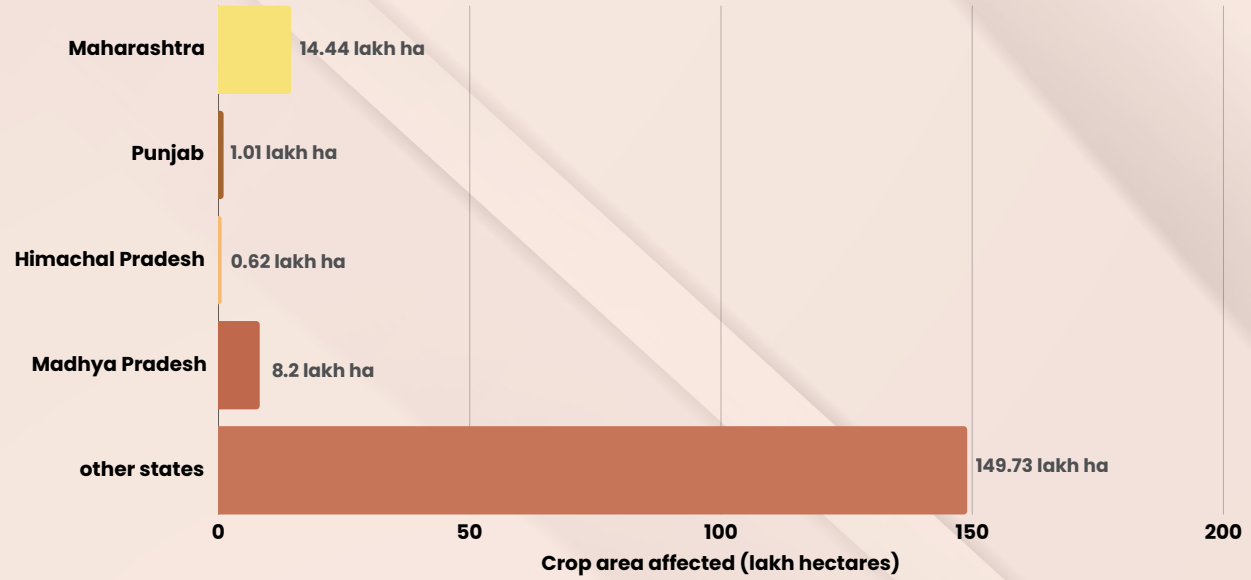
Recent Major Disaster Timeline

Year	Disaster	Impact
2019	Cyclone Fani	**Odisha: 1.2M evacuated, 80+ deaths, extensive infrastructure damage**
2020	Cyclone Amphan	**West Bengal; ~100 deaths; $13B+ damages; worst in 20 years**
2020-2022	COVID-19 Pandemic	**Nationwide, 500,000+ deaths exposed gaps in public health and biological disaster preparedness**
2021	Chamoli Glacier Burst	**Uttarakhand; ~200 deaths/dead; Rishiganga hydropower project destroyed**
2022	Record Heatwaves	**Nationwide, temperatures > 45°C, wheat crop loss ~15%, and there are health impacts across 20+ states**
2022	Morbi Bridge Collapse	**Gujarat; 135+ deaths; man-made infrastructure failure**
2023	Cyclone Biparjoy	**Gujarat; ~180,000+ evacuated; successful preparedness model validated**
2023	Sikkim GLOF	**Sikkim: ~100 deaths, Teesta river flooding, hydropower damage**
2024	Wayanad Landslide	**Kerala: 250+ deaths; villages of Mundakkai & Chooralmala buried; last-mile warning failure**
2025	Widespread Extreme Weather	**331 of 334 days; 4,419 deaths; 17.4M hectares damaged; $12B+ losses**

- **The 2025 Monsoon Season**

The 2025 monsoon illustrated the scale and geographic spread of contemporary flood risk. Punjab experienced its most severe flood event in nearly four decades beginning 20 August 2025, with **more than 1,400 villages across 13 districts affected, more than 55 deaths, and roughly 3.54 million residents affected.** Maharashtra recorded the submersion of 14.44 lakh hectares of farmland across **29 districts** between 15 and 20 August, with Nanded district alone accounting for **6.20 lakh hectares.** Himachal Pradesh reported infrastructure damage of approximately **2,007 crore rupees,** including **1,395 crore rupees** in losses to power infrastructure. Nationally, crop insurance payouts of approximately **3,200 crore rupees** were made to roughly **30 lakh farmers** during the season, while motor insurance claims rose by about **33%.**

Crop Area Affected by the 2025 Monsoon, Selected States



Source: Union Ministry of Agriculture and Farmers Welfare, State Government disclosures, 2025

Taken over a longer horizon, one assessment places India's cumulative loss from extreme weather between 1993 and 2022 at approximately **180 billion US dollars,** ranking it sixth globally for climate-related economic losses. Annual urban flooding losses are currently estimated at approximately **4 billion US dollars** and are projected to reach approximately **30 billion US dollars by 2070** in the absence of expanded urban drainage and flood management investment.



India's Disaster Management Ecosystem

Architecture and Response Framework



6.1 Institutional Architecture: National to Local Governance

India's disaster management framework operates through a four-tier structure established under the Disaster Management Act, 2005, running from national policy down to the community level.

Tier-1: Policy & Oversight Level

The policy & oversight level is responsible for establishing the national framework for disaster risk management through policy formulation, strategic planning, and interministerial coordination. It ensures that disaster management is integrated with national security, governance, climate resilience, and sustainable development objectives.

Authority / Agency	Role
Cabinet Committee on Security (CCS)	Takes national security and high-level disaster response decisions.
National Crisis Management Committee (NCMC)	Coordinates interministerial emergency response during major disasters.
Ministry of Home Affairs (MHA)	The nodal ministry is responsible for disaster management policies and coordination.
Ministry of Environment, Forest and Climate Change (MoEFCC)	Develops climate policy, environmental governance, and disaster risk reduction initiatives.



Tier-2: National Operational Level

The national operational level comprises specialized agencies that provide technical expertise, early warning systems, disaster monitoring, and emergency response capabilities across the country. These organizations support preparedness, coordinate large-scale response operations, and enable informed decision-making during disasters.

Authority / Agency	Role
National Disaster Management Authority (NDMA)	Apex is responsible for formulating disaster management policies, plans, and guidelines.
National Disaster Response Force (NDRF)	Specialized disaster response force comprising 16 battalions for rescue and relief operations.
India Meteorological Department (IMD)	Issues weather, cyclone, heatwave, and severe weather forecasts and early warnings.
Central Water Commission (CWC)	Provides flood forecasting, river monitoring, and water resource assessments.
Indian Space Research Organisation (ISRO)	Supports disaster management through satellite imagery, remote sensing, and earth observation.
Indian National Centre for Ocean Information Services (INCOIS) Directorate general of fire service, Civil Defense, and home guards	Provides tsunami, storm surge, and ocean-related early warning services.

Tier-3: State & District Level

The state & district level translates national disaster management policies into state-specific and local implementation plans. These authorities coordinate preparedness, response, relief, rehabilitation, and recovery activities while addressing region-specific disaster risks.

Authority / Agency	Role
State Disaster Management Authority (SDMA)	Develops and oversees disaster management policies and plans at the state level.
State Disaster Response Force (SDRF)	Conducts disaster response, rescue, and relief operations within the state.
Revenue & Disaster Management Department	Coordinates relief distribution, rehabilitation, and recovery activities.
District Disaster Management Authority (DDMA)	Implements disaster preparedness, response, mitigation, and recovery at the district level.



Tier-4: Community & Last Mile Level

The Community & Last Mile level represents the first point of action during disasters, where local institutions, volunteers, and civil society organizations play a critical role in preparedness and emergency response. Their close engagement with communities enables timely evacuation, awareness generation, relief distribution, and faster recovery at the grassroots level.

