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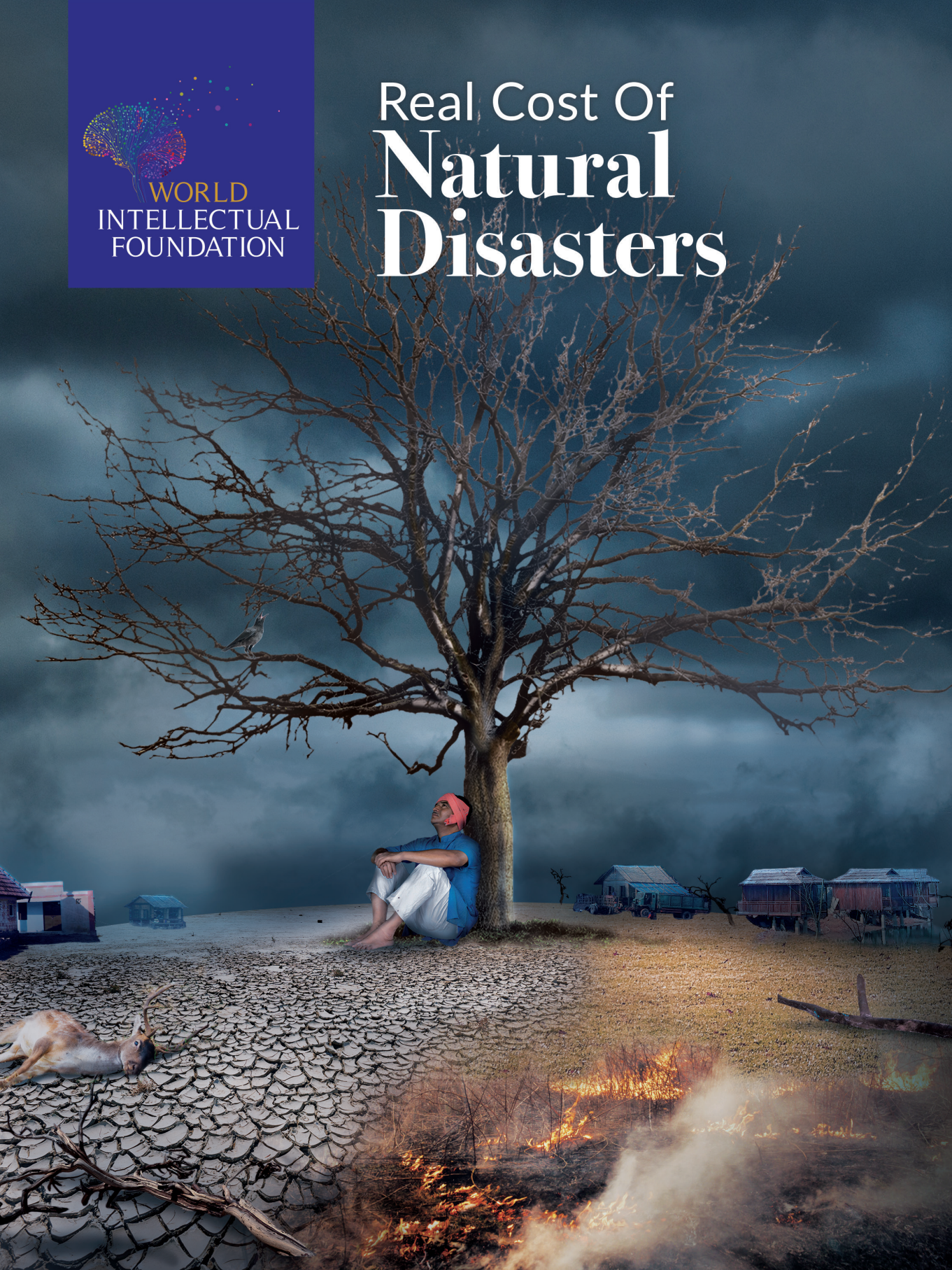
Real Cost Of Natural Disasters



Foreword

With natural disasters becoming a regularity, it is time to understand their 'real impact'. With this objective in mind, I initiated this study on natural disasters and their impact so that the concerned authorities could design the needed policy and programme interventions. I am sure that this brief report will serve as a primer to initiate a broader study on the definition of natural disasters and programmes related to disaster management and mitigation.

Local governments must invest in studying this subject at a deeper level and define a model for calculating the cost and impact of natural disasters. Also, disaster management must be embedded in the design by default into all urban and local infrastructure planning. This will ensure that growth-oriented projects are not decimated when disasters strike.

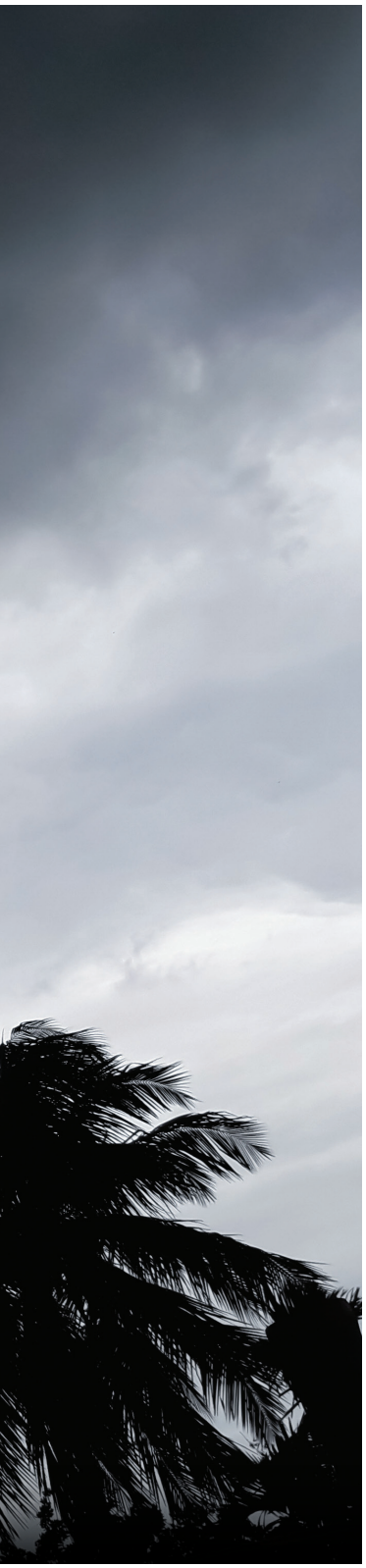
I wish to put on record my thanks and appreciation for the people who have contributed to bringing out this report. This report would not be possible without the hard work of my colleague, Ms. Prithvi Dutt, and the critical review by Ms. Priya Shukla. The amazing team at the World Intellectual Foundation for their invaluable inputs from time to time, Designbox for the creative design and SAGE MILES for ensuring it is error-free.

The funders and supporters of the World Intellectual Foundation deserve special praise for making all the resources available needed for bringing this report into your hands.

We are open to your feedback and collaboration to further this project's objectives.

Prof. Rajendra Pratap Gupta
Executive Chairman
World Intellectual Foundation

Cloudy sky because of super cyclone Amphan over the Bay of Bengal.



Background

Climate change and unplanned development are causing unprecedented damage to the country. Also, given the unique topographical and socio-economic conditions of India, it has been heavily prone to natural disasters, which have a long-term and lingering impact on society. India has substantially witnessed severe and frequent cyclones, floods, droughts and earthquakes. *27 out of 36 states and UTs* are disaster-prone, *58.6%* of the landmass is prone to earthquakes (differing in intensity); *12%* of the land is prone to floods and river erosions; *75.8%* of the coastline is prone to cyclones and tsunamis; and *68%* of the cultivated land is prone to droughts[1]. India ranked 89th out of 181 countries in the Global Risk Index 2020 due to its soaring vulnerability to extreme natural events because of poor preparedness as mentioned in the report. India's performance for strengthening the adaptive capacities also plunged, stating a lack of responsiveness to damages and consequences by associated systems, institutions and other related organizations. The average number of districts affected by cyclones annually has increased from 8 in 2005 to 28 after 2005[2].

