CLIMATE RISK AND INSURANCE FOR INDIA'S INFRASTRUCTURE PROJECTS

CLIMATE TRENDS

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Climate risk & insurance for India's infrastructure projects

Introduction

India's decisive push for infrastructure growth comes at a time when climate risks are intensifying in frequency, severity, and geographic spread. With public and private capital expenditure on infrastructure now expected to exceed 3% of GDP[1] — and projected to rise further — its roads, ports, power plants, railways, urban assets, and logistics networks will expand rapidly across some of its most climate-vulnerable regions. The expansion is critical to driving economic growth, but the projects are also being commissioned against a backdrop of rising instances of hydro-meteorological disasters (cyclones, floods, cloudbursts and glacial lake outburst floods, heatwaves and climate-induced landslides).

While the country's exposure to climate hazards is well documented, less attention has been paid to the connections between climate risk, infrastructure development and insurance coverage. Infrastructure assets are particularly a point of concern as they are capital-intensive undertakings that have operational lives that generally exceed 50 years, and they are geographically fixed. This elevates their risk of damage from climate events over a prolonged period, and the cost implications for the country.

This paper argues that India's infrastructure push may be expanding climate exposure faster than risk-transfer mechanisms are adapting. This could create a growing protection gap that may translate into fiscal and financial stress, and reduced investment appetite in high-risk regions due to a pullback by the insurers. The paper also includes the insurance industry's perspectives on evolving climate impacts and what it implies for their business, with the objective to answer three interlinked questions:

- What are the climate risks facing India's vulnerable regions and co-located national infrastructure projects?
- What does India's current infrastructure expansion imply for future loss exposure?
- How is the non-life insurance sector responding, and where does it see the constraints?

Most importantly, it is argued that till the time climate risk remains insurable, the losses can be pooled and/or transferred through various mechanisms. When this is no longer possible, the losses would shift to the project owners, its lenders and ultimately, the states and the Centre. Due to the uncertainty of how climate impacts will manifest, this is a daunting prospect that needs a discussion.

[1] https://economictimes.indiatimes.com/news/economy/indicators/budget-2026-infra-spending-expected-to-anchor-indias-push-among-top-economies/articleshow/126120686.cms?from=mdr

1: India's Vulnerability

1.1 Vulnerable geographies

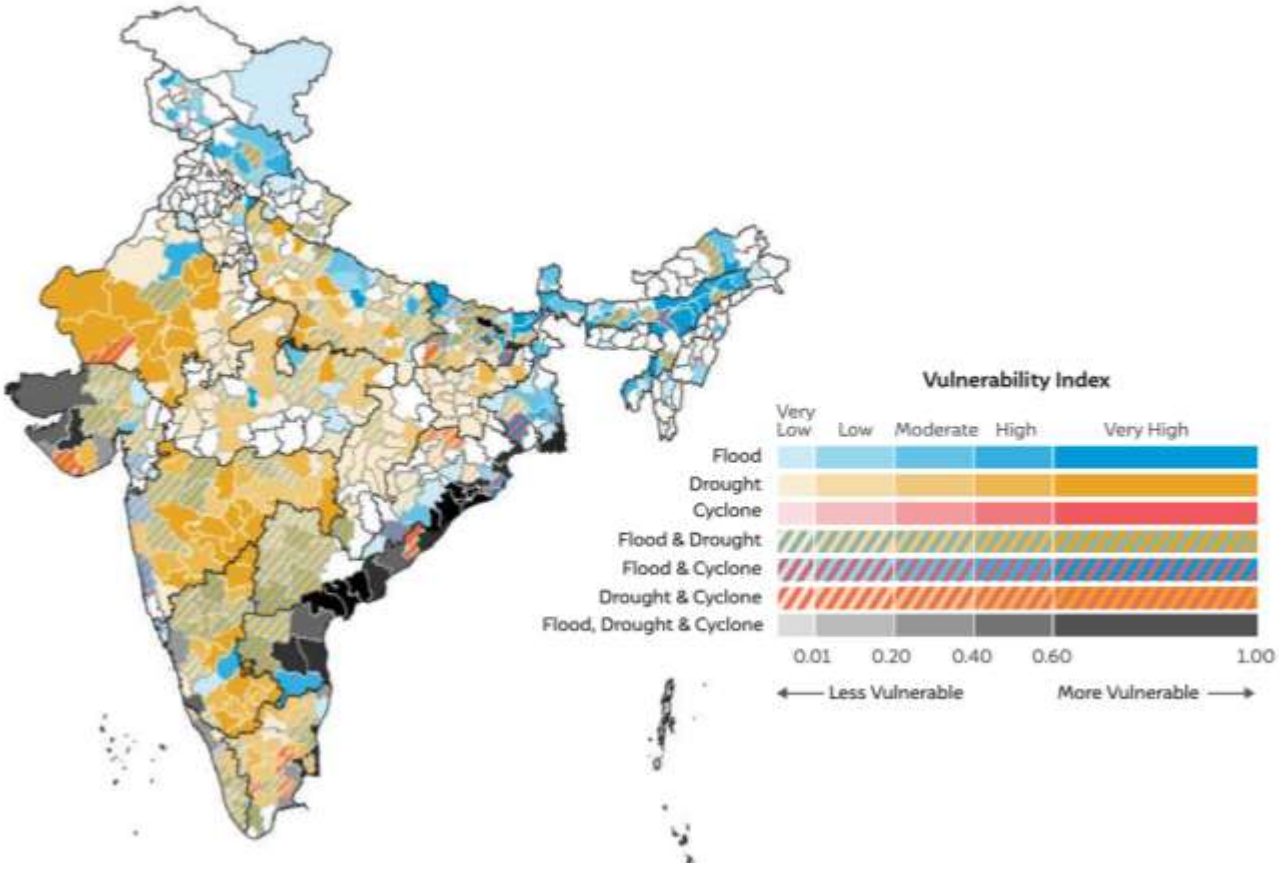


Figure 1: India's vulnerability map for hydro-met climate risks
Source: Mapping India's Climate Vulnerability, CEEW, Oct 2021

Swiss Re estimates that India's life and non-life insurance premiums will grow at one of the fastest rates in the world through to 2028, at 6.7% and 8.3% respectively[2]. The latter stems from the fact that India is ranked as the seventh-most vulnerable in terms of climate impacts. Sub-nationally, Assam, Andhra Pradesh, Odisha, Uttarakhand, Himachal Pradesh, parts of Ladakh, Sikkim and the north-eastern states are deemed to be the most vulnerable.

[2] https://www.swissre.com/institute/research/topics-and-risk-dialogues/economy-and-insurance-outlook/india-insurance-market-growing-fast-build-resilience.html

The biggest climate risks arguably stem from cyclones, flooding, droughts (*hydro-meteorological threats*), high speed winds and storm surges, cloudbursts, torrential/prolonged rainfall, landslides and extreme heat. Cyclones and floods account for the most economic damage every year (discounting earthquakes, which are not proven to be a direct climate risk).

