A review of Floods disaster in India, mitigation and their impacts

Abstract

India's flood troubles are getting worse all the time. Both natural and man-made factors contribute to the emergence of flood-like circumstances. Compared to the 20th century, these flooding issues are becoming worse in the 21st century. In addition to the financial losses, it is now producing more issues in the villages along the banks of the rivers, affecting the health of millions of affected humans and other living things. In addition, flooding causes significant harm to the ecosystem, soil, groundwater, wildlife, forests, and farmed land. Assam, Bihar, Uttarakhand, Jammu and Kashmir, Kerala, Gujarat, Maharashtra, and other regions are among the most often flooded locations in India.

In Assam, flooding is a frequent calamity that seriously damages infrastructure, property, and human lives. Because to its geographic location, intense monsoon rains, and the existence of significant rivers like the Brahmaputra and Barak, the state frequently sees severe flooding.

In Bihar, flooding is a serious problem that impacts millions of people annually. Because of its position, intense monsoon rains, and rivers that come from the Himalayas, the state is extremely vulnerable to flooding.

Uttarakhand's steep geography and abundant rainfall make it prone to landslides and floods, particularly during the monsoon season. Recent floods have put lives in jeopardy, seriously damaged infrastructure, and interfered with transportation.

Kerala has faced significant challenges due to flooding, particularly during the monsoon season.

In Gujarat, flooding has been a major problem, especially during the monsoon season. The state has already suffered from severe flooding, including as the Gujarat floods of 2017, which left significant devastation in their wake.

In Maharashtra, flooding has been a persistent problem, especially during the monsoon season. The state has already suffered from catastrophic flooding, such as the floods in 2017 and 2021, which left significant damage in their wake.

The history from 1943 to 2025, as well as all the flood-affected locations, their damage, flood management strategies, and mitigations, have all been covered in depth in this review.

Keywords: India's floods, their causes, areas at risk, effects, and mitigation.

Introduction

High tide is the term used to describe a high water level that floods the natural banks along a portion of a stream. As a result, floods are typically connected to rivers or streams. When the flow of a river exceeds the bed's capacity, it is said to be in flood. Overflowing water overflows the banks and floods the normally dry terrain nearby. When this occurs, the water can flow through the floodplain and channel. Droughts and floods are threats that can occur together. Yet, because of the unique characteristics of the Indian monsoon, droughts and floods can strike various regions of the nation simultaneously. Thus, floods may be seasonal. Water that typically breaches the earthen embankments is referred to be a flood. The term "flowing water" can also refer to the tide's inflow. Floods can be divided into three categories. 1. Flash floods: brought on by heavy, quick rains, 2. River Flood: When a river reaches its maximum level due to continuous precipitation or snowmelt, 3. Coastal floods: Resulting from storm surges linked to tropical cyclones and tsunamis. Floods impacted 2 billion people globally between 1998 and 2017. At least three million people have died and millions more have been impacted by natural catastrophes worldwide over the last 30 years. Developing nations account for 90% of natural disasters and 95% of all natural disaster-related fatalities.

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according to the average number of fatalities from natural disasters per year in the top 10 nations. One of the nation's most vulnerable to flooding worldwide is India. The most frequent and expensive natural disaster in the world, floods significantly disrupt both the economy and human life. It is described as: "Alluvial stages in which water overflows from its natural or artificial banks to normally dry land, like a river that overflows its floodplain" . There is little to no alarm associated with this often local and brief occurrence. A flood is considered a disaster when the risks it poses are more than the impacted population can handle. In India, floods are a frequent occurrence that result in significant losses in infrastructure, public services, livelihoods, property, and human life. In a geographical region of 3290 lakh hectares, 40 million hectares are vulnerable to flooding, highlighting India's significant risk and vulnerability. An average of 1600 people are killed, 75 lakh hectares of land are impacted year, and flooding causes Rs. 1805 in damage to houses, public infrastructure, and crops. In 1977, the greatest number of lives (11,316) were lost. Major floods occur more than once every five years. Recent floods that caused significant damage include the Kosimega flood in 2008, which happened on August 18 in Bihar state, and the Jammu and Kashmir flood in 2014. s a yearly issue in the area. The Government of India (GOI) created the National Disaster Management Authority (NDMA) as the highest Disaster Management (DM) body in India with the Disaster Management Act 2005 (DM Act, 2005). Among other things, the NDMA's mandate is to implement a paradigm shift from the previous focus on mitigation and post-event syndrome to a proactive GD that is centered on prevention, mitigation, and preparedness. These initiatives will minimize the loss of life, livelihoods, and property while simultaneously protecting development gains. The NDMA used a nine-step procedure to establish these guidelines.