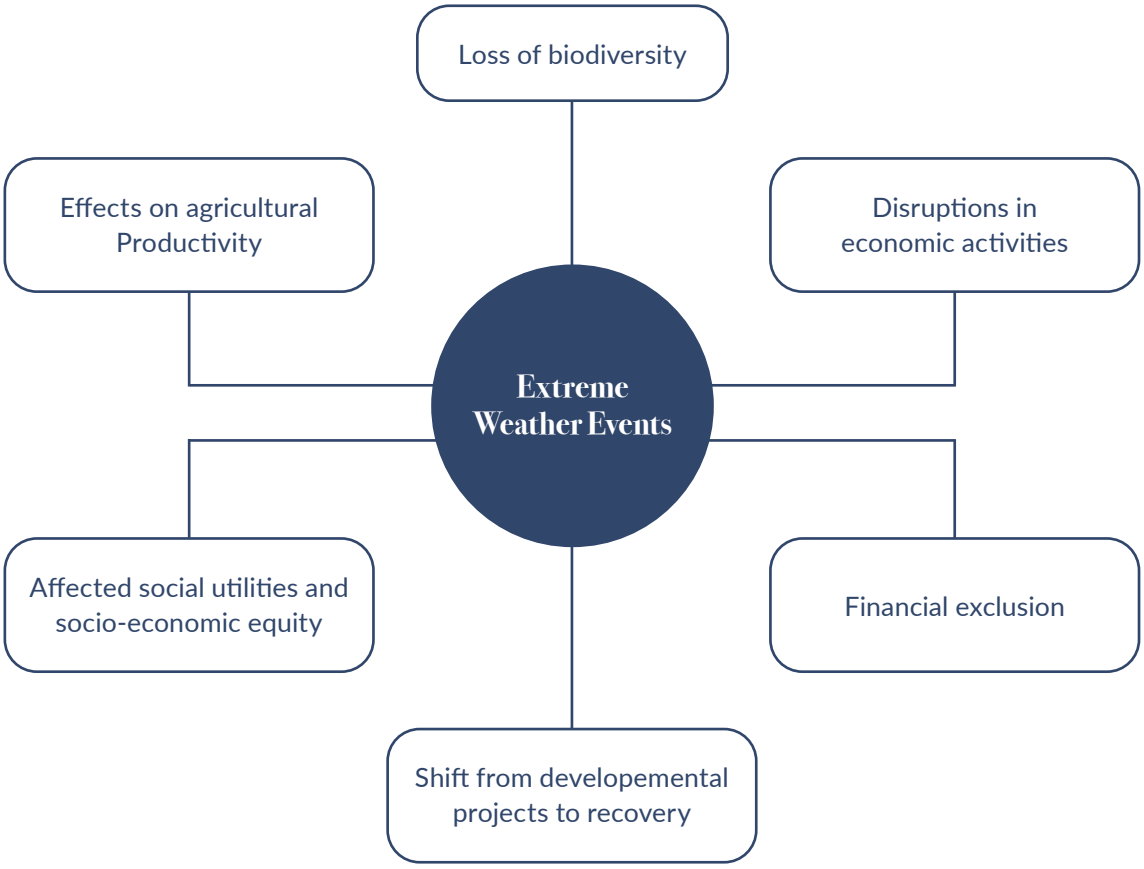
The vulnerability index of Indian states for adaptation planning to the climate reports on 14 indicators that include the following:

- Poverty
- Dependence on natural resources for livelihood
- Proportion of small and marginal landholders
- Lack of coverage of forest per landholders
- Proportion of rainfed agriculture
- Variability of crop yields
- Lack of crop insurance
- Vector- and waterborne diseases
- Poor implementation of MGNREGA
- Lower density of health workers
- Low density of rail+road
- Women's participation in the workforce
- Female literacy rate
- Share of horticulture in agriculture

[1] Ministry of Home affairs, Govt. of India, *Disaster Management in India* (New Delhi:Ministry of Home affairs, Govt. of India, 2011).
[2] Abinash Mohanty, Preparing India for Extreme Climate Events (New Delhi: CEEW, 2020). Available at https://www.ceew.in/publications/preparing-india-for-extreme-climate-weather-events#:~:text=The%20study%2is%2the%2first,non%2Dlinear%20trends%20and%20patterns (accessed on 9 February 2022).

These try to capture the multidimensional vulnerability of the states with respect to both 'sensitivity' and 'adaptability'. Jharkhand, Mizoram, Odisha, Chhattisgarh, Assam, Bihar, Arunachal Pradesh and West Bengal are among the top 25% most vulnerable states.

The standard economic accounting of the damages caused due to natural catastrophes merely accounts for the direct losses, that is, losses to physical assets, crops, livestock, human lives or public utilities, but dismisses indirect losses that increase the 'loss potential' in the long run. These may cause a deterioration in growth momentum by disrupting long-term growth fundamentals. For example, decreased tax revenues and increased reconstruction and recovery expenditure may widen fiscal deficits; this is supplemented by a worsened balance of trade due to damaged export infrastructure and rising import demands. The following are the general indirect losses attributed to natural catastrophe or extreme weather events (EWEs):



a) Disruptions in economic activities, for example, reduction in the labour supply, that is, working hours being affected due to EWEs

b) Harmed agricultural productivity and primary economic activities

c) Financial inaccessibility due to the following reasons:

- Increase in the prevailing uncertainty lessens the investments, affecting the creditworthiness and financial health of the economy.

- Drawn households' savings set aside for other purposes

d) Disruptions in the balance of trade
e) Diversion of human resources, funds and technology from new development projects to reconstruct and revive damaged ones
f) Amplified socio-economic inequity
g) Loss of biodiversity

Real cost = Economic damage + Economic loss (opportunity costs) + Recovery costs (loss of human resource) + Social costs

There is a persistent gap between the requirement and availability of funding for long-term recovery from natural catastrophes. The purpose of the report is to analyse the indirect effects of EWEs on people and the nation as a whole.

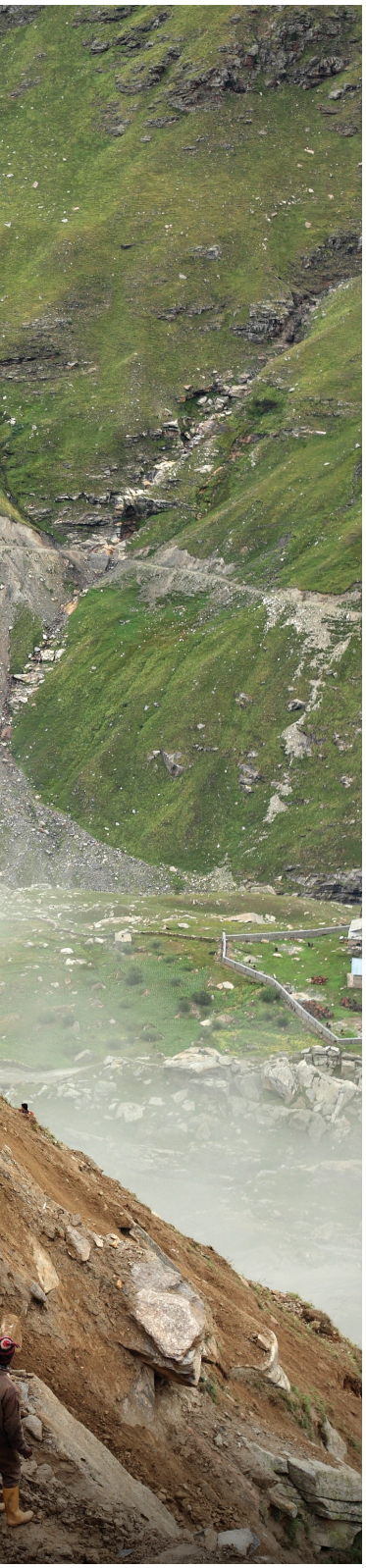
1) Direct Damages-
a) Physical Assets
b) Crops and Livestock
c) Human Lives
d) Public Utilities
e) Livlihood

2) Indirect Costs -
a) Stagnation -
- Disrupted Infrastructure
- Social Costs
  - Disruptions in education and upskilling
  - Health Hazards (Including mental health)
  - Debt Trap and Financial Exclusions
  - Poverty and Socio-economic equity
  - Crimes
  - Migration and Movement

b) Economic Loss -
- Productivity - Human Resource
  - Agriculture
  - Business Capital
- Banking, Finances and Investment
- Restoration Costs > Damaged Value

c) Opportunity Costs -
- Halted new investment for infrastructure, Public and social utilities

Border Roads Organization clear the road to Leh affected by a landslide on August 29, 2012 in Manali, India.



Force amplifier for natural disasters

Climate change furthers the intensity of natural catastrophes. However, man-made factors such as deforestation, highway construction, hydropower projects and other interventions that include the destruction of natural ecosystems without an informed decision-making process and intergenerational planning act as a catalyst in intensifying climate change. The absence of prudent development and necessary monitoring systems worsens it. A weak economic base forces people to remain in hazardous regions and engage in environmentally harmful practices.
For example, an increase in the tourist inflow to Uttarakhand was simultaneously facilitated with a higher level of infrastructure (multi-storey buildings, bridges and roads) in ecologically sensitive areas to meet the demands. Despite several hardships, people still tend to engage in agricultural practices (even on steeper slopes) due to a lack of alternatives. The combination of these two worsens the ecology and the biodiversity of the state through a series of chain events caused by the disturbances.

The persistent occurrence of severe natural catastrophes and deviations of weather phenomena from their historical normal (e.g., average temperatures) can cause the above-listed chain events and have an impact on a region's long-term growth potential both socially and economically. The RBI released a report[3] analysing the risks of climate change on the macroeconomic outlook of the country in the longer run. Pairwise Granger-causality tests for India were conducted from 1960 to 2014, highlighting a causal relationship between GDP per capita, CO_2 emissions and increased average temperature. Economic activity increases CO_2 emissions, which raises the average temperature. Also, rainfall affects the available irrigated area, which in turn affects agricultural yields. The report established a strong causality between weather conditions, especially rainfall, and food inflation (which lasts for a few months), with volatility in rainfall patterns having the greatest influence on vegetable prices.

[3] **RBI**, *Climate Change: Macroeconomic Impact and Policy Options for Mitigating Risks* (New Delhi: RBI, 2020).

Political economy and disaster responsiveness

People watching the rescue operations in Pathanamthitta, Kerala, India, when the city was flooded with rainwater.