Authority / Agency	Role
Gram Panchayats	Lead village-level disaster preparedness, awareness, and response activities.
Urban Local Bodies (ULBs)	Manage disaster preparedness, emergency response, and recovery within urban areas.
Community Volunteers (Aapda Mitra)	Support first response, evacuation, search and rescue, and community awareness.
NGOs & Civil Society Organizations	Assist in awareness generation, relief distribution, rehabilitation, and capacity building.
Armed Forces / Indian Coast Guard	Provide emergency support, logistics, evacuation, search and rescue, and humanitarian assistance during major disasters



6.2 Policy Framework: Disaster Management Act and National Plans

The Disaster Management Act, 2005, provides the legal and institutional framework for disaster management across India. It was enacted after the 2004 Indian Ocean Tsunami exposed the absence of any institutional mechanism for coordinated disaster response.

Key Features of the Disaster Management Act, 2005:

- **Created a three-tier institutional structure:** NDMA (national) → SDMA (state) → DDMA (district)
- **Mandated preparation of National,** State, and District Disaster Management Plans
- **Defined "disaster" broadly:** Includes natural and man-made catastrophes causing substantial loss of life, property, or environmental degradation beyond the coping capacity of the affected community
- **Established the National Disaster Response Force (NDRF)** as a specialized response force

Disaster Management (Amendment) Bill, 2024:

The bill adds key functions to NDMA and SDMA, including:

- Taking periodic stock of disaster risks, including emerging risks from extreme climate events
- Providing technical assistance to authorities below them
- Recommending guidelines for minimum standards of relief
- Preparing national and state disaster databases



6.3 Alignment with International Frameworks

India's disaster management framework aligns with key international frameworks:

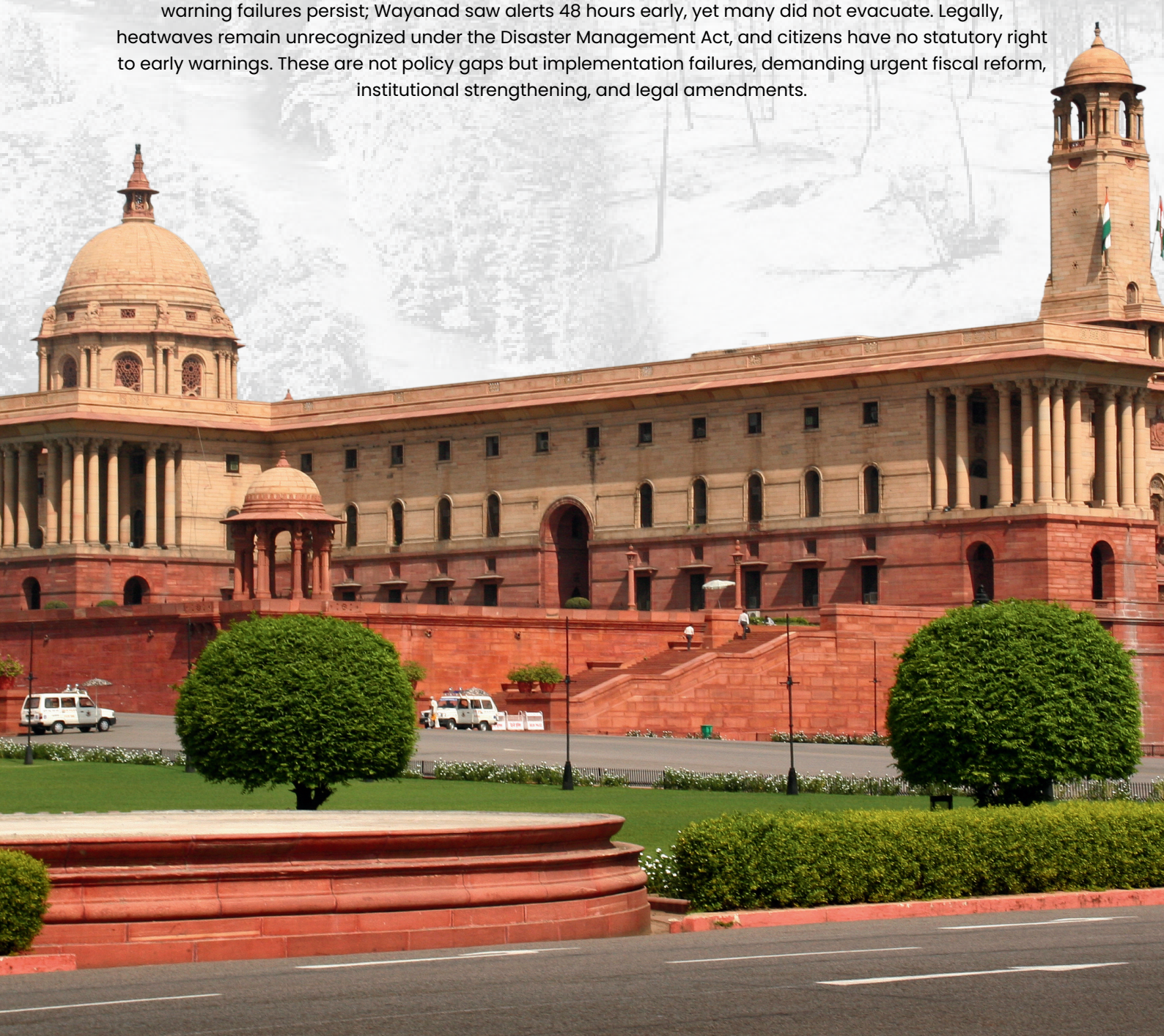
Framework	Alignment
Sendai Framework for Disaster Risk Reduction 2015-2030	India's shift from a relief-centric to a proactive, holistic, and integrated approach of strengthening disaster preparedness, mitigation, and emergency response aligns with Sendai's four priorities.
Paris Agreement (2015)	India's climate adaptation and mitigation commitments are integrated into disaster resilience planning.
Sustainable Development Goals (SDGs)	Disaster resilience contributes to SDG 1 (No Poverty), SDG 11 (Sustainable Cities), SDG 13 (Climate Action), and SDG 17 (Partnerships).



Structural Gaps and Systemic Challenges in India's Disaster Governance

Despite policy advancements, India's disaster governance framework suffers from critical implementation deficits across institutional, financial, operational, and legal dimensions. Interdepartmental coordination remains fragmented, response forces face **67–96% vacancy rates,** and only 12 cities have functional Urban Disaster Management Authorities.

Financially, outdated compensation norms **(₹4 lakh for death vs. ₹8–10 lakh actual reconstruction cost)** and bureaucratic delays mean Kerala received just **12%** of requested funds. Operationally, last-mile warning failures persist; Wayanad saw alerts 48 hours early, yet many did not evacuate. Legally, heatwaves remain unrecognized under the Disaster Management Act, and citizens have no statutory right to early warnings. These are not policy gaps but implementation failures, demanding urgent fiscal reform, institutional strengthening, and legal amendments.