Photographs in Figure 1 illustrate the extent of the 2008 flood.

Flood causes

Natural Causes

Climate Change: The International Panel for Climate Change predicts that future rains will be more intense, longer, and more frequent. Additionally, climate change is increasing the frequency of cloud bursts and cyclonic circulations that result in flash floods.

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Rainfall Pattern Skewed: The monsoon season, which lasts from June to September, accounts for 80% of total rainfall. The rivers transport large amounts of silt from the catchment areas during this time. Flooding is caused by these factors as well as inadequate river carrying capacity, drainage obstructions, and embankment erosion.

Transnational Rivers: The issue is made more complicated by the fact that some rivers, such as the Brahmaputra and other Ganga tributaries, cause harm in India even though they start in nearby nations. Floods in northern India are also caused by abrupt topographical changes from high mountains to plain plains.

Earthquakes: According to the National Disaster Management Authority (NDMA), over 56% of India is susceptible to moderate to large earthquakes, according to the Earthquake Disaster Risk Index (EDRI). Since many of India's river basins are located in seismically active regions, the river's flow is unstable and causes flooding.

Human Factors

Unplanned construction: Deforestation, land use change, sedimentation in riverbeds, failure of flood control structures, unplanned reservoir operations, unplanned construction, encroachment on riparian regions, and inadequate drainage infrastructure all contribute to flooding. Heavy rains cause the river to breach the embankments, destroying homes on the sandbars and along the banks.

Urban Flooding: The growing frequency of intense rainfall in a brief period of time has resulted in flooding in cities and towns, a recent phenomenon. Random invasion of wetlands and streams, inadequate drainage capacity, and poor drainage infrastructure maintenance are the causes of this. In addition, poorly designed road projects are obstructing flood flows, and inadequate waste management is making the issue worse by clogging lakes, canals, and sewers.

Ignorance of Pre-Disaster Planning: The history of flood management demonstrates that post-flood relief and recovery have received the majority of the attention. There are insufficient gauging stations in many reservoirs and hydroelectric facilities to detect flood level, which is the primary factor in flood forecasting and prediction.

Different kinds of floods

The fact that there are various kinds of floods that might happen worldwide should be noted before discussing the causes and consequences of floods. The two most prevalent types of floods are as follows: River floods and flash floods as the name implies, flash floods are the sudden rise in water levels in low-lying areas brought on by an abundance of rainfall. Because of their great speed and destructive force, these weather phenomena are extremely dangerous and frequently result in fatalities because they don't give people enough time to take precautionary measures or flee to higher ground.

Because there is less soil or vegetation to function as a barrier or defense against torrential rainfall streaming overland, flash floods are more likely to occur in regions with rocky terrain and a dry environment. On the other side, river flooding happens when a river overflows its bed and its water level becomes unmanageable. Areas near melting snow and ice, as well as those with a wetter climate and longer rainfall seasons, are more likely to see these occurrences.