When disasters are viewed through the lens of the political economy, their effects can be mitigated and avoided. A study[4] of 156 countries found a strong relationship between the number of fatalities during a disaster and the impact on removing the incumbent government. Another study[5] found that half of disaster-related payments and declarations in the USA are politically motivated and peak during elections. In the context of India, it was found that flood fatalities were lower during state election

[4] Chun-Ping Chang and Aziz N. Berdiev, 'Do Natural Disasters Increase the Likelihood That a Government Is Replaced?', *Applied Economics* 47, no. 17 (2015): 1788–1808.
[5] Thomas Garrett and Russell Sobel, 'The Political Economy of FEMA Disaster Payments', *Economic Inquiry* 41 (2003): 496–509, doi:10.1093/ei/cbg023.

years compared to non-state election years; and political alignment of the centre and state, as well as higher socio-economic development, can reduce flood mortalities[6]. A study[7] found that greater regional newspaper circulation can positively affect the state government's response to floods and famines in India. This is due to better and more efficient information symmetry between the affected and incumbent responses. Thus, the unaccounted indirect losses that transcend through generations are, to the greatest extent possible, preventable.

A study[8] found that incumbents tend to invest less in disaster preparedness and more in post-disaster aid because the latter is more important to the affected people than the former. The myopic voter incentivizes political parties to focus more on relief than mitigation and preparedness. The reliance majorly on the post-calamitic emergency funds, reconstruction and rehabilitation from the public funds has proved inefficient[9]. The 15th Finance Commission suggests that national- and state-level allocations for disaster risk management should be 20% for mitigation and 80% for response. Presently, 30% of the National Disaster Relief Force/State Disaster Relief Force (NDRF/SDRF) goes to recovery and reconstruction, 40% to response and relief, and a mere 10% to preparedness and capacity building. The financial assistance for post-disaster relief has increased substantially; agricultural assistance has been increased by 50%, and ex-gratia relief for death has been increased from ₹1.5 lakh to 4 lakh per person. The government of India (GOI) has increased the SDRF allocation from ₹33,580 crore (FY 2010–2011 to FY 2014–2015) to ₹61,220 crore (FY 2015–2016 to FY 2019–2020)[10].

[6] Yashobanta Parida, *Economic Impact of Floods in Indian States* (New Delhi: Centre for International Trade and Development, Jawaharlal Nehru University, 2016).
[7] Tim Besley and Robin Burgess, 'The Political Economy of Government Responsiveness: Theory and Evidence from India', *Quarterly Journal of Economics* (2002): 1445–1451.
[8] Andrew Healy and Neil Malhotra, 'Myopic Voters and Natural Disaster Policy', *American Political Science Review* 103 (2009): 387–406.
[9] National Institute of Disaster Management, *Working Group Report—Disaster Risk Financing, Insurance and Risk Transfer* (New Delhi: National Institute of Disaster Management, 2021).
[10] GOI, Rajya Sabha, Starred Question No. 103 (New Delhi: GOI, 2018).

Extreme weather events

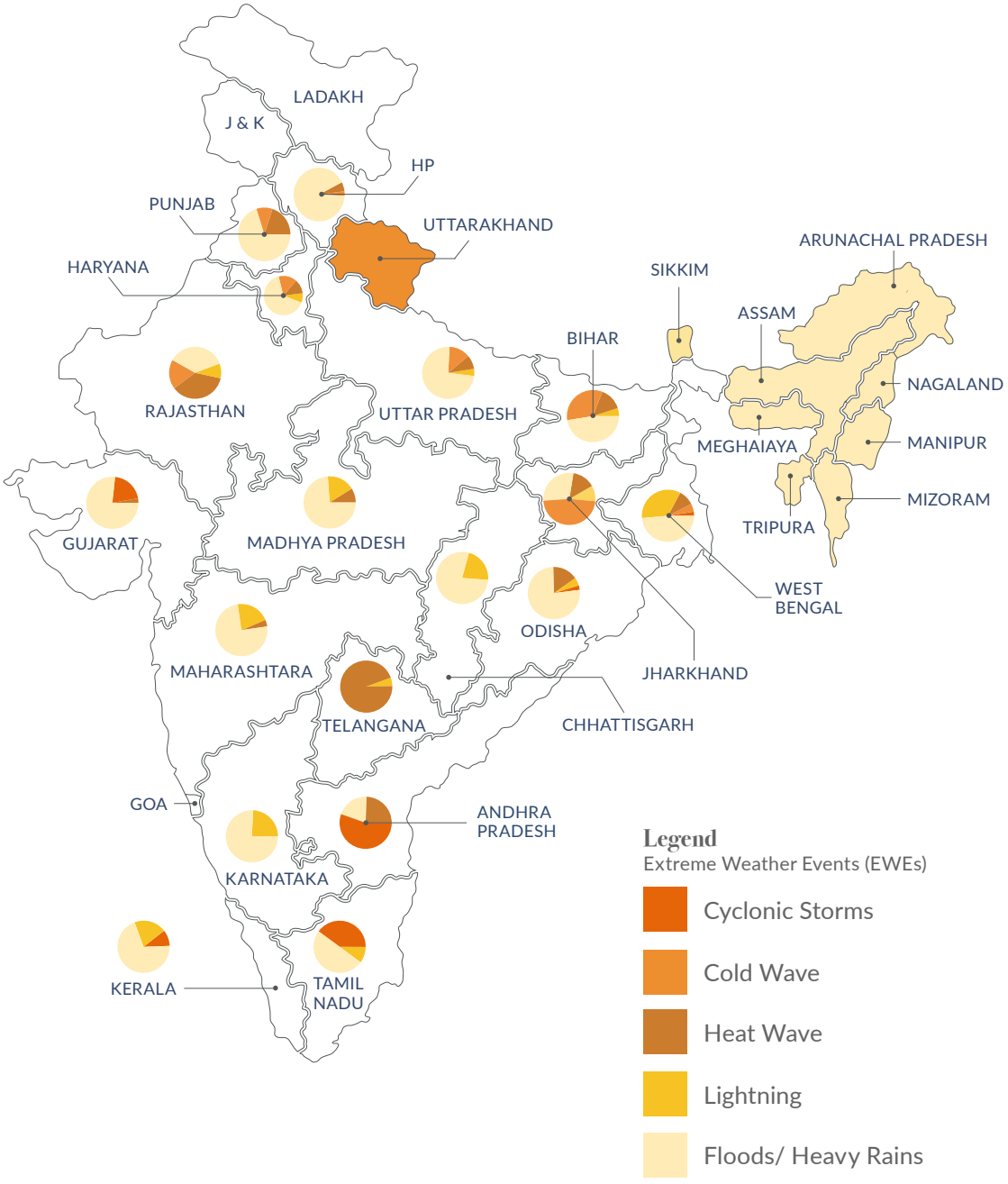
A report[11] studied EWEs in India over the past *50 years (1967–2019)*, compiling years of data published by the Indian Meteorological Department (IMD). As per the report, a total of *7,063* EWEs occurred during these 50 years, with at least one mortality per event and an average mortality rate of *20 per event*, totalling *141,308 deaths*. Floods caused the highest fatalities (46.1%), followed by tropical cyclones (28.6%), heatwaves (12.3%), cold waves (6.8%) and lightning (6.3%). The annual averages of EWEs have been increasing; from 2007 to 2016, the annual EWEs increased by 18% compared to the previous decade[12]. This increasing trend of annual EWEs caused floods that led to an annual economic loss of US$3 billion[13]. These EWEs *caused damages worth US$99 billion in India over a five-decade period (1967–2019)*: floods = US$60 billion, tropical cyclones = US$22 billion and extreme events and lightning = US$17 billion. The study compared two 20-years periods, 1980–1999 and 2000–2019, and found the following:

Recent flood in the state of West Bengal (District Howrah). A father is looking for the high & dry land with his kids.

EWEs	Occurrence	Total Events	Mortalities	Mortality per event
Heatwaves	↑ 138%	706	17,362	24.6
Lightning strikes	↑193%	548	9,596	17.5
Cold waves	↑25%	3175	65,130	20.5
Floods	↑28%	2517	8,862	3.5
Tropical cyclone	↓19%	117	40,358	344.9

[11] Ministry of Earth Sciences, *An Assessment of Long-term Changes in Mortalities Due to Extreme Weather Events in India: A Study of 50 Years' Data, 1970–2019* (New Delhi: Ministry of Earth Sciences, 2021).
[12] Kamaljit Ray, K. Arora, and A. Srivastav, 'Weather Extremes and Agriculture', *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences* XLII-3/W6 (2019): 493–449.
[13] M. K. Roxy, S. Ghosh, A. Pathak, R. Athulya, M. Majumdar, R. Murtugudde, P. Terray, and M. Rajeevan, 'A Threefold Rise in Widespread Extreme Rain Events over Central India', Nature Communications 8, no. 708 (2017). Available at https://doi.org/10.1038/s41467-017-00744-9 (accessed on 9 February 2022).

State wise average mortality per year



An assessment of long-term changes in mortalities due to extreme weather events in India: A study of 50 years' data, 1970–2019

Source: Ministry of Earth Sciences (2021)

Effects of climate change on India by 2100

Over the last few decades, India has witnessed an increase in climate adversity. To account for the climate projections, the Indian government released its first-ever climate change assessment report, which projected the effects of the human-induced climate change in the following aspects *by the end of the 21st century*[14].