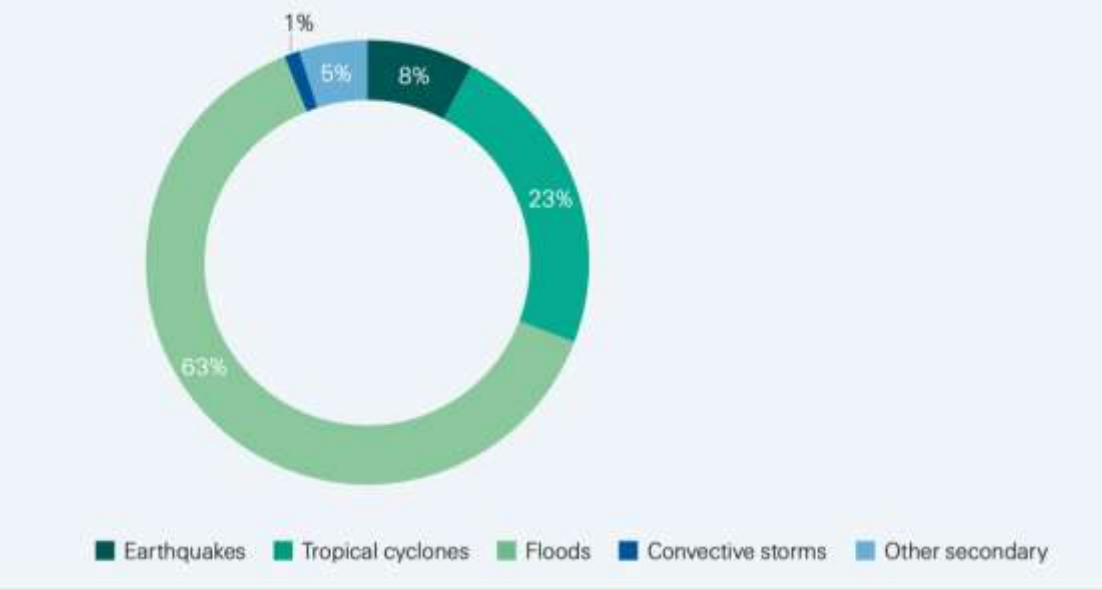


Figure 2: Share of annual average economic losses in India during 2000–2023 due to extreme weather
Source: Swiss Re Institute, 2025

India's vulnerability and incidences of climate catastrophes have risen considerably since 2000 with its rising population and as more infrastructure gets developed. Drawing inferences from the national landslide vulnerability map (figure 3), cloudbursts and torrential rainfall, or prolonged rainfall in hilly areas developed (without adequate consideration to site location and the terrain's carrying capacity), will be increasingly more vulnerable.

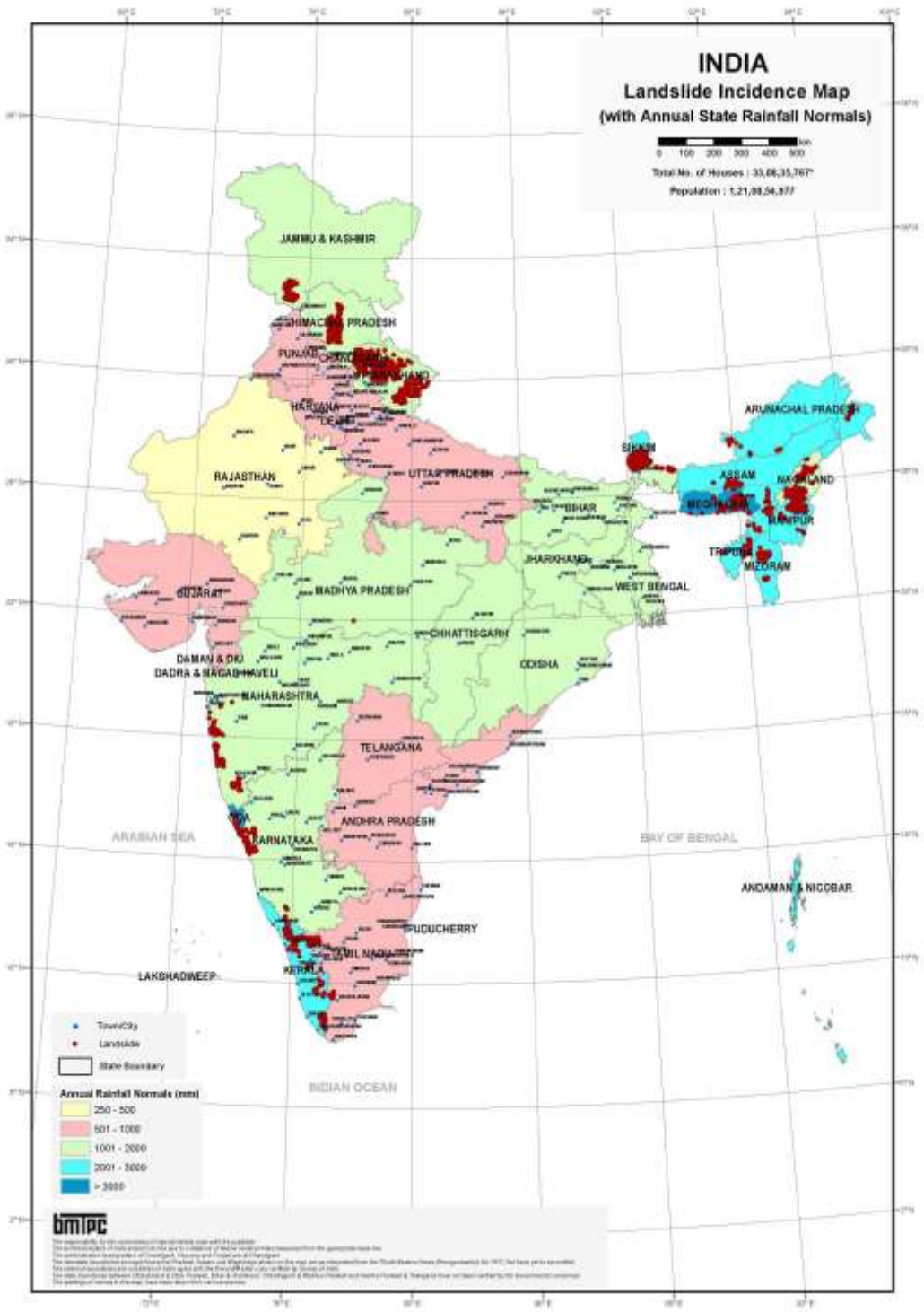


Figure 3: India's landslide vulnerability hotspots
Source: Building Materials & Technology Promotion Council, Ministry of Housing & Urban Affairs, Government of India, 2019

1.2 Natural Catastrophes and Losses

By 2021, Natural Catastrophes (NAT CATS)/extreme weather events were estimated to have cost India a total of USD 99 billion in the preceding 50 years[3]. Table 1 summarises the biggest NAT CATS India has faced since 2000 (although extreme heat is not yet not classified as a NAT CAT in India under the Disaster Management Act, 2005).

Table 1: Prominent NAT CAT events in India since 2000

Year	Event	How it played out
2005	Mumbai Floods	944 mm of rain in 24 hours (July 27) – one of highest ever recorded
2006	Surat Floods	Up to 500,000 cusecs discharge from Ukai dam
2010	Leh Cloudburst	~100mm+ rainfall in <2 hours
2013	Uttarakhand Flash Floods/Kedarnath Disaster	Heavy cloudburst + glacial lake triggers; multi-day extreme rainfall >340 mm in some catchments
2013	Cyclone Phailin (Odisha, Andhra Pradesh)	Wind speed ~200 kmph
2014	Cyclone Hudhud (Odisha, Andhra Pradesh)	Wind speed ~185 kmph
2015	Chennai Floods	Over 345 mm in a day
2015	National Heatwave (Andhra Pradesh, Telangana)	Temperatures up to 48°C
2016	Assam Floods	Heavy monsoon flooding, Brahmaputra & tributaries
2017	Cyclone Ockhi (Kerala, Tamil Nadu)	Cyclone + heavy rainfall
2018	Kerala Floods	Two weeks of extreme monsoon rainfall; over 2,300 mm season total
2018	Cyclone Titli (Odisha)	Wind speed 150–165 kmph
2019	Cyclone Fani (Odisha)	Wind speed ~200 kmph
2020	Cyclone Amphan (West Bengal, Odisha)	240 km/h winds (one of strongest Bay of Bengal since 1999)
2021	Cyclone Yaas (Odisha & West Bengal)	Surge & winds 130–155 kmph
2022	Assam & Northeast India floods	Multiple extreme rainfall events, widespread river flooding
2023	Cyclone Biparjoy (Gujarat, Rajasthan)	Sustained winds ~140–150 kmph
2023	Teesta III Dam / Lhonak Lake GLOF (Sikkim)	Glacial lake outburst flood triggered by Lhonak Lake breach, impacting Teesta III hydropower project, Chungthang town & downstream valleys