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Escalation of flood magnitude

- A flood's "severity" as a purely hydrological occurrence is measured by the flood magnitude value; damage assessment is not involved. The lowest number that has been documented is "0" (flow less than 1.5 years, no flooding). Since 1998, "10" has been the record flood, making it the most significant. When the reported current flooding/flood of record ratio is multiplied by 10, a number of 8 means that the flood runoff volume is equal to.8 times the flood of record.
- Total runoff volumes are determined for the flood hydrograph above the bank full discharge, utilizing the 1.5 y recurrence interval flow as this threshold discharge in order to determine the flood magnitude. The runoff volume amassed thus far in relation to the flood volume of record periods is the reported current magnitude figure.
- To assess the duration of most floods and to avoid including runoff volumes from previous floods, the algorithm that automatically determines the extent of the flood from the River Watch discharge data uses a 30-day window for that accumulation.
- Once discharge surpasses this level, daily runoff values are added up, and the total is multiplied by the contributing watershed area to determine the overall flood runoff volume (m3). Every day, the volume rises until the discharge falls below the threshold.
- The magnitude of a flood increases with its duration. Higher magnitudes will also be displayed by floods that attain higher peak rates. River size and catchment area have no bearing on the magnitude number, which compares the flood volume to the recorded flood. Larger basins will have higher flood volumes (all other things being equal).

India's floods

This is a list of floods that have happened in India that have received special attention. In India, floods are the most frequent natural calamity. The Brahmaputra is the heaviest in the southwest, while other rivers spread their banks, frequently inundating the neighboring areas.

Table: -1 This is a list of floods that have happened in India but are not table-recorded.

YEAR	REGION	DAMAGES	SOURCES
October 1943	Chennai, now known as Madras	Property and human life were severely damaged. The projected amount is uncertain, though. Thousands of people were rendered homeless by the flood.	[13, 14]
August 11, 1979	Gujarat's Rajkot District, Machchhu River	Although the precise number of fatalities is unknown, it is thought to be between 1800 and 2500.	[13, 18]

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1987	Bihar's Koshi River	It resulted in the deaths of 302 animals, 1,399 people, and INR68 billion (US$850 million) worth of public property.	[13]
1993	India has eight states.	530 persons were killed by flash floods.	[13]
2004	Bihar	During this time, 3272 animals and 885 humans perished.	[19]
June of 2005	Gujarat	This resulted in the deaths of 123 individuals.	[19]
July 26, 2005.	Maharashtra	Killed a minimum of 1,094 individuals. The estimated damage of public property was INR 550 Crors, or US$69 million.	[19]
November through December of 2005	Chennai	The floods claimed the lives of fifty people.	[19]
2008	Bihar	Approximately 2.3 million individuals were impacted.	[19]
August 6 2010	Ladakh	Approximately 71 cities had been devastated by the flood waters. 255 individuals died as a result of this.	[19]
2012	Barhamputra River	This resulted in 124 fatalities. In addition, water from the deluge had reached Kaziranga National Park ultimately resulted in the death of 500 animals.	[19]
August 3 2012	Himalaya	This resulted in the deaths of thirty-one persons.	[19]
June 2013	Chaar Dham Utrakhand	Over 5,700 persons were thought to be dead.	[13,20]
2014	Jammu and Kashmir	There were 200 fatalities.	[21]

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June 2015	Gujarat	Over 70 fatalities	[13,22]
July through August of 2016	Assam	1.8 million people are impacted, and about 200 wild animals are killed as the Kaziranga National Park floods.	[13,23]
July 2017	Gujarat	More than 200 people died as a result of the devastating flood.	[13,24]
8 August 2018	Kerala	445 or more deaths.	[13]
16 July 2019	Brahmaputra , Assam	Impacted 1, 63,962.02 hectares of cropland and 52, 59,142 persons in total. On July 20, there were 59 fatalities in the state. In the districts that are impacted, at least 3,024 villages remained submerged and 44,08,142 individuals	[25,26]
2020	Brahmaputra , Assam	Over 30,000 were impacted, and 1.6 million people in 22 Assamese districts were impacted by landslides in July.	[25,27]
May 2022	Assam	Over 60,000 hectares (600 km2) of cropland and thousands of villages have been impacted throughout the state, according to the Assam State Disaster Management Authority (ASDMA). Authorities provide refuge to thousands of individuals throughout the state through a number of distribution facilities and relief camps.	[25,28]