Rise in Temperature

Warming Indian Ocean and sea Level rise

Changes in Rainfall

Droughts

Tropical Cyclones

Changes in the Himalayas

[14] Ministry of Earth Sciences (MoES), Government of India, *Assessment of Climate Change over the Indian Region* (New Delhi: Ministry of Earth Sciences, 2020).

01 Temperature rise

(Under RCP 8.5 scenario, reference period of 1975–2005 average)

- Average temperature across India is expected to rise by approximately 4.4°C.
- Under an RCP 4.5, the average temperature could rise up to 2.4°C.
- Rise in the temperatures of warmest day and coldest night of the year by 4.7° C and 5.5° C, respectively.
- Frequency of warm days and warm nights is projected to go up by 55% and 70%, respectively.
- 3–4 times higher occurrence of summer heatwaves with a doubled average duration

02 Changes in the Himalayas

- The Hindu Kush Himalayas (HKH) experienced a temperature rise of about 1.3°C during 1951–2014 and a declining trend in snowfall.
- By the end of the 21st century, the annual average surface temperature is projected to rise by 5.2°C under the RCP 8.5 scenario.

03 Changes in rainfall

- The Summer Monsoon precipitation declined by 6% over the period 1951–2015.
- Occurrence of more frequent dry spells; 27% higher during 1981–2011 relative to 1951–1980 and more intense wet spells during summer monsoons.
- Daily precipitation extremes with rainfall intensities exceeding 150 mm per day increased by 75% during 1950–2015

04 Indian Ocean warming and sea level rise

- Sea surface temperature (SST) of the tropical Indian Ocean rose by an average of 1°C during 1951–2015 as compared to the global average SST warming of 0.7°C during the same time period.
- Ocean heat content in the upper 700 m has also increased in the last six decades, with the last two decades showing the steepest rise.
- The sea-level rise in the North Indian Ocean accelerated from 1.06–1.75 mm per year (1874–2004) to 3.3 mm per year (1993–2017).
- By 2100, sea level in the North Indian Ocean is expected to rise.

05 Tropical cyclones

- The frequency of cyclones has decreased in the Northern Indian Ocean basin (1951–2018); however, the occurrence of very severe cyclones in the post-monsoon season has increased significantly (+1 event per decade) over the period 2000–2018.

06 Droughts

- Both the spatial extent (up by 1.3% per decade) and the frequency of droughts have increased during 1951–2016.
- Projections signal towards increased frequency with more than two events per decade, intensity and spatial expansion under the RCP 8.5 scenario.

A brief timeline of India

Climate change mitigation

Laws and Policies:

2001
Energy Conservation Act (Last Amended: 2010)

Electricity Act (Last Amended: 2007) **2003**

2005
- National Electrcity Policy,
- Disaster Management Act

- Integrated Energy Policy,
- Tariff Policy (Last Amended: 2016)

2006

2008
National Action Plan on climate change

- National Afforestation Programme
- National Policies on Bio-fuels

2009

2010
- National GreenTribunal Act, 2010
- The Finance Bill 2010-11 and the Clean Energy Cess Rules, 2010

- National Electricity Plan (Generation)-(Last amended-2016)
- National mission for electric mobility Plan 2020

2012

2014
- National Agroforestry Policy
- National Urban Transport Policy
- National Auto Fuel vision and Policy 2025

Compensatory Afforestation Fund Act (entry into force in 2018, budget allotted in 2020) **2016**

2019
PM-KUSUM scheme

Notification S.O. 4259(E) Creating the Apex Committee for Implementation of Paris Agreement **2020**

Direct losses

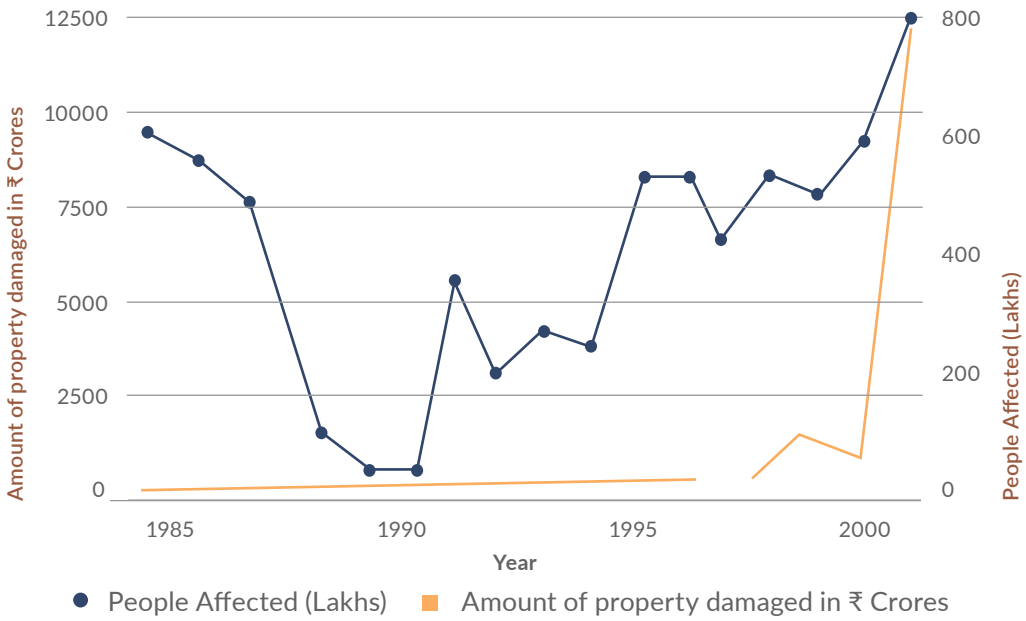
Destroyed crop fields by flood and heavy rain.

The conventional definition and management of the consequences of 'disasters' have undergone a shift after the enactment of the Disaster Management Act, 2005. Now, it consists of events caused by natural or man-made factors and the events caused by accidents or negligence. This report will focus primarily on natural or man-made disasters.

A report[15] stated an increase in the global economic losses due to natural catastrophes from US$1.63 trillion (1980–1999) to US$2.97 trillion (2000–2019). In 2015, UNISDR estimated[16] annual average losses from earthquakes, tsunamis, tropical cyclones and flooding at US$314 billion. The direct cost of natural disasters can be divided into total damages and losses, which are referred to as 'reconstruction and stagnation' costs.

The increase in the frequency of natural disasters has been accompanied by an increase in their severity. Total direct losses from natural disasters in India quadrupled during the period 1981–1995, up from $2.9 billion to $13.4 billion reported losses in the preceding 15 years. However, the surge in reported losses of natural disasters during 1981–1995 was only outnumbered by $0.4 billion over the next 6 years from 1996 to 2001[17]. Counting on the major impacted elements of the vulnerabilities, natural assets and ecosystems, physical assets (both public and private), agriculture (crops and livestock), human resources, mental trauma and decay in the development gains momentum, the damages caused by natural disasters are multifaceted. The following graph depicts the details of people affected and property damage caused by natural disasters from 1985 to 2001. The amount of property damage increased from ₹40.06 crore in 1985 to ₹12,000 crore in 2001 (substantial hike owing to the Gujarat earthquake 2001 and the Odisha super cyclone 1999).

[15] UNDRR, *The Human Cost of Disasters—An Overview of the Last 20 Years 2000–2019* (Geneva: UNDRR, 2020).
[16] UNDDR, *Global Assessment Report on Disaster Risk Reduction 2015* (Geneva: UNDDR, 2015).
[17] World Bank, *Financing Rapid Onset Natural Disaster Losses in India: A Risk Management Approach,* Report no. 26844-IN (Washington, DC: World Bank, 2003).



Source: 10th Five year plan, Planning Commission of India, GOI Damages caused by natural disasters 2011 -2010

Damages Caused by Natural Disasters 2010–2011

Year	Lives Lost Human (in No.)	Cattle Lost (in No.)	Houses Damaged (in No.)	Cropped Areas Affected (in Lakhs)
2001-02	834	21,269	3,46,878	18.72
2002-03	898	3,729	4,62,700	21.00
2003-04	1,992	25,393	6,82,209	31.98
2004-05	1,995	12,393	16,03,300	32.53
2005-06	2,698	1,10,997	21,20,012	35.52
2006-07	2,402	4,55,619	19,34,680	70.87
2007-08	3,764	1,19,218	35,27,041	85.13
2008-09	3,405	53,833	16,46,905	35.56
2009-10	1,677	1,28,452	13,59,726	47.13
2010-11	2,310	48,778	13,38,619	46.25

Source: 11th five year plan, Planning Commission of India, GoI

The economic costs inflicted by natural disasters on the micro level may relate to individual households' and businesses' (mainly MSMEs') refurbishment, financial security and recovery purposes. On a macro level, it would include instilling market confidence for investments, as well as a speedy recovery and prioritization of projects due to a scarcity of resources (causing a delay in some).

