



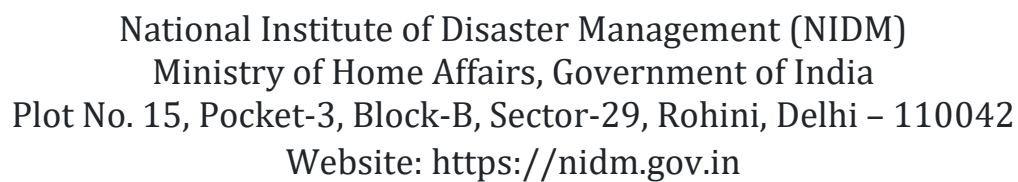
India Disaster Report 2025



nidm

Resilient India - Disaster Free India

National Institute of Disaster Management
Ministry of Home Affairs, Govt. of India



INDIA DISASTER REPORT 2025

ISBN No : 978-81-69202-01-5

Copyright © 2026, National Institute of Disaster Management, Delhi

Edition : 2026

Editors : *Dr. Sushma Guleria*
Dr. Vishal Katekar

Citation : Guleria S., Katekar V., (2026) India Disaster Report - 2025.
National Institute of Disaster Management, Delhi, India. Page 212

Published by : National Institute of Disaster Management, Ministry of Home
Affairs, Government of India, Delhi-110042

Disclaimer : All rights reserved. No part of this publication may be reproduced or
transmitted in any form or by any means electronic or mechanical,
including photocopying, recording or by any information storage
or retrieval system without permission from National Institute of
Disaster Management (NIDM).

India Disaster Report 2025

Table of Contents

FOREWORD	v
EXECUTIVE SUMMARY	vi-vii
INTRODUCTION	1
1. Air India Dreamliner Crash, Ahmedabad, Gujarat	7
2. Chashoti Flash Flood, Jammu & Kashmir	20
3. Dharali Flash Flood, Uttarakhand	38
4. FlooosQ in Himachal Pradesh	51
5. FlooosQ in Punjab	75
6. Cyclone Ditwah	92
7. Prayagraj Kumbh Stampede	108
8. Delhi Railway Station Stampede	119
9. IPL Bengaluru Stampede	132
10. Karur Rally Crowd Crush	144
11. Telangana Chemical Factory Explosion	155
12. Arpora Nightclub Fire, Goa	171
13. Indore Water Contamination Crisis	184
Annexure : Other Disasters in 2025	200

मधुप व्यास, भा. प्र. से.
कार्यकारी निदेशक
Madhup Vyas, IAS
Executive Director



Foreword

The *India Disaster Report 2025* is presented at a critical juncture in our nation's journey toward comprehensive disaster resilience. Our vast geographical diversity inherently brings a complex and evolving hazard profile, and the events of the past year have served as a stark reminder of the compounding nature of these risks. As disasters cease to be isolated incidents and increasingly manifest as interconnected crises, our approaches to documenting, analyzing, and mitigating them must evolve accordingly. To provide a clear, actionable understanding of these cascading risks, the disaster documentation in this compendium has been deliberately categorized based on natural and human-induced factors. This delineation allows for a precise analysis of root causes, thereby facilitating more targeted policy interventions and preparedness strategies.

Under the category of natural factors, this report examines the profound impacts of climate variability and extreme weather, particularly in our fragile mountain and coastal ecosystems. Events such as the cryosphere-triggered Dharali flash flood, the Chashoti cloudburst, the severe Punjab floods, and the devastating Cyclone Ditrwah highlight the escalating vulnerabilities of our communities to hydro-meteorological extremes. Conversely, the documentation of human-induced factors casts a necessary and critical light on the intersection of rapid urbanization, industrialization, and infrastructural decay. The tragic structural failures of the Gambhira Bridge and the Piplodi school, the catastrophic industrial explosions in Deesa and Telangana, and the severe public health crisis stemming from water contamination in Indore all underscore the pressing need for rigorous safety compliance and infrastructure audits. Furthermore, the catastrophic stampedes recorded at diverse venues—from the Prayagraj Kumbh Mela to the M. Chinnaswamy Stadium—demonstrate that crowd disasters are pervasive risks requiring modernized, systemic management.

The lessons drawn from these dual categories point to a singular, unifying imperative: we must accelerate our transition from reactive emergency management to a development-embedded, risk-informed, and resilience-driven approach. As we chart our strategic roadmap toward the 2047 Amrit Kaal vision, safeguarding our development gains will require us to leverage advanced technologies such as Artificial Intelligence for predictive crowd modelling and Digital Twins for structural health monitoring integrated seamlessly with nature-based solutions like wetland and mangrove restoration. This report serves not only as a record of the past year's challenges but as a foundational tool for policymakers, administrators, and practitioners. I am confident that the insights contained within these pages will drive the necessary institutional and technological reforms required to build a safer, more disaster-resilient India.

(Madhup Vyas)

EXECUTIVE SUMMARY

The India Disaster Report 2025 presents a comprehensive overview of the country's evolving disaster risk landscape, highlighting the growing complexity of hazards arising from hydro-meteorological events, infrastructure failures, industrial accidents, public health emergencies, and human-induced disasters. The report underscores that many disasters are no longer isolated events but interconnected crises where climatic, environmental, infrastructural, and governance factors combine to intensify impacts. These cascading risks reinforce the urgent need for India to move toward development-embedded, risk-informed, and resilience-driven Disaster Risk Reduction (DRR) strategies. A significant portion of disasters was driven by climate variability and extreme weather, particularly in fragile mountain and flood-prone regions. The Dharali flash flood demonstrated how cryospheric instability can trigger sudden disasters, as the event was linked to the collapse of an exposed ice mass near the Srikanta glacier rather than rainfall alone. Similarly, the Chashoti cloudburst caused destructive debris flows, while the Punjab & Himachal Pradesh floods illustrated the compounding effects of extreme monsoon rainfall, high reservoir releases, and unregulated floodplain encroachment. These events highlight the increasing vulnerability of ecosystems and communities to climate-induced hazards.

The report also documents critical infrastructure and public health failures that amplified disaster impacts. In urban areas, deteriorating municipal systems created serious public health threats, exemplified by the Indore water contamination crisis, where sewage infiltration into drinking water pipelines resulted in a major health emergency. Industrialization and rapid urban expansion have also intensified industrial and fire-related risks. Explosions at the Sigachi chemical factory in Telangana, along with the Arpora nightclub fire in Goa, exposed gaps in industrial safety compliance, hazardous material management, and fire safety enforcement. These incidents demonstrate the consequences of weak regulatory oversight and poor adherence to safety protocols in high-risk industries and crowded urban establishments.

Another major concern highlighted in the report is the increasing occurrence of crowd disasters across different types of events. Fatal stampedes and crowd crush incidents were reported at the Prayagraj Kumbh Mela, New Delhi Railway Station, Bengaluru IPL celebrations, and a Karur political rally. These tragedies illustrate that crowd risks are not limited to religious gatherings but extend to transportation hubs, sports events, and political events. In most cases, the disasters were caused by excessive crowd density, inadequate crowd flow planning, infrastructure bottlenecks, and poor communication during emergencies. To address these emerging risks, the report emphasizes the need for transformative and technology-enabled disaster management strategies. It recommends the deployment of advanced Multi-Hazard Early Warning Systems (MHEWS) that integrate artificial intelligence for crowd modelling, drone-based

surveillance, and IoT-enabled structural health monitoring for critical infrastructure such as bridges and buildings. In mountain regions, the report calls for establishing a dedicated Himalayan Cryosphere Monitoring Programme to track glacier dynamics, ice mass instability, and related hazards.

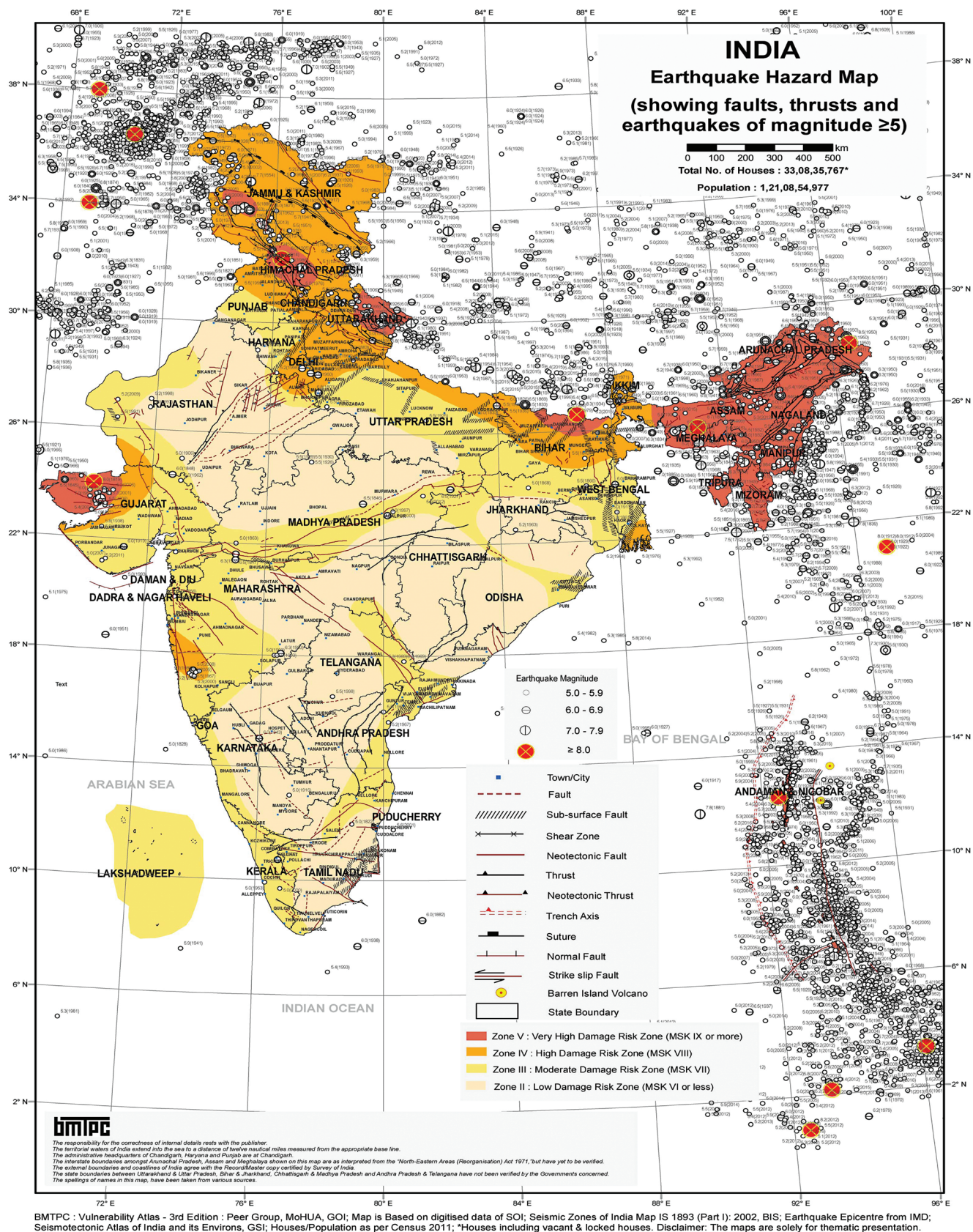
The report further stresses the importance of climate-resilient infrastructure and risk-sensitive planning. This includes mandatory structural safety audits for public buildings and transport networks, enforcement of climate-resilient engineering standards, strict floodplain zoning regulations, and restoration of natural wetlands that act as buffers against floods. Finally, strengthening governance, compliance, and institutional coordination is identified as a critical priority. The report recommends strict enforcement of National Disaster Management Authority (NDMA) guidelines for mass gatherings and industrial safety, establishment of digital monitoring registries for hazardous industries, and adoption of unified command systems to improve inter-agency coordination during emergency response. Overall, the India Disaster Report 2025 highlights that disaster risk in India is increasingly shaped by the intersection of climate change, urbanization, infrastructure stress, and governance challenges. Building resilience therefore requires an integrated approach that combines technology, regulatory enforcement, risk-informed development planning, and stronger institutional capacity to anticipate, prevent, and manage disasters effectively.

INTRODUCTION

India has diverse geography, ranging from the Himalayas in the North to coastal and forested regions in the South, and from the fertile Brahmaputra valley in the East to the Thar desert in the West. It covers an area of 3.28 million sq. km, making it the seventh largest country globally. Geographically distinct, India lies entirely in the northern hemisphere between latitudes 8°4'N to 37°6'N and longitudes 68°7'E to 97°25'E, with a coastline of 11,098.81 km. Physically, India is divided into four major regions: the Himalayan mountain system, the Indo-Gangetic plains, the desert region, and the Peninsular Plateau. The Himalayas, extending about 2,400 km, contain some of the world's highest peaks and fertile valleys. The Indo-Gangetic plains are vast, fertile, and densely populated, formed by major river systems like the Ganga, Indus, and Brahmaputra. The Thar desert in the West is arid, while the Peninsular plateau is a stable landmass rich in minerals, bordered by the Western and Eastern Ghats. Geologically, India's formation is linked to the collision of the Indian and Eurasian plates around 40-50 million years ago, leading to the uplift of the Himalayas. The Indo-Gangetic plains consist of fertile alluvium, while the peninsular region contains some of the oldest rock formations. India's climate is predominantly tropical monsoon type, with four main seasons: winter, summer, monsoon, and post-monsoon. The South-West monsoon brings most of the annual rainfall, while the North-East monsoon influences winter weather patterns.

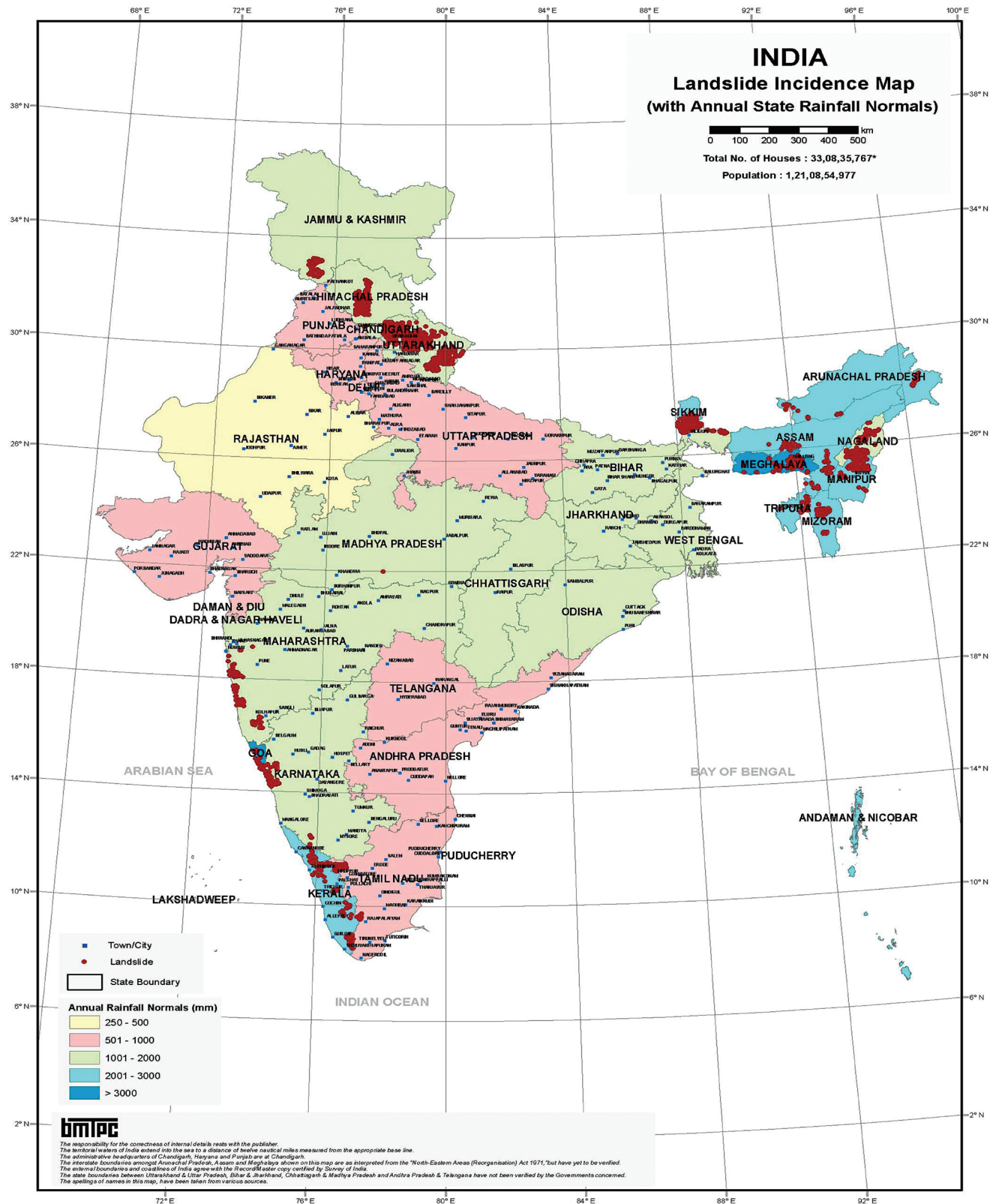
1.2 Hazard and Vulnerability Profile of India

India is highly vulnerable to a wide range of natural hazards due to its unique geo-climatic conditions. Approximately 59% of the country's landmass is prone to moderate to severe earthquakes (Zones III, IV, and V). Floods affect nearly 40 million hectares of land, especially in the Ganga-Brahmaputra-Meghna basin. The eastern coastline remains highly exposed to tropical cyclones originating in the Bay of Bengal, while around 68% of cultivable land is susceptible to drought. Landslides frequently occur in the Himalayan region and the Western Ghats. In addition, the increasing frequency of heatwaves and cold waves reflects the growing impact of climate change. These hazards are further intensified by socio-economic vulnerabilities such as poverty, unplanned urbanization, environmental degradation, and inadequate infrastructure, making disaster risks more severe across the country.