India's flood-prone areas

India's flood-prone areas: The geographical makeup of the Indian subcontinent makes certain regions vulnerable to flooding. Numerous perennial rivers originate from one of the world's largest glaciers, which is part of the snow-capped northern Himalayas. Millions of Indians live on the vast plain created by these rivers. Rivers that overflow from intense monsoon rains are a major cause of flooding in these enormous plains. The NIDM reports that India receives 1150 mm of rainfall on average, with notable regional variations.

The Khasi Hills, the Western Ghats, the West Coast, and the majority of the Brahmaputra Valley receive more than 2500 mm of rain annually. River flooding mainly happens during the monsoon season and is typically linked to active monsoon conditions, tropical storms, or depressions. Flooding is caused by rivers, but it can also be caused by tornadoes, tsunamis, glacial lake outbursts, and strong rains. The Indo-Ganga-Brahmaputra plain and the coastal regions in the east and west are the primary flood-prone zones in India, according to the Central Water Commission's report on the country's flood zone susceptibility.

A river flood occurs when water from the river's many tributaries collects and deposits massive amounts of silt and sand on the riverbed. The river's flow is decreased by the deposited clefts, and it starts to spread horizontally, inundating the surrounding habitats. The two primary synoptic systems that cause flooding in the majority of flood-prone states are lows and lows. According to the NIDM's report, overland depressions and clearly defined depressions are the primary cause of 82% of floods in Uttar Pradesh and 100% of floods in Bihar. Cyclone circulation is the primary cause of flooding in West Bengal. In contrast, low-pressure zones are the primary cause of regular flooding in Punjab, Gujarat, Rajasthan, and Jammu & Kashmir.

The monsoon depression is the cause of the floods in Andhra Pradesh and Orissa. Flooding is a common occurrence in metropolitan areas nowadays. Poor sewage management and a clogged sewer system brought on by negligent waste disposal and inadequate maintenance by the appropriate authorities are the causes of these floods. Cyclones and tsunamis are the primary causes of coastal flooding. According to Rashtriya Barh Aayog (1980), 12% of India is made up of flooded areas, which cover around 40 million hectares of land.

Based on data on flood damage reported by states for the years 1953–2010 (Report of the Working Group on Flood Management and Region-Specific Problems for XII Plan 2011), this amounts to more than 49,815 MHAs, with an average area and population affected by floods of 7.2 M. ha. and 3.19 million, respectively.
The entire countries flood-prone region, comprising the 33.516 m.ha unprotected floodplain and the remaining protected land, was estimated by the National Flood Commission (RBA) in 1980 to be 40 m.ha. The countries flood-prone region, which is 45.64 m ha, was then evaluated by the flood management working groups for floors X and XI.