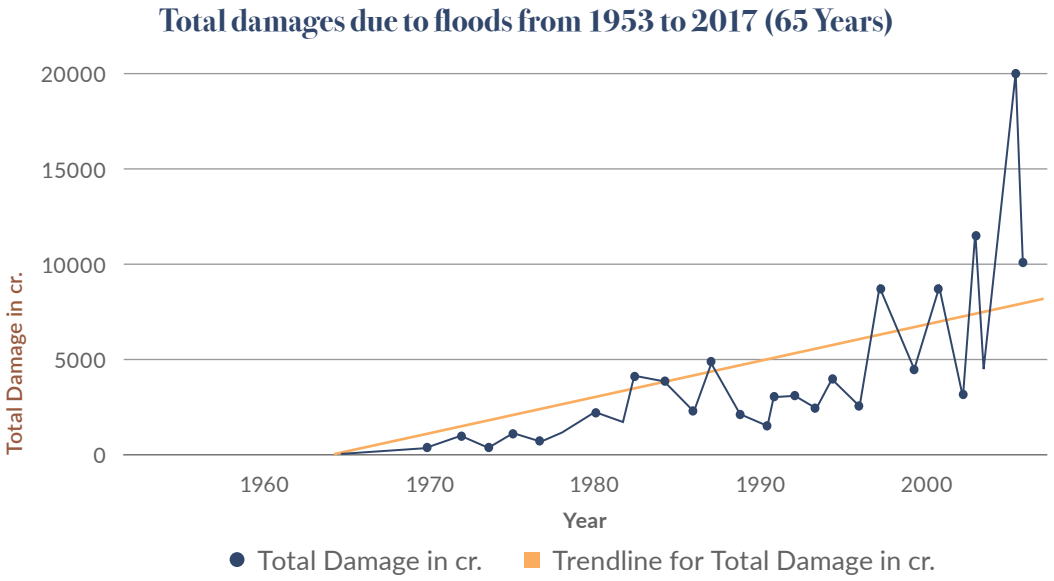
- According to a 2015 UN report, *India loses $9.8 billion every year* due to natural hazards[18]. India's GDP in 2019 might have been about 25% higher than actual in the absence of global warming that occurred up to that time[19].
- Between 2000 and 2019 (20 years), natural disasters claimed the lives of *79,732* people and affected *108 crore people*[20].
- As per a report[21] published under IMF, GDP per capita loss to India will be approximately (with moderate-level adaptation)
  a) 2.6%, if the temperature is kept below 2°C
  b) 9.9%, if the temperature follows an unmitigated path and goes up to 13.4%

The composition of damages due to floods has been changed over the last six decades. From 1953 to 1962, crop damage accounted for 76%, but this fell to 29.7% from 2013 to 2017. During the same time period, the share of public utilities in total damages increased to around 60%.

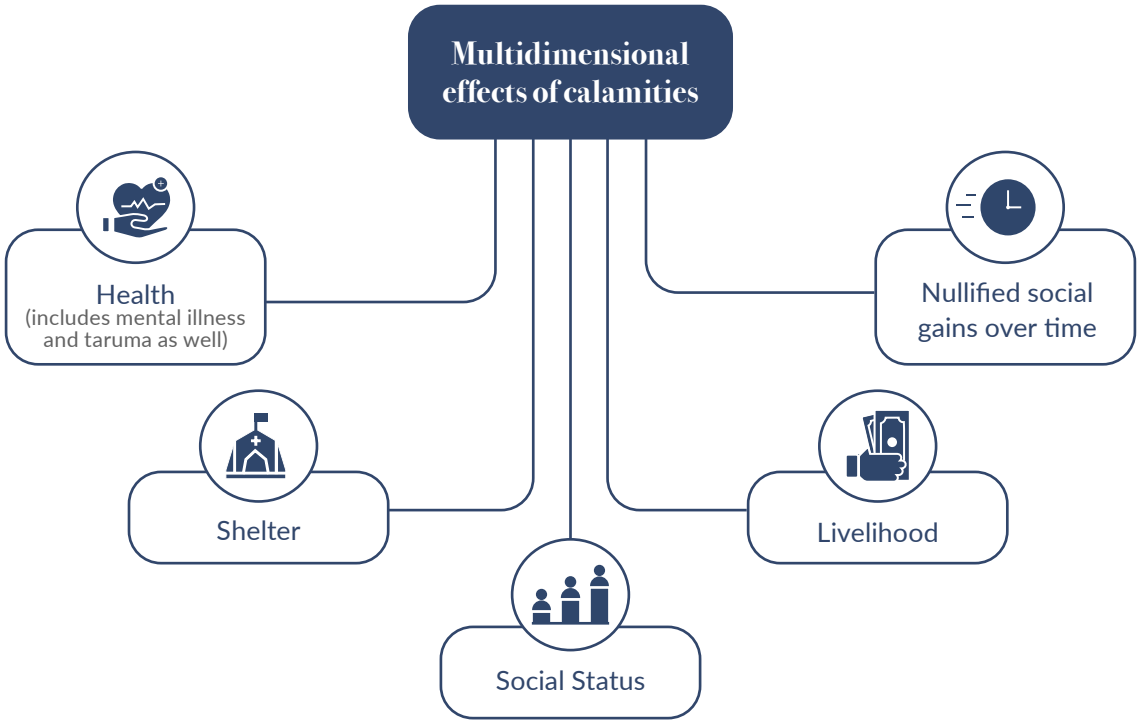
Between 1953 to 2017 (65 years), India suffered following losses due to floods[22]:

Total damage	**₹37,82,47,04,70,000 *(₹3,78,247.047 Cr.)***
Population affected	2,087.60 Million
Lives lost	107,535
No. of houses damaged	80,717,993 *(worth ₹53774.362Cr.)*
Area of crops damaged	256.018 m. hectare *(worth ₹111,225.621 Cr.)*
Cattle lost	6,049,349
Damage to public utilities	₹212,060.003 Cr.

[18] United Nations Office for Disaster Risk Reduction (UNISDR), *Global Assessment Report on Disaster Risk Reduction (GAR) 2015* (Geneva: UNISDR, 2015).
[19] J. Nixon, *The Economic Impact of Global Warming, an Oxford Economics White Paper* (Oxford: Oxford Economics, 2020).
[20] UN Office for Disaster Risk Reduction, Human Cost of Disasters 2000-2019 (Geneva: UN Office for Disaster Risk Reduction, 2020).
[21] IMF, *Long-Term Macroeconomic Effects of Climate Change: A Cross-Country Analysis, working paper* (Washington, DC: 2019, IMF), 32.
[22] Central Water Commission, Flood Forecast Monitoring Directorate, State Wise Flood Damage Statistics (New Delhi: CWC, 2019). Available at http://www.indiaenvironmentportal.org.in/files/file/state%20wise%20flood%20damage%20statistics.pdf (accessed on 9 February 2022).



The direct losses cause other indirect losses, which are mediated by several external factors. The displacement and property damage can set people back in time, sometimes destroying their lifelong earnings and sometimes being a recurring phenomenon that hinders social and economic progress. Thus, the effects are multidimensional and cascading in nature.



The impact of disasters is heterogeneous in nature (in terms of incidence), owing to various socio-economic and geological factors. People's vulnerabilities are exacerbated by their poor economic foundations for sustaining housing, sanitation, safety, livelihood, health and education (it has a direct link behind settling to a hazard-prone area due to halted socio-economic mobility). The speed of the recovery from a dysfunctional state of infrastructure, when disrupted by disasters or calamities, will be determined by the degree of resilience embellished into it[23].

According to the 15th Finance Commission on post-disaster recovery:

The PDNA[24] should cover damage, loss, recovery and the reconstruction need of different sectors such as housing, infrastructure, livelihood, etc. Such an assessment would indicate entire inter-sectoral needs and the annual requirements of each such sector. The governments contribute only a part of the requirements of each sector, with the rest to be contributed by the disaster-affected people.

However, the opportunity costs associated with rebuilding the destroyed lives might nullify the social gains earned through various policies and drive them back in time. Cyclone Phailin 2013 led to a huge devastation in the Puri district of Odisha, and families that lost more than 50% of their crop got only 34.3% of the losses covered and had to bear the burden of the remaining costs[25]. The partial compensation forms an individual responsibility for recovery, which increases the burden of disaster-affected people.

[23] M. Bruneau, S. E. Chang, R. T. Eguchi, G. C. Lee, T. D. O'Rourke, A. M. Reinhorn, M. Shinozuka, K. Tierney, W. A. Wallace, and D. von Winterfeldt, 'A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities', *Earthquake Spectra* 19, no. 4 (2003).
[24] NIDM, *Post Disaster Needs Assessment India* (New Delhi: NIDM, 2019).
[25] Asian Development Bank, I*mpacts of Natural Disasters on Households and Small Businesses in India* (Mandaluyong: ADB, 2019).

Finances

Private savings are used up for refurbishment and rehabilitation post-calamity, often out of the funds kept for other purposes, reversing economic and social progress. It also affects the ability of the poor to climb the income ladder and passes the vicious cycle of social and educational backwardness through generations due to poor socio-economic base.

Natural catastrophes disrupt business operations by disrupting transaction channels (for the elements of business: sale, production and finance) and capital. As bad debts increase, the cost to avail credit increases and consumption patterns plunge, leading to a slow recovery. Recovery from natural catastrophes can be delayed due to the unavailability of funds and investments by worsened credit ratings[26]. This phenomenon is more apparent in low-income developing countries. Although credit ratings are changed due to many explicit or implicit factors arising out of natural catastrophes,[27] the prevailing uncertainty and future expectations of additional damages may be contributing factors to their degradation.