Map 1: Earthquake Hazard Map of India.

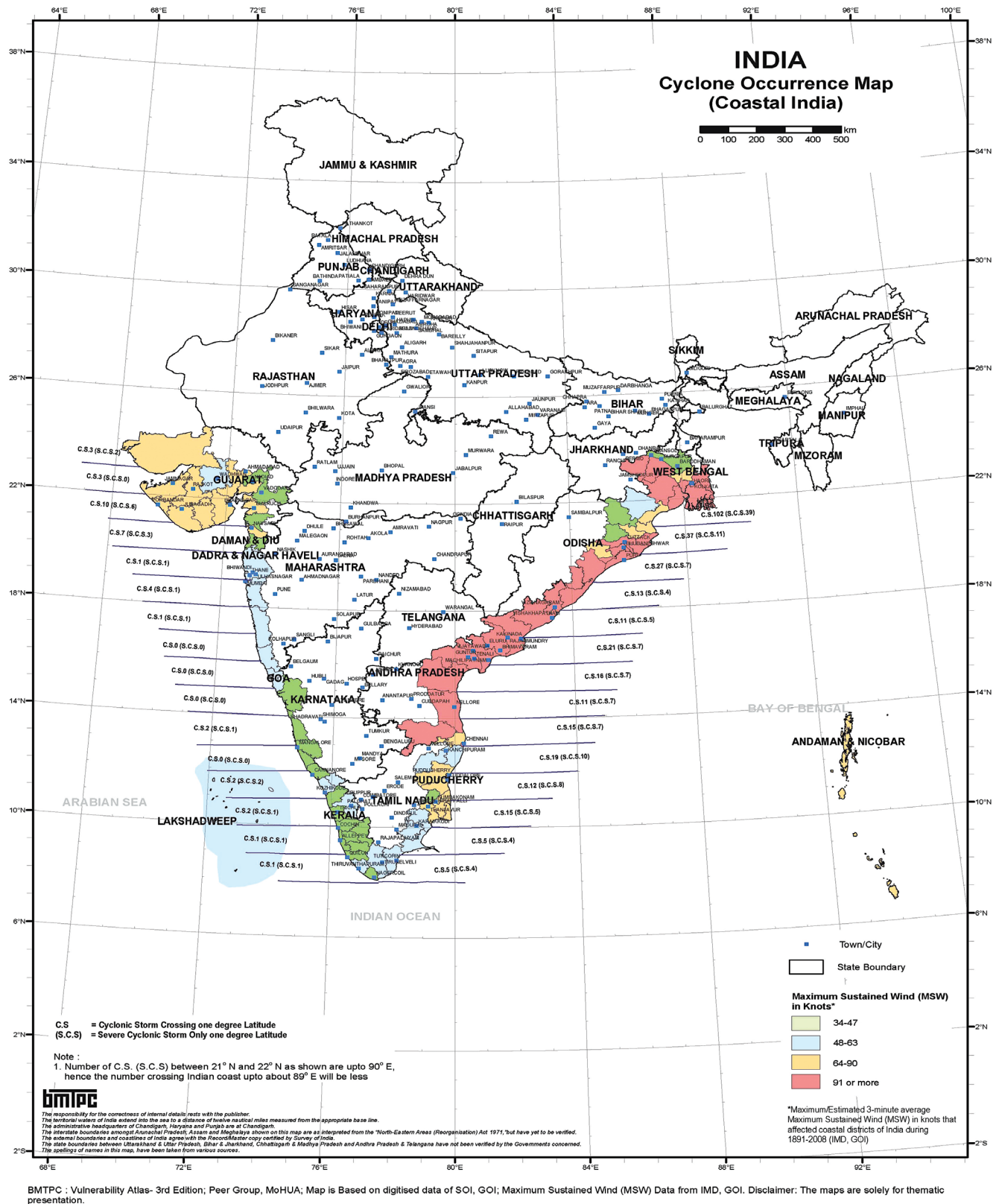
Source: BMTPC: https://bmtpc.org/DataFiles/CMS/file/VAI2019/MAP/eqmap/EQ_JPG/EQ_INDIA.jpg



BMTPC: Vulnerability Atlas - 3rd Edition: Peer Group, MoHUA, GOI: Map is Based on digitised data of SOI; Landslide Incidence data GSI; Annual Rainfall data IMD. Houses/Population as per Census 2011;
 * Houses including vacant & locked houses. Disclaimer: The maps are solely for thematic presentation.

Map 3: Landslide Incidence Map of India.

Source: BMTPC: https://bmtpc.org/DataFiles/CMS/file/VAI2019/MAP/lsmmap/ls_jpg/LS_India.jpg



Map 4: Cyclone Occurrence Map of India.

Source: BMTPC: https://bmtpc.org/DataFiles/CMS/file/VAI2019/MAP/cymap/06_INDIA_CYCLONE_OCCURRENCE_DEC_2018.jpg

1.3 Disasters in India - 2025

The year 2025 witnessed multiple disaster events across India, reflecting the country's multi-hazard vulnerability. Major incidents included floods and flash floods in Himalayan states such as Uttarakhand and Himachal Pradesh, as well as urban flooding in metropolitan cities due to intense rainfall and inadequate drainage systems. Cyclonic storms along the eastern coast impacted states like Odisha, Andhra Pradesh, and Tamil Nadu, while heavy rainfall triggered landslides in hilly regions. In addition, several industrial and technological disasters, including fires and infrastructure failures, were reported. These events resulted in loss of lives, damage to infrastructure, displacement of populations, and significant economic losses, highlighting the urgent need to strengthen disaster risk reduction and preparedness strategies in the country.

1.4 Objectives of the India Disaster Report (IDR) 2025

The primary objectives of the India Disaster Report (IDR) 2025 are:

1. To document major disaster events that occurred in India during 2025.
2. To analyze causes, impacts, and response mechanisms associated with these disasters.
3. To identify gaps in disaster preparedness, response, and recovery.
4. To provide evidence-based insights for policy formulation and Disaster Risk Reduction (DRR).
5. To enhance knowledge sharing among stakeholders, including government agencies, researchers, and practitioners.
6. To contribute in strengthening resilience and adaptive capacity at National and State levels.

1.5 Methodology and Database

The report is based primarily on secondary data collected from multiple credible sources, including the National Disaster Management Authority (NDMA), India Meteorological Department (IMD), Central Water Commission (CWC), Ministry of Home Affairs (MHA), State Disaster Management Authorities (SDMAs), EM-DAT (Emergency Events Database), UNDRR reports, TERI publications, and the Ministry of Civil Aviation. In addition, media reports and verified news sources were used to supplement and cross-validate the information.

The methodological approach involved the systematic compilation of disaster events using standardized criteria, followed by their chronological and thematic classification. The study includes a comprehensive impact assessment covering human, economic, and environmental dimensions. Maps, tables, and figures have been used extensively to present spatial and temporal variations, enhancing the analytical clarity of the report.

1. Air India Dreamliner Crash, Ahmedabad, Gujarat

1. Introduction

Civil aviation plays a critical role in global connectivity and economic development. With the rapid expansion of air travel in India, ensuring aviation safety and preparedness for aviation disasters has become increasingly important. Despite technological advancements and strict international safety standards, aviation accidents still occur due to a combination of technical failures, human factors, environmental conditions, or operational lapses. On 12 June 2025, a major aviation disaster occurred when Air India Flight AI-171, a Boeing 787-8 Dreamliner, crashed shortly after take-off from Sardar Vallabhbhai Patel International Airport in Ahmedabad, Gujarat. The flight was scheduled to travel from Ahmedabad to London Gatwick with passengers and crew from multiple nationalities on board.

Within seconds after take-off, the aircraft lost engine thrust and descended rapidly before crashing into a densely populated area near B. J. Medical College hostel complex. The accident resulted in one of the deadliest aviation disasters in India in recent decades, causing large-scale loss of life both onboard and on the ground. The disaster triggered a comprehensive investigation led by the Aircraft Accident Investigation Bureau (AAIB), Ministry of Civil Aviation, with support from international aviation safety authorities and aircraft manufacturers. The crash highlighted concerns regarding aviation safety management, cockpit coordination, emergency preparedness, and regulatory oversight, prompting renewed discussions on strengthening aviation safety systems in India.

2. Overview of the Disaster Event

On 12 June 2025, Air India flight AI-171, operated by a Boeing 787-8 Dreamliner, departed from Sardar Vallabhbhai Patel International Airport in Ahmedabad for Gatwick Airport in London. Shortly after take-off, while the aircraft was climbing normally, it reportedly experienced a sudden and severe loss of thrust in both engines within less than a minute of departure. The loss of power resulted in a rapid decrease in altitude, leaving the pilots with limited time to recover control of the aircraft. The aircraft subsequently crashed into a densely populated residential area near B. J. Medical College in Ahmedabad. Upon impact, the aircraft's fuel ignited, triggering a massive explosion and fire that caused extensive damage to nearby structures, including hostel buildings associated with the medical college. Emergency responders faced significant challenges due to the intensity of the fire and the scale of destruction in the surrounding area.

The crash resulted in the deaths of 241 passengers and crew members on board, along with 19 individuals on the ground. Only one passenger survived, making it one of the deadliest aviation disasters involving an Indian carrier in recent decades. Due to the severity of the fire and the extent of the damage to bodies, DNA analysis was required for the identification of several victims. The incident drew widespread international attention

because the Boeing 787-8 Dreamliner is widely regarded as one of the most technologically advanced commercial aircraft, with a strong global safety record. Consequently, the crash prompted investigations into potential technical malfunctions, engine failure, cockpit operations, and systemic safety issues in order to determine the exact cause of the disaster.

Table 1: Disaster Identification Table

Parameter	Details
Disaster Name	Air India Dreamliner Crash, Ahmedabad
Date	12 June 2025
Location	Near Sardar Vallabhbhai Patel International Airport
Aircraft	Boeing 787 Dreamliner
Operator	Air India
Regulating Authority	Directorate General of Civil Aviation
Investigation Agency	Aircraft Accident Investigation Bureau
Disaster Type	Aviation accident (aircraft crash)
Immediate Hazard	Aircraft impact and fire
Secondary Risks	Fuel explosion, structural fire, debris hazard

Source: <https://frontline.thehindu.com/news/air-india-flight-ai171-crash-boeing-787-ahmedabad-2025/article69688127.ece>

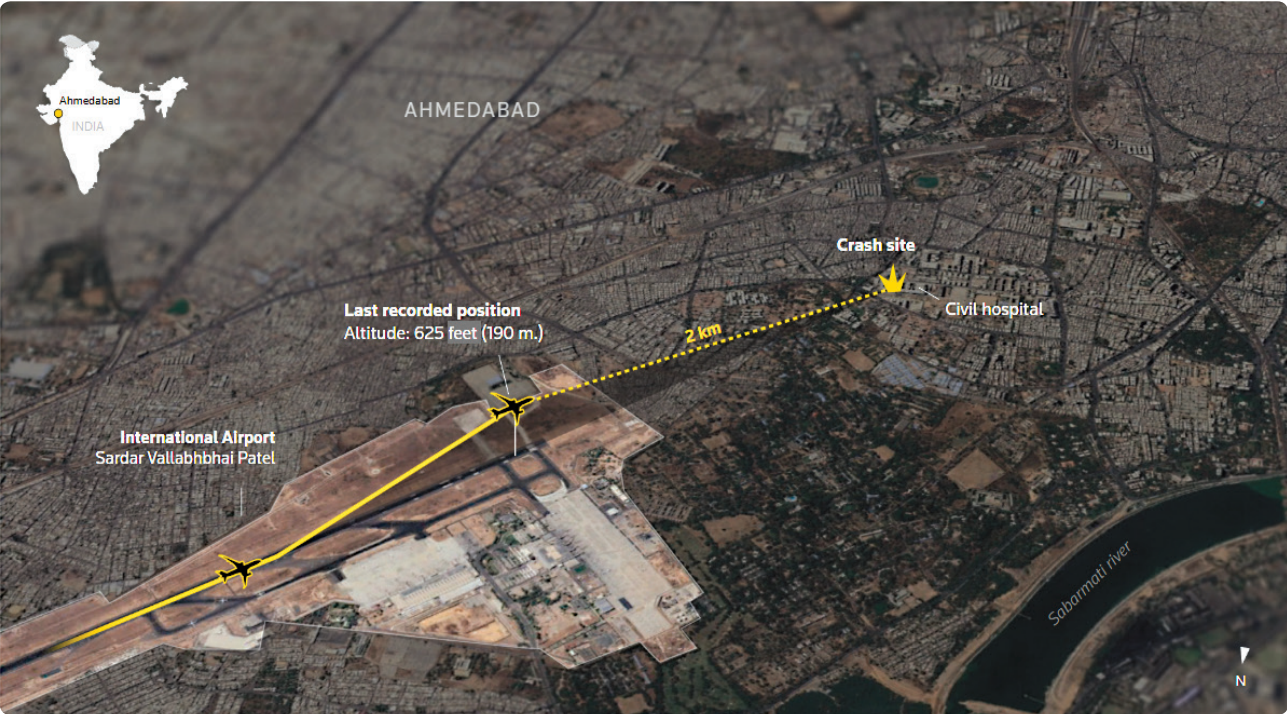


Figure 1: Location of the Air India Dreamliner Crash Site.

Source: <https://www.reuters.com/graphics/INDIA-CRASH/MAP/jnpwlqbryvw/>



Figure 2: Post-crash wreckage of the Air India Dreamliner and structural damage to the adjacent hostel building at the impact site.

Source: <https://frontline.thehindu.com/news/air-india-flight-ai171-crash-boeing-787-ahmedabad-2025/article69688127.ece>



Figure 3: Firefighters work to put out a fire at the site where an Air India Boeing 787 Dreamliner plane crashed in Ahmedabad, India, June 12, 2025.

Source: <https://www.reuters.com/graphics/INDIA-CRASH/MAP/jnpwlqbryvw/>

Table 2: Aircraft and Flight Details

Parameter	Details
Aircraft Model	Boeing 787 Dreamliner
Manufacturer	Boeing
Aircraft Type	Wide-body twin-engine jet
Passenger Capacity	Approx. 250–300 passengers depending on configuration
Fuel Type	Jet A-1 aviation fuel
Safety Systems	Fly-by-wire system, advanced avionics, electronic monitoring systems

Source: <https://www.airindia.com/in/en/newsroom/press-release/AI171.html>

2.1 Aviation Safety Mechanism in India

The aviation safety mechanism in India involves multiple regulatory bodies, investigation agencies, operational systems, and technological monitoring frameworks that work together to ensure safe air travel. The system is primarily overseen by the Ministry of Civil Aviation and implemented through several specialized agencies.

Table 3: Aviation Safety Mechanism in India

Component / Agency	Role in Aviation Safety	Key Functions
Directorate General of Civil Aviation (DGCA)	Primary aviation safety regulator	Issues safety regulations, licenses pilots and engineers, monitors airlines, conducts safety audits and inspections
Aircraft Accident Investigation Bureau (AAIB)	Independent accident investigation authority	Investigates aircraft accidents and incidents, analyzes flight recorders, issues safety recommendations
Airports Authority of India (AAI)	Airport and air navigation service provider	Manages air traffic control, airport infrastructure, navigation systems, and aeronautical communication
Bureau of Civil Aviation Security (BCAS)	Aviation security regulator	Develops aviation security standards, supervises airport security, coordinates with security agencies
Airports Economic Regulatory Authority (AERA)	Economic regulation of airports	Regulates tariffs and charges for airport services ensuring financial sustainability and safety investment
Airline Safety Management Systems (SMS)	Internal safety monitoring	Airlines implement risk assessment, incident reporting, and safety audits
Air Traffic Management System	Safe aircraft movement	Real-time monitoring of aircraft movement, collision avoidance, and airspace management
International Compliance	Global aviation safety standards	India follows standards of the International Civil Aviation Organization (ICAO)

Source: [https://sansad.in/getFile/rsnew/Committee_site/Committee_File/ReportFile/20/166/321_2022_9_11.pdf?source=rajyasabha#:~:text=\(iii\)%20Bureau%20of%20Civil%20Aviation,and%20the%20Aircraft%20Rules%2C%201937](https://sansad.in/getFile/rsnew/Committee_site/Committee_File/ReportFile/20/166/321_2022_9_11.pdf?source=rajyasabha#:~:text=(iii)%20Bureau%20of%20Civil%20Aviation,and%20the%20Aircraft%20Rules%2C%201937)

India's aviation safety mechanism operates through a multi-layered regulatory framework involving government regulators, airport operators, investigation agencies, and airline safety systems. The DGCA regulates operational safety, while the AAIB investigates accidents independently. Infrastructure and air navigation services are managed by AAI, and aviation security is supervised by BCAS. These institutions collectively ensure compliance with international safety standards set by ICAO, helping maintain safe and efficient air transportation in India.