[3] https://epic.uchicago.in/the-cost-of-inaction-in-a-changing-climate/

Year	Event	How it played out
2024	Cloudbursts & Landslides in Himachal Pradesh	Daily rainfall in repeated blocks of 200-300mm, triggering slope failures
2025	Severe heatwaves across north, central & eastern India	Prolonged extreme temperatures exceeding 45–47°C; widespread health impacts, power demand spikes, water stress and productivity losses.
2025	Assam & Northeast floods	Flooding of the Brahmaputra and its tributaries; large-scale displacement, damage to infrastructure damage & crop losses
2025	Himachal Pradesh cloudbursts & landslides	Short, high-intensity rainfall triggered landslides, road washouts, and prolonged highway closures
2025	Uttarakhand forest fires (late winter) and a repeat in 2026	Extended dry and warm conditions led to early and intense forest fires, degrading air quality, stressing forest ecosystems & rural livelihoods
2025	East coast cyclonic storm (Bay of Bengal)	Strong cyclones brought high winds, storm surge, and intense rainfall to eastern coastline; port operations disrupted, coastal infrastructure damaged, and inland flooding reported
2025	Urban flooding episodes (Delhi, Mumbai, Chennai)	Drainage systems overwhelmed; transport disruption, property damage, and economic losses, even outside peak monsoon days

Sources: Various news reports

Inferences

1. 2025 reinforces how hydro-met events dominated India's climate impacts calendar
2. The recurring and prolonged heatwaves, urban flooding and forest fires show that climate impacts are no longer rare and short-lived
3. Most of the events affected roads, coastal projects and urban infrastructure

This paper does not have access to the engineering designs behind the national infrastructure projects, so at this stage an accurate assessment of their climate vulnerability is not possible in the context of a Hazard-Exposure-Vulnerability Index.

However, Chapter 2 explores India's large infrastructure projects, some of the funding commitments that have been announced, and the host of climate risks that the projects could face.

2: India's infrastructure push

2.1 Schemes and Key Investments

India has scaled up its plans to build new infrastructure, with the Union budget for 2024-25 allocating INR 11,11,111 crore (~USD 135 billion) for capital expenses[4]. This is more than triple the amount allocated in 2019 and is approximately 3.4% of the GDP – which by some estimates may rise to 6.5% of GDP by FY29. The push spans all segments of national interest:

- Airports
- Docks and costal terminals
- Highways and bridges
- Railways
- Power plants
- Dedicated freight corridors
- Telecommunications

Table 3 lists the various government schemes supporting infrastructure development.

Table 3: Active Indian schemes around infrastructure development

Scheme	Covers	Ministry / Nodal Agency	Launched
PM Gati Shakti – National Master Plan	Multimodal connectivity & integrated GIS-based planning to reduce logistics time & cost; spans road, railways, ports, power and fibre telecom	Prime Minister's Office and inter-ministerial	2021
National Infrastructure Pipeline (NIP)	Energy projects, roads, railways, ports and urban development	Department of Economic Affairs / Ministry of Finance (NIP Secretariat)	2019–2020 (NIP published)
Bharatmala Pariyojana (national highways)	Road connectivity, economic corridors, port connectivity Phase 1: 34,800 km of roads (24,800 new) Phase 2 (post-2028): 4000 km of new roads (3000km expressways)	Ministry of Road Transport & Highways (MoRTH / NHAI)	2017

[4] https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2036078&reg=3&lang=2

Scheme	Covers	Ministry / Nodal Agency	Launched
Sagarmala (ports & coastal connectivity)	New ports, port-led industrialisation, coastal community development, multimodal connectivity; port capacity expansion, new terminals, hinterland connectivity	Ministry of Ports, Shipping & Waterways / Indian Ports Authority	2015
UDAN (Regional Aviation Development)	Regional connectivity, subsidised regional routes, development of regional airports and heliports; target: connect underserved airports and routes	Ministry of Civil Aviation	2017
Dedicated Freight Corridors (DFCC) & Rail Modernisation	High-capacity freight corridors (freight electrification, grade-separation)	Ministry of Railways / DFCCIL (Dedicated Freight Corridor Corporation of India)	Early 2000s
PMAY (Pradhan Mantri Awas Yojana – Urban & Rural housing)	Affordable housing; infrastructure linkages with city planning & basic services	Ministry of Housing & Urban Affairs (Urban) & Ministry of Rural Development (Rural schemes overlap)	2015 (PMAY-U)
Smart Cities Mission	Urban infrastructure modernisation (smart infrastructure, urban services, green & climate-resilient design)	Ministry of Housing & Urban Affairs (MHUA)	2015
PMGSY (Pradhan Mantri Gram Sadak Yojana)	Rural all-weather road expansion and connectivity	Ministry of Rural Development	2000
Inland Jal Marg Vikas	Inland waterways development, multi-modal cargo movement, national waterways enhancement	Ministry of Ports, Shipping & Waterways / Inland Waterways Authority of India (IWAI)	2016
BharatNet / National Broadband Mission	Rural broadband connectivity, digital infrastructure, fibre internet to gram panchayats	Ministry of Electronics & IT / BharatNet programme body	2011; National Broadband Mission started 2020

Sources: Respective ministries & official press releases

Of these, the largest undertakings by capital investment are tabulated as follows:

Table 4: India's largest infrastructure projects by investment, as of 2025

State	Project	Sector	Capital Investment (INR)	Proposed Completion
Odisha	Paradip Port Modernisation & Expansion	Ports & logistics	One of India's biggest projects; most recent approval of 1.45 lakh crore	Western Dock Project by 2026 By 2030: increase cargo handling capacity from 289 MTPA to 400 MTPA.
Andhra Pradesh	Machilipatnam, Ramayapatnam, and Mulapeta ports, and Kakinada Gateway Port	Ports & logistics	5000 crore	By December 2026 (phase 1)
Uttarakhand	Char Dham Road Connectivity Project (NH upgrades)	Highways / Mountain connectivity	11,700 crore	Ongoing, was supposed to be completed in December 2024 By 2028 (tentative)
Himachal Pradesh	Four national highways: Shimla-Mator, Parwanoo-Shimla, Kiratpur-Manali and Pathankot-Mandi	Highways & tunnels	38,000 crore	
Sikkim	Teesta VI Hydropower project	Hydropower	5748 crore (Jul 2018 price level)	December 2027
Ladakh	Zojila Tunnel (Srinagar-Leh connectivity) / BRO strategic tunnels & roads	Strategic tunnels / Roads	6809 crore	September 2026
Arunachal Pradesh	Trans-Arunachal Highway / Frontier Highway segments & bridges	Highways / bridges	11,643 crore (1077km stretch)	Delayed (deadline was 2024)
Arunachal Pradesh	Dams & hydropower projects:	Hydropower	25,296 crore (Etalin)	Various

3,087 MW Etalin project	18,000–18,500 crore (Lower Siang)
2,880 MW Dibang Multipurpose project	20,749 crore (Subansiri Lower)
2,220 MW Oju project	28,080 crore (Dibang)
700 MW Tato-II Hydro Electric Project	
Lower Siang Hydroelectric Project (2,700 MW)	
Lower Siang Hydroelectric Project (2,700 MW)	
Upper Siang Stage I (3,750 MW) & Stage II (3,750 MW)	
Total Investment: ~2.95 lakh crores	

2.2 Key Vulnerabilities

These projects are vulnerable to the following impacts:

A. From cyclones and storm surges

Persistent tidal flooding and salinisation of soil and local freshwater due to sea-level rise, damage to port access routes, port closures (full or partial), disruptions to import and export, delays in relaying goods inland, material spoilage for perishable goods, maintenance and repair costs over and above anticipated wear and tear due to damages to quay walls, dock cranes and other cargo unloading/relay machinery, repairs to storage units, and increased dredging expenses to remove untimely sedimentation.

B. From excess rainfall, cloudburst and landslides/mudslides

Flood inundation, surface washouts, roadbed erosion, dam failure and downstream impacts, infrastructure decommissioning from weeks to months, traffic and freight disruption, delays in access to essential commodities, added costs due to re-routing, and mounting repair and

rebuild costs – including full reconstruction for sections that are washed away. For key passes that feed isolated communities and defence deployments, closures can be a critical impediment.