Category	Gap / Issue	Current Status	Key Data Point
INSTITUTIONAL & GOVERNANCE	Poor inter-departmental coordination	Ministries work in silos; no mandatory data-sharing	Delayed response in 2023 Himachal floods
	Slow disaster planning	States take 5–7 years to update plans.	Only 18/28 states have approved SDMPs.
	Weak city-level authorities	UDMAs lack budgets & staffing.	Only 12 cities have functional UDMAs.
	Critical staff shortages	SDRF severely understaffed	67–96% vacancy rates (CAG 2023)
	No permanent response framework	NDRF deployed on a request basis.	Deployment delays: 24–48 hours
FINANCIAL	Outdated compensation	₹4 lakh (death); ₹1.2 lakh (house), unchanged since 2014	Actual house reconstruction cost: ₹8–10 lakh.
	Funds not reaching states	Bureaucratic delays in fund release	Kerala got ₹260 crore of the ₹2,200 crore requested (~12%).
	No definition of "severe disaster"	The Disaster Management Act lacks severity thresholds.	States must plead case-by-case for funds.
	Poor insurance coverage	Only 7–10% of losses insured	Global average: 30–40%
	Inadequate budget allocation	NDRF/SDRF: ~₹12,000–15,000 crore annually.	Assessed need: ₹40,000+ crore

Category	Gap / Issue	Current Status	Key Data Point
OPERATIONAL	Warnings don't reach communities.	Last-mile communication fails.	Wayanad: alerts issued 48 hrs early; many did not evacuate
	Hospitals unprepared	Lack of surge capacity & emergency stockpiles	Only 3/13 surveyed hospitals in Eastern India prepared
	Building codes not enforced	NBC 2016 exists, but enforcement is weak.	>60% urban buildings in high-risk zones non-compliant
	No pandemic preparedness plan	The COVID-19 response was reactive.	Biological threats not covered under the Disaster Management Act.
	Equipment shortages	SDRF lacks modern gear (drones, thermal cameras).	Procurement cycles take 2–3 years.
LEGAL & POLICY	Heatwaves not recognized as a disaster	Not classified under the Disaster Management Act	No dedicated funds; ~2,000 heat-related deaths (2024)
	Coastal erosion ignored	Act excludes slow-onset disasters.	Affects ~45% of coastline (1,500+ km); no formal relief
	Vulnerability narrowly defined	Measured only by physical/exposure metrics	Community coping capacity & resilience not factored in
	No legal right to early warning	Citizens have no statutory entitlement.	No accountability for warning failures.
	The Disaster Management Act is outdated.	Drafted pre-climate crisis; no multi-hazard coverage.	Amendments recommended since 2020; none tabled.

Regional Perspectives

Disaster Scenarios in Neighboring Countries



Nepal

faced unprecedented rainfall (239.7 mm in 24 hours in Kathmandu, the highest in 22 years) in September 2024, triggering floods and landslides that killed 250 people, injured 178, and affected over 2.5 million across 20 districts.



Total damage exceeded NPR 56 billion (~$420 million), with major infrastructure losses including 11 hydropower plants, 9 highways, 1,639 water projects, and 43 schools. Bagmati Province was hardest hit.

Bhutan's

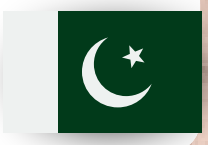


Bhutan's hydropower-dependent economy proved highly vulnerable in October 2025, when continuous rain and flash floods forced five major plants (Tala, Suchhu, Dagachhu, Punatsangchhu-II, and Chhukha) offline, causing nationwide power outages that cascaded into transport, communications, and health system disruptions.

Nearly 60% of existing and planned hydropower capacity lies in flood-prone districts facing 100 mm more monsoon rainfall under worst-case climate scenario.

Pakistan

experienced catastrophic 2025 monsoon flooding, with 657 deaths and 929 injuries nationwide. The crisis was compounded by glacial lake outburst floods (GLOFs);



a July 2025 GLOF from the Shishper glacier severed the Karakoram Highway, destroying homes and GLOF systems in Hunza Valley. Over 6.9 million people were affected across Punjab, Khyber Pakhtunkhwa, Gilgit-Baltistan, and Sindh, with estimated losses reaching $40 billion.

Sri Lanka



Shri Lanka was devastated by Cyclone Ditwah (November 2025), which brought 150–500 mm of rainfall and winds of 70–90 km/h. The cyclone affected 2.18 million people (10% of the population), displaced 286,377, and killed 618, with 209 still missing.

Over 75,000 homes were damaged (6,288 fully), and more than 106,000 hectares of paddy, critical for the Maha season and supplying 70% of annual rice, were destroyed. An estimated 1.2 million people (including 527,000 children) require humanitarian assistance, with 239,500 still displaced.

Myanmar

was hit by Typhoon Yagi's remnants in September 2024, causing the heaviest rainfall in 70 years and flooding 59 townships across nine regions.



An estimated 631,000 people were affected, with over 480,000 hectares of cropland submerged, 585,000 buildings damaged, and 433 deaths reported. Telecommunications and internet instability hampered early warning dissemination, while ongoing conflict delayed response efforts.

Transboundary Risks: Over 20 major rivers flow across South Asian borders, supporting nearly 1.9 billion people, yet regional governance remains fragmented. The 1960 Indus Waters Treaty faces growing strain from glacial melt (the HKH region losing glaciers under the 1.5°C scenario) and shifting monsoon patterns. Shared basins Indus (China, India, Pakistan), Ganges-Brahmaputra (Nepal, India, Bangladesh), and Teesta (lunder the Bangladesh), face unresolved water-sharing disputes, with climate change projected to increase flood risks by up to 25% in the Brahmaputra Basin by 2100. SAARC cooperation has stalled since 2016.

Key Takeaway: Neighboring countries share Himalayan glacial melt, transboundary rivers, and intensifying cyclones, yet regional coordination remains weak, demanding strengthened early warning systems, joint flood forecasting, and mutual aid agreements.

Emerging Disaster Scenarios

Anticipating New Threats



9.1 Climate Cascades: When Hazards Collide

Climate risk in India no longer arrives as isolated events but as cascading sequences where one trigger unleashes multiple disasters. A cloudburst in fragile terrain triggers a landslide, cuts off power, and disrupts water supply—a single trigger, many failures. The 2023 Sikkim GLOF exemplifies this: **14.7 million** cubic meters of moraine collapsed into South Lhonak Lake, triggering a 20-meter tsunami wave and releasing **50 million cubic meters** of water that destroyed five hydropower plants and **killed 55 people.**

Key Projection: India ranks sixth globally in climate impact (1993–2022), enduring 400+ extreme weather events with ~80,000 fatalities and $180 billion in damages. The IPCC warns that climate risk is now less about single massive events and more about sequences of moderate events cascading through weak systems.

9.2 Forest Fire Epidemic: India's Burning Crisis

Forest fires are emerging as a distinct climate-driven disaster in India. Approximately 36% of India's forests are prone to frequent fires, with regions like Uttarakhand, Madhya Pradesh, Chhattisgarh, and Odisha witnessing alarming increases. **The 2016 Uttarakhand fires alone recorded over 1,600 events, destroying 4,000+ hectares in weeks.**

Key Drivers: Rising temperatures, erratic rainfall, and prolonged droughts create ideal conditions for fire ignition and spread. Over 90% of fire incidents are human-caused, but climate factors—high temperatures, low humidity, and strong winds—determine severity and extent.

Impact: Fires emit 5–10% of global carbon annually, damage soil quality, humidity, and nutrient cycles, and threaten livelihoods. 6 billion forest-dependent people worldwide. India's forest cover (21.67% of land area) faces accelerating vulnerability.

9.3 The Cyber-Physical Threat: India's Critical Infrastructure Under Siege

As AI becomes embedded in India's critical infrastructure, such as power grids, nuclear facilities, defense installations, and telecommunications, cyber-physical attacks represent a new national security imperative. A compromise at any layer—processors, firmware, AI models, remote update mechanisms—could compromise the confidentiality, integrity, and availability of essential services.

The Gap: India lacks a native IEC 62443 Compliance Platform to secure Industrial Control Systems . Current efforts are fragmented; there is no dedicated institute integrating research and services, practice in securing critical infrastructure, and national security systems. The 2020 Mumbai power outage and AIIMS Delhi server attacks are harbingers of what targeted cyber warfare can unleash.

Emerging Vector: Attacks on Battery Management Systems, like the 2026 e-rickshaw incident, reveal connected batteries as a new threat vector where adversaries could remotely disable vehicles or disrupt power grids.