2.2 Aviation Accident Investigation Process

Once an aviation occurrence is classified as an accident or serious incident, the Aircraft Accident Investigation Bureau (AAIB) appoints an Investigator-in-Charge to conduct the investigation under the Aircraft (Investigation of Accidents and Incidents) Rules, 2017. The concerned states such as the State of Registry, Operator, Manufacturer, and Design are notified in accordance with International Civil Aviation Organization Annex 13 standards. Investigators immediately visit the accident site to collect and preserve evidence such as wreckage distribution, flight recorders, witness statements, and operational data. The collected information is then reviewed to determine the need for detailed technical examination and the involvement of subject-matter experts.

During the detailed investigation stage, investigators analyse flight recorder data, aircraft components, operational records, and other technical evidence to understand the sequence of events and contributing factors. After completing the analysis, the investigation team prepares a draft report containing factual findings, analysis, conclusions, and safety recommendations. The draft report is shared with concerned States and stakeholders for consultation and comments. After incorporating relevant feedback, the final report is approved by the Director General of AAIB and published for public access, with recommendations forwarded to regulatory authorities for implementation.

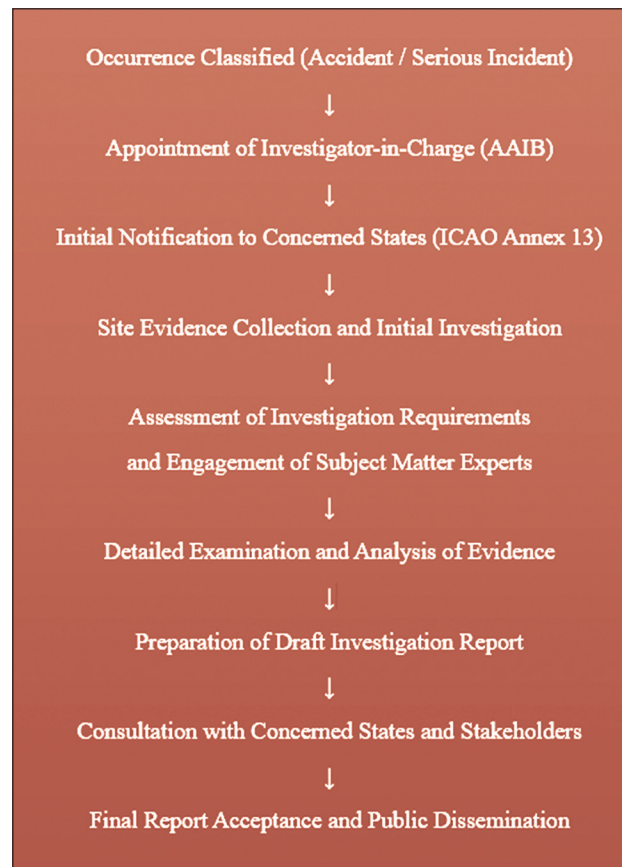


Figure 4: Aviation Accident Investigation Process

Source: <https://aaib.gov.in/investigationprocess.html>

3. Impact

3.1 Human Casualties

The crash resulted in approximately 260 fatalities, including passengers, crew members, and individuals on the ground. Among the victims were several foreign nationals, reflecting the international nature of the flight from Ahmedabad to London. The tragedy affected families across multiple countries, causing profound grief and emotional distress among relatives and communities. Due to the intense post-crash fire, many victims' bodies were severely damaged, making identification challenging. Consequently, authorities relied extensively on DNA analysis and forensic procedures to confirm the identities of the deceased.

3.2 Damage to Infrastructure

The aircraft crashed into a densely populated residential area near B. J. Medical College in Ahmedabad, resulting in extensive structural damage. Several buildings, including student hostels and nearby residential structures, were either partially destroyed or severely damaged due to the impact and subsequent fire. Emergency response operations also temporarily disrupted activities at Sardar Vallabhbhai Patel International Airport, as authorities restricted access and coordinated rescue, firefighting, and investigation efforts in the vicinity of the crash site.

3.3 Economic and Aviation Sector Impact

The disaster had broader implications for the aviation sector. The crash of Air India flight AI-171, involving a Boeing 787-8 Dreamliner, temporarily affected passenger confidence in airline safety. In response, aviation regulators and the airline initiated several precautionary measures:

- Additional safety inspections were ordered for the Air India Boeing 787 fleet.
- Operational reviews were conducted focusing on aircraft maintenance, crew training, and safety procedures.
- Regulatory authorities increased scrutiny of airline operational and safety compliance.

These actions aimed to reassure passengers and ensure the continued safety of aircraft operations.

3.4 Psychological and Social Impact

Major aviation disasters often result in long-lasting psychological trauma for survivors, families of victims, and emergency responders involved in rescue operations. The crash in Ahmedabad generated widespread public concern regarding aviation safety and led to a period of National mourning. Media coverage and public discourse also highlighted the emotional and social consequences of such disasters, reinforcing the need for stronger safety oversight, crisis response mechanisms, and support systems for affected families and communities.

4. Possible Causes / Reasons

The exact cause of the crash of Air India flight AI-171, involving a Boeing 787-8 Dreamliner, remains under investigation by the Aircraft Accident Investigation Bureau. Preliminary findings and technical assessments by aviation authorities have identified several possible contributing factors, although a definitive conclusion will depend on the detailed analysis of flight data and cockpit recordings.

4.1 Fuel Control Switch Movement

Initial findings indicated that the fuel control switches of both engines were moved from the RUN position to the CUTOFF position shortly after take-off. This action interrupted the fuel supply to the engines, leading to a sudden loss of thrust. Engine thrust is particularly critical during the take-off and initial climb phase, when aircraft operate at low altitude and limited recovery time is available. A simultaneous loss of engine power during this stage can quickly result in a loss of altitude and control.

4.2 Cockpit Coordination Issues

Preliminary analysis of cockpit voice recordings suggested the possibility of confusion or miscommunication between the pilots regarding engine fuel management. Effective Crew Resource Management (CRM) is a cornerstone of aviation safety, requiring clear communication, coordinated decision-making, and shared situational awareness between flight crew members. Any breakdown in cockpit coordination, particularly during high-stress phases such as take-off, can significantly increase operational risk.

4.3 Technical or Electrical Malfunction

Some aviation experts have also suggested the possibility of technical anomalies or electrical system malfunctions that may have affected cockpit controls or engine operations. Modern aircraft such as the Boeing 787-8 Dreamliner rely heavily on advanced electronic control systems, and any malfunction within these systems could potentially influence engine management or flight control responses.

4.4 Human Factors

Human factors remain a critical component in aviation accident investigations. Several possible human-related elements are being examined, including:

- Inadvertent activation of cockpit switches
- Misinterpretation of cockpit warnings or alerts
- High workload and decision pressure during the critical take-off phase

A comprehensive analysis of the Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) is essential to reconstruct the sequence of events and identify the precise chain of technical and human factors that led to the accident.

5. Response

5.1 Emergency Response

Immediately following the crash, local authorities initiated large-scale rescue and firefighting operations in the affected area of Ahmedabad. Emergency response teams were rapidly mobilized to control the fire, rescue survivors, and secure the crash site. The agencies involved included:

- Fire brigade units
- Police personnel
- Emergency medical teams
- Disaster response units

Firefighters worked to extinguish the intense blaze caused by the ignition of aviation fuel, while rescue teams searched the debris for survivors and victims. Hospitals across Ahmedabad were placed on emergency alert to receive injured individuals and provide medical assistance. Medical authorities and forensic teams also began the process of victim identification, including DNA analysis where required.

5.2 Government Response

The Government of India responded promptly to the disaster. The Ministry of Civil Aviation directed the Aircraft Accident Investigation Bureau (AAIB) to conduct a formal investigation to determine the cause of the crash. Simultaneously, the Directorate General of Civil Aviation (DGCA) ordered enhanced safety inspections and operational reviews of aircraft operated by Air India, particularly those involving the Boeing 787-8 Dreamliner fleet. Senior government officials closely monitored rescue and recovery operations and expressed condolences while assuring support to the families of the victims.

5.3 International Cooperation

Given the International nature of aviation safety investigations, the inquiry involved collaboration with multiple international stakeholders. Key participants included:

- Boeing, the aircraft manufacturer
- GE Aerospace, the engine manufacturer
- Aviation safety authorities from other countries

These organizations provided technical expertise, engineering analysis, and operational data to assist investigators in reconstructing the sequence of events leading to the crash. International cooperation is a standard practice in major aviation accident investigations to ensure transparency, technical accuracy, and adherence to global aviation safety standards.

6. Issues / Challenges / Concerns

The aviation accident raised several critical concerns related to aviation safety oversight, human factors, urban planning, and emergency response coordination. These issues highlight areas that require improvement to enhance aviation safety and reduce the impact of similar incidents in the future.

6.1 Aviation Safety Oversight and Regulatory Compliance

The crash highlighted the importance of strong regulatory oversight to ensure strict compliance with aviation safety standards. Effective monitoring by aviation regulators such as the Directorate General of Civil Aviation is essential to verify that airlines consistently adhere to maintenance protocols, operational procedures, and safety management systems. Regular safety audits, inspections, and transparent reporting mechanisms are necessary to identify potential risks and ensure continuous improvement in aviation safety practices.

6.2 Human Factors and Pilot Training

Human factors remain one of the most significant contributors to aviation accidents worldwide. The incident raised concerns regarding pilot training, cockpit resource management, decision-making under stress, and adherence to standard operating procedures. Strengthening training programs in areas such as Crew Resource Management (CRM), situational awareness, and emergency response procedures can help reduce the likelihood of human-error-related accidents.

6.3 Urban Development and Land-Use Planning Near Airports

The presence of densely populated settlements and infrastructure in areas surrounding airports increases the potential risk of casualties and property damage during aviation accidents. Rapid urban expansion near airport boundaries often results in residential developments and commercial establishments being located within high-risk zones. This highlights the need for stronger enforcement of airport zoning regulations and land-use planning policies to limit development in vulnerable areas near flight paths and runways.

6.4 Emergency Response and Multi-Agency Coordination

Major aviation accidents require rapid and coordinated responses from multiple agencies, including airport authorities, fire services, police, medical teams, and disaster management organizations. Ensuring effective communication and coordination among agencies such as the National Disaster Response Force, airport emergency services, and local authorities is essential for timely rescue operations, medical evacuation, and recovery efforts.

6.5 Public Confidence in Aviation Safety

Aviation accidents can significantly affect public confidence in the safety of air travel. Transparent investigation processes and timely communication of findings are critical to maintaining trust in the aviation system. Independent investigations conducted by authorities such as the Aircraft Accident Investigation Bureau play a vital role in identifying the causes of accidents and recommending corrective measures to improve aviation safety standards.

7. Lessons Learned

The Ahmedabad Aviation Disaster provides several critical lessons for strengthening aviation safety and improving disaster preparedness in the civil aviation sector. Aviation accidents often result from a combination of technical, human, and systemic factors; therefore, comprehensive safety management and regulatory oversight are essential to prevent similar incidents in the future.

7.1 Importance of Human Factors in Aviation Safety

One of the most important lessons from the disaster is the continuing significance of human factors in aviation operations. Pilot decision-making, situational awareness, cockpit communication, and adherence to standard operating procedures play a vital role in ensuring flight safety. Even with advanced technology, human performance remains a key determinant in preventing accidents.

7.2 Need for Strong Regulatory Oversight

Effective regulation and monitoring are essential for maintaining aviation safety standards. Aviation authorities such as the Directorate General of Civil Aviation must ensure strict compliance with operational guidelines, maintenance procedures, and training requirements. Periodic inspections and independent safety audits help identify potential risks and ensure that airlines follow established safety protocols.

7.3 Continuous Training and Safety Audits

Regular training programmes and safety audits are crucial for maintaining operational readiness. Pilots, air traffic controllers, and maintenance personnel should undergo frequent training updates, simulator exercises, and safety briefings. Continuous evaluation of operational procedures helps organisations identify weaknesses and improve safety culture.

7.4 Adoption of Advanced Monitoring Technologies

Modern aircraft systems generate large volumes of operational data that can be used to enhance safety. The disaster highlights the importance of adopting advanced monitoring technologies, such as real-time aircraft health monitoring systems and predictive maintenance tools. These systems can detect anomalies in aircraft performance early and allow corrective action before a critical failure occurs.

7.5 Strengthening Airport Disaster Preparedness

Airports must maintain robust disaster management systems capable of responding rapidly to aviation emergencies. Regular full-scale disaster simulation exercises, involving emergency responders, hospitals, and airport authorities, are necessary to ensure coordinated response during crises. Such exercises help improve communication, evacuation procedures, and emergency medical response.

7.6 Importance of Safe Land-Use Planning Near Airports

Another key lesson is the importance of regulating land use around airports. Unplanned urban development near airport runways can increase the risk of casualties in the event of an aviation accident. Urban planning authorities should ensure that high-density residential development is restricted in high-risk zones surrounding airports, thereby reducing potential disaster impacts.

7.7 Transparency in Accident Investigation and Safety Reporting

Timely and transparent investigation of aviation accidents is essential for improving safety practices across the industry. Investigations conducted by agencies such as the Aircraft Accident Investigation Bureau should focus on identifying systemic causes and sharing findings with aviation stakeholders. Transparent reporting enables regulators, airlines, and manufacturers to implement corrective measures and strengthen global aviation safety standards.

References

- Aircraft Accident Investigation Bureau. Ministry of Civil Aviation, Government of India. <https://aaib.gov.in>
- Air India. (2025, June 12). Statement on flight AI171: Ahmedabad to London Gatwick incident. Tata Sons. <https://www.airindia.com/in/en/newsroom/press-release/AI171.html>
- Air India. (2025, July 12). Air India acknowledges receipt of AAIB preliminary report on AI171. <https://www.airindia.com/in/en/newsroom/press-release/AI171.html>
- Directorate General of Civil Aviation. (2025, July 14). Directive on fuel control switch inspections for Boeing 787-8/9 fleet. Ministry of Civil Aviation, Government of India. <https://www.dgca.gov.in>
- Ministry of Civil Aviation. (2025, June 13). Constitution of multidisciplinary team for investigation of Air India flight AI-171 accident. Press Information Bureau, Government of India. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2139785>
- Ministry of Civil Aviation. (2025, June 26). Status report on recovery and examination of data from black boxes – Air India flight AI-171. Press Information Bureau, Government of India. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2139785>
- Chandra, J. (2025, June 13). Air India flight with 242 on board crashes in Ahmedabad; sole survivor rescued. The Hindu. <https://www.thehindu.com/news/national/plane-crashes-at-ahmedabad-airport-on-june-12-rescue-underway/article69686196.ece>
- Economic Times Online. (2025, June 15). ‘Mayday! Mayday! Thrust not achieved’: What Air India pilot’s last words before tragic crash possibly mean. The Economic Times. <https://m.economictimes.com/industry/transportation/airlines/-aviation/mayday-mayday-thrust-not-achieved-what-air-india-pilots-last-words-before-tragic-crash-possibly-mean/articleshow/121859343.cms>

- Hindustan Times Correspondent. (2026, January 22). Boeing 787 had technical faults long before Air India plane crash in Ahmedabad: US safety group. Hindustan Times. <https://www.hindustantimes.com/india-news/boeing-787-had-technical-faults-long-before-ahmedabad-crash-us-safety-group-101769022777498.html>
- Lalitha, S. (2026, March 14). US aviation safety group accuses AAIB of ignoring key evidence in Ahmedabad Air India crash probe. The New Indian Express. <https://www.newindianexpress.com/nation/2026/Mar/14/us-aviation-safety-group-accuses-aaib-of-ignoring-key-evidence-in-ahmedabad-air-india-crash-probe>
- Press Trust of India. (2025, June 16). Air India Ahmedabad plane crash updates: Govt constitutes high-level committee to look into possible causes of crash. The Hindu. <https://www.thehindu.com/news/national/ahmedabad-air-india-plane-crash-deaths-vijay-rupani-funeral-live-updates/article69686204.ece>
- Press Trust of India. (2026, January 31). AI171 crash probe: AAIB assessing various aspects; nothing has been ruled out, says source. The Hindu. <https://www.thehindu.com/news/national/ai171-crash-probe-aaib-assessing-various-aspects-nothing-has-been-ruled-out-says-source/article70572154.ece>
- The Hindu Bureau. (2025, June 14). Air India Ahmedabad plane crash: Death toll hits 270, families wait for bodies. The Hindu. <https://www.thehindu.com/news/national/gujarat/air-india-ahmedabad-plane-crash-death-toll-rises/article69693991.ece>

2. Chashoti Flash Flood, Jammu & Kashmir

1. Introduction

Flash floods are among the most devastating natural disasters in mountainous regions, particularly in the Himalayan belt where steep slopes, fragile geology, intense rainfall, and glacial systems combine to create high disaster vulnerability. In recent years, the Himalayan region has experienced an increase in extreme weather events such as cloudbursts, intense rainfall, and sudden flooding. These hazards are often aggravated by climate change, rapid land-use changes, and increasing human activities in environmentally sensitive zones. On 14 August 2025, a catastrophic cloudburst-triggered flash flood struck Chashoti village in the Paddar subdivision of Kishtwar district, Jammu & Kashmir. The disaster occurred along the Machail Mata pilgrimage route, which attracts thousands of devotees each year. At the time of the incident, a large number of pilgrims and local residents were present in the area. The sudden cloudburst generated a massive surge of water mixed with mud, rocks, and debris, which rushed through the narrow mountain valley and swept away settlements, pilgrim camps, and infrastructure. The disaster resulted in significant loss of lives, injuries, and extensive damage to property and infrastructure. The Chashoti flash flood represents a critical example of the growing vulnerability of Himalayan communities and pilgrimage routes to extreme weather events. The disaster highlighted the need for improved early warning systems, hazard mapping, infrastructure planning, and disaster preparedness in mountainous regions.