2.3 Ranking the Risk

From Chapter 1, it is evident that India's essential infrastructure projects *will be situated in the geographies that are the most at risk of hydro-meteorological disasters*, including rainfall-induced landslides and storm surges. Table 5 qualitatively evaluates this risk over the next 10 years (2026-2035) to help determine the order of priority in which they must be addressed.

The scale used is as follows:

1: Very Low risk
2: Low risk
3: Moderate risk
4: High risk
5: Very High risk

Table 5: India's infrastructure vulnerability risk in the context of climate hazards, 2026-2035

Projects	Flooding / Extreme Rainfall	Cyclones / Storm Surge	Landslides / GLOFs	Heat Stress / Drought	Overall Climate Risk
Ports & Coastal Terminals	4	5	1	3	4
Highways & Bridges (Plains)	4	3	1	4	4
Mountain Roads & Tunnels	4	1	5	2	5
Railways & Freight Corridors	4	3	2	4	4
Hydropower Projects	5	1	5	2-3	5
Thermal Power Plants	3	3	1	4	4
Renewable Energy (Solar & Wind projects)	2	4	1	4	3
Urban Infrastructure	5	3	2	5	5
Airports	3	4	1	4	4
Inland Waterways	3	2	1	3	3

Projects	Flooding / Extreme Rainfall	Cyclones / Storm Surge	Landslides / GLOFs	Heat Stress / Drought	Overall Climate Risk
Telecom & Digital Infrastructure	3	3	1	3	3

2.4 Inferences

The above table shows that:

1. Score 4 and 5 sectors, that are also the most capital-intensive, represent key vulnerable projects that could experience repeated losses unless long-term climate resilience is integrated into their design and construction. Damages and downtimes to these projects would be major disruptions to economic activity, but the primary concern with certain assets, such as hydropower dams, would be the immediate downstream impact on life and livelihoods in the event of a catastrophic failure.

2. Score 5 sectors would be the primary points of concern for non-life insurers. The high asset values combined with their high PMLs (Probable Maximum Loss, discussed in Chapter 3) implies that they are most at risk of reduced insurance cover – which would set an unwanted precedent for similar expansion in the future.

3. Score 4 sectors, despite their vulnerability, may also be the most manageable due to their geolocations. Potentially, they offer the highest scope for design upgrades and other mitigative mechanisms that could cost-effectively manage their climate risk – and their associated PMLs for the insurers.

4. Score 3 projects, by virtue of their locations away from India's most vulnerable regions (for the most part) and their modularity, represent assets that hold the most potential for quick recoveries and/or post-disaster reconstruction. Their lower CAPEX lock-ins and PMLs also lend them to long-term insurance coverage despite rising climate impacts.

Chapter 3 discusses the non-life insurance industry's perspectives on the matter and what the sector is doing to adapt its business, while simultaneously attempting to minimise its risk exposure.

3: Non-life Climate Insurance

Insurability is central to economic activity as it offers the project developers and its financiers the safety net to recover their losses, if the project fails due to pre-defined perils. This implies that without insurance cover, it would be difficult – if not impossible – to establish new projects. When entire geographical regions risk becoming uninsurable (as discussed in this chapter), it turns into a deterrent to economic expansion and therefore, to growth and self-sufficiency.

This chapter therefore argues that:

1. Rising uninsurability will lead to mounting climate-induced losses, which places a progressively higher fiscal burden on the country
2. Rising Infrastructure losses are a growing risk for financial institutions
3. Rising insurance stress will inevitably lead to a higher cost of capital, which in a feedback loop will elevate project costs, PMLs, insurance premiums and therefore the projects' unattractiveness to the insurers.

3.1 Market Trends

~91% of India lacks insurance coverage (against a global average of ~43%, 2024 data)[5] and figure 3 indicates that the 10-year average value of the losses from 2014-2024 is around 8-8.5X that of 1981-1991.

[5] https://www.swissre.com/risk-knowledge/mitigating-climate-risk/natcat-protection-gap-infographic.html#/country/India

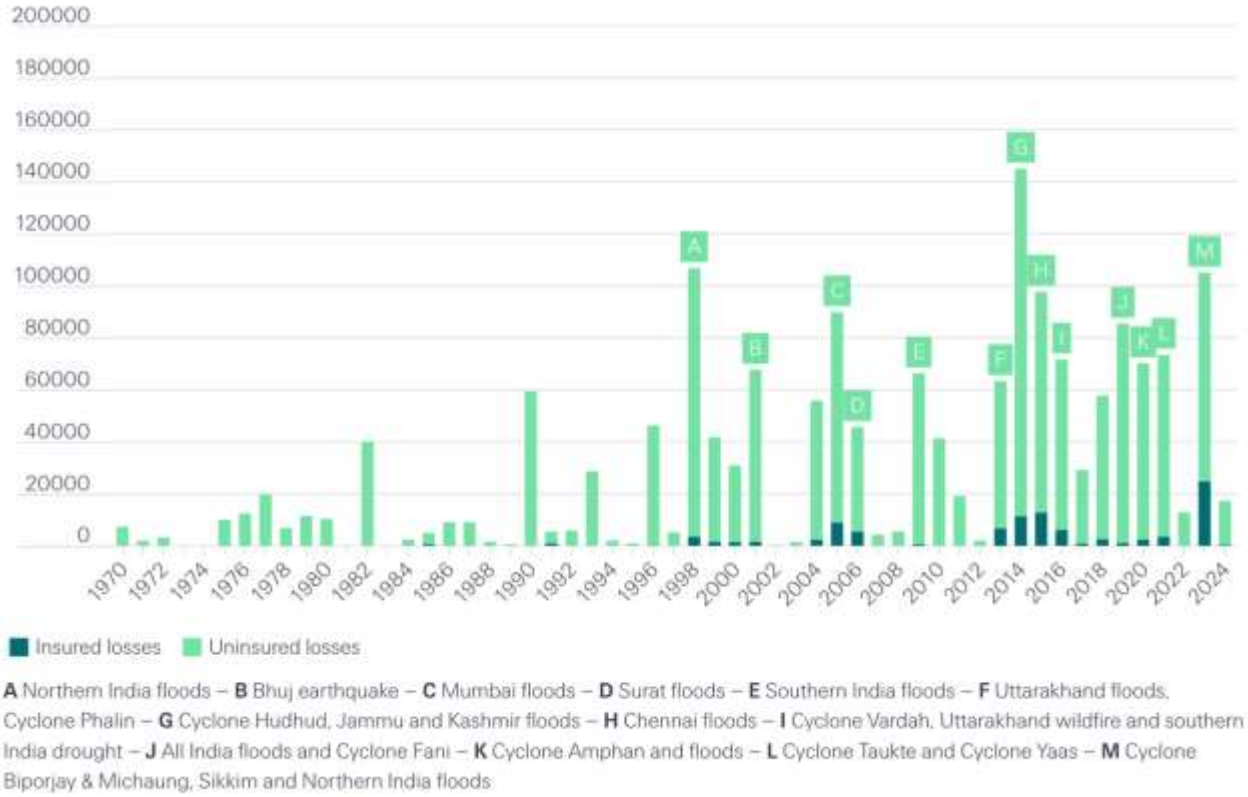


Figure 4: Insured & uninsured natural catastrophe losses in India (in USD billion, 2024 prices), 2000-2024, with major flood catastrophes
Source: Swiss Re Institute, 2025

As per IRDAI, insurance penetration also dropped to 3.7% of GDP in FY 2023-24[6]. In the non-life segment, private insurers hold 65% of the market share while public players retain 35%. Total non-life premiums penetration has remained flat at 1% of GDP since 2020. Additionally, according to an analysis by Centre for Science and Environment (CSE), during the first nine months of 2024, India experienced extreme weather events on 255 out of 274 days[7] which resulted in 3.2 million hectares of crop land affected and over 235,000 houses/buildings destroyed.