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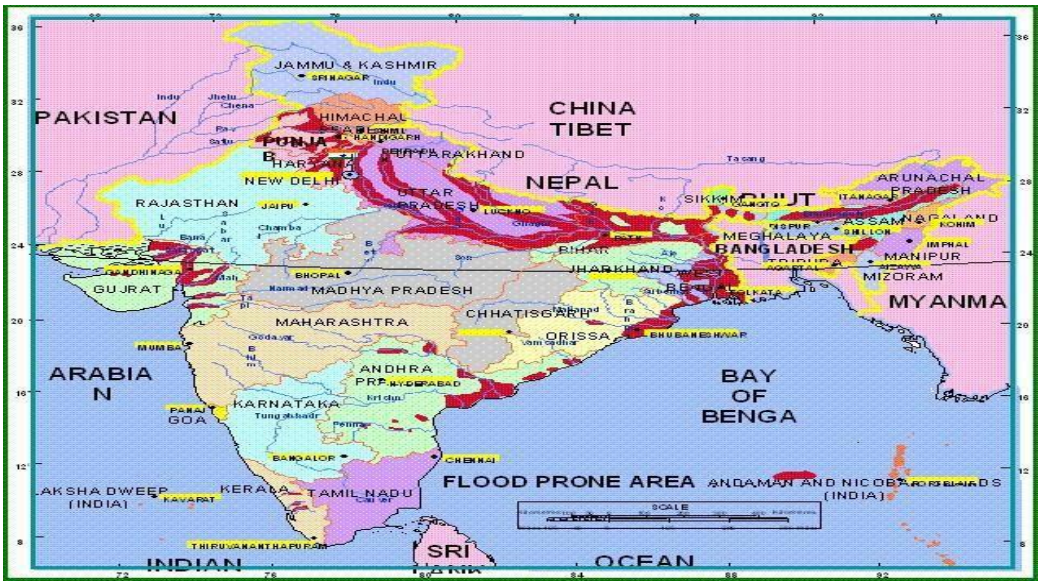

Figure 2 shows the areas of India that are vulnerable to flooding (Source: https://indiawris.gov.in/wiki/doku.php?id=flood_management)

River systems and related issues with flood

For the purpose of researching the flood issue, India's rivers can be loosely divided into the following four regions.

1. Brahmaputra,
2. Ganga,
3. North West
4. Central India and the Deccan [30]

Region of the Brahmaputra River:

This area, which includes the northern portions of West Bengal, Manipur, Tripura, Nagaland, and the seven states of Assam, Arunachal Pradesh, Meghalaya, and Mizoram, is comprised of the Brahmaputra and Barak rivers and their tributaries. Rainfall in these rivers' basins is quite copious, ranging from 110 to 635 cm annually, with the majority of this falling between May and June and September. Consequently, this area experiences severe and regular floods. These rivers also contain a remarkable amount of mud since the rocks of the hills from which they originate are brittle and prone to erosion. In addition, the area experiences regular and severe earthquakes that disrupt the waterway regime and result in several landslides on the hills. Floods brought on by river overflows, stagnant drainage, and the propensities of certain rivers to do so are the primary issues in this area. Modify their plans. In recent years, the Brahmaputra's banks have experienced significant erosion.

Region of the Ganga River:

This river region is formed by the Ganga River and its several tributaries, of which the Yamuna, Sone, Ghaghra, Gandak, Kosi, and Mahananda are significant. Ten states are included in it: Uttaranchal, Uttar Pradesh in its basin region, Jharkhand, Bihar, sections of Haryana, Himachal Pradesh, Rajasthan, Madhya Pradesh, Delhi, and South and Central West Bengal. Over 80% of the region's typical yearly rainfall, which ranges from 60 to 190 cm, falls during the southwest monsoon. Rainfall rises from the south to the north and from the west to the east.

Generally speaking, the flooding issue only affects regions on the Ganges' north bank. The Ganges' northern tributaries overflowing their banks and altering their path are to blame for the destruction. Although the Ganga is a powerful river with massive flows of 57,000 to 85,000 cumec (2 to 3 million cusecs), the issues of erosion and flooding are limited to a small number of locations. Generally speaking, the issue of flooding gets worse from south to north and from west to east. The issue of drainage congestion is present in the regions northwestern and some eastern regions.

In the states downstream, erosion and flooding are major issues. Some states that weren't often prone to flooding have also seen some instances of severe flooding in recent years.

Region of the North West River:

The Sutlej, Beas, Ravi, Chenab, and Jhelum are the principal rivers in this area. They are all tributaries of the Indus and come from the Himalayas. These transport a lot of debris and significant runoff during the monsoon season. They often veer off course, leaving behind sand litter patches. The states of Jammu & Kashmir, Punjab, and portions of Himachal Pradesh, Haryana, and Rajasthan are all included in the region.