2. Overview of the Disaster Event

On 14 August 2025, a devastating cloudburst occurred over the upper catchment area above Chashoti Village, located in the remote mountainous region of Paddar Valley. The sudden and intense precipitation triggered a powerful flash flood that rapidly descended through mountain streams into the valley. At the time of the incident, hundreds of pilgrims had gathered in Chashoti village as part of the annual Machail Mata Yatra, a significant pilgrimage in the region. The pilgrims were preparing to begin the approximately 20-kilometre trek to the Machail Mata shrine. The yatra had officially commenced on 25 July 2025 and was scheduled to continue until 5 September 2025. According to reports from the State Emergency Operations Center, the cloudburst struck the base camp area near Chashoti at approximately 12:45 PM. Within minutes, intense runoff from the steep catchment area generated torrents of water that surged through the settlement and the pilgrimage route. The flash flood carried large volumes of mud, boulders, uprooted trees, and debris, which overwhelmed the temporary infrastructure established for pilgrims. Several community kitchens (langars), pilgrim camps, small shops, and residential houses located along the valley floor were destroyed. A community kitchen where a large number of pilgrims had gathered was completely washed away by the force of the floodwaters. The disaster caused extensive damage to local infrastructure, including roads, bridges, vehicles, and temporary shelters, while the remote location and rugged terrain significantly

hindered rescue and relief operations. According to official reports and media coverage, more than 60 people lost their lives, over 100 individuals were injured, and several others were reported missing. In response to the incident, authorities suspended the Machail Mata Yatra and initiated emergency rescue operations. Temporary relief camps were established in Gulabgarh to provide food, shelter, and medical assistance to affected pilgrims and residents.

Table 4: Disaster Identification Table

Parameter	Details
Name of Disaster	Chashoti Cloudburst-Induced Flash Flood, 2025
Type of Disaster	Hydro-meteorological Disaster (Cloudburst leading to Flash Flood)
Date of Occurrence	14 August 2025
Time of Occurrence	Approximately 11:30 AM (Late Morning)
Location (Village)	Chashoti Village
Location (Valley/Region)	Paddar Valley
District	Kishtwar
Union Territory	Jammu & Kashmir, India
Geographical Setting	Remote, mountainous Himalayan terrain with steep slopes and narrow valleys
Triggering Event	Intense localized cloudburst resulting in sudden heavy rainfall
Primary Hazard	Flash flood with high-velocity water flow
Secondary Hazards	Landslides, debris flow, riverbank erosion, infrastructure damage
River/Stream Involved	Local seasonal streams (nallahs) in Paddar Valley
Climatic Conditions	Monsoon season with high moisture content and unstable atmospheric conditions

Source: <https://kashmirtimes.com/opinion/comment-articles/cloudbursts-in-the-himalayas-kishtwar-tragedy-a-grim-warning#:~:text=On%20August%2014%2C%202025%2C%20a,remain%20missing%20or%20feared%20trapped>



Figure 5.1 : Location of Kishtwar District in Jammu and Kashmir

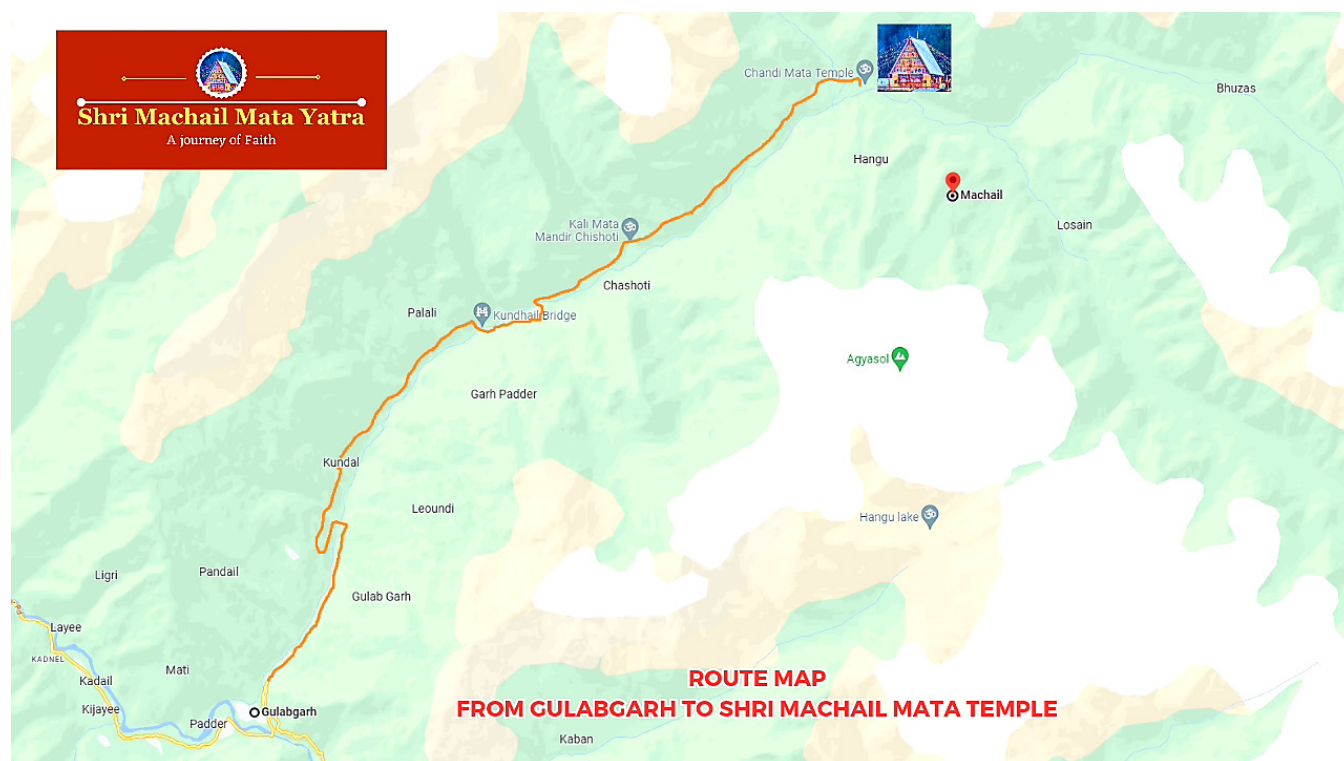


Figure 5.2 : Route Map of Shri Machail Mata Yatra

Source: <https://shrimachailmatayatra.com/>

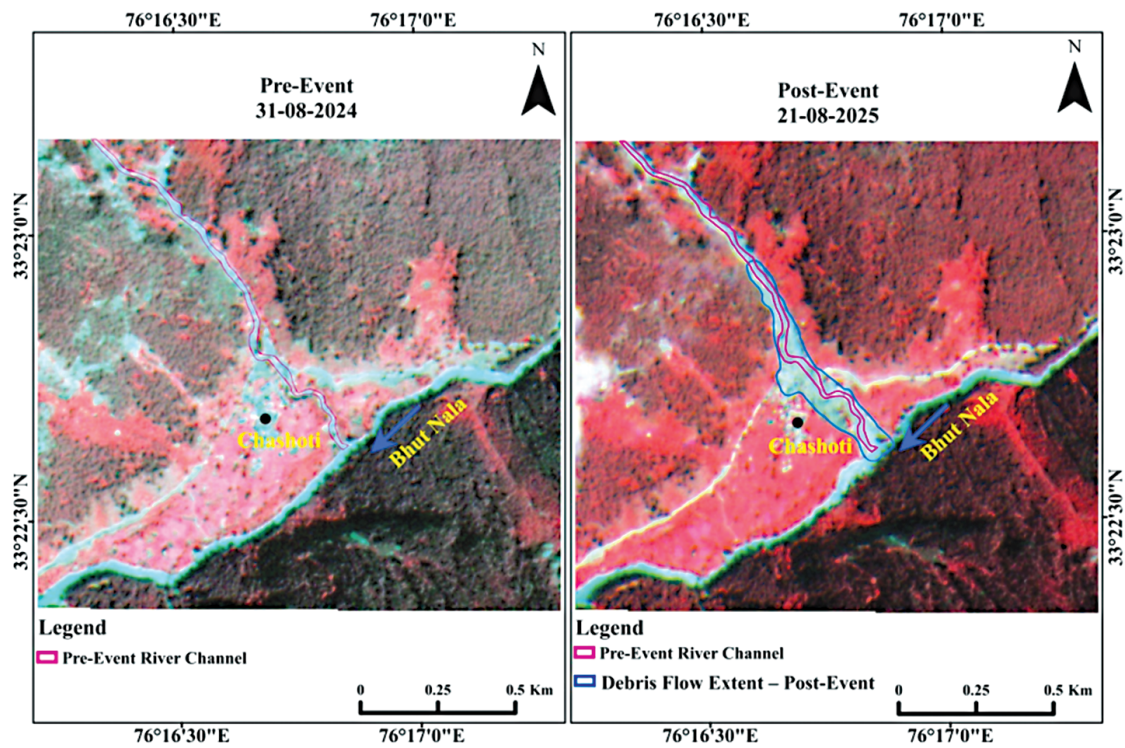


Figure 6.1: Satellite imagery of the Chashoti area depicting pre-event channel morphology versus post-event expansion of the Chachai nala and associated debris flow deposits

“Source: <https://link.springer.com/article/10.1007/s10346-025-02669-7/figures/4>”

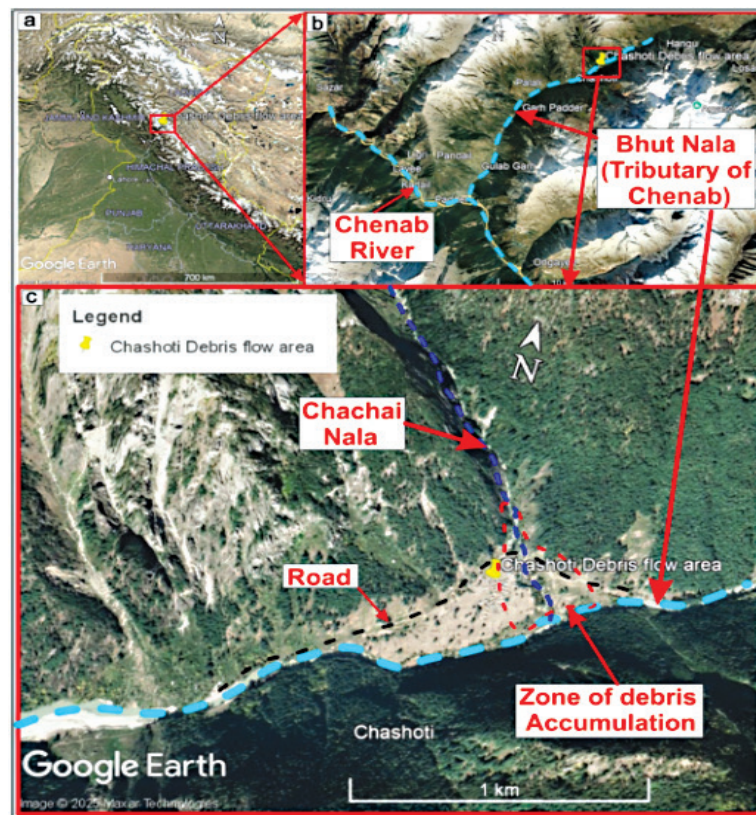


Figure 6.2: Google Earth images showing: (a) Jammu and Kashmir region; (b) Bhut Nala, tributary of Chenab River; (c) Chashoti village depicting the Chachai Nala, and the zone of debris accumulation

“Source: <https://link.springer.com/article/10.1007/s10346-025-02669-7/figures/7>”

Table 5: Chronology of the Chashoti Flash Flood Event

Date & Time	Event Description
Early August 2025	India Meteorological Department (IMD) issued warnings of heavy rainfall across Jammu & Kashmir during the monsoon period.
14 August 2025 (Morning)	Pilgrims and local residents gathered at Chashoti village in Kishtwar District, the last motorable point on the Machail Mata Yatra route. Temporary shelters and community kitchens (langars) were operating.
14 August 2025 ~11:30 IST	A sudden cloudburst occurred over the Chashoti region, triggering intense rainfall (>100 mm within a short period) in the upper catchment area.
Minutes after the cloudburst	A massive flash flood and debris flow descended through the narrow Himalayan valley, destroying structures and sweeping away pilgrims, shops, and a security post.
14 August 2025 (Afternoon)	Initial casualty reports emerged; dozens feared dead and many injured. Local administration activated emergency protocols.
14 August 2025 (Evening)	Rescue operations launched by National Disaster Response Force (NDRF), State Disaster Response Force (SDRF), police, and the Indian Army.
14-5 August 2025	More than 160 people rescued; injured shifted to hospitals in Atholi and Kishtwar. Search operations continued overnight despite difficult terrain.
15-18 August 2025	Death toll continued to rise as bodies were recovered from debris and downstream channels; the Machail Mata Yatra was temporarily suspended.
Late August 2025	Government initiated compensation and relief measures while restoration of roads and communication infrastructure began.

Sources: https://internal.imd.gov.in/press_release/20250814_pr_4218.pdf



Figure 7.1: Rescue workers searching for missing people after cloudburst at village Chashoti in Kishtwar District of Jammu and Kashmir on August 15, 2025.

Source: <https://kashmirtimes.com/opinion/comment-articles/cloudbursts-in-the-himalayas-kishtwar-tragedy-a-grim-warning#:~:text=On%20August%2014%2C%202025%2C%20a,remain%20missing%20or%20feared%20trapped.>



Figure 7.2: Houses damaged in an area after a massive cloudburst at Chashoti village.

Source: <https://indianexpress.com/article/india/jk-kishtwar-cloudburst-news-live-updates-amit-shah-speaks-with-l-g-cm-ndrf-teams-rushed-to-site-10189035/>

3. Impact of the Disaster

The cloudburst and subsequent flash flood that struck Chashoti Village on 14 August 2025 caused extensive human, infrastructural, economic, and environmental damage. The incident occurred during the peak period of the Machail Mata Yatra, which significantly increased the number of people present in the area and amplified the disaster's impact.

3.1 Human Impact

The disaster resulted in significant loss of lives, injuries, and missing persons, affecting pilgrims, local residents, and workers operating temporary facilities along the pilgrimage route. Many victims were swept away by the sudden surge of floodwaters or buried under debris consisting of mud, rocks, and uprooted vegetation. Rescue teams had to conduct extensive search operations through thick layers of debris to locate survivors and recover bodies. The tragedy also caused psychological trauma among survivors and families of victims, while the loss of livelihoods and property has created long-term socio-economic challenges for the local communities dependent on pilgrimage-related activities.

Table 6: Human Impact of the Chashoti Flash Flood

S. No.	Impact Category	Numbers
1	Dead bodies recovered	65
2	Persons injured	115
3	Persons reported missing	32

Source: <https://www.thehindu.com/news/national/rajnath-singh-meets-chashoti-flood-victims-in-jammu-hospital-reviews-relief-measures/article69972699.ece>

The figure 8 highlights the impact of extreme weather events on human lives during 2010–2022, showing substantial variation in deaths across districts. Kupwara recorded the highest district-wise total deaths (approximately 58), followed by Kishtwar (around 50) and Anantnag (around 46). Among different extreme weather events, heavy snowfall/avalanches caused the highest number of deaths (approximately 245), followed by flash floods/cloudbursts (around 120) and heavy rain (around 110). The figure 8 indicates that snowfall/avalanches, floods, and landslides were major contributors to weather-related fatalities, while heat waves and cold waves accounted for comparatively fewer deaths."