Impact on insurers

The most evident impacts globally have been the rising claim ratios and combined ratios crossing sustainable limits. The GIC Re Annual Report (FY 2024–25) reveals that total insured losses under

[6] https://www.business-standard.com/finance/insurance/irdai-annual-report-2023-24-insurance-penetration-decline-124122500470_1.html
[7] https://www.cseindia.org/india-has-faced-more-extreme-weather-events-and-higher-damages-in-2024-compared-to-last-year-says-cse-and-down-to-earth-s-annual-state-of-extreme-weather-report-12462

property lines exceeded USD 140 billion[8], marking the period as the sixth-costliest year on record for the industry.

In India, NAT CATS in 2023 alone resulted in USD 12 billion in economic losses, significantly higher than the previous 10-year average of USD 8 billion[9].

3.2 Insights from Indian insurers

This section collates the insights received from India's largest non-life insurers on their perceptions of climate risk. These are results obtained from one-on-one conversations.

The entities covered were SBI General Insurance, Swiss Re India, Munich Re India, General Insurance Corporation of India (GIC) Re, New India Assurance and the National Disaster Management Authority (NDMA).

A. On extreme weather

The respondents agreed that the incidents of extreme weather had become more frequent of late and present a material risk. The underlying reasons could be deduced intuitively: higher ambient temperatures and more moisture evaporating from the land and the water bodies, which they linked to increased cyclogenesis in the Arabian Sea and the Bay of Bengal and the increased frequency of cyclones and flooding.

Consequently there is an observable increase in climate-related losses, and if the insurance penetration does not improve, the country's already large protection gap of ~92% would widen.

B. On Insurability

The majority of India remains within the insurability envelope. This is even though, according to some of the individuals spoken to, the country's economic losses due to NAT CATS are growing faster than GDP gains. There was no consensus on whether the addition of new assets is exacerbating the risk, but alignment on the view that economic growth is essential. Also, that asset allocation in certain regions will necessitate additional safeguards.

The insurers and re-insurers are therefore willing to assume risk across most of the country, which includes the high-risk states. Importantly, the high-risk states fall into two categories:

[8] https://www.gicre.in/en/investors-public-disclosures/investors-en/financial-performance/annual-report
[9] https://www.swissre.com/dam/jcr:4c54602e-f24f-4322-8e8a-bfd6ada77062/2025-01-14-swiss-re-%2520institute-expertise-publication-india-economy-and-insurance-market.pdf

- By concentration of assets: Tamil Nadu (majorly Chennai), Maharashtra (along the west coast), Gujarat & Delhi NCR
- By climate vulnerability: Listed in Chapter 1.

However, recurring NAT CATS (such as cloudbursts) in these states are subtly redrawing their risk profile, with some entities stating that parts of Himachal Pradesh and Uttarakhand are approaching the limits of insurability. Although there is no recorded instance of an Indian region being denied coverage due to climate risk – yet – if it does happen, the pullout could be along the lines of how some insurers have withdrawn from US states (table 6):

Table 6: Insurers moving out of US geographies over NAT CAT risks (select list)

State	Insurer	Year	Climate Risk(s)	Action
California	State Farm	2023	Wildfires, record loss costs, inflation, reinsurance strain	Stopped accepting new homeowners' & commercial property applications; 72,000 non-renewals in 2024
	Allstate	2022	Wildfire risk + rising replacement costs	Paused all new homeowners' policies
	Falls Lake Insurance	2023	Could not obtain wildfire reinsurance	Fully exited California
Florida	Farmers Insurance	2023	Hurricanes, coastal losses	Fully exited Florida homeowners' & auto insurance
	AIG (Private Client Group)	2022	Hurricane risk	Halted renewals for high-value homes
	UPC Insurance	2023	Hurricane Ian losses	Insolvent; withdrew from all policies
	Weston Property & Casualty	2022	Hurricanes + reinsurance failure	Insolvent
Louisiana	AIG / Lexington	2021–22	Hurricanes	Massive reductions in coastal homeowners
	Allstate	2022	Hurricanes	Limited new business, raised deductibles
	State Farm	2022	Hurricanes	Restricted coastal exposure
	Weston P&C	2022	Hurricanes + reinsurance failure	Insolvent

State	Insurer	Year	Climate Risk(s)	Action
Texas	Allstate	2022–23	Hailstorms, severe convective storms	Reduced homeowners' exposure
	State Farm	2022–23	Hail & storm surge	Tightened underwriting in hail-prone areas
	Germania Insurance	2021–22	Hailstorm losses	Large premium hikes & reduced coverage
Colorado	State Farm	2022–24	Wildfires & hail	Restricted new policies in high-risk areas
	The Hartford	2022	Wildfires	Withdrew from certain counties
	American Family	2022	Wildfires + hail	Raised rates 25–40%; limited new business intake
Oregon & Washington	State Farm	2021–23	Wildfires	Limited new policies in wildfire corridors
	Mutual of Enumclaw	2021	Wildfires	Stopped new policies in high-risk zones
New York	AIG (Private Client Group)	2023	Flood + storm surge	Reduced underwriting in coastal Long Island and New York City
	Allstate	2021–22	Flood + hurricane risk	Tightened coastal exposures

Sources: US news reports

These developments come at a time when the world could warm by more than 2°C above pre-industrial levels by 2050[10]. This would not only exacerbate human survivability challenges in the vulnerable countries, but insurers pulling out of a region also has the knock-on effect of making it less attractive to project developers and financiers.

Staying within the insurability limits is thus critical to a region attracting investments, but an area becomes uninsurable when a loss is certain. In such a case, the premium theoretically equals the value of the loss – which is an untenable situation for the insurers. A heavy concentration of assets in a region also exacerbates the risk of uninsurability, since the quantum of the loss is a function of the assets' vulnerability.

This is what has driven some insurers out of parts of the US, but the Indian market with its low penetration and considerably less pricey assets (for most of the country) is unlikely to present a similar challenge any time soon. Moreover, Indian insurers cannot simply shun geographies. Some of the respondents touched upon their responsibility of providing "social

[10] https://www.bbc.com/news/articles/cx24kllyye1o

security", which necessitates that they devise ways and means of assuming the increased risk.

It may be noted that in January 2025, Italy decreed NAT CAT insurance for all large and small businesses operating in the country[11] – with suitable safeguards allowed for the insurers -- in response to the growing recognition of the risk of climate impacts. The coverage will mandate insurance against floods, overflow, inundation, earthquake, and landslides only; hurricanes, typhoons and hail are not covered. Yet, it is similar to India's call for Insurance for All by 2047[12] – an objective that its industry regulator, the Insurance Regulatory and Development Authority of India (IRDAI), is committed to.

C. On Probable Maximum loss (PML)

Probable Maximum loss (PML) is a crucial metric that ultimately determines the extent of coverage offered. As the incidence (and impact) of a NAT CAT grows in high-risk geographies, so does the PML. Consequently, the insurer may either seek re-insurance, or the projected PML may be so high that the risk is pooled amongst multiple re-insurers. This includes spreading the risk across different countries to minimise any one entity's exposure.

Also, each re-insurer may only be comfortable underwriting a certain amount of risk. The threshold may be limited by:

a. The re-insurer's and/or the insurer's solvency
b. The degree of volatility in the underwriting (which is a function of the entity's capability to predict risk exposure)
c. The confidence the re-insurer has in the insurer's assessments
d. Whether the re-insurer is a listed entity; demonstrating sound decisions to stakeholders is a necessary filter
e. The safeguards demonstrated by the customer that would lessen its risk of a loss
f. The diversity and geographical spread in the re-insurer's portfolio; taking on more of the same risk in a region may be undesirable

D. On pricing climate risk into premiums

India's insurers use "zonal/local loading" and "CAT Loading" to factor in climate risks for high-risk areas. This is standard procedure, and the historical data informing the calculations can go back from anywhere between 3-100 years (or more).

Yet, the respondents acknowledged that climate change was inherently unpredictable and that climate impacts are changing in frequency and severity (arguably) every year. Therefore

[11] https://www.reinsurancene.ws/mandatory-nat-cat-cover-in-italy-a-credit-positive-for-pc-sector-moodys/
[12] https://irdai.gov.in/web/guest/document-detail?documentId=1624671

they are open to exploring advanced predictive models, or some other alternative, whose results would ideally align more closely with the observed incidence of a CAT event.