[26] Jiyoun An and Bokyeong Park, 'Natural Disasters and International Financial Accessibility in Developing Countries', *Asian Economic Papers* 18, no. 1 (2019): 245–261.
[27] Moritz Kraemer, Mrsnik Marko, Alexander Petrov, and Boris Glass, *Storm Alert: Natural Disasters Can Damage Sovereign Creditworthiness* (New York, NY: Standard and Poor's, 2015).

Also, economic damages cause a spike in non-performing assets (NPAs) as usual business operations are disrupted, adversely affecting the revenues and the paying capacity of the borrowers. The RBI (Relief Measures by Banks in Areas Affected by Natural Calamities) Directions, 2018, outlined a blueprint for immediate actions to be taken in response to natural catastrophes that necessitate relief and assistance. Immediately after the official declaration of a natural calamity by the concerned authorities, all commercial bank branches/zonal offices shall initiate relief actions (with discretionary powers granted to the zonal manager), as prescribed by the RBI. The relief measures include, among other things, restructuring of short-term loans except those overdue at the time of the occurrence of natural calamity, considering a moratorium of at least 1 year for all types of restructuring, and initiating relief to farm loans if losses are more than 33%. This also includes guidelines for fresh loans 'without collateral'.

Banks' health is restored as more loans are demanded for recovery (mainly for refurbishment purposes), but as the restructuring period passes without a significant improvement in the economic health of the region, NPAs tend to rise. Following the 2013 Kedarnath floods, the loan growth rate in Uttarakhand increased from 25% in 2013 to 35% in 2014. However, loan growth declined to less than 5% in the next financial year[28]. Although bad loans remained constant, the ratio of bad loans to total loans decreased by 0.5 percentage points to 1% (could be due to the increase in loans) and then jumped to 2.2% in the next fiscal year.

Concentrated business operations of banks in the given region and loans in priority sectors increase the 'portfolio at risk' for banks. For example, Federal Bank derived 34% loans and the South Indian Bank derived 41% of loans from Kerala at the time of floods in 2018.

Bandhan Bank estimated that cyclone Amphan had a ₹260 crore impact on the loans of 65,000 micro-borrowers. After the Tamil Nadu cyclone, the portfolio at risk was ₹1lakh crore; for example, City Union Bank had 70% of the branches and three-fourths of the business operations in Tamil Nadu[29].

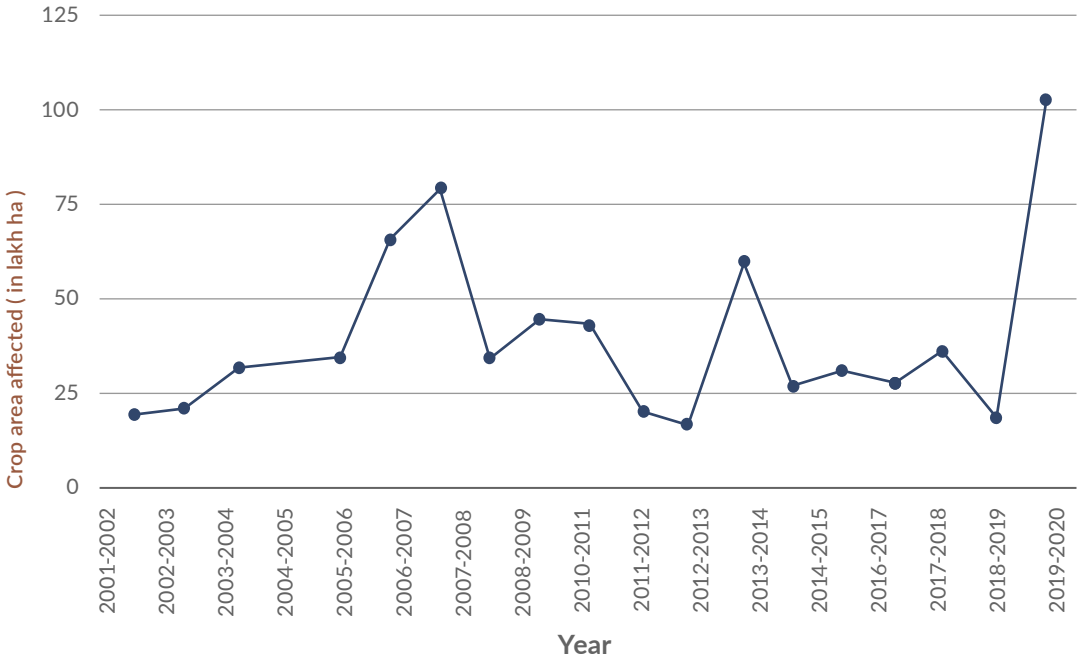
[28] https://timesofindia.indiatimes.com/business/india-business/rs-1-lakh-crore-small-business-loans-face-uncertanity-after-chennai-floods/articleshow/50361351.cms
[29] https://timesofindia.indiatimes.com/business/india-business/rs-1-lakh-crore-small-business-loans-face-uncertanity-after-chennai-floods/articleshow/50361351.cms?utm_

Agriculture

The heating up of the environment and more frequent EWEs have affected agriculture (cropping patterns and operations) as a two-pronged challenge: direct losses and changing crop yields and productivity over the years. Natural disasters have a direct effect on people's livelihoods and food security. The Food and Agriculture Organization (FAO) estimates a 22% economic incidence on agriculture due to natural disasters[30]. The direct loss of crops is amplified by the time required for recovery. For example, coconut provided a major source of income in Odisha, and cyclone Fani led to the destruction of 40% of them. It was estimated that these coconut crops would require at least five years to regenerate and revive[31]. The damage inflicted on agriculture has a direct link to the socio-economic landscape of the nation, given the dependence of a high proportion of the population on it. The following graph depicts the direct crop loss (in hectares) over the last two decades.

[30] FAO, *The Impact of Natural Hazards and Disasters on Agriculture and Food Security and Nutrition a Call for Action to Build Resilient Livelihoods* (Rome: FAO, 2015).
[31] Inter Agency Group, Odisha, *Cyclone* FANI Joint Rapid Needs Assessment Report (Bhubaneswar: Inter Agency Group, 2019).

Crop area affected (in lakh ha) in two decades due to cyclones, extreme rains,floods and landslides



Weather still plays a critical role in determining the productivity of the agricultural sector despite having advanced technologies, high yielding and genetically modified seeds. The effects of the volatility of weather conditions on the crop may vary from region to region or crop to crop depending upon various factors, but they significantly hold the possibility of affecting crop yield by shortening the growth period, water unavailability, reduced soil fertility and higher occurrence of natural catastrophes. This can be furthered by not following agro-climatic farming and sustainable utilization of external inputs. According to the National Innovations in Climate Resilient Agriculture (NICRA), following are the effects of climate change on Indian agriculture[32]:

- Rainfed rice yields are expected to reduce by less than 2.5% by 2050 and 2080, while irrigated rice yields are expected to reduce by 7% by 2050 and 10% by 2080.
- Wheat yields are expected to drop by 6%–25% in 2100 and maize yields by 18%–23%.
- Chickpea productivity is expected to increase by 23%–54%.

The Economic Survey for FY 2017–2018 estimates an average annual agricultural income loss of 15%–18%, which can rise to 20%–25% in unirrigated areas. It also highlighted average revenue losses from Kharif crops: 4% due to a one-degree rise in temperature and 12.8% due to a 100 mm decline in rainfall. Revenue from unirrigated Rabi crops falls by 6% due to extreme temperatures and 6.6% because of rainfall shocks.

[32] PIB, Ministry of Agriculture and Farmers Welfare, *Effect of Climate Change on Agriculture* (New Delhi: PIB, 2021). Available at https://pib.gov.in/Pressreleaseshare.aspx?PRID=1696468 (accessed on 9 February 2022).

The report highlighted that this annual income loss will account for ₹3,600 annually for the median farming household (at the FY 2017–2018 income levels). Agriculture sector employs 42.6% of the total population, and a 15%–18% loss in income would have serious implications for the entire country.

Food security versus sustainability trade-off

To meet self-sufficiency in food grain production and availability to the growing population, the Indian government emphasized the production of subsidized high-yielding hybrid crops. The idea was to enhance crop productivity and not the area expansion. Along with the policies for a 'food-sufficient' nation, the change in subtly required air moisture, heat, temperature and rainfall due to climate change necessitates the utilization of external inputs, such as fertilizers and pesticides, to overcome productivity losses or to increase crop yield.

In India, fertilizer consumption as per hectare of arable land was 175kg, compared to the global average of 136kg (World Bank). The Indian Council of Agricultural Research studied the impact of chemical fertilizers on crop productivity at fixed sites for over five decades under the 'All India Coordinated Research Project on Long-Term Fertilizer Experiments (AICRP-LTFE)' and indicated that continuous use of only nitrogenous fertilizer alone had a deleterious effect on soil health and crop productivity[33]. *India has lost more than 100,000 (approx.) varieties of indigenous rice* that took several centuries to evolve[34].