THE IMPACT OF EXTREME WEATHER EVENTS

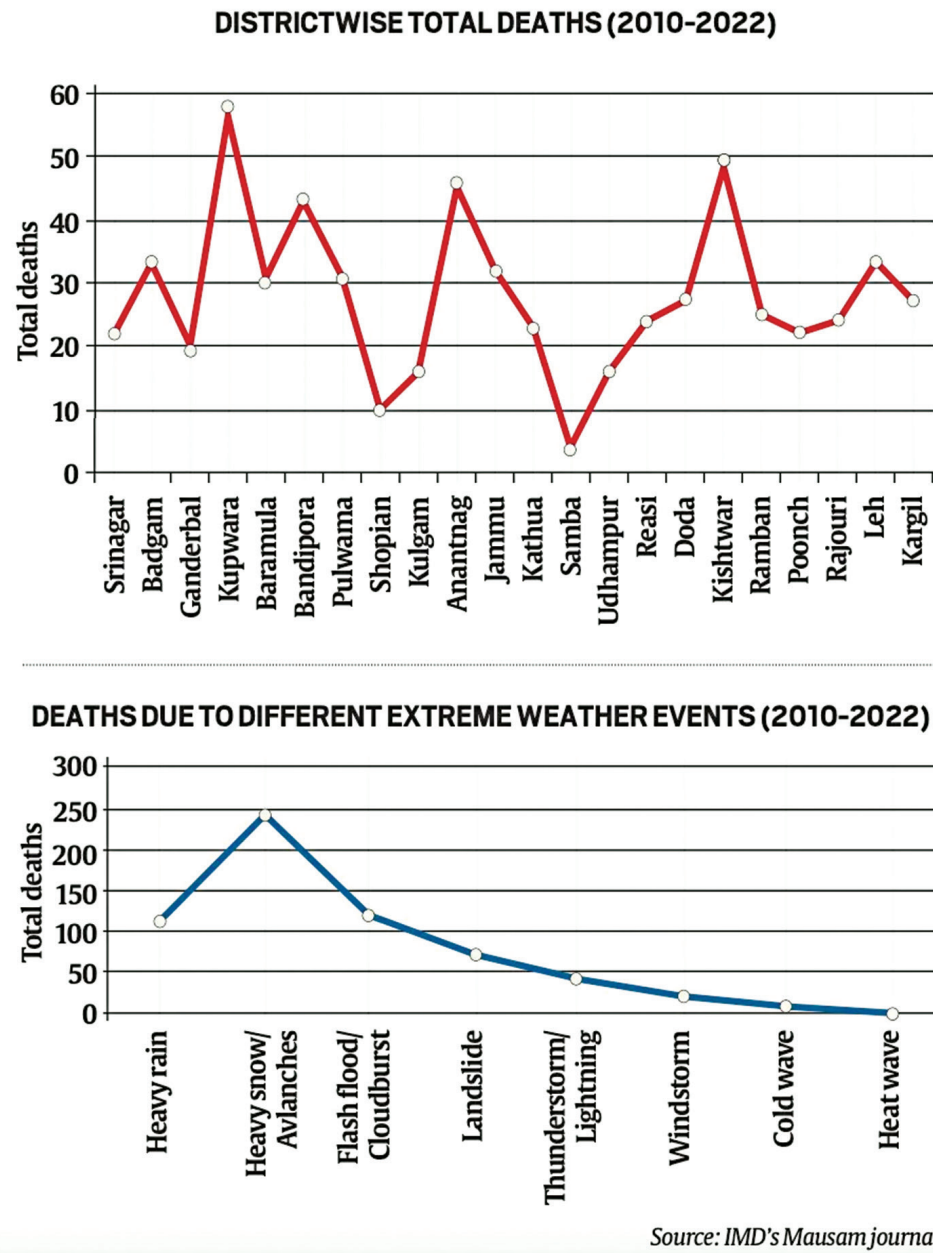


Figure 8: Human deaths due to extreme weather events.

Source: <https://indianexpress.com/article/explained/explained-climate/kishtwar-flash-flood-how-climate-change-has-contributed-to-extreme-weather-events-in-jk-10191928/>

3.2 Damage to Infrastructure

The flash flood caused extensive damage to both permanent and temporary infrastructure in the affected region. The high-velocity flow of water, combined with heavy debris, led to the destruction of several critical facilities that supported both the pilgrimage activities and local settlements. The damaged infrastructure included residential houses in nearby villages, temporary shelters and camps set up for pilgrims, community kitchens (langars),

local markets and small shops, vehicles and transport facilities, as well as security and administrative posts. RoaosQ and bridges along the pilgrimage route were also severely affected. The destruction of transport infrastructure significantly disrupted connectivity in the remote mountainous terrain, which in turn delayed search, rescue, and relief operations, making the overall response more challenging.

Table 7: Infrastructure Damage in Chashoti Flash Flood

S. No.	Infrastructure Type	Impact Summary
1	Road Network / Access Routes	RoaosQ washed away or severely damaged due to flash floosQ and debris flows, disrupting the Padder-Chashoti road link and affecting the 8.5 km Machail pilgrimage foot route.
2	Bridges & Connectivity	A key bridge at Chashoti with a 30-meter span was washed away, severely affecting regional connectivity.
3	Community Infrastructure	A makeshift market, community kitchen, security post, houses, temples, water mills, and several vehicles were destroyed or damaged.

Source: <https://risingkashmir.com/cloudburst-triggers-flash-floosQ-in-chashoti-padder-along-machail-mata-yatra-route-rescue-ops-underway/>

3.3 Loss and Damage to Public Infrastructure

The disaster caused structural damage to several public facilities and essential services, affecting local governance and community functioning.

Table 8: Loss and Damage Summary

S. No.	Loss Details	Numbers
1	Houses collapsed	10
2	Government buildings damaged	6
3	Other infrastructure damaged	7
	Bridge damage	Chashoti bridge (30 m span washed away)

Source: <https://ndmindia.mha.gov.in/ndmi/viewUploadedDocument?uid=NEW2651#:~:text=%3E%20The%20Monsoon%20trough%20runs%20south,activity%20over%20eastern%20&%20central%20India.>

Damage to government buildings and public infrastructure disrupted administrative services and emergency response coordination in the region.

3.4 Disruption of Pilgrimage Activities

Following the disaster, authorities temporarily suspended the Machail Mata Yatra to ensure the safety of pilgrims and allow rescue and recovery operations to proceed. The suspension affected thousands of pilgrims who were planning to visit the shrine. It also caused economic losses for local communities, many of whom depend on pilgrimage tourism through services such as accommodation, food stalls, transport, and retail shops.

3.5 Environmental Impact

The flash flood transported large quantities of sediments, rocks, uprooted trees, and debris, which significantly altered the local river channels and geomorphology of the valley. Such events highlight the high ecological sensitivity of the Himalayan region, where steep slopes, fragile geology, and intense rainfall events make landscapes highly vulnerable to flash floods and landslides. Studies indicate that extreme weather events are becoming increasingly frequent in Jammu & Kashmir. According to a study published in the journal *Mausam*, the region experienced 2,863 extreme weather events between 2010 and 2022, resulting in over 552 deaths. These trends underscore the growing disaster risk associated with climate variability and changing precipitation patterns.

4. Possible Causes / Reasons

4.1 Cloudburst Event

The primary cause of the disaster was a cloudburst, a meteorological phenomenon characterized by extremely heavy rainfall within a short period. Cloudbursts are common in mountainous regions and can lead to sudden flooding when water accumulates rapidly in narrow valleys.

4.2 Fragile Himalayan Geology

The Himalayan region consists of relatively young and unstable geological formations. The steep slopes and loose sediments make the region highly susceptible to landslides and debris flows during intense rainfall events.

4.3 Climate Change and Extreme Weather

Climate scientists have observed an increase in extreme rainfall events across the Himalayan region. Rising temperatures and changing atmospheric conditions may be contributing to more frequent cloudbursts and flash floods.

4.4 Unregulated Construction and Human Activities

Temporary structures, shops, and camps along the pilgrimage route were located close to the stream channels and flood-prone areas. These structures increased exposure to flood hazards.

4.5 Limited Early Warning Systems

Remote mountainous areas often lack adequate weather monitoring and early warning infrastructure. As a result, people in the affected area had little time to evacuate before the floodwaters arrived.

5. Response

The cloudburst and subsequent flash floods that struck Chashoti Village on 14 August 2025 triggered a large-scale emergency response involving multiple agencies. The remote location of the incident, rugged terrain, and extensive infrastructure damage posed major challenges to rescue and relief operations. Following the disaster, authorities immediately activated emergency response mechanisms and mobilised personnel from national, state, and local agencies to conduct search and rescue operations, provide medical assistance, and restore essential connectivity.

5.1 Multi-Agency Response

The response involved coordinated efforts from several government and security agencies, including:

- National Disaster Response Force
- State Disaster Response Force
- Indian Army
- Jammu and Kashmir Police
- Border Roads Organisation
- District administration and local volunteers

More than 300 soldiers from the Indian Army, including medical personnel from the White Knight Corps, were deployed to assist in rescue and relief operations. Joint teams conducted intensive search operations across the affected areas to locate survivors and recover bodies trapped under debris.

5.2 Immediate Search and Rescue Operations

Search and rescue operations were launched immediately after the cloudburst and ensuing flash flood. Three teams from the National Disaster Response Force, along with personnel from the State Disaster Response Force (SDRF) and units of the Indian Army, were deployed to the affected areas to carry out rescue efforts. The teams operated under extremely challenging conditions, including thick layers of mud and debris, damaged roads and bridges, continuous rainfall, and unstable terrain. Access to remote villages was also severely limited, further complicating rescue operations. Despite these constraints, heavy machinery was deployed to clear debris and reopen blocked routes. Aerial reconnaissance using helicopters was also conducted to locate stranded pilgrims and residents in remote hamlets that had been cut off due to the disaster.

5.3 Medical Assistance and Evacuation

Medical assistance was provided promptly to the injured victims by teams from the Indian Army and local health departments. Immediate emergency care included on-site first aid and trauma management to stabilise affected individuals. Efforts were also made to evacuate the injured to nearby hospitals for further treatment, while mobile medical teams were deployed in the affected areas to ensure continued healthcare support. Several critically injured victims were transported to medical facilities in nearby towns for advanced treatment, ensuring timely medical intervention and reducing the risk of further complications.

5.4 Restoration of Connectivity and Infrastructure

The flash flood caused severe damage to roads and bridges in the region, significantly hampering rescue and relief operations. Engineers from the Border Roads Organisation (BRO) and the Indian Army worked to restore connectivity.

Key measures included:

- Clearing debris and boulders from damaged road sections
- Repairing washed-out roads along the pilgrimage route
- Construction of a Bailey bridge by Army engineers to reconnect Chashoti village and the Machail Mata shrine

Restoring access routes was critical for facilitating the movement of rescue teams, relief supplies, and medical assistance.



Figure 9.1: Search and rescue operation underway at Chashoti village.



Figure 9.2: Army engineers working on a bailey bridge to restore connectivity to Chashoti.

5.5 Relief and Rehabilitation Measures

The government initiated several relief and rehabilitation measures to support affected communities and victims' families in the aftermath of the disaster. Immediate steps included the provision of temporary shelters for displaced persons and the distribution

of food, safe drinking water, and other essential supplies. Financial assistance was also provided to the families of deceased and injured victims under established disaster relief schemes. In addition, relief camps were set up in nearby locations, including Gulabgarh, to accommodate stranded pilgrims and affected residents, ensuring their safety and basic needs during the emergency period.

5.6 Suspension of Pilgrimage

In view of the safety concerns and ongoing rescue operations, authorities temporarily suspended the Machail Mata Yatra. The suspension allowed emergency agencies to focus on rescue, recovery, and restoration activities without further risk to pilgrims.



Figure 10: Rescue work in the affected area in Kishtwar District of Jammu and Kashmir on Friday.

Source: <https://indianexpress.com/article/india/a-rush-of-pilgrims-and-then-all-swept-away-eyewitnesses-recount-kishtwar-flash-flood-horror-10192011/>



Figure 11: Rescue operation underway in Kishtwar district's Chashoti village.

Source: <https://indianexpress.com/article/india/all-hanosQ-on-deck-in-kishtwar-as-desperate-search-for-the-missing-picks-up-10191998/>

6. Issues / Challenges / Concerns

The Chashoti Village Flash Flood exposed several structural and operational challenges associated with disaster risk management in high-altitude regions of Uttarakhand. The incident highlighted how geographical constraints, infrastructure limitations, and environmental pressures can complicate emergency response and increase disaster vulnerability in Himalayan regions.

6.1 Difficult Terrain

One of the most significant challenges during the disaster response was the rugged mountainous terrain surrounding Chashoti Village. The steep slopes, narrow valleys, and unstable geological conditions made it difficult for rescue teams and heavy machinery to reach the affected locations. The flash flood caused large deposits of debris, landslides, and road damage, which blocked key access routes. As a result, rescue personnel had to rely on manual clearing of debris and limited road access, significantly slowing down search and rescue operations. In several instances, emergency teams had to traverse difficult terrain on foot to reach stranded individuals.

6.2 Limited Communication Infrastructure

The region's weak telecommunications network created additional difficulties during the emergency response. Mobile connectivity and internet services in many Himalayan villages are often unreliable, particularly during extreme weather events. During the disaster, disrupted communication channels made it difficult for authorities to coordinate rescue teams, share real-time situational information, and contact affected communities. Limited communication also delayed the transmission of early reports from the affected village to district authorities.

6.3 Lack of Localized Early Warning Systems

Another major concern highlighted by the incident was the absence of localized weather monitoring and early warning systems capable of detecting sudden extreme rainfall or cloudburst events. Flash floods in mountainous regions often occur with very short lead times, leaving little opportunity for evacuation if early warnings are not available. In the case of the Chashoti event, the lack of automated rain gauges, hydrological sensors, and community-level warning mechanisms reduced the ability of authorities to alert residents in advance. Strengthening localized meteorological monitoring and early warning dissemination systems is therefore critical for reducing future disaster risks in such areas.

6.4 Unregulated Pilgrim and Tourism Infrastructure

The affected region lies along routes frequently used by pilgrims and tourists traveling to Himalayan religious destinations. Over time, temporary infrastructure such as pilgrim camps, roadside shops, and informal lodging facilities has developed along riverbanks and flood-prone valleys. In many cases, these structures are established without proper

land-use planning, hazard assessment, or regulatory oversight. Their proximity to river channels significantly increases exposure to flash floods and debris flows. The disaster highlighted the risks associated with unplanned tourism and pilgrimage-related infrastructure in ecologically sensitive zones.

6.5 Environmental Degradation and Ecosystem Stress

The event also underscored broader concerns related to environmental degradation in fragile Himalayan ecosystems. Increased human activities- including road construction, deforestation, slope cutting, and infrastructure development- can destabilize slopes and alter natural drainage patterns. Such environmental changes may increase runoff, reduce soil stability, and intensify the impacts of extreme rainfall events, thereby amplifying the likelihood and severity of flash floods and landslides. The incident therefore highlights the need for sustainable land-use planning, environmental conservation, and ecosystem-based disaster risk reduction strategies in mountainous regions.

7. Lessons Learned

The cloudburst and flash flood disaster in Chashoti Village offers critical insights for disaster risk reduction and climate adaptation in Himalayan regions. The event illustrates how extreme weather events, fragile ecosystems, and human activities intersect to amplify disaster risks. The lessons derived from this incident highlight the importance of integrating scientific monitoring, risk-informed planning, resilient infrastructure, and community preparedness into disaster management strategies.

7.1 Increasing Frequency and Intensity of Extreme Weather Events

One of the most important lessons from the disaster is the growing frequency and intensity of extreme precipitation events in the Himalayan region. Scientific studies indicate that climate change is altering atmospheric circulation patterns, leading to more localized and intense rainfall events such as cloudbursts. These events can release extremely high volumes of rainfall within a short period, triggering flash floods, landslides, and debris flows in mountainous terrain. Because the Himalayan ecosystem is geologically young and highly fragile, it is particularly susceptible to such hydrometeorological hazards. This incident demonstrates the urgent need to strengthen meteorological observation networks, including high-resolution rainfall monitoring, Doppler weather radars, and satellite-based forecasting systems in mountainous regions. Improved predictive capabilities can support early warnings and enhance preparedness measures.

7.2 Vulnerability of Pilgrimage Routes in Mountainous Terrain

The disaster highlights the inherent vulnerability of pilgrimage routes located in narrow mountain valleys and along riverbanks. During the Machail Mata Yatra, thousands of pilgrims travel through these routes, creating temporary settlements consisting of camps, shops, community kitchens, and parking areas. Such temporary infrastructure is often

located close to rivers or on unstable slopes due to limited available land in mountainous regions. These areas are highly susceptible to flash floods, landslides, and debris flows triggered by heavy rainfall. The disaster demonstrates the importance of adopting risk-sensitive pilgrimage management strategies. Authorities must regulate the location of camps, limit overcrowding in vulnerable zones, and implement structured crowd management systems. Seasonal pilgrimages should incorporate hazard assessments and contingency planning to ensure the safety of pilgrims.