Meanwhile, some conversations revealed that insurance premiums are certainly getting pricier in select pockets, such as auto insurance premiums in the flood-prone parts of Mumbai. The trend is expected since India's metro cities have a high concentration of assets (businesses, buildings, public & private vehicles) and drainage systems that get overwhelmed almost every year.

This is supported by data from the National Institute of Disaster Management (NIDM), which states that ~12% of India's land (nearly 40 million hectares) is susceptible to riverine and flash floods, 8 million of which runs the risk of annual flooding[13]. That 67% of India's economic losses in the last 20 years were due to flooding[14] is because it heavily impacts the major economic and industrial hubs: NCT of Delhi, Mumbai, Ahmedabad, Jamshedpur and Hyderabad.

[13] https://nidm.gov.in/safety_flood.asp
[14] https://www.swissre.com/risk-knowledge/mitigating-climate-risk/billion-dollar-rain-india.html

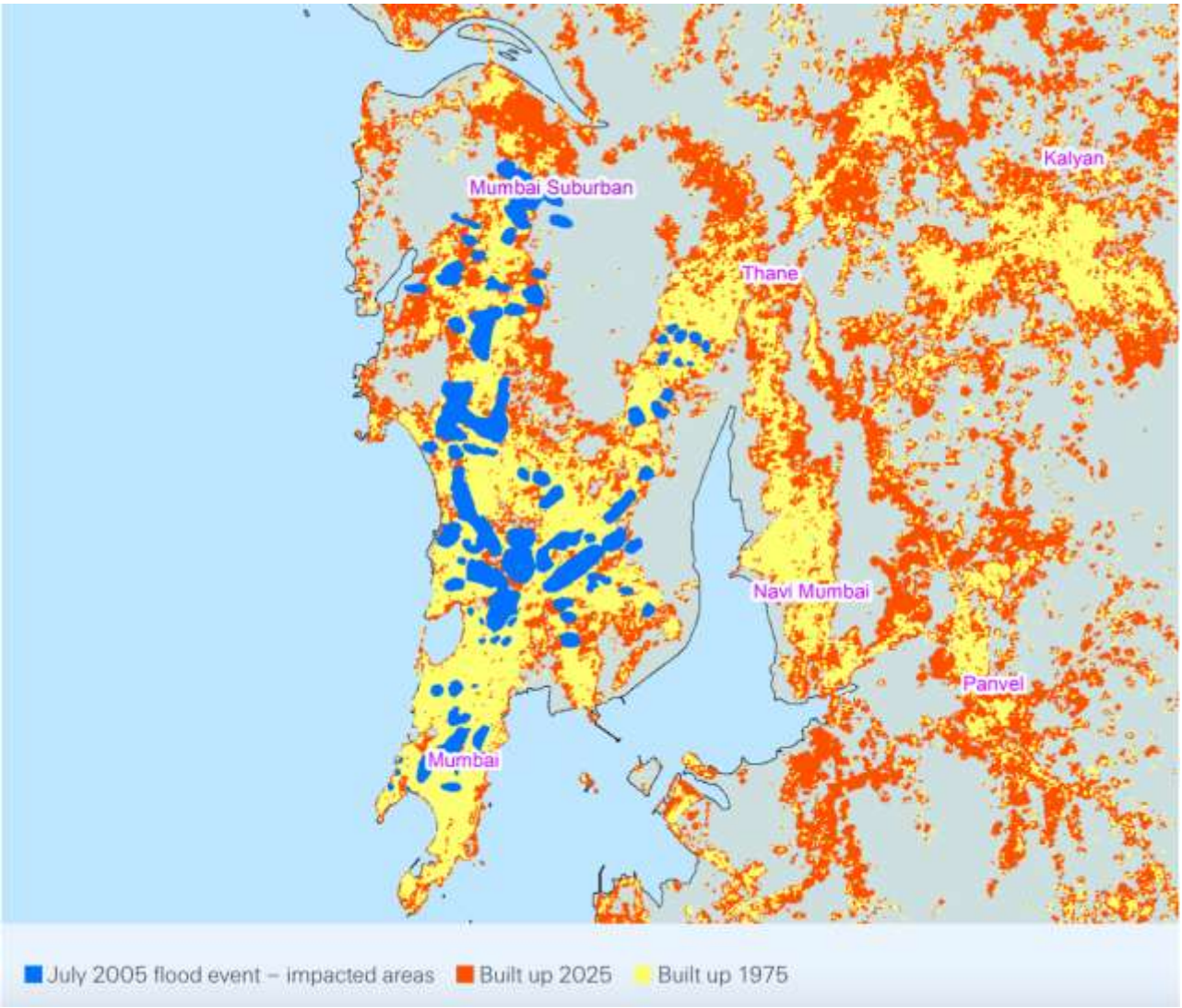


Figure 5: Mumbai built-up areas 1975 vs 2025, with 2005 flood event
Source: Swiss Re Institute

In fact, Swiss Re estimated that the 2005 Mumbai flood was the costliest CAT event for Indian insurers to date, with INR 2,250 crore (USD 500 million) worth of claims (at 2005 prices). A repeat today would cost INR 20,000 crore (USD 2.3 billion) – ~8X worse, without even being the worst-case scenario.

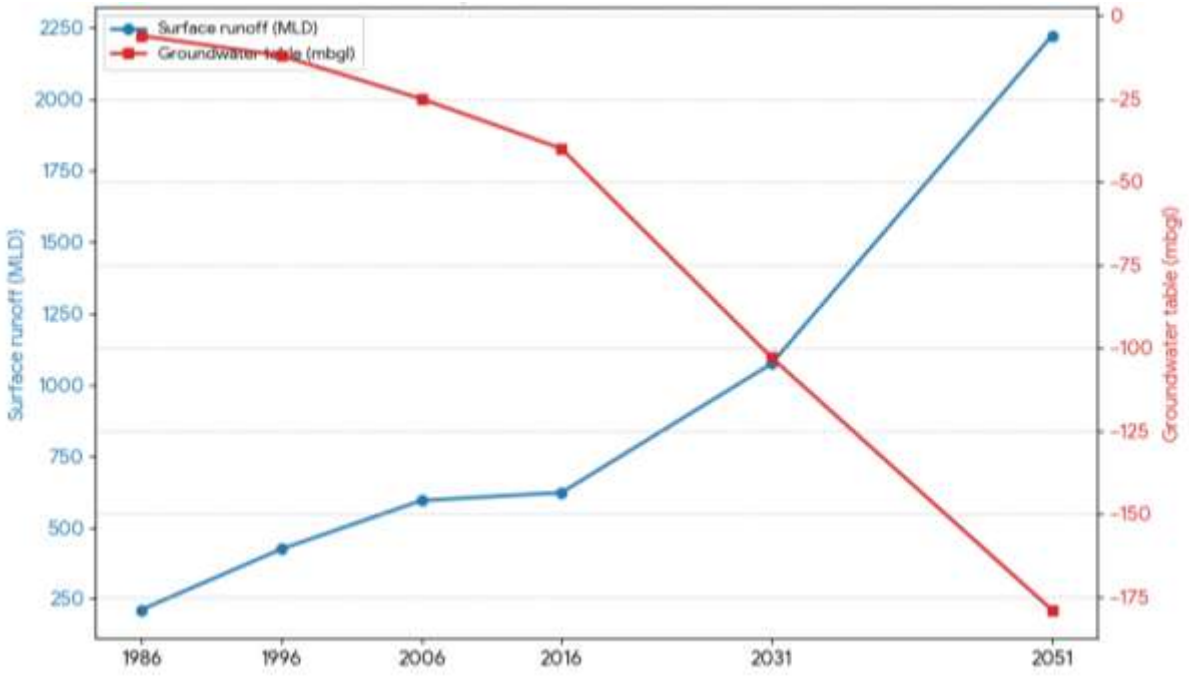
Meanwhile the following charts highlight how flooding could affect Delhi by 2051.