9.4 Himalayan Water Towers: Peak Water and Perpetual Crisis



The Hindu Kush Himalaya, warming at **0.28°C per decade,** is the world's most vulnerable "water tower," supporting **240 million downstream people.** The region faces a dual crisis: short-term GLOFs and flash floods, and long-term "peak water" as glaciers disappear.

Key Statistics:

- Himalayan glaciers have shrunk by 38% in 40 years.
- Projected **30–50% glacier** volume reduction by **2100 at 1.5–2°C warming.**
- **28,000+** glacial lakes in the Himalayas; the intensity and frequency of GLOFs have been increasing since 2000.
- Monsoonal precipitation plays a critical role in triggering GLOFs.

The 2023 Sikkim Event: The South Lhonak Lake breach detected years earlier with moraine shifts up to 15 meters/year was a warning ignored. It destroyed the 1,250 MW Chungthang Dam and washed away 270 million cubic meters of sediment.

9.5 Emerging Heat Stress: A New Geography of Danger

Extreme heat and humidity are reshaping India's risk map. By mid-century, the annual number of days with dangerously high heat index values (≥27°C) is projected to rise by more than 50 days under moderate emissions scenarios.



Key Statistics:

- **India's average temperature rose 0.9°C in the last decade versus the early 20th century; the hottest day warmed by 1.5–2°C in Western and northeastern India.**
- **Heatwave days:** 5–10 extra days per decade across most regions.
- **Marine heatwaves in the Indian Ocean:** 20 days/year historically → 200 days/year by 2050.
- **Compound extremes of heatwaves and droughts** occurring simultaneously pose escalating challenges that overwhelm response capacities.

Unique Insight: Heat stress in India often peaks not during the hottest pre-monsoon afternoons but during moist monsoon nights along the eastern seaboard, where high humidity throttles evaporative cooling.

Technology and Innovation for Disaster and Climate Resilience

Technology plays a vital role in strengthening India's disaster risk management ecosystem by enabling early warning, real-time monitoring, and coordinated emergency response.

India has made significant technological strides, from high-performance computing and AI-driven early warnings to space-based monitoring, representing a paradigm shift from reactive relief to anticipatory resilience.



Key Digital Platforms and Applications

Technology / Platform	Launch	Developed By	Role
Sachet	2023	NDMA and C-DOT	CAP-based multi-channel disaster alerts in multiple Indian languages
FloodWatch India 2.0	2024	Central Water Commission (CWC)	Seven-day flood forecasting and real-time river monitoring
National Landslide Forecasting Centre	2024	Geological Survey of India (GSI)	Daily landslide forecasting and risk assessment
C-FLOOD	2025	Ministry of Jal Shakti, CWC, C-DAC and ISRO NRSC	Village level flood inundation forecasting up to two days in advance
SAMUDRA App	2024	INCOIS	Ocean forecasts, tsunami warnings, and fishing advisories
Integrated Control Room for Emergency Response	2025	Ministry of Home Affairs and ISRO NRSC	Twenty four hour disaster monitoring and emergency coordination
Bhookamp App	2025	National Center for Seismology (NCS)	Real time earthquake information and alerts
Cell Broadcast System (CBS)	2026	DoT, C-DOT and NDMA	Geo targeted emergency alerts to mobile devices
Damini App	2020	Indian Institute of Tropical Meteorology (IITM)	Real time lightning alerts within a 20 to 40 kilometre radius
Mausam App	2020	India Meteorological Department (IMD)	Weather forecasts and severe weather warnings
Meghdoot App	2019	IMD and ICAR	Weather based agricultural advisories for farmers
Bhuvan Disaster Services	Ongoing	ISRO NRSC	Satellite based disaster mapping and damage assessment
MOSDAC	Ongoing	ISRO Space Applications Centre (SAC)	Meteorological satellite data and cyclone monitoring
National Database for Emergency Management (NDEM)	Ongoing	ISRO NRSC	GIS platform for hazard, infrastructure, and response management

Key Innovations

Innovation	Capability	Status
Bharat Forecasting System	6 km resolution weather forecasts with panchayat-level coverage	Operational (2025)
Arka and Arunika HPC Systems	High-performance computing for weather and climate modelling	Operational (2025)
Mithuna Forecasting System	4 km regional and 330 m urban weather forecasting	Operational (2026)
AI-Based Landslide Forecasting	AI-driven landslide prediction with early warnings	Pilot deployment in Himachal Pradesh
ISRO International Charter Leadership	Global satellite-based disaster response coordination	Completed (2025)

Institutional Framework

- **National Action Plan on Climate Change (NAPCC):** Nine National Missions guiding climate resilience and adaptation.
- **State Climate Change Cells:** Established across 30 States and Union Territories to support state-level climate planning.
- **India AI Mission:** Strengthens access to AI infrastructure, datasets, and computing for public sector innovation.
- **RuTAG, NIDHI, and Atal Innovation Mission:** Support technology development, startups, and rural innovation for disaster resilience.

Key Challenges

Challenge	Issue
Last Mile Communication	Limited reach of early warning systems in vulnerable and remote communities
Data Interoperability	Inconsistent data sharing across agencies and platforms
AI Adoption	Limited technical capacity, trust, and governance for AI deployment
Cyber Security	Increasing risks to interconnected digital infrastructure and critical systems

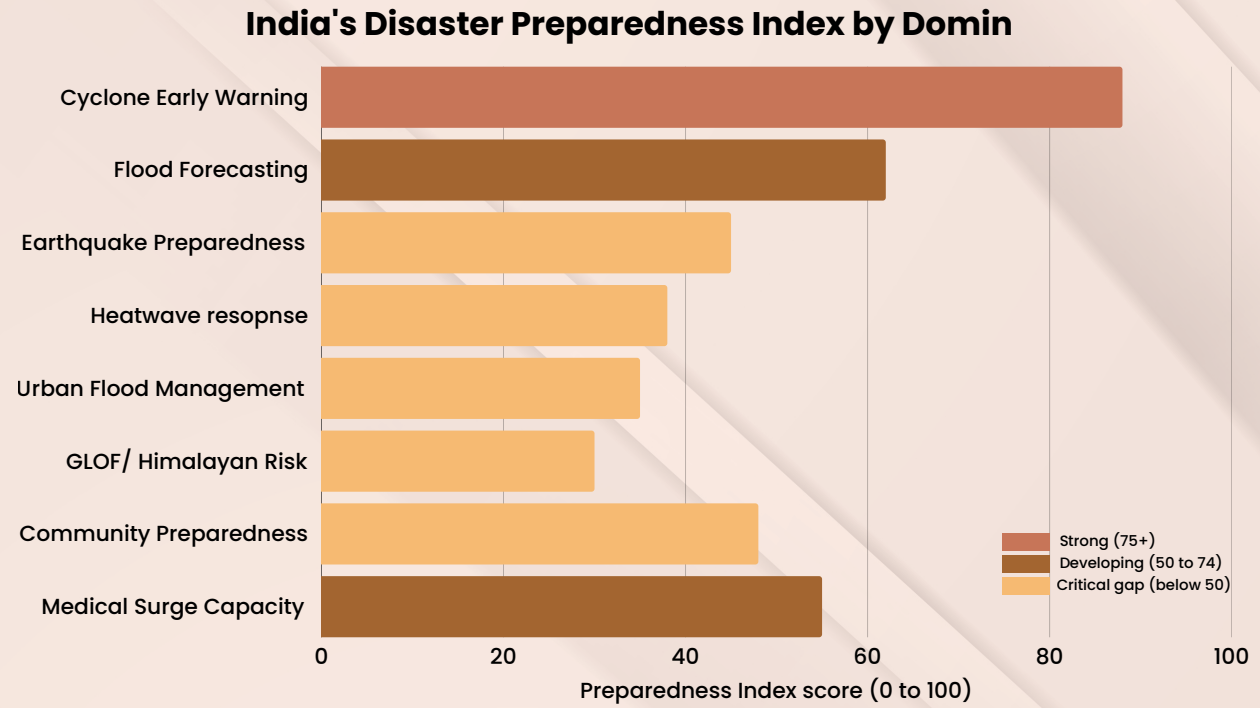
India's Preparedness

A Critical Stocktake



India's disaster preparedness has advanced considerably since the 2004 Indian Ocean tsunami exposed the country's institutional gaps, yet that progress remains sharply uneven across hazard types, geographies, and levels of government. A single national preparedness score would obscure more than it reveals.