7.3 Importance of Hazard Mapping and Risk-Informed Land Use Planning

Another key lesson is the importance of comprehensive hazard mapping and geospatial risk assessment in mountainous regions. Many disaster-prone areas in the Himalayas lack updated hazard zonation maps that identify flood-prone areas, landslide zones, and vulnerable river corridors. The absence of such scientific assessments often leads to the establishment of settlements, camps, or infrastructure in high-risk areas. Detailed hazard mapping using Geographic Information Systems (GIS), satellite imagery, and remote sensing technologies can help identify vulnerable zones and guide land use decisions. Risk-informed planning should be integrated into local development strategies, pilgrimage route management, and infrastructure planning to minimize disaster exposure.

7.4 Need for Strengthening Early Warning Systems

The disaster also highlights the limitations of early warning systems in remote mountainous regions. Although meteorological agencies may issue forecasts for heavy rainfall, the dissemination of timely warnings to communities and pilgrims remains a major challenge due to limited communication infrastructure. Remote Himalayan regions often suffer from weak mobile connectivity, lack of real-time monitoring stations, and limited access to warning systems. To address this gap, authorities must establish localized early warning mechanisms that include automated weather stations, river monitoring sensors, and satellite-based communication systems. In addition, warning messages should be disseminated through multiple channels such as mobile alerts, siren systems, radio communication, and local administrative networks. Effective last-mile communication is essential to ensure that warnings reach vulnerable populations in time.

7.5 Infrastructure Vulnerability in Fragile Mountain Ecosystems

The destruction of roads, bridges, and temporary infrastructure during the disaster demonstrates the vulnerability of existing infrastructure in mountainous regions. Many mountain roads and structures are constructed without adequate consideration of hydrological dynamics, slope stability, or climate-induced hazards. Flash floods carrying debris, rocks, and sediment can easily damage poorly designed infrastructure. This highlights the need to adopt climate-resilient and disaster-resilient infrastructure design in Himalayan regions. Engineering practices must incorporate improved drainage

systems, slope stabilization measures, reinforced bridges, and flood-resistant structures. Infrastructure planning should also integrate environmental impact assessments and long-term climate projections to ensure sustainability and resilience.

7.6 Importance of Community Awareness and Preparedness

Another important lesson is the need to strengthen disaster awareness and preparedness among local communities and visiting pilgrims. Many people in disaster-prone areas may not fully understand the warning signs of hazards such as cloudbursts, flash floods, or landslides. During sudden events, lack of awareness about safe evacuation routes or emergency procedures can increase casualties. Community-based disaster preparedness programs can play a crucial role in reducing disaster impacts. Training programs should focus on early warning interpretation, evacuation procedures, first aid, and search-and-rescue basics. Local volunteers, village disaster management committees, and community leaders should be actively involved in preparedness initiatives to build local capacity for responding to emergencies.

7.7 Significance of Multi-Agency Coordination in Disaster Response

The response to the disaster demonstrated the critical importance of coordinated action among multiple agencies. Rescue operations involved several organizations, including the National Disaster Response Force, State Disaster Response Force, the Indian Army, and local administrative authorities. Effective coordination among these agencies enabled rapid deployment of rescue teams, evacuation of stranded pilgrims, and restoration of connectivity in affected areas. However, the disaster also underscores the need for improved inter-agency communication, unified command structures, and pre-established standard operating procedures. Regular joint training exercises and disaster simulations can strengthen coordination and improve operational efficiency during real emergencies.

7.8 Need for Integrated Mountain Disaster Management Strategies

The disaster further highlights the necessity of adopting integrated disaster management approaches specifically tailored for Himalayan regions. These regions face multiple hazards simultaneously, including floods, landslides, avalanches, and glacial lake outburst floods. Disaster management strategies must therefore combine climate adaptation, ecosystem conservation, sustainable tourism management, and resilient infrastructure planning. Institutions should integrate scientific research, local knowledge, and technological innovation to develop comprehensive risk reduction strategies that address the unique vulnerabilities of mountain ecosystems.

References

- Government of Jammu and Kashmir. (2025, August 16). Chief Minister Omar Abdullah visits Chashoti to oversee rescue operations and announce relief under UTDRE. Relief and Rehabilitation Department. <https://jksdma.jk.gov.in>
- India Meteorological Department. (2025, August 14). Special weather bulletin: Intense cloudburst activity over Kishtwar district, Jammu & Kashmir. Ministry of Earth Sciences, Government of India. <https://mausam.imd.gov.in>
- National Disaster Management Authority. (2025, August 30). Situation report: Monsoon 2025 – Impact analysis of Chashoti cloudburst. Government of India. <https://ndma.gov.in>
- Sphere India. (2025, August 28). Situation report 02: J&K cloudburst, flood, and landslides. [https://www.sphereindia.org.in/sites/default/files/2025-09/SitRep_02-J%26K_Clouburst%2C_Flood%2C_and_Landslides_28-08-2025%5B1%5D.pdf](https://www.sphereindia.org.in/sites/default/files/2025-09/SitRep_02_J%26K_Clouburst%2C_Flood%2C_and_Landslides_28-08-2025%5B1%5D.pdf)
- Dhar, A. (2025, August 15). J&K flash floods: At least 60 dead, over 100 injured on Machail Mata pilgrimage route after cloudburst. Hindustan Times. <https://www.hindustantimes.com/india-news/cloudburst-hits-kishtwar-s-chashoti-101755157455420.html>
- The Hindu Bureau. (2025, August 14). Cloudburst in J&K's Kishtwar: At least 40 dead; more than 100 missing. The Hindu. <https://www.thehindu.com/news/national/jammu-and-kashmir/jammu-kashmir-kishtwar-chashoti-cloudburst-floods-august-14-2025/article69932180.ece>
- The Indian Express. (2025, August 15). 65 and counting: Why assessing toll of Kishtwar cloudburst is proving difficult. The Indian Express. <https://indianexpress.com/article/india/kishtwar-cloudburst-toll-rises-machail-mata-pilgrimage-9513476/>
- Naseem, I. (2025, August 16). Kishtwar cloudburst 2025: Flash floods kill 65 in Jammu & Kashmir's Chashoti village. Outlook India. <https://www.outlookindia.com/national/kishtwar-cloudburst-2025-ground-report>
- Press Trust of India. (2025, August 16). J&K CM Omar Abdullah reaches Chashoti village to assess damage; 75 still missing. The Hindu. <https://www.thehindu.com/news/national/jammu-and-kashmir/kishtwar-cloudburst-flood-landslides-updates/article69939949.ece>

3. Dharali Flash Flood, Uttarakhand

1. Introduction

The Himalayan region is one of the most hazard-prone mountain systems in the world due to its fragile geology, steep topography, high seismicity, and rapidly changing climate. In recent decades, the frequency and intensity of hydro-meteorological disasters such as flash floods, landslides, and glacial hazards have increased significantly across the Indian Himalayan Region (IHR). Events such as the Kedarnath disaster (2013) and the Chamoli disaster (2021) highlighted the complex interaction between climate change, glacial processes, and unplanned development in mountain environments. Against this backdrop, the Dharali flash flood disaster of August 2025 in Uttarkashi district, Uttarakhand, represents another critical example of cascading hazards in the Himalayas. The disaster occurred along the Khir Gad stream near Dharali village, located on the route to the Gangotri pilgrimage corridor. A sudden surge of water, debris, mud, and boulders swept through the settlement, causing widespread destruction to houses, hotels, and infrastructure. Initial reports attributed the disaster to a cloudburst or Glacial Lake Outburst Flood (GLOF). However, subsequent scientific investigations indicated a more complex cryospheric trigger linked to the collapse of an exposed ice mass near the Srikanta glacier. The Dharali disaster illustrates how extreme weather, cryospheric instability, and geomorphic processes can combine to produce high-impact flash floods in Himalayan catchments. Understanding the causes, impacts, and lessons from this event is essential for improving Disaster Risk Reduction (DRR) strategies in mountain regions.

2. Overview of the Disaster Event

The Dharali flash flood disaster occurred on 5 August 2025 in Dharali Village, located in the Harsil Valley along the Bhagirathi River basin. Dharali village lies near the channel of the Khir Gad Stream, a glacier-fed tributary that drains the upper catchments of the region. The village also serves as an important halt for pilgrims travelling to the Gangotri Temple and nearby tourist destinations such as Harsil. During the early hours of the disaster, eyewitness accounts and video recordings documented a sudden surge of debris-laden floodwaters composed of water, mud, rocks, and glacial sediments rushing down the Khir Gad channel. Within minutes, the high-energy flow entered Dharali village, destroying buildings, damaging roads and infrastructure, and burying parts of the settlement under thick layers of debris. Initial reports suggested that the disaster may have been triggered by a cloudburst event in the upper catchment. However, rainfall observations from nearby meteorological stations indicated only light to moderate precipitation, suggesting that extreme rainfall alone could not fully explain the magnitude of the event. Subsequent scientific investigations conducted by the Indian Space Research Organisation revealed that the disaster was likely triggered by the collapse of a large exposed ice patch in the nivation zone of the Srikanta Glacier at an elevation exceeding 5,000 metres above sea level. Approximately 75,000 cubic metres of ice suddenly detached from the glacier and rapidly descended

downslope over a vertical drop of nearly 1,700 metres. As the ice mass moved downslope, it entrained loose glacial sediments, moraine material, and meltwater.

This cascading process generated a high-velocity debris flow within the Khir Gad channel, which progressively increased in volume and destructive power as it moved downstream. The debris flow transported large quantities of boulders, sediment, and uprooted vegetation, significantly amplifying the hazard. The settlement of Dharali is situated on an active alluvial fan formed by repeated debris-flow and flood deposition over geological timescales. Such geomorphic landforms often provide relatively flat terrain suitable for habitation and infrastructure development. However, these fan surfaces are inherently dynamic and prone to periodic flooding and debris-flow activity. The location of the village within this depositional zone increased its exposure to the cascading hydro-geomorphic processes that unfolded during the disaster.

As the debris flow emerged from the confined upper channels into the wider valley near Dharali, the flow rapidly spread laterally across the fan surface, inundating settlements and damaging infrastructure located directly along the depositional pathway. This resulted in extensive geomorphic alterations, including channel widening, sediment deposition, and reconfiguration of local drainage pathways. The Dharali disaster illustrates the complex interaction of cryospheric processes, geomorphology, hydrology, and human settlement patterns in the Himalayan region. Rather than being solely caused by a cloudburst or extreme rainfall event, the disaster represents a cascading hydro-geomorphic hazard, where glacier dynamics, sediment availability, slope instability, and channel processes combined to generate a destructive debris flow. The event highlights the need for integrated monitoring of glacier systems, improved hazard zonation mapping, and risk-sensitive land-use planning in Himalayan settlements, particularly those located on active debris-flow fans and along steep tributary valleys.

Table 9: Disaster Identification Table

Parameter	Details
Name of Disaster	Dharali Flash Flood 2025
Disaster Type	Flash Flood / Debris Flow
Date of Occurrence	August 2025
Location	Dharali Village, Uttarkashi District, Uttarakhand
Geographic Setting	Upper Himalayan region near Bhagirathi river basin
Triggering Hazard	Intense rainfall and rapid runoff in steep mountain catchments
Secondary Hazards	Landslides, debris flow, infrastructure damage
Administrative Jurisdiction	Uttarkashi District Administration
Key Response Agencies	National Disaster Response Force, State Disaster Response Force, District Disaster Management Authority

Meteorological Monitoring Agency	India Meteorological Department
Geological Assessment Agency	Geological Survey of India
Disaster Management Authority	Uttarakhand State Disaster Management Authority

Sources:- https://reliefweb.int/report/india/situation-report-1-uttarakhand-cloudburst-and-flash-flood-date-06th-august-2025-time-1000am#:~:text=A%20cloudburst%20over%20the%20Kheer%20Ganga%20catchment,washed%20away%20road%20*%20Disrupted%20road%20connectivity

Table 10: Timeline of Dharali Flash Flood Event

Date	Event
Early August 2025	IMD reported heavy rainfall activity in Uttarkashi district
4-5 Aug 2025	Continuous rainfall saturated slopes and increased stream discharge
5 Aug 2025	Sudden flash flood and debris flow affected Dharali village
5 Aug 2025 (same day)	Emergency rescue operations initiated
6 Aug 2025	Relief and evacuation activities continued
7-8 Aug 2025	Infrastructure restoration and damage assessment

Source: <https://reliefweb.int/report/india/situation-report-1-uttarakhand-cloudburst-and-flash-flood-date-06th-august-2025-time-1000am#:~:text=SITUATION%20UPDATE,%E2%80%A2>

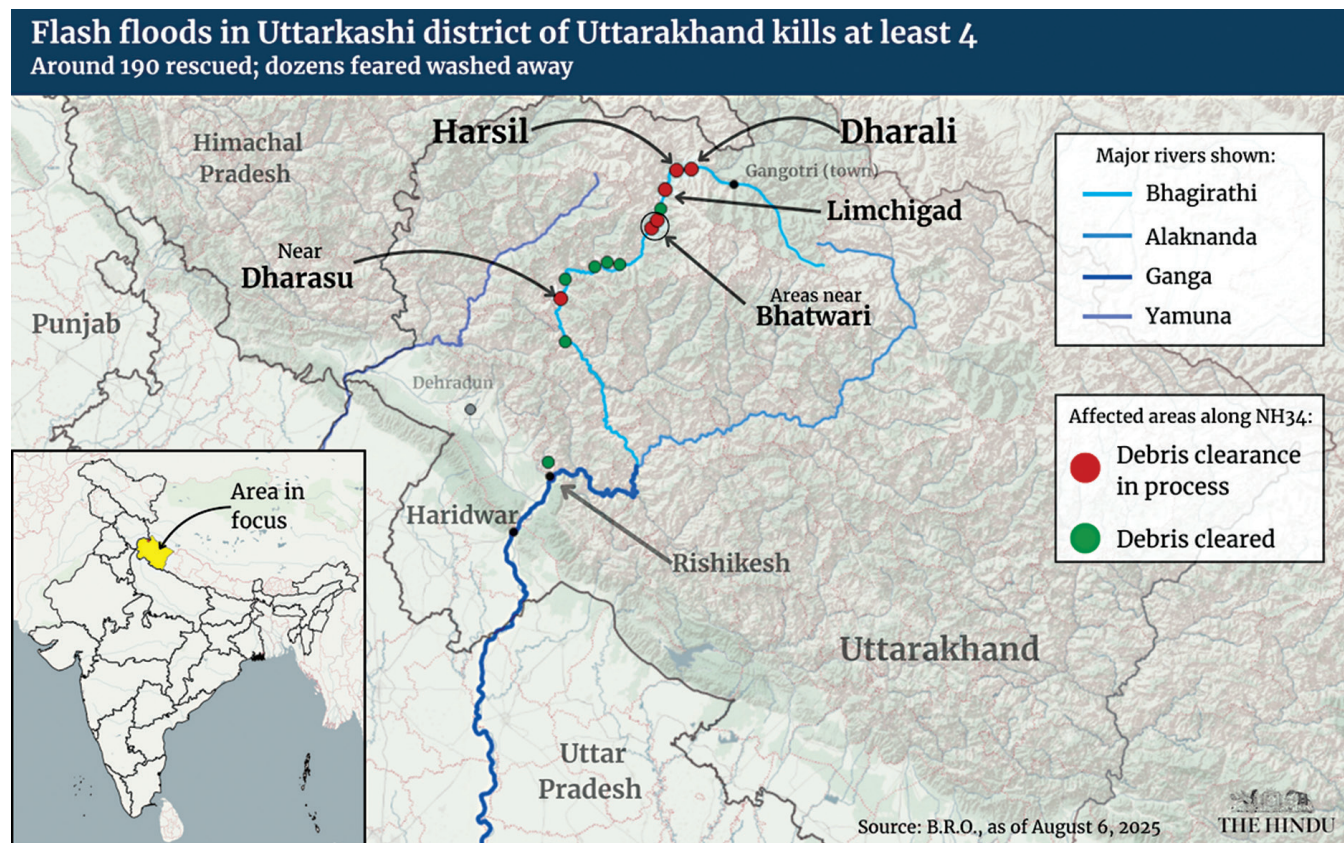


Figure 12: Map showing Dharali flash flood location



Figure 13: Relief and rescue operations are underway after flash flood caused by cloudburst, at Dharali in Uttarkashi on Wednesday (August 6, 2025).

Source: <https://www.thehindu.com/news/national/16-persons-missing-from-maharashtras-jalgaon-after-cloudburst-in-uttarkashi/article69903941.ece>



Figure 14: Search and rescue operation underway following flash floods triggered by a cloudburst, at Dharali, in Uttarkashi, Uttarakhand.