Table 7: Urban Development with Drainage and Flooding in Delhi, 1986-2051

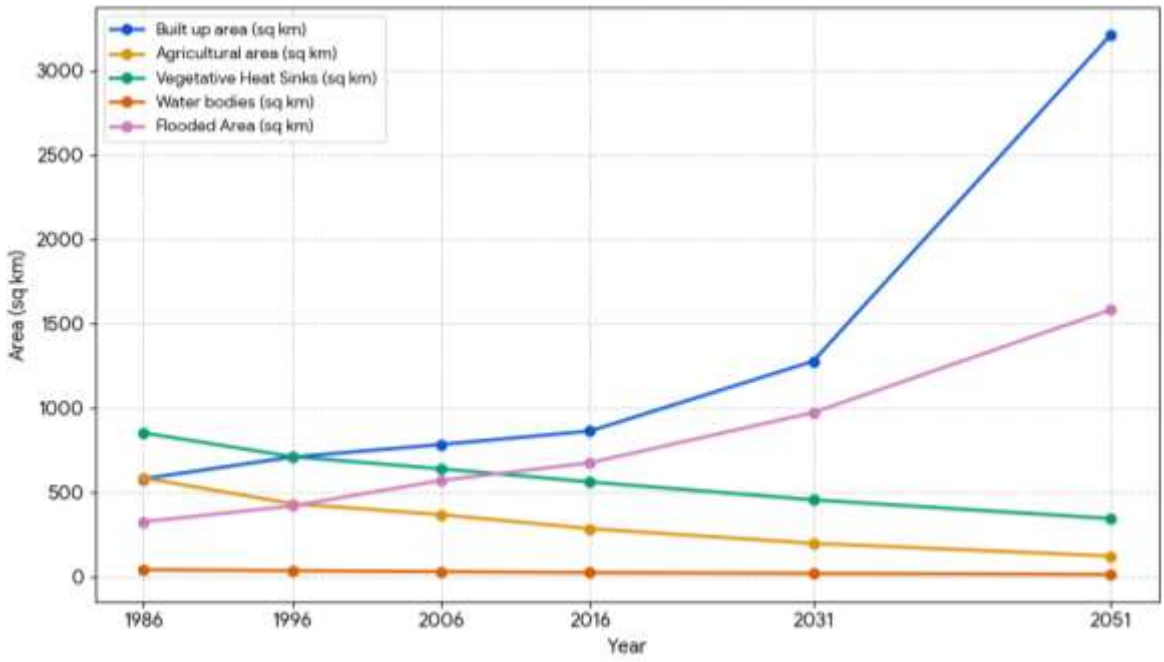
Parameters	Indicators	Year				CAGR (1986-2016)	Projected Change – Business As Usual (BAU)	
		1986	1996	2006	2016		2031	2051
Urban Development	Developed Area (ha)	58,145	71,040	78,360	86,350	1.33%	105,248	137,030
	Developed Area Density (pph)	107	133	177	194	2.01%	261	389
	Agricultural area (sq km)	586	433	368	285	-2.38%	198	123
	Built up area (sq km)	581	710	784	864	1.33%	1,278	3,214
	Vegetative Heat Sinks (sq km)	853	712	640	562	-1.38%	456	345
	Water bodies (sq km)	42	36	30	25	-1.65%	20	14
	Surface runoff (MLD)	211	424	594	622	3.71%	1,074	2,223
	Loss of flood plains (ha)	552	640	723	777	1.14%	921	921
	Groundwater table (mbgl)	-6	-12	-25	-40	6.54%	-103	-179
Sectoral Impacts	Flooded Area (sq km)	326	420	571	676	2.46%	973.68	1,584
	Road length affected (km)	13	26	116	233	10.25%	1,008.08	7,098
	Average travel time increase due to localised flooding (minutes)	10	15	32	42	4.92%	86.35	226
	Per capita expenditure on health (INR)	324	419	625	2,999	7.89%	9,366.39	42,760
	Vector-borne diseases (in ‘000)	4.9	6.4	76.4	127.4	12.03%	700.30	6,794

Source: Impacts of floods in Delhi Gupta; Prof. D. (2017, August), School of Planning and Architecture

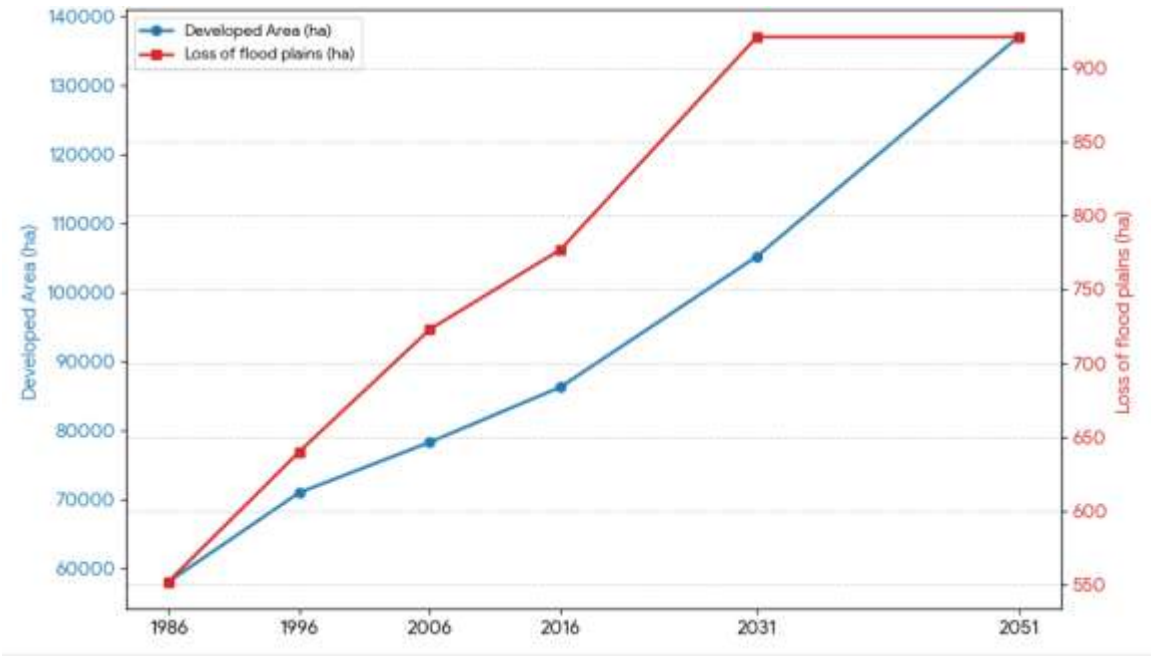
Some of the sectoral impact projections are visualised as follows:



A. Water Dynamics (Runoff vs. Groundwater)



B. Land Cover Changes (in sq. km)



C. Urban Expansion & flood plain loss (hectares)

Inferences

Table 7 shows that:

1. Under the BAU trajectories, compared to urban expansion at ~1.3% CAGR from 1986-2016, there is a non-linear growth in flood exposure (@ ~2.46% CAGR), and the divergence widens in the future. This is critical as it indicates the probability of a disproportionate increase in insured losses.

   From an insurance point of view, this would imply higher PMLs and higher premium pricing, a greater reliance on re-insurance to underwrite the elevated risk, and the possibility of higher CAT loadings (discussed later) for new policies.

2. A similar observation can be made about road length affected by flooding; 233km in 2016 to >7,000km in 2051 – which is a 30X increase. This is far higher than the 1.58X increase in the city's developed area over the same window. This implies that, due to the high asset values in the city and their concentration, a single heavy flooding could trigger multiple claims (well above historical averages) that cumulatively could amount to an enormous claim value. Unless the risk is sufficiently spread across several insurers and re-insurers, this would be an undesirable situation across the board.