The evidence instead points to a country that has built genuine, internationally recognized strength in one domain (cyclone early warning) while leaving others (heatwave response, urban flood management, and Himalayan or GLOF risk monitoring) as critical gaps. This section examines that unevenness through three lenses: the preparedness scorecard by hazard domain, the financial architecture that underwrites preparedness, and the institutional and technological mitigation measures now being scaled.



Source: NDMA Annual Report 2024; IMD; CWC; ISRO; NIDM Assessment Report; INFORM Risk Index 2024

India's disaster preparedness varies significantly across hazard types. The **country scores 88 in cyclone early warning,** a world-class strength with zero casualties during recent cyclones like Biparjoy (2023) and Dana (2024). However, critical gaps remain in heatwave response, urban flood management, and GLOF/Himalayan risk monitoring areas, where legal recognition, institutional frameworks, and last-mile delivery are severely lacking.

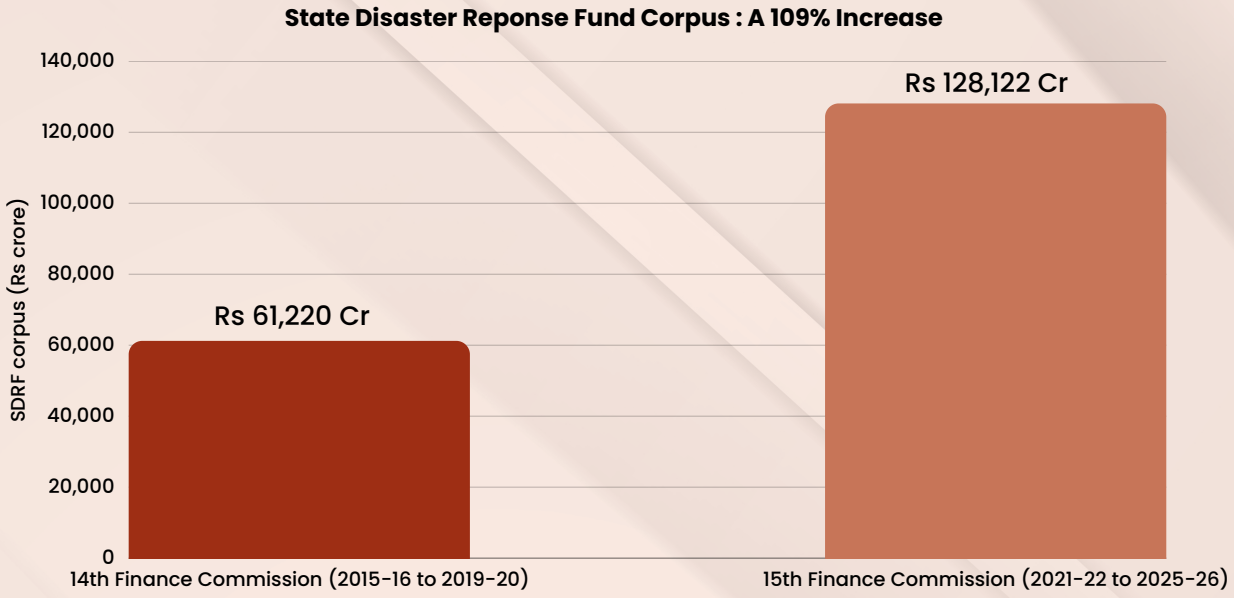
The visual presents an indicative assessment of India's preparedness across major disaster domains. While cyclone early warning systems demonstrate a high level of preparedness, significant gaps remain in heatwave response, urban flood management, Himalayan hazard monitoring, and community-level preparedness, highlighting priority areas for future investment and policy action.

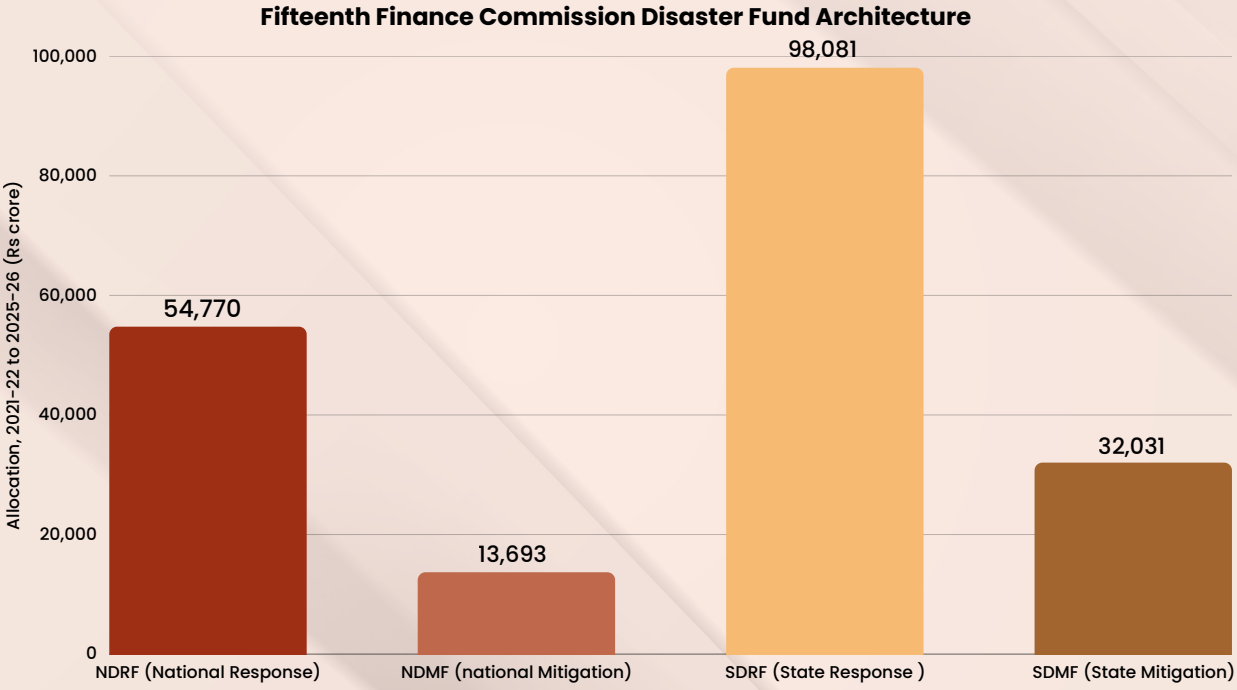


11.1 Financing Disaster Preparedness: Scale and Trend

Disaster financing in India follows a two-tier, four-fund framework under the Disaster Management Act, 2005, comprising the National Disaster Response Fund (NDRF) and National Disaster Mitigation Fund (NDMF) at the national level and the State Disaster Response Fund (SDRF) and State Disaster Mitigation Fund (SDMF) at the state level.

For the Fifteenth Finance Commission (2021/22 to 2025/26), a total of **Rs 228,616 crore** was allocated for disaster risk management, including Rs 160,153 crore for state funds (SDRF and SDMF) and Rs **68,463 crore** for national funds (NDRF and NDMF). Compared to the Fourteenth Finance Commission, which allocated Rs **61,220 crore** only for SDRF, the current framework significantly increases funding and introduces dedicated mitigation funds, marking a shift from relief-focused financing to proactive disaster risk reduction.