Source: <https://www.thehindu.com/news/national/uttarakhand/uttarkashi-uttarakhand-flash-flood-cloudburst-lanosQlip-death-toll-rescue-operations-august-6-2025/article69901072.ece>

Indian Satellite data based analysis of the Dharali Flash Flood

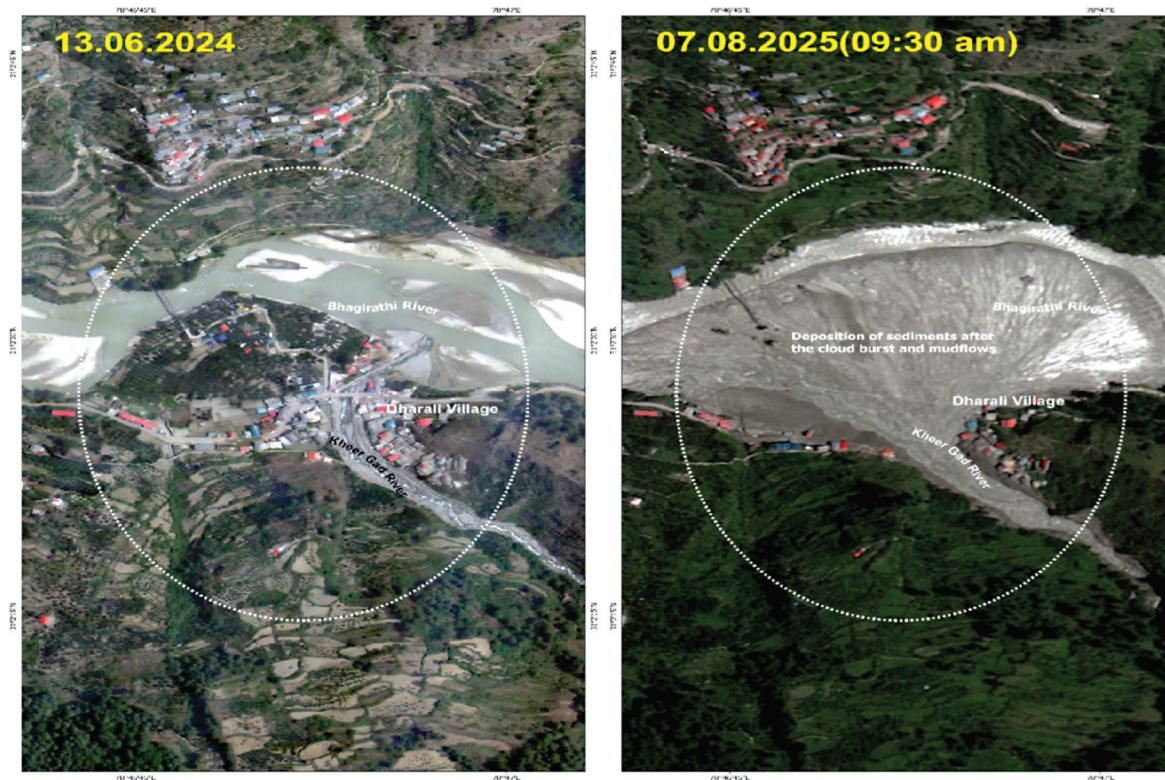


Figure 15: Pre- event Cartosat-3 image of 13.06.2024 and post-event Cartosat-2S image of 07.08.2025

Source: https://www.isro.gov.in/indian_satellite_data_based_analysis_of_the_dharali_flash_flood.html



Figure 16: A surge of water and heavy debris from nearby hills gushed into the village.

Source: <https://indianexpress.com/article/india/in-photos-uttarkashi-flash-floosQ-dharali-harshil-10171252/>



Figure 17: Two nascent lakes have formed near the mouth of Telgad in Harsil, a sensitive mountainous region of Uttarakhand.

Source: <https://www.newindianexpress.com/nation/2025/Sep/06/army-drones-detect-two-new-lakes-near-telgad-after-harsil-landslide-heightening-flood-concerns>



Figure 18: Flash flood impacting Dharali village.

Source: <https://indianexpress.com/article/india/when-residents-of-an-uttarkashi-village-saw-death-rolling-down-a-mountain-10176703/>



Figure 19: Flash flood in Dharali village, Kheer Gad area near Harsil, Uttarkashi, triggered by a cloudburst.

Source: <https://www.hindustantimes.com/india-news/kedarnath-to-uttarkashi-seven-deadly-disasters-that-shook-the-indian-himalayas-chamoli-joshimath-climate-change-101754467289755.html>

3. Impact

The Dharali disaster caused significant human, economic, environmental, and infrastructural damage in the upper Himalayan region of Uttarakhand. The sudden debris flow and flash flooding affected settlements along the Khir Gad stream and disrupted livelihoods dependent on tourism, agriculture, and pilgrimage activities.

Table 11: Summary of Disaster Impacts

Impact Category	Estimated Impact
District affected	Uttarkashi
Main affected settlement	Dharali village
Population affected	Approximately 400-600 residents
Houses damaged	Around 20-30 houses partially or fully damaged
Infrastructure damage	Local roads, bridges, and power lines affected
Agricultural impact	Terrace farming and orchards damaged
Water supply	Disruption due to pipeline damage
Power supply	Temporary outage in affected areas

Source: https://www.isro.gov.in/indian_satellite_data_based_analysis_of_the_dharali_flash_flood.html#:~:text=%7C-,Indian%20Satellite%20data%20based%20analysis%20of%20the%20Dharali%20Flash%20Flood,intense%20mud%20flow%20and%20debris.

3.1 Human Casualties and Missing Persons

The disaster resulted in significant human casualties and displacement in the affected region. Initial reports confirmed at least five fatalities, while 50-100 individuals were reported missing in the immediate aftermath of the incident. Many victims were believed to have been trapped beneath debris from collapsed buildings, mud deposits, and boulder accumulation carried by the debris flow. The sudden onset of the flood left little time for evacuation, increasing the vulnerability of residents and tourists present in the area.

Rescue teams evacuated several injured individuals and transported them to nearby medical facilities for treatment, including the Indian Army medical facility at Harsil, which played an important role in providing emergency healthcare support to affected persons. The incident also caused temporary displacement of many families, who had to be relocated to relief camps and temporary shelters during the emergency response phase.

3.2 Damage to Infrastructure and Property

The disaster caused widespread damage to residential structures, tourism infrastructure, and transportation networks in Dharali and nearby settlements.

Key infrastructure impacts included:

- 40-50 houses were swept away or severely damaged, leaving many families homeless.
- Several hotels, guesthouses, and homestays located along the tourism corridor were destroyed.
- Sections of the Gangotri pilgrimage route were disrupted due to road damage and debris accumulation.
- Local bridges and internal roads were damaged, affecting mobility and access to relief operations.
- Parts of an Army camp and helipad in Harsil were impacted by debris flows.

The destruction of hotels, homestays, and tourist facilities had severe economic implications because tourism and pilgrimage activities constitute the primary source of income for many households in the region. Damage to power lines and water pipelines also caused temporary disruption in basic services, further affecting the local population.

3.3 Environmental and Geomorphological Impact

The disaster significantly altered the geomorphology of the Khir Gad stream channel, demonstrating the dynamic and fragile nature of Himalayan mountain environments.

Major environmental impacts included:

- Deposition of large quantities of sediments, rocks, and boulders along the valley floor.
- Widening and shifting of sections of the stream channel, altering natural drainage patterns.
- Formation of temporary natural dams upstream, which created the potential risk of secondary flash floods if breached.
- Erosion of riverbanks and destabilization of slopes in surrounding areas.

Such geomorphological changes increase long-term vulnerability in the region by altering drainage patterns and destabilizing slopes, which may trigger future landslides or debris flows during heavy rainfall events.

4. Possible Causes / Reasons

The Dharali disaster resulted from a complex interaction between cryospheric processes, geomorphological characteristics, and climate-related changes in the Himalayan environment.

4.1 Collapse of Ice Patch Near Srikanta Glacier

Scientific investigations identified the collapse of an exposed ice patch near the Srikanta Glacier as the primary trigger of the disaster. Satellite imagery and Digital Elevation Model (DEM) analysis indicated that a large ice mass suddenly detached from the slope and released approximately 75,000 cubic metres of ice and debris. The mass rapidly descended through steep terrain into the Khir Gad channel, generating a high-energy debris flow. This mechanism resembles the process observed during the 2021 Chamoli disaster, where a sudden cryospheric collapse triggered destructive flooding downstream.

4.2 Climate-Induced Glacier Instability

Climate change is significantly affecting the Himalayan cryosphere. Rising temperatures are accelerating glacial melting and permafrost degradation, which weakens the structural stability of ice masses and surrounding rock formations. Deglaciation exposes previously insulated ice patches and destabilizes slopes, increasing the likelihood of sudden collapses. Researchers have noted that such cryospheric hazards are becoming more frequent in the Himalayas, highlighting the need for systematic monitoring of glacier dynamics and permafrost conditions.

4.3 Steep Terrain and Loose Sediments

The Himalayan region is characterized by steep slopes and large deposits of unconsolidated glacial and fluvial sediments. When triggered by sudden mass movements or heavy rainfall, these sediments can rapidly mobilize into debris flows, landslides, and flash floods. The Khir Gad valley contained substantial loose material that amplified the destructive force of the debris flow.

4.4 Extreme Weather and Monsoon Conditions

Although rainfall intensity during the event did not qualify as a cloudburst, prevailing monsoon conditions may have contributed to slope saturation and weakened the stability of ice and sediment masses. Saturated soils reduce friction and increase the likelihood of slope failure, thereby facilitating the rapid mobilization of debris.

4.5 Anthropogenic Factors

Human activities have also increased vulnerability in the region. Rapid expansion of tourism infrastructure, road construction, and settlement development along riverbanks has altered natural drainage systems and disturbed slope stability. Construction activities

in fragile mountain environments can accelerate erosion, destabilize slopes, and reduce the natural buffering capacity of ecosystems against hazards.

5. Response

Following the disaster, multiple agencies at the national, state, and local levels initiated emergency response operations to rescue affected individuals and restore essential services.

5.1 Search and Rescue Operations

Search and rescue operations were conducted jointly by the Indian Army, the National Disaster Response Force, and the State Disaster Response Force. Rescue teams deployed heavy machinery, drones, and trained sniffer dogs to locate survivors trapped under debris and collapsed structures. During the initial response phase, more than 190 people were rescued from affected areas.

5.2 Government Intervention

The Government of Uttarakhand coordinated relief operations under the leadership of the Chief Minister. The administration continuously monitored the situation and mobilized resources to support rescue and relief activities. The Union Government assured full assistance for emergency response and rehabilitation. Helicopters from the Indian Air Force were placed on standby to support evacuation and supply operations if required.

5.3 Relief and Rehabilitation Measures

Authorities established temporary relief camps and shelters to accommodate displaced residents.

Key relief measures included:

- Distribution of food and drinking water
- Provision of medical assistance
- Supply of essential relief materials
- Initiation of damage assessment surveys

These assessments were necessary to evaluate infrastructure losses and plan long-term rehabilitation and reconstruction strategies.

6. Issues / Challenges / Concerns

Despite rapid response efforts, several structural challenges and systemic gaps became evident during the disaster.

6.1 Limited Early Warning Systems for Cryospheric Hazards

The sudden collapse of the ice patch provided little to no warning for local communities. Unlike river floods or cyclones, cryospheric hazards such as glacier collapses or ice avalanches remain difficult to predict. Existing early warning systems in Himalayan regions primarily focus on rainfall and glacial lake outburst floods, leaving significant monitoring gaps for other cryospheric threats.

6.2 Difficult Terrain and Accessibility

The rugged mountainous terrain significantly hampered rescue operations. Damaged roads, landslides, and continuous rainfall made it difficult for rescue teams and relief materials to reach affected areas. Remote settlements often remain isolated for extended periods during such disasters.

6.3 Unplanned Development in Hazard-Prone Zones

Many residential buildings, hotels, and tourist facilities in Dharali were constructed close to river channels or on unstable slopes. Such unplanned development increases exposure to flash floods and debris flows, highlighting the need for stricter land-use regulations and hazard zoning in Himalayan regions.

6.4 Lack of Real-Time Cryosphere Monitoring

While glacial lakes are monitored in several Himalayan regions, exposed ice patches and permafrost zones are rarely monitored systematically. The absence of real-time monitoring systems for these features limits the ability of authorities to anticipate sudden cryospheric collapses.

6.5 Climate Change and Emerging Disaster Risks

The increasing frequency of glacier-related disasters suggests that existing disaster management frameworks may not adequately address emerging climate-driven hazards. Future disaster management strategies must integrate climate science, glacier monitoring, and mountain ecosystem protection to effectively address these evolving risks.

7. Lessons Learned

The disaster in Dharali Village highlights several critical lessons for disaster risk reduction in the fragile Himalayan region. The event demonstrates how cascading hydro-geomorphic processes, combined with settlement exposure and limited monitoring systems, can lead to severe impacts.

7.1 Importance of Monitoring Cryospheric Hazards

The disaster underscores the growing importance of monitoring glacier-related hazards in the Himalayan region. The collapse of an ice patch from the Srikanta Glacier illustrates that cryospheric processes can trigger sudden debris flows even without extreme rainfall. Continuous glacier and snowfield monitoring using satellite observations and ground-based sensors is therefore essential.

7.2 Need for Integrated Multi-Hazard Early Warning Systems

Traditional early warning systems in the Himalayas often focus primarily on rainfall-induced hazards. However, the Dharali event demonstrates that disasters can arise from complex interactions among glaciers, sediment, and hydrological processes. Early warning mechanisms should therefore integrate meteorological, hydrological, and cryospheric monitoring to detect cascading hazards.

7.3 Risk of Settlements Located on Active Alluvial Fans

Dharali village is located on an active depositional fan formed by repeated debris-flow events over geological time. Such landforms offer relatively flat terrain for habitation but remain highly vulnerable to sudden floods and debris flows. The disaster highlights the importance of risk-sensitive land-use planning and hazard-based settlement zoning in mountain regions.

7.4 Growing Disaster Risk in the Himalayan Region

The event reflects broader trends of increasing hazard frequency and intensity in the Himalayas due to climate variability, glacier retreat, and changing hydrological regimes. These changes are increasing the likelihood of glacial collapses, debris flows, and flash floods, making proactive risk management essential.

7.5 Importance of Scientific Investigation and Remote Sensing

Scientific investigations conducted by agencies such as the Indian Space Research Organisation played a crucial role in identifying the actual trigger mechanism of the disaster. This highlights the value of remote sensing, satellite imagery, and geospatial analysis for understanding complex mountain hazards and improving disaster preparedness.

7.6 Need for Climate-Resilient Infrastructure in Mountain Areas

The destruction of roads, bridges, and buildings during the debris flow indicates that existing infrastructure in Himalayan regions is often not designed to withstand extreme geomorphic processes. Future infrastructure development must incorporate climate-resilient design standards and hazard-informed engineering practices.

7.7 Strengthening Community Awareness and Preparedness

Local communities and tourists in mountain regions are often unaware of the risks posed by sudden debris flows and glacial hazards. Strengthening community-based disaster preparedness, evacuation awareness, and early response capacity can significantly reduce casualties in such sudden-onset disasters.

References

- Indian Space Research Organisation. (2026, March 7). Ice-patch collapse and early-warning implications from a Himalayan flash flood: Emerging cryo-hydrological hazards under deglaciation. <https://www.thehindu.com/sci-tech/energy-and-environment/dharali-floods-large-ice-patches-on-melting-glaciers-greater-threat-than-believed/article70745747.ece>
- India Meteorological Department. (2025, August 7). Special report on localized extreme precipitation and weather systems over Northwest India: August 2025. Regional Meteorological Centre, New Delhi, Ministry of Earth Sciences.
- ReliefWeb. (2025, August 11). LOCAL situation report: Uttarakhand flash floods 2025 – Dharali, Harsil, and Sukki (Report No. HAI-2025-08-11). <https://reliefweb.int/report/india/local-situation-report-uttarakhand-flash-floods-2025-11-august-2025>

- Sphere India. (2025, September 2). Joint rapid needs assessment: Dharali flash floods – Uttarkashi (August 2025).
- CENJOWS. (2025). Integrated UAVs and GIS for environmental security of glaciated regions (In-Depth Analysis Report). Centre for Joint Warfare Studies. https://cenjows.in/wp-content/uploads/2025/12/Mr_Chander_Shekhar_IB_Sep25.pdf
- Indian Space Research Organisation. (2025, August 7). Indian satellite data based analysis of the Dharali flash flood. https://www.isro.gov.in/indian_satellite_data_based_analysis_of_the_dharali_flash_flood.html
- Rana, N., & Kumar, S. (2026). Nature's fury: The deadly landslides saga in Uttarakhand Himalaya. *Journal of Earth System Science*, 135(35). Indian Academy of Sciences. <https://www.ias.ac.in/article/fulltext/jess/135/0035>
- Hindustan Times Correspondent. (2025, August 6). Cloudburst in Uttarkashi: Dharali village buried under debris; 4 dead, 50 feared missing. Hindustan Times. <https://www.hindustantimes.com/india-news/uttarakhand-rain-fury-dharali-cloudburst-101754449210332.html>
- Press Trust of India. (2025, August 7). Dharali landslide: Rescue operations intensified as death toll rises; Gangotri highway blocked. The Hindu. <https://www.thehindu.com/news/national/other-states/uttarakhand-dharali-flash-flood-updates/article69821443.ece>
- The Indian Express. (2025, August 8). Why Dharali was a disaster waiting to happen: Experts point to 'sediment stores' and climate shifts. The Indian Express. <https://indianexpress.com/article/india/dharali-uttarakhand-cloudburst-analysis-9501234/>
- Times News Network. (2025, August 6). Dharali flash floods: 16 houses destroyed, pilgrims stranded on Char Dham route. The Times of India. <https://timesofindia.indiatimes.com/city/dehradun/dharali-village-disaster-uttarkashi/articleshow/112345678.cms>

4. FloosQ in Himachal Pradesh

1. Introduction

Himachal Pradesh, characterized by its fragile Himalayan ecosystem, steep gradients, high-intensity rainfall, and geologically unstable terrain, remains highly susceptible to hydro-meteorological disasters such as floosQ, flash floosQ, lanosQlides, cloudbursts, and land subsidence. The state's increasing exposure to extreme weather events, compounded by ecological fragility and expanding human interventions in vulnerable zones, has heightened disaster risks in recent years. The monsoon season of 2025 witnessed above-normal rainfall across several districts of Himachal Pradesh, triggering a series of extreme rainfall-induced disasters that caused widespread disruptions to transportation networks, communication systems, water supply infrastructure, and public utilities. The intensity and persistence of rainfall led to flash floosQ, lanosQlides, road blockages, and land subsidence in several disaster-prone regions, severely affecting normal life and emergency response mechanisms.