The utilization cycle of external inputs tends to set a vicious cycle in motion; though the use of pesticides and fertilizers depends upon a variety of factors such as crop intensity, area under cultivation, type of crop and agro-climatic conditions, the consumption of the external inputs is increased year by year so as to maintain the yield level; the excess utilization imbalances the use of groundwater and soil's natural micronutrients. The following secondary micronutrients are deficient in the soil due to the excessive use of fertilizers and pesticides: sulphur (41%), iron (12%), zinc (48%) and manganese (5%)[35]. Additionally, overuse of N-fertilizers exerts a possibility of nitrate contamination of groundwater above the permissible limit of 10mg NO_3-N/L, causing harm to human/animal health if consumed for drinking. This might also affect the aquatic life system, as excess nutrients reach the water bodies, causing 'eutrophication' which induces the growth of algal blooms and fish kills.

[33] PIB, *Excessive Use of Fertilizer* (New Delhi: Ministry of Agriculture & Farmers Welfare, 2021). Available at https://pib.gov.in/PressReleasePage.aspx?PRID=1696465 (accessed on 21 February 2021).
[34] A. R. L. Eliazer Nelson, K. Ravichandran, and U. Antony, 'The Impact of the Green Revolution on Indigenous Crops of India', Journal of Ethnic Foods 6, no. 8 (2019).
[35] FAO, *National Dialogue—Indian Agriculture towards 2030, Pathways for Enhancing Farmers' Income, Nutritional Security and Sustainable Food Systems* (Rome: FAO, 2021). Available at https://www.fao.org/india/news/detail-events/es/c/1369694/ (accessed on 9 February 2022).

Economic activities

The increasing intensities of natural catastrophes disrupt business operations and their profitability in the concerned region. The effect can be both 'forward' as a result of the inability to provide intermediate goods to the value chain and 'backward' as a result of reduced demand for inputs is reflected on the linked industries. Cyclone Phailin in Odisha is estimated to have caused the loss of livelihood of 46,871 households (estimated financial loss of ₹39.64 crore cumulative of sectors such as fisheries, tourism, handlooms and handicrafts) and 1,309 MSMEs[36]. Odisha and Bihar face the wrath of natural disasters regularly, which may be an important factor for their acute economic and social backwardness. This can be linked to the UNDP's risk–poverty nexus pushing people into debt traps and loss cycles. Odisha witnessed a negative gross state domestic product (GSDP) growth rate (–4.85%) during the FY 1996–1997 (drought year), and the super cyclone 1999 led to a –1.72% growth rate the next year of its occurrence[37]. The two consecutive cyclones and floods in 2013 and 2014 plunged the GSDP growth rate from 9.3% (FY 2013–2014) to 1.8% (FY 2014–2015). Economic indicators, however, cannot be a sufficient indication of a region's overall prosperity, but they necessarily contribute towards it.

These effects hamper the long-term development and growth momentum of the economy. The damaged infrastructure furthers the slowing economy and livelihood of people. For example, the Uttarakhand floods in 2013 led to the disconnection of about 4,200 villages and inflicted a reconstruction cost of ₹22,293.04 million of the 2,174 damaged roads, ₹271.82 million of the 85 motor bridges and ₹1,002.62 million of the 140 bridle bridges. The restoration cost of urban infrastructure was ₹707 million for water supply (directly affecting 1.12 lakh people), ₹145 million (US$2.42 million) for drains and ₹180 million (US$3 million) for sewerage[38].

Businesses can be impacted through the following:

- Interruptions caused in the business value chain during the catastrophe
- *Post-catastrophe:* Damaged assets for production
- *Supply chain:* Disrupted backward and forward linkages of inputs indirectly affect the producer who was not directly affected.

These disruptions can even make the already distressed economic activities go extinct due to high recovery costs. Disrupted capital's restoration or upgradation requires time for production adjustment and preparation, which might not follow the producers' rush to restart economic activities. Thus, if the capital is repaired or replaced at the

[36] ADB, Government of Odisha, and World Bank, *Cyclone Phailin in Odisha, October 2013, Joint Rapid Damage and Needs Assessment Report* (Mandaluyong, ADB; Bhubaneswar: Government of Odisha; Washington, DC: World Bank, 2013).
[37] Government of Odisha, *Odisha Economic Survey 2018–19* (Bhubaneswar: Government of Odisha, 2019).
[38] ADB, Government of Uttarakhand, and World Bank, *India Uttarakhand Disaster June 2013, Joint Rapid Damage and Needs Assessment Report* (Mandaluyong, ADB; Dehradun: Government of Odisha; Washington, DC: World Bank, 2013).

same outdated level, this 'technology inheritance' might not boost productivity[39]. The speedy recovery of a disrupted economy requires increasing returns to scale to reach a fully functional economy and not only recover to the pre-calamity levels but also show signs of growth. This necessitates technological upgradation and hence increased expenditure. ILO, in its report,[40] projected Indian productivity loss to 34 million full-time jobs by 2030. The table below highlights the total percentage of working hours lost (sector-wise for the economy as a whole [in an RCP 2.6 scenario]) due to heatwaves and the associated mental and physical health deterioration.

Category	Years	
	1995	2030
Agriculture	5.87%	9.04%
Industry	2.95%	5.29%
Construction	5.87%	9.04%
Services	0.63%	1.48%
Total %	4.31%	5.8%
Total full-time jobs (in thousands)	15,519	34,056

[39] S. Hallegatte and P. Dumas, 'Can Natural Disasters Have Positive Consequences? Investigating the Role of Embodied Technical Change', Ecological Economics 68 (2009): 777–786

[40] ILO, *Working on a Warmer Planet: The Impact of Heat Stress on Labour Productivity and Decent Work* (Geneva: ILO, 2019).

Displacement of people

Rescue team helps people escape from the flooded area of Alleppey, Kerala.

People often tend to migrate in search of livelihood or due to threats of future prospects of recurrence of such events post-natural calamities. India recorded the highest number of people displaced due to EWEs (2.678 million) in 2018, which is double the number in 2017 (1.3 million)[41]. People engaged in primary economic activities tend to diversify their livelihoods or escape destitution by migrating to nearby cities. Such migrants are likely to work in unorganized sectors with little or no bargaining power, a lack of welfare schemes and a lack of secured employment. Every sixth urban Indian lives in slums (Census 2011); these places are generally densely populated with low-income communities (provides restricted greenery and open spaces). The lack of affordable and adequate housing, clean drinking water and healthcare facilities might increase their susceptibility to health risks, which in turn makes them more vulnerable.

Even in modern times, migrants face different sets of problems, such as limited knowledge of the language, culture, environmental conditions, institutions and markets; and restricted social networks and mobility, to name a few. This might affect their capabilities to attain early warning, rehabilitation and relief. For example,

[41] IDMC, *Global Report on Internal Displacement 2019* (Geneva: IDMC, 2019).

migrant and daily wage workers in Chennai lost their identification documents during the calamity and were considered ineligible to subscribe to the relief measures[42]. The 'invisibility' of migrant workers in disaster risk reduction efforts is both the cause and the consequence of their losses being addressed in an unsystematic manner[43]. Daily wage earners, who earn and spend on a per-day income-based constraints, lose their working days (opportunity costs), which furthers their economic vulnerabilities.

Displacement due to natural catastrophes has raised concerns over the linkages of vulnerability and human trafficking. Destitute migrants may be forced to come in contact with exploiters or may be 'duped' by them in the hope of finding work. In the absence of relevant efforts to address such deficiencies, migrants may suffer disproportionately. Evidence has shown a direct relationship between the increase in crime rates in the aftermath of natural catastrophes. Factors such as inaccessible government officials, corruption, poor mental health and powerlessness can all contribute to an increase in societal violence[44].

[42] *Deccan Chronicle,* 'Migrant Workers Worst Hit by Tamil Nadu Floods: Survey' (2016). Available at https://www.deccanchronicle.com/current-affairs/140116/migrant-workers-worst-hit-by-tamil-nadu-floods-survey.html (accessed on 9 February 2022).

[43] Lorenzo Guadagno, *Reducing Migrants' Vulnerability to Natural Disasters through Disaster Risk Reduction Measures* (Geneva: ILO, 2015).

[44] World Health Organization, *The World Health Report, 2001 Mental Health: New Understanding, New Hope* (Geneva: WHO, 2001), 43.

Health

Doctor treats flood victims at a free medical health camp in a flood-affected village in Assam.

Devastating natural calamities involving water and sanitation disruptions often set the chances of endemics in the region, furthering public health issues. This may be enhanced by the loss of past medical records, the unavailability of drugs, the spread of waterborne diseases and the denial of sanitation when people are crammed into temporary shelters (as the urgent provision of sanitation to a large number of people might not be a feasible option)[45]. Factors leading to the widespread public health disruptions are listed below.

[45] Meena Gupta, 'Cyclone and After—Managing Public Health: Orissa', *EPW 35*, no. 20 (2000).

- *Unavailability of logistics:* Medicines, medical records, check-ups and human resources (including the halted training)
- Increased incidences of mental health deterioration
- Widespread communicable diseases due to improper sanitation
- Disruptions in non-communicable diseases' detection and treatments.
- Affected nutritional indicators across the population due to the disrupted delivery system; major disruptions being the ICDS' frontline workers' restricted movements and damaged infrastructure
- Plunging women's health indicators, especially for the pregnant and lactating women

It is evident that at least one-third to one-half of those people affected by natural disasters are prone to mental stress and the development of mental illness[46]. This can be attributed to several factors such as the loss of loved ones, disrupted livelihoods and social security and the breakdown of social harmony, among others.