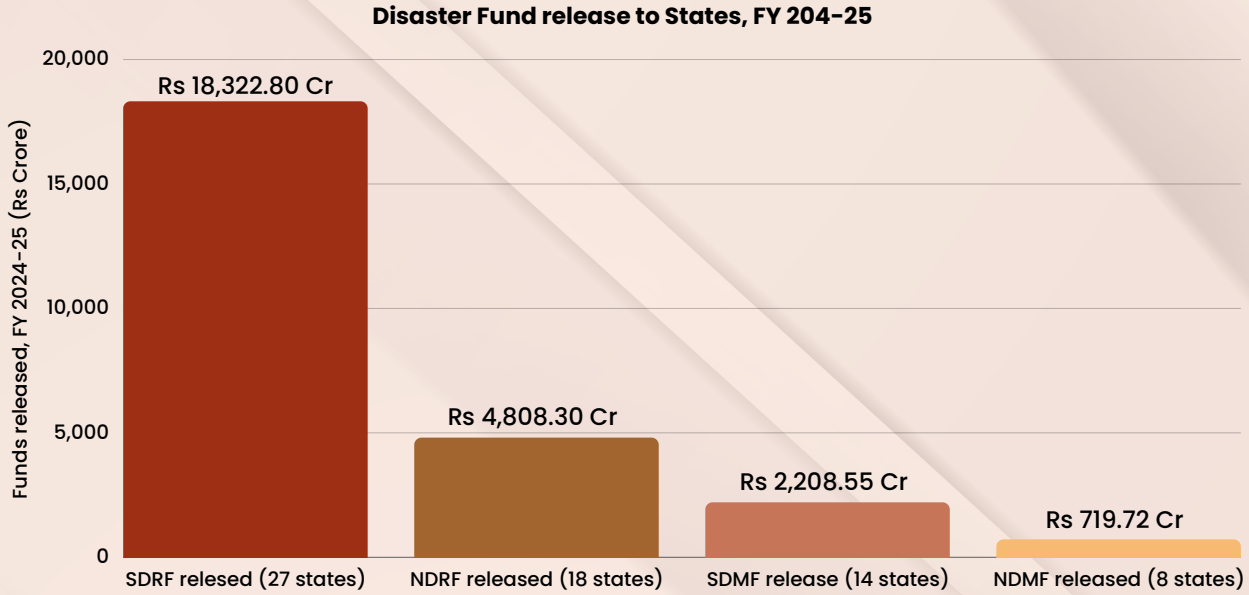




The Fifteenth Finance Commission earmarked mitigation funding for key risk areas, including fire services **(Rs 5,000 crore),** urban flood management **(Rs 2,500 crore),** erosion mitigation **(Rs 1,500 crore),** drought resilience **(Rs 1,200 crore),** resettlement of erosion-affected communities **(Rs 1,000 crore),** and seismic and landslide risk reduction **(Rs 750 crore).** These targeted allocations strengthen preparedness by prioritizing India's most vulnerable hazards and regions.

Fund Utilization: Are Allocations Reaching the Ground?

Allocation is only half the story; disbursement determines whether preparedness translates into capacity on the ground. In financial year 2024/25, the Centre released **Rs 18,322.80 crore** in SDRF to 27 states, **Rs 4,808.30 crore** in NDRF assistance to **18 states, Rs 2,208.55 crore** in SDMF to 14 states, and **Rs 719.72 crore in NDMF to 8 states.** A further **Rs 1,554.99 crore** in supplementary NDRF assistance was approved in February 2025 for Andhra Pradesh, Nagaland, Odisha, Telangana, and Tripura following Inter Ministerial Central Team assessments of flood, landslide, and cyclonic storm damage in 2024.

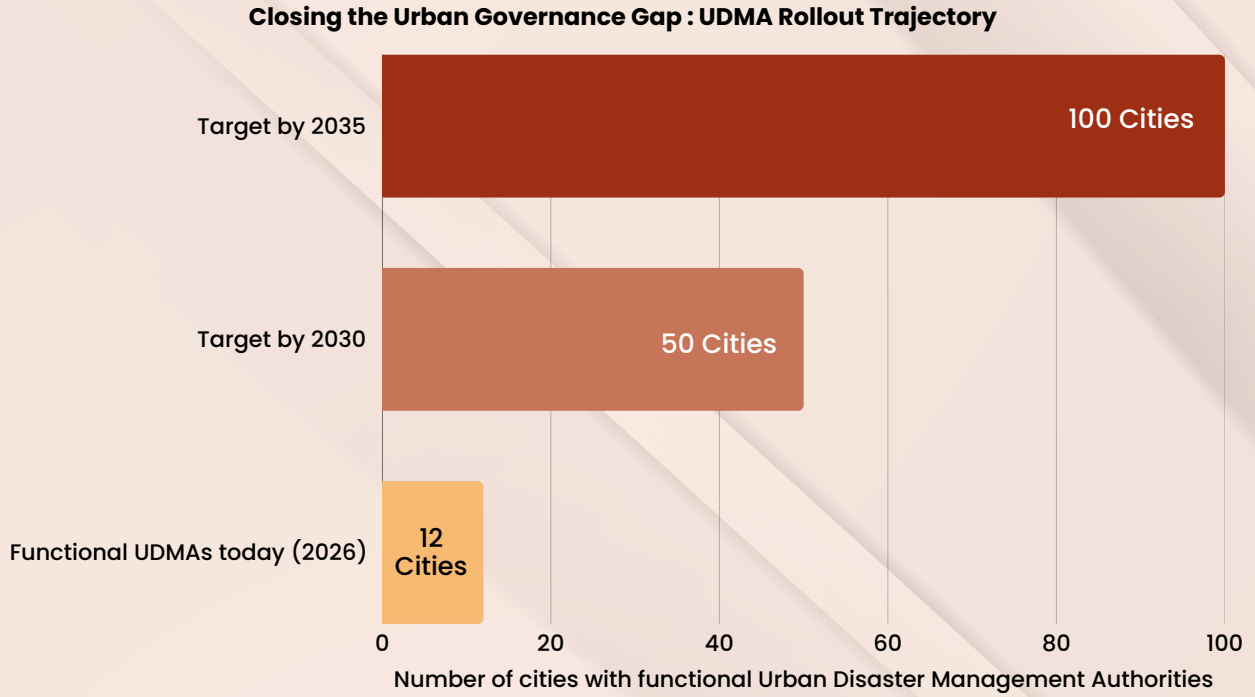


The gap between mitigation fund releases (SDMF and NDMF combined, roughly **Rs 2,928 crore** in FY 2024/25) and response fund releases (SDRF and NDRF combined, roughly **Rs 23,131 crore)** illustrates a structural imbalance this report flagged earlier: the system still spends far more on relief after a disaster than on prevention before one, even though the mitigation funds now formally exist. Closing this gap, not merely allocating money to a mitigation fund on paper, is central to the strategic priorities set out in the next section.



11.2 Institutional and Legal Mitigation Measures

The Disaster Management (Amendment) Act, 2025, strengthened India's disaster governance by granting statutory status to national crisis bodies, enabling Urban Disaster Management Authorities (UDMAs), establishing a National Disaster Database, mandating a unified early warning framework, allowing states to create State Disaster Response Forces (SDRFs), and formally separating disaster response and mitigation funds. However, implementation remains limited, with Karnataka being the first state to operationalize a UDMA.