This area has a comparatively lower flooding problem than the Ganges and Brahmaputra regions. The primary cause of flooding and water logging in vast areas is inadequate surface drainage.

The Deccan Region and Central India:

The Narmada, the Tape, the Mahanadi, the Godavari, the Krishna, and the Cauvery are the major rivers in this area. The majority of these rivers have steady, well-defined channels. With the exception of the delta region, they have sufficient capacity within the natural banks to carry the flood runoff. The flood issue has mostly been resolved by embanking the lower portions of the major East Coast Rivers.

Flooding's impact

It should come as no surprise that rivers have played a significant role in human history because they supply fresh water, food, and arable land. Water may be damaging even though it is necessary for life. The consequences of river flooding can be disastrous. Effects of flooding on people: Floods affect people in a number of ways, including:

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- Floods have the potential to kill or seriously harm people;
- They are frequently tainted with sewage, which can contaminate drinking water and cause illness; and they can disrupt power supply.
- Hospitals, schools, and other facilities could have to close, and businesses might be compelled to close.
- Transportation networks could be impacted, including roads, railroads, and bridges damaged by flooding.
- Goods may be damaged and removed;
- Homes and properties may flood;
- People may be forced to evacuate their homes until flood damage is rectified.

Flooding's effects on the environment include:

- Destroying wildlife habitats;
- Polluting rivers and habitats with contaminated flood water;
- Destroying crops on farms with silt and sediment;
- Removing river banks and natural dykes when rivers reach capacity;
- Widening rivers and increasing deposits downstream;
- Uprooting trees;
- Killing plants that survive the initial inundation.

Flood management in India

- STRUCTURAL MEASURES: Flood walls and embankments, reservoirs and dams, channel and drainage enhancements, and flood water diversion
- Non-structural measures include flood disaster relief, flood fighting, flood plain management and zoning, flood proofing, forecasting, monitoring, and early warning systems.

Readying for flood mitigations

A stream can overflow and result in flooding due to a number of factors, including extreme rainfall, a broken dam or levee, and severe ice melt. While some floods develop gradually over hours or even days, giving ample time for planning and evacuation, others might happen suddenly and with little notice, giving little time for these activities. Businesses can reduce the effects of floods by using mitigating strategies. Planning beforehand for flood events that could endanger a business can pay off handsomely when they happen; it lowers the risk of property damage, business interruption, bodily injury, and related insurable losses.

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Before a flood happens, a company can use these tactics to safeguard its resources and the people it is in charge of.

- Determining whether or whether the facilities under your jurisdiction are located in a floodplain, learning about past flooding in these locations, and determining the elevation of facilities connected to rivers, dams, and streams;
- Recognize and be familiar with the local community's emergency plans, warning signs, escape routes, and shelter locations;
- Discuss populations with special needs under your organization's control with local emergency management officials, and make sure that efficient emergency evacuation plans are followed and kept up to date for intervention as necessary;
- Establish protocols for facility shutdown and early release of personnel/persons involved;
- Provide routine monitoring of a NOAA weather radio device;
- Identify and understand where and how to shut down critical plant services, including but not limited to electrical, gas, water, hydraulics, compressed air, sewage systems, etc.
- Transfer as many items and machinery as you can to higher ground or elevations for storage. Priority must be given to high-quality real estate;
- Using sandbags or other materials construct storm surge barriers; relocate all cars and/or mobile devices to higher land or elevations.
- De-energize every electrical system component and make sure that all outlets, switches, circuit breakers, cords, and related devices are at least 12 inches above the facility's intended flood height;
- In the event of flooding, turn off all fuel-burning equipment; Prior to a flood, identify and secure any hazard sources; conduct routine maintenance and cleaning of facilities' drainage systems, including but not limited to culverts, gutters, downspouts, and related pipes;
- In the case of flooding or heavy rain, access to and/or installation of sump pumps at designated damage control facilities; in the event of flooding or heavy rain, access and/or installation of check valves or plugs to recognized damage control facilities.