   Interestingly, though, a self-balancing mitigation measure is understood to exist in the industry that tempers the price escalation. This happens because more customers tend to purchase insurance in an area after a CAT event. Insurance being the practice of spreading the risk of a few amongst many, the widened bed of policyholders lowers the

impact of the heightened risk – to an extent. Additionally, insurers analyse region-specific data every quarter and the dynamism of the review can pass on price reductions to the customers when feasible.

3. The steady loss in water bodies and agricultural area, paired with the accelerated depletion in groundwater and increase in surface runoff, *increases the certainty of flood damage rather than just its magnitude*. The damage will affect not just affect more immovable assets, but also more personal property, such as two-wheelers and four-wheelers, with almost predictable certainty. This would bring conditions in the city very close to what makes a geography approach the limits of uninsurability.

E. On "rewarding" proactive risk reduction

The insurers confirmed that customers that demonstrate proactive risk reduction are likely to benefit from favourable premium pricing. For instance, a warehouse in a flood-risk zone that stores its inventory well above the known overflow limit is likely to enjoy a more affordable premium. The same may hold true for other customers, such as a village investing in rows of tall trees around the farms to shield the crops from wind damage.

Proactive risk-reduction and resilience-building are thus complimentary to insurance and are welcomed.

F. Responses to Questionnaire

The responses below have been collated from a questionnaire that was circulated amongst India's non-life insurers and re-insurers.

1. On the perceived risk of climate impacts: 100% said that were concerned about their long-term profitability, but equally, that it was an opportunity for them to expand their business.

2. On climate risks' anticipated severity over the next 10 years: 100% ranked it as High, with one flagging the frequency as well

3. On attributing premium loading for national infrastructure specifically to climate risk since 2015: One reported >10%, with two instances of loadings due to CAT perils. It also reported >10% change in its Combined Ratio due to climate change

4. On the barriers to the adoption of climate risk insurance: 66% ranked the price of premiums as the primary barrier. The other top 5 barriers were the lack of awareness of policies, complexity of policies, the belief that NAT CATS will not personally affect the customer, and a lack of trust in insurers.

5. On the barriers to accurately pricing climate risk premiums: 100% agreed that their current modelling capabilities do not capture the complex ways in which climate change is expected to play out going forward. It was also reported that:

    a. That historical data is insufficient and current CAT models do not fully capture the evolving and increasingly erratic climate patterns
    b. The high uncertainty with which events such sea level rise (SLR) will manifest is a barrier, and the extent of damage it will cause
    c. That is difficult to model perils like wildfires and floods
    d. That it is inherently difficult to decouple long-term climate trends from short-term volatility
    e. That India's limited risk-sharing pools hinder the accurate pricing of premiums
    f. That there exists a large barrier between the economic and insured losses
    g. That underwriting policies and premium calculations are complicated by the absence of standardised approaches to climate risk pricing, which is a result of gaps in regulatory frameworks and market practices

6. On climate risk impacting premium pricing since 2015: 66% reported a noticeable but gradual upward trajectory

7. On any infrastructure clients reporting challenges with premium affordability due to climate risks: 100% reported Yes, with one specifically flagging hydropower projects

8. On instances since 2015 when risk was not underwritten specifically due to the risk of a climate-induced catastrophe: Only one reported such an instance, but for <1% of policies issued

9. On developing climate-responsive policies: 100% reported that they were developing new products, such as microinsurance, and parametric insurance to cover flooding, cyclones, excess rainfall, extreme heat and humidity, and climate-related crop and/or livestock losses. None reported products for cloudbursts and landslides.

3.3 How insurers are adapting

Analyses on annual reports and one-on-one conversations revealed the following strategies:

1. Recalibrating underwriting practices

Companies like GIC Re, New India Assurance, and ICICI Lombard are becoming more selective, implementing zonal loading and are looking to updating their catastrophe models using satellite and more granular meteorological data to achieve accurate pricing.

2. Retrocession & NAT CAT pools

Reinsurers are increasingly seeking retrocession[15], which is secondary reinsurance that helps spread CAT risks. Simultaneously, the industry is advocating for the establishment of a NAT CAT Pool – a collective fund that would be supported by insurer contributions to provide nationwide coverage for extreme events.

3. Product innovation

Pilots of parametric insurance have been run in Gujarat, Maharashtra and Rajasthan (for extreme heat)[16] and Nagaland (damage from excess rainfall)[17]. The instrument automatically triggers payouts once predefined thresholds (e.g., pre-defined rainfall or temperature levels) are breached.

However, even though this model releases payments in as little as 48 hours and improves claim efficiency, the adequacy of the coverage remains to be studied.

3.4 Relevance of Public-Private Model

Collaborative models used by the industry, such as the Surplus Sharing Mechanism (SSM), exemplify successful state–insurer partnerships.

For instance, under its crop insurance model, insurers and the government share both surpluses and losses within predefined claim ratio slabs. If the claim ratio stays between 60% and 110%, insurers bear the loss; if it falls below 60%, the surplus is shared; and if it exceeds 110%, the government absorbs the excess loss. This structure ensures equitable risk distribution and encourages insurer participation in climate-sensitive sectors.

Depending on how climate impacts play out in India, SSM could be extended to other businesses, including coverage for national infrastructure.

3.5 Elevated risk for the government

Combined with the other large infrastructure projects listed in table 4, India's asset pool has grown considerably, but insurance for PSU-owned projects works differently to private undertakings. The

[15] https://www.insuranceinstituteofindia.com/documents/d/college-of-insurance/newsletter-08th-june-14th-june-2024-1-
[16] https://www.weforum.org/stories/2025/03/the-heatwave-that-sparked-a-new-era-for-women-workers-in-india/
[17] https://india.mongabay.com/2025/06/first-payout-under-extreme-weather-insurance-triggers-relief-and-intrigue/

former are covered under two phases: Construction and Operational. Conversations with the insurers revealed that insurance policies for the construction phase are on an average, 3-7 years long. Post-commissioning, the policies generally switch to a 1-year renewal cycle.

However, 6-7 years for a high-value asset in a country that's increasingly vulnerable may force a rethink at some point. While details are being sought on how the coverage is structured, it's unclear at the moment if such rapid asset-building could expose the government to undue risk. Also, Centre-owned assets are not insured by anyone other than the government itself. So it remains to be discussed how the government plans to tackle its assets' rising exposure.

4: Conclusion

It is evident that climate impacts are no longer a sporadic event in India. Rather, they are increasingly more frequent and severe. This has implications for the country's infrastructure vulnerability, as well as the limits to which they can be covered under insurance, their credit-worthiness and the government's ability to handle the rising exposure.

Most of India remains well within the insurability envelope, but by their own admission, the insurers and underwriters agree that their current models are unable to cope with climate change's uncertainties. This will mean that premium prices may be grossly under- or over-valued – depending upon who is asked – and that sooner than later, the responsibility of covering the losses to high value assets in high-risk geographies will fall onto the states or the Centre. The growing gap between insured amounts and the value of actual damages for projects insured externally is also an emerging concern. At this point it is unclear how the shifts will be received and which preventive steps will be acceptable to all the stakeholders.

Nevertheless, it may be prudent to explore these recommendations:

1. Mandating climate resilience as a design constraint, and not a matter of post-construction compliance: Adequately engineered projects that account for high-risk scenarios years into the future will be essential to safeguard against costly reconstruction efforts.

2. Ensuring the insurability of projects by involving every stakeholder at decision-making: This will be necessary to present the climate risks upfront, the cost implications of project damage and/or failure at progressively worsening iterations of an impact, and the limits to which the project must be designed to ensure it is not rendered inoperable. Clarity on these aspects will minimise surprises and the possibility of disagreements on claim settlements.

3. Standardising the regulatory framework for risk disclosure, risk modelling, underwriting, premium pricing and loss assessment & reporting: This has been pointed out by the respondents as it may alleviate the inherent uncertainty with climate impacts to an extent. This will of course necessitate granular risk mapping to begin with, advanced risk modelling capabilities and a model validation system that is approved by the regulator.

4. Investing in innovation: New mechanisms, such as parametric insurance, CAT bonds and SSMs are a good start in this regard, but discussions on the degree to which they meet the demands set by both the insurers and the insured, may be helpful.

//Ends//