The lack of privacy and maintenance of hygiene for women is also prevalent, especially during their menstrual cycles. Socially determined values and responsibilities often lead to vulnerabilities for women during natural catastrophe processes. The safety net of women against domestic and sexual violence also tends to decline due to their poor social linkages, which are hampered due to these disasters[47]. Thus, gender has been an integrated principle of the Hyogo Framework for Action 2000–2015: On Building Resilience of Nations and Communities to Disaster: 'A gender perspective should be integrated into all disaster risk management policies, plans and decision making processes, including those related to risk assessment, early warning, information management, and education and training.'

Loss and damage to the environment can also indirectly affect the public health landscape through different channels like pollution-level disrupted ecology, among others. These costs are usually more than the original damage; for instance, Kerala floods 2018 incurred a damage of ₹26 crore and losses of ₹0.04 crore to the environment against the recovery and restoration cost of ₹146 crore[48].

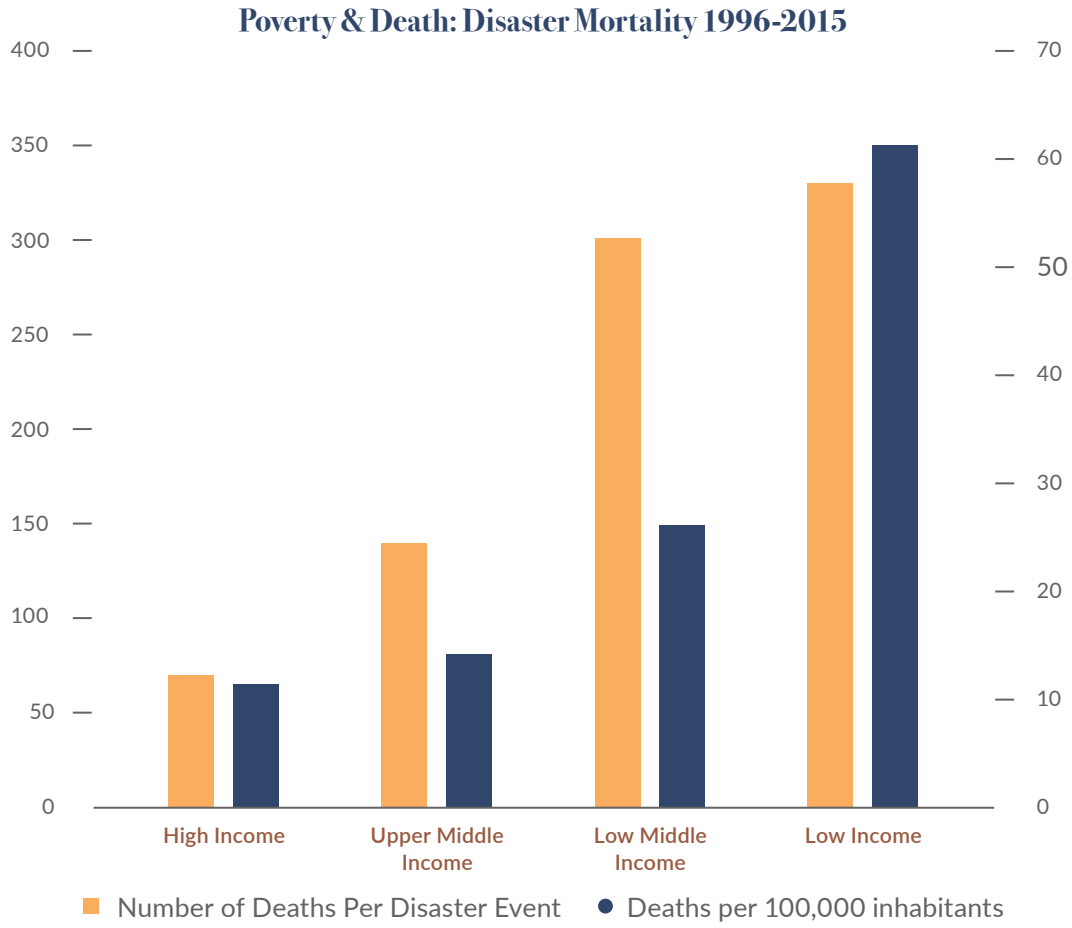
[46] World Health Organization, *The World Health Report,* 43.
[47] WHO, *Gender and Health in Disasters* (Geneva: WHO, 2002).
[48] ECHO, Government of India, UNDP, and World Bank, *Kerala: Post Disaster Needs Assessment, Floods and Landslides—August 2018* (Ghent, ECHO; New Delhi: GOI; New York, NY: UNDP; Washington, DC: World Bank, 2018).

Underprivileged, uncounted and left behind

Indirect losses tend to be relatively higher than the direct losses in poor countries when a natural catastrophe occurs[49]. Also, larger disasters constitute a larger proportion of indirect costs of the total costs[50]. Thus, severe disasters lead to affecting the poor countries with more indirect costs. The poor countries face a trade-off of diverting limited funds from social utilities towards disaster mitigation and hence are often more prone to be highly vulnerable to unexpected, unprecedented and severe events.

As per a report,[51] low-income and lower middle-income countries together constituted 68.3% of total disaster-related mortalities over the period 1996–2015. The average number of deaths as well as deaths per 100,000 inhabitants were also five times higher in low-income countries than in higher income countries, as depicted in the following graph.

[49] M. B. Anderson, 'Vulnerability to Disaster and Sustainable Development: A General Framework for Assessing Vulnerability' *in Disaster Prevention for Sustainable Development: Economic and Policy Issues, eds.* M. Munasinghe and C. Clarke (Washington, DC: IBRD/World Bank, 1995).
[50] R. Litan, 'The Impacts of Natural Disasters: A Framework for Loss Estimation' (Washington, DC: Committee on Assessing the Costs of Natural Disasters, National Research Council, National Academy Press, 1999).
[51] UNISDR and CRED, *Poverty & Death: Disaster Mortality 1996–2015* (Geneva: UNISDR; Brussels: CRED, 2015).



Source: UNISDR and CRED (2015).

Disasters are discrimination blind; they occur with the equal devastating force for everyone with uniformity. However, our societal adaptive and responsive capabilities during and after a calamity lead to a varying impact of natural catastrophes for different strata.

Poor and marginalized usually have poor health, less savings and insurance coverage, live in poor housing facilities and lack alternative sources of food supply routes; this makes them more vulnerable and less equipped to reduce the risk of calamity and adapt post-calamity[52]. Natural disasters not only destroy physical assets but also tend to redistribute wealth among social and economic diversities. Long-term policies directed towards the agriculture sector don't reach landless farm workers; business relief packages take time to indirectly reach industrial workers and daily wage workers and marginalized communities have low coping capacities for rehabilitation given the

[52] David Strömberg, 'Natural Disasters, Economic Development, and Humanitarian Aid', *Journal of Economic Perspectives 2* (2007).

social exclusion and economic vulnerability. The Mumbai floods (July 2005) caused damages of 1,480% of the average monthly income of below poverty line (BPL) class[53]. As most people lack insurance coverage, the impartial compensation or relief forces them into a debt trap to rebuild their lives, using their savings, causing a loss of gains from social upliftment programmes.

Social programmes for facilitating health and education to the poor are also hampered. Since the poor have limited alternatives due to socio-economic constraints, the impact transcends through the years in the form of a 'vicious cycle of poverty' by damaging their means to achieve social upliftment (both extrinsic and intrinsic). For example, the Uttarakhand floods (2013) damaged 873 educational services related to public buildings (reconstruction cost: ₹848.77 million), 56 health services-related buildings (reconstruction cost: ₹131.35 million), 49 women and children centres (reconstruction costs: ₹14.83 million)[54]. The reconstruction costs have been used by foregoing other social benefit schemes.

Post-disaster impacts such as inadequate facilities and infrastructure, staff absenteeism, utilization of buildings as emergency shelters and loss of livelihood and finances can be attributed as major threats to the continuation of education and the long-term development of children. Health and nutritional indicators of children are also worsened due to epidemics or malnutrition that is further projected on their ability to learn. Regions that suffer from regular disasters lose learning hours regularly, which in turn impacts a child's overall growth. As poor children are highly dependent on public services, their choices are limited to choose their service providers, making them even more vulnerable to losing months of education. Also, the reconstruction and restoration of educational institutions are often not on the priority list, given the financial constraints and usually being more than the damaged value. For example, the Kerala floods 2018 recorded damage and loss to education and child protection worth ₹179 crore against recovery costs of ₹214 crore, while health and nutrition faced ₹527 crore of damage and losses against the recovery needs of ₹600 crore[55].

[53] Archana Patankar, *Impacts of Natural Disasters on Households and Small Businesses in India* (Mandaluyong: Asian Development Bank, 2019).
[54] ADB, Government of Uttarakhand, and World Bank, *India Uttarakhand Disaster June 2013.*
[55] ECHO, Government of India, UNDP, and World Bank, *Kerala.*

Natural disasters can now be termed man-made disasters as we have prioritized growth over development. The traditional way of calculating the cost of natural disasters needs to be relooked. In my view, besides direct and indirect costs, we need to look at multidimensional costs and intergenerational impact of natural disasters, which should include stagnation cost, opportunity cost, temporary or short-term impact, and long-term or permanent impact. The new method of calculating the cost of natural disasters will imply that disaster mitigation should be prioritized over disaster management.

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