11.3 Capacity Building and Technology Deployment

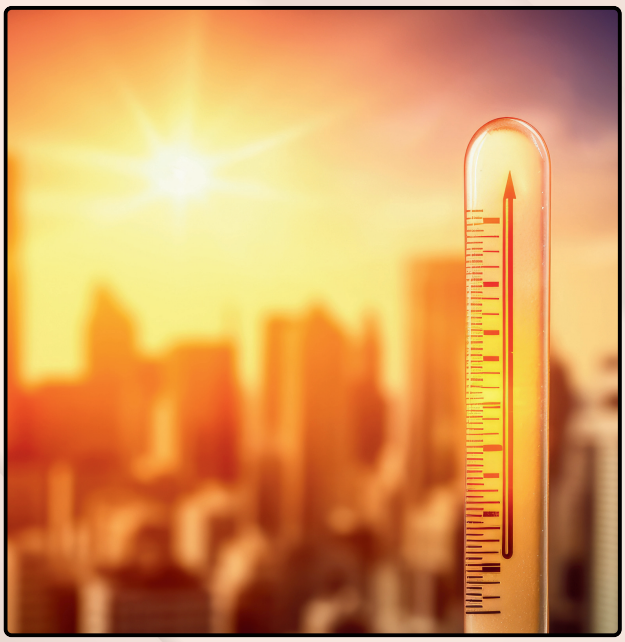
India has strengthened disaster preparedness through the establishment of the NDRF Academy for standardized training and nationwide SDRF capacity building. Under Mission Mausam (2025), IMD has integrated AI and machine learning into weather forecasting, supported by the Bharat Forecasting System and the Mithuna Forecasting System for high-resolution weather prediction.



11.4 Outcomes

Despite a rise in extreme weather events due to climate change, India's preparedness has significantly reduced disaster mortality in some hazards. Cyclone-related deaths have declined by over 90% since 1999, reflecting improvements in forecasting, early warning systems, and evacuation planning. However, heatwaves, urban flooding, and Himalayan hazards continue to face preparedness gaps, highlighting the need to strengthen last-mile communication and community-level response.





Strategic Imperatives and Recommendations for 2035

India's disaster risk trajectory to 2035 will be shaped less by whether hazards intensify, since the evidence in Sections 3 through 5 indicates they will, than by how quickly the country converts its existing legal, financial, and technological foundation into implemented, last-mile capacity. This report proposes five strategic priorities, each paired with concrete actions, an accountable institutional owner, and an indicative timeline. Together they are designed to close the gap between the roughly 18x estimated return on resilience investment cited in the executive summary and the annual resilience investment shortfall of more than USD 24 billion.



Priority 1: Universal Early Warning Coverage

Cyclone early warning demonstrates what is achievable; the priority now is extending that same standard, forecast accuracy paired with guaranteed last-mile delivery and community-level evacuation drills, to floods, heatwaves, landslides, and GLOFs.

- Operationalize the Cell Broadcast System nationwide (piloted 2026) so that geo-targeted emergency alerts reach every mobile handset in an affected zone without requiring an opt-in app download.
- Give citizens a statutory right to early warning under the Disaster Management Act, with defined accountability when warnings are issued but not disseminated, directly addressing the Wayanad pattern of adequate lead time but failed last-mile delivery.
- Expand village-level and panchayat-level evacuation drills, using Aapda Mitra community volunteers as the last-mile link between IMD, CWC, and GSI forecasts and household-level action.
- Extend the Bharat Forecasting System's panchayat-level resolution to full national coverage ahead of the Mithuna system's national rollout beyond its current pilot base.

Priority 2: Climate-Proofed Infrastructure Standards

- Mandate climate risk disclosure and resilience standards in the National Building Code, closing the gap in which more than 60% of urban buildings in high-risk zones remain noncompliant.
- Require climate stress testing (flood, heat, and wind loading) for all new public infrastructure financed through central schemes, extending the logic already applied to the seven cities targeted under the Rs 2,500 crore urban flood mitigation earmark.
- Fast-track hill state building and slope stability codes in the ten states covered under the Rs 750 crore seismic and landslide mitigation allocation, given that GLOF and landslide risk monitoring remain the lowest-scoring domains on the preparedness index.

Priority 3: Strengthening Disaster Risk Financing and Insurance

- Expand disaster risk financing beyond government relief funds by strengthening insurance coverage and mobilizing private capital, reducing the current protection gap where less than 5% of disaster losses are insured.
- Strengthen and modernize Pradhan Mantri Fasal Bima Yojana (PMFBY) while promoting parametric insurance products for floods, cyclones, heatwaves, and other climate-related hazards to enable faster post-disaster payouts.
- Develop innovative financing mechanisms such as catastrophe bonds, resilience bonds, and blended finance, while incentivizing greater participation from the private insurance sector to help close the estimated USD 24 billion annual resilience investment gap.

Priority 4: Scaling Nature-Based Solutions for Climate Resilience

- Integrate nature-based solutions into national and state disaster risk reduction strategies to complement conventional infrastructure and strengthen long-term climate resilience.
- Accelerate mangrove restoration along vulnerable coastlines to reduce cyclone impacts and coastal erosion, while expanding wetland conservation and urban blue-green infrastructure to improve flood management in rapidly growing cities.
- Promote river floodplain restoration, watershed management, and forest conservation in Himalayan and other ecologically sensitive regions to reduce flood, landslide, and soil erosion risks while enhancing ecosystem resilience and water security.

Priority 5: Urban Flood Resilience for More Than 100 Cities

- Accelerate the UDMA constitution beyond the single functional authority in Bengaluru, targeting all state capitals and municipal corporation cities as enabled under Section 41A of the amended Act.
- Ring-fence a minimum share of municipal and state disaster budgets for drainage, stormwater, and wetland restoration, reversing the 2% to 3% annual wetland loss that is actively reducing natural flood buffering capacity.
- Publish annual, city-level urban flood preparedness scorecards, modelled on the national domain-level index, to create public accountability for the 12- to 100-city gap.

Priority 6: Formal Integration of Man-Made and Biological Risk

- Designate a single coordinating authority for biological hazard preparedness, replacing the currently distributed responsibility across agencies that the executive summary identifies as a structural weakness exposed by COVID-19.
- Bring heatwaves and coastal erosion within the statutory definition of disaster under the Disaster Management Act, unlocking dedicated NDRF and SDRF-eligible funding for both, rather than the current reliance on ad hoc state notifications.
- Build a native, sovereign compliance platform for Industrial Control System security aligned with IEC 62443, addressing the cyber-physical infrastructure gap described in Section 9.3, including emerging vectors such as compromised battery management systems.
- Modernize government compensation norms (currently Rs 4 lakh for a death and Rs 1.2 lakh for a destroyed house, both unchanged since 2014, against an actual reconstruction cost of Rs 8 to 10 lakh) to reflect present-day costs.

Priority 7: Closing the Annual Resilience Investment Gap

- The single largest constraint on every priority above is financing. Despite the Fifteenth Finance Commission's more than doubled allocation, India's insurance resilience index remains at just 5% to 7%, against a global average nearer 27%, and annual disaster-related economic losses of 0.4 percent of GDP continue to fall overwhelmingly on uninsured households, farmers, and state budgets.
- Scale parametric insurance and catastrophe risk pooling instruments for agriculture and coastal property, building on the roughly Rs 3,200 crore in crop insurance payouts already made to 30 lakh farmers during the 2025 monsoon.
- Fix the standing structural imbalance between response and mitigation spending identified in Section 11.2, where mitigation fund releases remain a small fraction of response fund releases, by enforcing the amended Act's requirement that states allocate a defined mitigation share of the disaster budget.
- Resolve the 67% to 96% SDRF staffing vacancy rate and the current request-based, 24- to 48-hour NDRF deployment model, moving toward a standing, prepositioned response framework in the highest-risk states.
- Pursue blended finance, combining Finance Commission transfers, multilateral concessional lending from the World Bank and Asian Development Bank, and private catastrophe bond issuance, to mobilize the estimated USD 24 billion annual shortfall against the cited 18x return on resilience investment.