The government's floods initiatives and policies

Following the 1954 floods, which were unprecedented, the Indian government established a number of committees to investigate the issue of flooding throughout the nation.
Expert Committees' Suggestions for Flood Management:

- Statement of Policy, 1954

- The 1957 and 1958 High-Level Committee on Floods and Policy Statement In 1980, the National Flood Commission (Rashtriya Barh Ayog) was established.
- National Water Policy (1987/2002/2012) [33, to 36]
- Expert committee to examine the application of the National Flood Commission's 2003 recommendations (Comité R Rangachari).

The National Disaster Management Institute (NIDM)

The National Institute of Disaster Management (NIDM) was created by the Indian government through an Act of Parliament as the primary institution for disaster management capacity building in accordance with the provisions of Chapter VII of the DM Act. Catastrophes in the area and in India. By increasing capacity for disaster prevention and preparedness at all levels, NIDM aims to make India disaster-resilient. NIDM has been given important tasks in the areas of disaster management research, documentation, training, capacity building, human resource development, and policy advocacy. A number of central, state, and municipal government departments, academic, scientific, and technical institutions in India and overseas, as well as other bilateral and multilateral international organizations, have formed strategic alliances with NIDM.

Through the State and Union Territory (ATI) Administrative Training Institutes' Disaster Management Centers (DMCs), it offers state governments technical assistance. Currently, up to 30 of these centers are supported. Floods, earthquakes, cyclones, droughts, landslides, and industrial catastrophes are among the six of these that are being established as centers of competence in specific risk management domains.

Conclusion

In India, the issue of floods is getting worse every day. If we examine the period from 1943 to 2024, the greatest flood issue occurred after 2000. In addition, floods have caused property damage and fatalities. The government should take the necessary actions to control flooding in Uttarakhand, Bihar, and Assam. These actions should include building dams on rivers, improving health care, education, and financial assistance for the populace, as well as raising awareness of the issue of flooding.

References

1. Floods: Causes, Effects, and Countermeasures–UPSC (2021)Floods-upsc: https://lotusarise.com/
2. Floods are a recurring disaster (2022). Perennial disaster floods: https://www.drishtiias.com/daily-updates/daily-news-editorials
3. Sharma, V. K., and A. Sinha (1999). India, National Centre for Disaster Management, Indian Institute of Public Administration, New Delhi. Culture of Prevention: Natural Disaster Management.

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4. Javed, A., Gupta, S., and Datt, D. (2003). India's flood protection economy. 199–210 in Flood Problem and Management in South Asia. Dordrecht, NJ: Springer.
5. In 2015, Tripathi, P. An examination of trends and readiness for the flood calamity in India. Journal of Contemporary Multidisciplinary Research, 2(4), 91-98.
6. P. K. Panda (2014). Flood vulnerability in India: a GIS and remote sensing approach to management, mitigation, and warning. 5(12), 843-846; Asian Journal of Science and Technology.
7. India's Flood Management (2020). Flood management in India: https://www.drishtiias.com/daily-updates/daily-news-editorials
8. Management of Floods: National Disaster Management Guidelines (2008). NDMA/3.pdf https://nidm.gov.in/PDF/pubs
9. Pourghasemi, H. R., Shit, P. K., Bhunia, G. S., and Samanta, R. K. (2018). An analysis of the Subarnarekha River Basin in India utilizing the geospatial frequency ratio technique for mapping flood susceptibility. Earth Systems and Environment Modeling, 4(1), 395–408.
10. India's Flood Management (2020).Flood management in India: https://www.drishtiias.com/daily-news-editorials
11. What are the primary causes and consequences of floods worldwide? (2021) What are the primary causes and consequences of floods? https://earth.org/
12. Flood,Observatory.colorado.edu/SatelliteGaugingSites/DFOFloodIndexExplanation.pdf: DFO Flood Magnitude Scale
13. India's floods in 2020.Floods in India: https://en.wikipedia.org/wiki/
14. Prince Frederick (November 22, 2011)."Memories of Madras: Story of asubmerged city" .The Hindu. Retrieved May 28, 2015.
15. A.G. Noorani (August 25, 1979).JSTOR4367866 "The Inundation of Morvi" Economic and Political Weekly, 14(34): 1454.
16. "Dissolving Commissions of Inquiry" by A.G. Noorani, 21 April 1984, Economic and Political Weekly, 19 (16): 667–668. JSTOR4373178.
17. Environment Department, World Bank (1991).Source book for environmental assessment. Publications of the World Bank, p.86.The ISBN is 0-8213-1845-4.Retrieved January 10, 2012.
18. Easwaran, S.B. (August 27, 2012). "The Loudest Crash Of '79" .India's outlook. On December 24, 2014, the original content was archived. Retrieved May 28, 2015.
19. https://www.inextlive.com/top-10-major-floods-in-of-India-history-201512020030

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20. "India raises flood death toll reaches 5,700 as all missing persons now presumed dead" .On July 16, 2013, CBS News. Retrieved August 26, 2018.
21. "Kashmir floods: phones down,roads submerged; toll touches200, rescue ops on" .Hindustan Times, August 8, 2014. On September 9, 2014, the original content was archived. Retrieved September 9, 2014.
22. "Gujaratfloods:72peopledead,over81,000cattleperisheddue toheavyrains" .August 5, 2015. Firstpost. Retrieved August 23, 2015.
23. Vidhi Doshi (27 July 2016). "FloodinginIndiaaffects1.6mpeopleandsubmergesnationalpark" .Guardian. Accessed August 2, 2016.
24. "PM rushes to Gujarat, announces relief package of Rs 500 crore" .India's Times. Retrieved July 26, 2017.
25. The article "Brahmaputra Floods" can be found at https://en.wikipedia.org/wiki/Brahmaputra flow.
26. "Assam flood waters show receding trend, but death toll rises to 59" . Indian Express, July 20, 2019.Retrieved July 21, 2019.
27. "Assam flood situation worsens, over30, 000 in 5 district saffected" .Times of India, May 25, 2020.
28. "Assam: Assam floods: 26 killed, 5.8 lakh affected across 17 districts" (retrieved May 26, 2020).32. Tripathi, P. (2015). The Times of India. 24 May 2022. Retrieved 25 May 2022. An examination of trends and readiness for the flood calamity in India. Journal of Contemporary Multidisciplinary Research, 2(4), 91-98.
29. https://Indiawris.gov.in/wiki/doku.php?id= flood_management, Flood Management (2021)
30. https://education.nationalgeographic.org/resource/many-effects-flooding The Many Effects of Flooding
31. Internet geography, https://www.internetgeography.net/topics/how-does-flooding-affect-humans-and-the-environment/
32. FLOOD MITIGATION PREPAREDNESS, Documents/Loss Outreach Articles/FLOOD MITIGATION PREPAREDNESS.pdf, https://brim.wv.gov/losscontrol
33. Flood Management Government Initiatives, https://www.gktoday.in/topic/government-initiatives-on-flood-management/
34. Chandniha, S.K., Krishnan, G., and Lohani, A.K. (2017).Risk assessment and management for hydrological disasters. 39. Lohani, A.K., Jain, S.K., & Singh, R.D.,

Combination of GLOF with relevant design flood, Workshop on Design Flood Issues, 19-20 November 2013, Central Water Commission, New Delhi (2013)

35. May 2016 National Disaster Management Plan, https://www.mha.gov.in/sites/default/files/National Disaster Management Plan May 2016 pdf

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