Regional and International Alignment

None of the five priorities can be pursued in isolation from South Asia's shared hydrology. Over 20 major transboundary rivers, including the Indus, Ganges Brahmaputra, and Teesta systems, support nearly 1.9 billion people, yet SAARC level cooperation has stalled since 2016 even as climate change is projected to raise flood risk in the Brahmaputra basin by up to 25% by 2100. India should pursue bilateral and minilateral joint flood forecasting and glacial lake monitoring agreements with Nepal, Bhutan, Bangladesh, and Pakistan where multilateral SAARC channels remain blocked, while continuing to lead in global frameworks such as the Sendai Framework, the Paris Agreement, and the Sustainable Development Goals referenced in Section 6.3.

Conclusion

India's disaster and climate risk landscape is becoming increasingly complex as climate change, rapid urbanization, ecological degradation, and emerging biological and technological threats continue to intensify hazard exposure. While significant progress has been made through strengthened institutions, improved early warning systems, enhanced disaster financing, and technological innovation, preparedness remains uneven across hazard categories and regions.

The findings of this report demonstrate that resilience is not solely determined by the ability to respond to disasters but by sustained investment in risk reduction, climate adaptation, resilient infrastructure, ecosystem restoration, and coordinated governance. Closing the remaining gaps in urban resilience, heatwave management, Himalayan hazard monitoring, biological preparedness, disaster risk financing, and last-mile communication will be critical to safeguarding lives, livelihoods, and economic development.

This report provides an evidence-based assessment of India's disaster and climate resilience landscape and identifies strategic priorities to strengthen preparedness through 2035. It is intended to support policymakers, disaster management authorities, industry, researchers, and development partners in advancing coordinated, risk-informed decision-making and long-term resilience planning.

As disaster risks continue to evolve, building a resilient India will require a sustained shift from reactive disaster response to proactive risk reduction, ensuring that resilience becomes an integral part of national development and climate action.



Abbreviations

Abbreviation	Full Form
ADB	Asian Development Bank
AI/ML	Artificial Intelligence / Machine Learning
BBMP	Bruhat Bengaluru Mahanagara Palike
CBS	Cell Broadcast System
CCS	Cabinet Committee on Security
C. DOT	Centre for Development of Telematics
CWC	Central Water Commission
DDMA	District Disaster Management Authority
DM Act	Disaster Management Act, 2005
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft fur Internationale Zusammenarbeit (German Development Agency)
GLOF	Glacial Lake Outburst Flood
GSI	Geological Survey of India
HKH	Hindu Kush Himalaya
ICIMOD	International Centre for Integrated Mountain Development
IITM	Indian Institute of Tropical Meteorology
IMCT	Interministerial Central Team
IMD	India Meteorological Department
INCOIS	Indian National Centre for Ocean Information Services
IPCC AR6	Intergovernmental Panel on Climate Change, Sixth Assessment Report

Abbreviation	Full Form
ISRO	Indian Space Research Organisation
MHA	Ministry of Home Affairs
MoEFCC	Ministry of Environment, Forest and Climate Change
NAPCC	National Action Plan on Climate Change
NCMC	National Crisis Management Committee
NCS	National Center for Seismology
NDEM	National Database for Emergency Management
NDMA	National Disaster Management Authority
NDMF	National Disaster Mitigation Fund
NDRF	National Disaster Response Fund / National Disaster Response Force
NDRMF	National Disaster Risk Management Fund
NIDM	National Institute of Disaster Management
NRSC	National Remote Sensing Centre
PDNA	Post Disaster Needs Assessment
SAARC	South Asian Association for Regional Cooperation
SAC	Space Applications Centre
SDG	Sustainable Development Goal
SDMA	State Disaster Management Authority
SDMF	State Disaster Mitigation Fund
SDRF	State Disaster Response Fund / State Disaster Response Force
SDRMF	State Disaster Risk Management Fund
UDMA	Urban Disaster Management Authority
ULB	Urban Local Body
UNDP	United Nations Development Programme
WMO	World Meteorological Organization

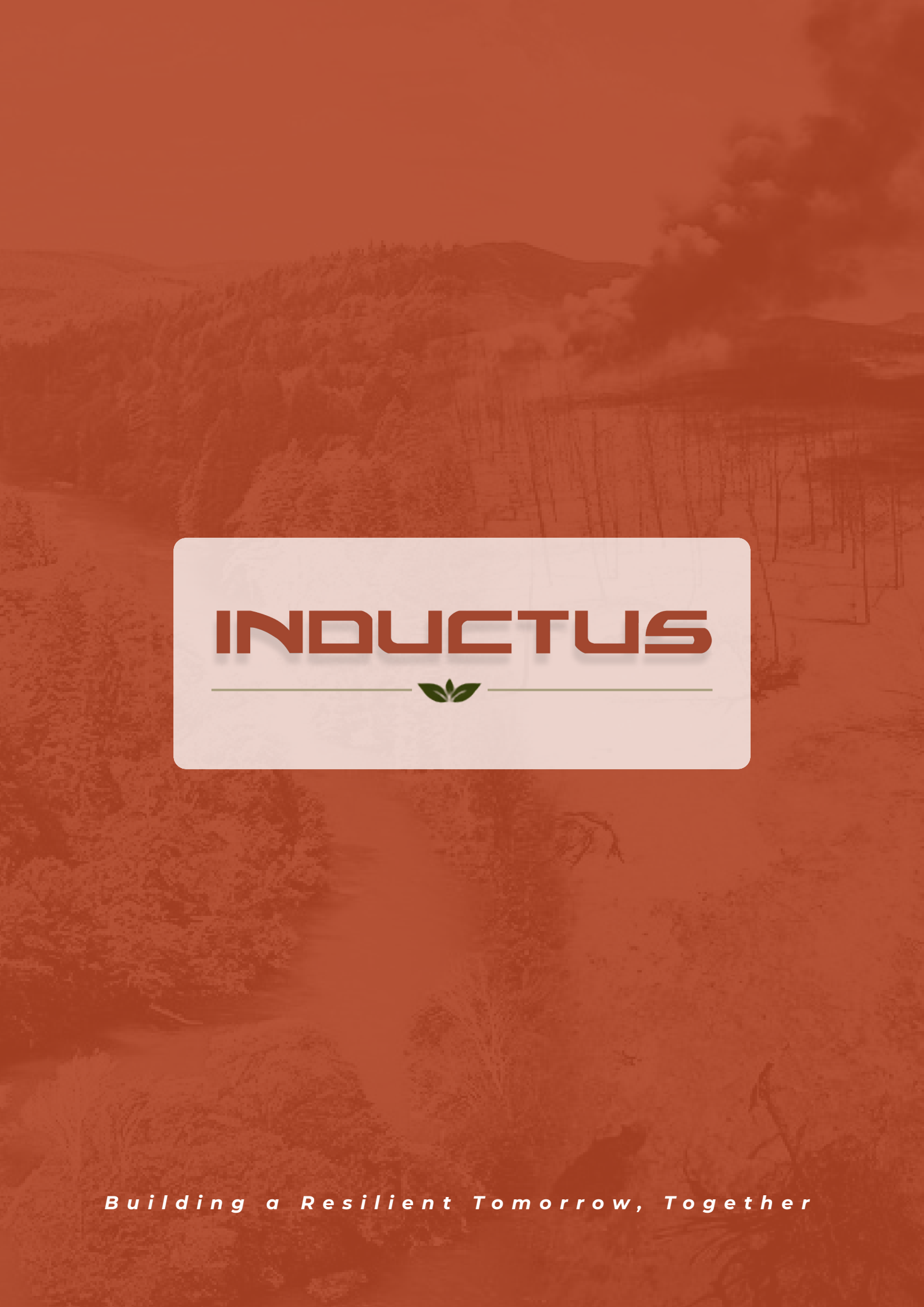
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Every degree of warming redraws the map of risk. Building resilience today is how we protect tomorrow's development.
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