The flood-related disaster events of 2025, particularly in the districts of Chamba, Kangra, Shimla, Solan, and Una, exposed significant vulnerabilities in infrastructure resilience, disaster preparedness, early warning dissemination, and emergency communication systems. The impacts were especially severe along pilgrimage routes and in remote mountainous areas, where access constraints and terrain instability complicated relief and rescue operations. These events underscore the increasing frequency and intensity of climate-induced disasters in the Himalayan region and highlight the urgent need for strengthening disaster risk reduction frameworks, climate-resilient infrastructure, localized early warning systems, and community-based preparedness mechanisms.

This chapter presents a comprehensive documentation and analysis of the flood-related disaster events in Himachal Pradesh during 2025, examining their causes, impacts, institutional response mechanisms, operational challenges, and policy recommendations for enhancing disaster preparedness and resilience across vulnerable districts of the state.

Devastation in Himachal

Relentless monsoon rains and cloudbursts have claimed nearly 70 lives and left over 100 injured in Himachal Pradesh, triggering landslides, flash floods, and widespread devastation across the state

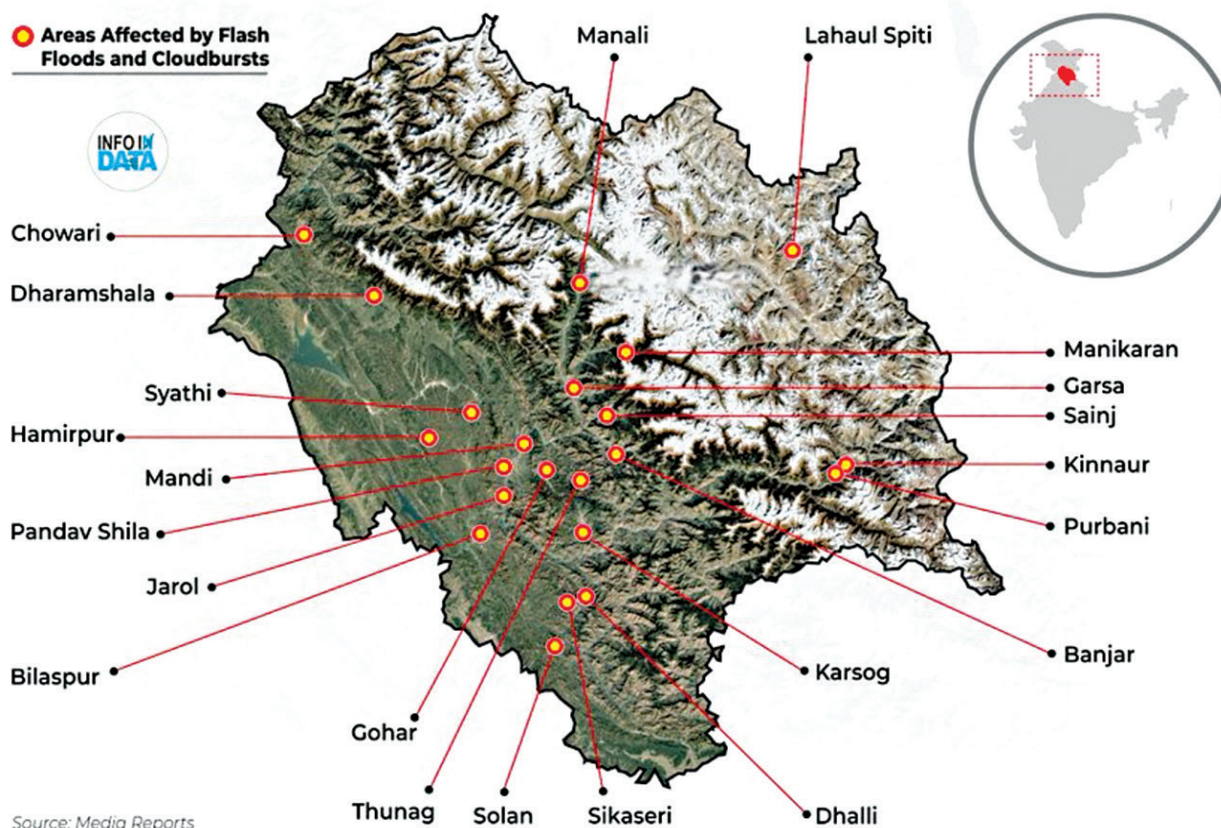


Figure 20: Areas affected by flash floods and cloudbursts in Himachal Pradesh.

Source: <https://www.opindia.com/wp-content/uploads/2025/07/4.jpg>

Case Study 1: Monsoon Floods, Landslides, and Mass Stranding Incident during Chamba Manimahesh Yatra, 2025

Chamba district, located in the North-Western Himalayan region of Himachal Pradesh, is highly vulnerable to hydro-meteorological disasters due to its fragile terrain, steep mountain slopes, and high monsoonal precipitation. The district experiences recurrent hazards such as flash floods, landslides, road blockages, and infrastructure damage during the monsoon season.

The Monsoon 2025 season emerged as one of the most challenging disaster periods for the district, marked by exceptionally high rainfall and a major humanitarian crisis during the annual Manimahesh pilgrimage. The crisis resulted in large-scale stranding of pilgrims, communication failures, disruption of road connectivity, and extensive infrastructure damages, necessitating one of the largest coordinated rescue operations in the state.

1. Overview of Disaster Event

1.1 Rainfall Analysis and Seasonal Overview

The monsoon season of 2025 witnessed significantly above-normal rainfall in Chamba district, resulting in widespread hydro-meteorological hazards, including landslides, flash floods, slope failures, and major infrastructure disruptions. The district recorded 30% excess seasonal rainfall during the monsoon period, which substantially increased soil saturation, surface runoff, and slope instability across vulnerable areas.

The rainfall pattern showed considerable temporal variation, with a rainfall deficit in July followed by exceptionally high rainfall in August and above-normal precipitation in early September. The sudden and concentrated increase in rainfall intensity during August acted as the primary trigger for multiple landslide incidents and flash-flood situations across the district.

Table 12: Monthly Rainfall Analysis (Monsoon 2025)

Month	Actual Rainfall (mm)	Normal Rainfall (mm)	Variation
July 2025	249.1	305.7	18% Deficit
August 2025	552.6	291.7	89% Excess
September 2025*	190.2	129.7	47% Excess
Seasonal Total	1,107.7	848.9	30% Excess

**Data up to 6 September 2025.*

Source: Himachal Pradesh State Disaster Management Authority (HPSDMA).

The rainfall trend clearly indicates that the highest precipitation occurred during August 2025, which significantly contributed to destabilizing slopes, blocking transportation routes, and damaging critical infrastructure.

2. Major Disaster Event: Manimahesh Yatra Crisis (24 August-9 September 2025)

One of the most significant disaster events during the monsoon season of 2025 in Chamba district was the crisis associated with the annual Manimahesh Lake pilgrimage.

The pilgrimage, undertaken annually to the sacred Manimahesh Lake situated at an altitude of approximately 13,500 feet, coincided with the peak monsoon period, exposing thousands of pilgrims to severe weather conditions and terrain instability.

Between 24 August and 9 September 2025, continuous heavy rainfall triggered landslides, flash floods, and road blockages along major pilgrimage routes, leading to large-scale disruption and stranding of pilgrims. Considering the escalating risks, the district administration suspended the pilgrimage under Section 30 of the Disaster Management Act, 2005, on 25 August 2025, as a preventive safety measure.

The crisis developed into a major disaster situation due to extensive infrastructure damage, transportation disruption, and breakdown of essential services.

Table 13: Major Impacts of Manimahesh Yatra Crisis (2025)

Category	Impact
National Highway Closure	NH-154 closed for 15 days
Communication Disruption	96-hour communication blackout
Road Blockages	314 roads blocked
Power Infrastructure Damage	390 distribution transformers affected
Water Supply Disruption	729 water supply schemes affected

Source: Himachal Pradesh State Disaster Management Authority (HPSDMA).

The prolonged closure of critical road infrastructure and communication systems significantly affected evacuation, rescue operations, and the supply of essential services, highlighting the vulnerability of pilgrimage management systems to extreme weather events. The incident underscored the urgent need for improved route monitoring, weather-based early warning systems, and contingency planning for mass religious gatherings in hazard-prone mountainous regions.



Figure 21: Disruption in pilgrimage movement during Manimahesh yatra due to floods and landslides in Chamba district.

Source:<https://economictimes.indiatimes.com/news/india/346-road-blocked-287-dead-until-august-21-as-monsoon-havoc-in-himachal-pradesh-continues/articleshow/123445283.cms?from=mdr>

Case Study 2: Monsoon-Induced Land Subsidence Incident in Garder Village, Kangra, 2025

1. Introduction

Kangra district, situated in the foothills of the Himalayas in Himachal Pradesh, is highly vulnerable to hydro-meteorological and geological disasters due to fragile geological formations, steep slopes, and intense monsoon rainfall. The district frequently experiences landslides, flash floods, soil erosion, and land subsidence during heavy rainfall events.

The monsoon season of 2025 witnessed prolonged and intense rainfall across Kangra district, resulting in slope instability and ground movement in several areas. One of the most significant incidents occurred in Garder Village of Bachhwai Panchayat in the Thural area, where land subsidence caused structural damage to residential houses and forced multiple families to evacuate their homes and seek temporary shelter in safer locations. The incident highlighted the vulnerability of settlements in unstable terrain and the need for improved slope monitoring, early warning, and disaster preparedness measures in the district.

2. Overview of Disaster Event

2.1 Climate and Geological Context

The Himalayan region has increasingly witnessed short-duration, high-intensity rainfall events over the past decade, a trend closely associated with changing climatic patterns and rising weather variability. These extreme precipitation events significantly increase the probability of hydro-geological disasters such as landslides, land subsidence, flash floods, and damage to critical infrastructure.

Kangra district, situated in the foothills of the Himalayas, remains highly vulnerable to such hazards due to its fragile geological setting, steep terrain, and high monsoonal rainfall intensity. The district's physical and geological characteristics amplify the impact of prolonged rainfall, making it particularly susceptible to rainfall-induced slope failures and ground instability.

2.2 Geological and Terrain Vulnerability

The geological framework of Kangra district is primarily dominated by the Siwalik formations, which consist mainly of weak sedimentary rocks such as sandstone, shale, siltstone, clay, and conglomerates. These formations are weakly consolidated and highly prone to weathering, erosion, and loss of structural stability under saturated conditions.

In addition to the sedimentary formations, the district also contains extensive unconsolidated fluvial deposits comprising sand, gravel, clay, and silt. These loose materials have a high-water absorption capacity and experience a significant reduction in shear strength during prolonged rainfall events, thereby increasing the likelihood of landslides, slope failures, and land subsidence.

The combination of steep slopes, active tectonic conditions, geological discontinuities such as joints and fractures, and weak lithological formations makes Kangra highly vulnerable to rainfall-triggered geohazards.

2.3 Detailed Description of the Incident

A major land subsidence incident was reported on 16 September 2025 in Garder Village under Bachhwai Panchayat in the Thural area of Kangra district. The event was triggered by continuous and heavy rainfall during the second half of September, which led to excessive soil saturation and destabilization of the underlying slopes.

The incident resulted in large-scale ground movement and subsidence over an area of approximately one-kilometre radius, causing severe distress to the local population. Ground sinking of up to 10 feet was observed at certain locations, leading to major structural cracks in residential houses and significant damage to adjoining roads and agricultural land.

Considering the risk of further ground movement, the district administration sealed the affected area and evacuated the affected families to temporary relief shelters as a precautionary safety measure.

2.4 Rainfall Analysis

The rainfall analysis for the monsoon season of 2025 indicates significantly high precipitation during the months of June to September, which created conditions favourable for slope instability and land subsidence.

Table 14: Monthly Rainfall Data (2025)

Month	Rainfall (mm)
June	107.544
July	180.550
August	483.249
September	355.460

Source: Himachal Pradesh State Disaster Management Authority (HPSDMA).

The rainfall data indicates that August 2025 recorded the highest rainfall (483.249 mm), followed by September (355.460 mm). This unusually high precipitation resulted in prolonged soil saturation, increasing hydrostatic pressure within slope materials and reducing their stability.

Critical Rainfall Events Prior to the Incident

A review of the daily rainfall pattern immediately preceding the incident shows significant rainfall accumulation during the critical period:

Table 15: Daily Rainfall Prior to Incident (September 2025)

Date	Rainfall (mm)
12 September	49.63
15 September	40.95
16 September	33.88

Source: Himachal Pradesh State Disaster Management Authority (HPSDMA).

The cumulative rainfall recorded between 12 and 16 September 2025 substantially increased soil moisture content and weakened the subsurface strata, which likely acted as the immediate trigger for the land subsidence event in Garder village.

Case Study 3: Monsoon-Induced Landslides and Hazard Events in Shimla District, 2025

1. Introduction

Shimla district, located in the middle Himalayan region of Himachal Pradesh, is highly susceptible to landslides due to its fragile geological formations, steep slopes, and intense monsoonal precipitation. The district's terrain, characterized by complex geology and high anthropogenic pressure through urban expansion and infrastructure development, increases the frequency and severity of landslide incidents.

Landslides remain one of the most common and destructive hazards in Shimla district, causing repeated damage to roads, buildings, water supply systems, and occasionally loss of human life. During the monsoon season of 2025, continuous and intense rainfall triggered multiple landslide incidents across the district, exposing significant gaps in preparedness and infrastructure resilience.

2. Overview of Disaster Event

2.1 Geological Characteristics

The geological formation of Shimla district ranges from the Precambrian to Quaternary period and is predominantly composed of hard rock formations. However, despite the presence of relatively strong rock masses, the district remains highly vulnerable to landslides due to tectonic disturbances, geological discontinuities such as faults, joints, and fractures, and prolonged weathering processes. Continuous erosion and weathering have weakened the slope structure and led to the accumulation of loose debris material on hill slopes, making many parts of the district highly unstable and susceptible to slope failures, particularly during the monsoon season.

2.2 Meteorological Factors

Shimla district receives the majority of its annual rainfall during the southwest monsoon season from June to September, and this concentrated rainfall plays a critical role in

triggering landslides. Prolonged and intense rainfall increases water infiltration into soil and rock layers, resulting in soil saturation, increased pore-water pressure, and reduced shear strength of slope materials. These conditions significantly weaken slope stability and increase the likelihood of landslides, especially when combined with poor drainage systems, concentrated surface runoff, and localized waterlogging.

2.3 Nature of Landslide Hazards

Landslide hazards in Shimla district mainly occur in the form of downward sliding of soil, rock, and debris, rock falls, slope failures, and drainage blockages caused by accumulated debris material. These hazards are often aggravated by human interventions such as hill cutting, excavation, road widening, and construction activities, which remove lateral support from slopes and disturb natural stability. The recurring occurrence of such landslide events causes significant damage to roads, buildings, public infrastructure, and settlements, disrupting normal life and posing serious risks to human safety.

2.4 Historical Pattern of Human Losses due to Landslides

Shimla district has experienced repeated human losses and infrastructure damage due to landslide incidents across various subdivisions, including Shimla Urban, Shimla Rural, Theog, Jubbal, Rohru, Kotkhai, Chopal, and Kumarsain, reflecting the widespread nature of landslide vulnerability in the district. The historical pattern indicates that both urban and rural settlements located in steep and unstable terrain remain highly exposed to such hazards. During the monsoon season of 2025, multiple landslide incidents were reported, particularly in densely populated urban and high-slope areas, highlighting the increasing risk exposure and the urgent need for improved preparedness, hazard mapping, and mitigation measures.



Figure 22: Cloudburst-affected area of Seraj valley in Himachal Pradesh.

Source: <https://www.hindustantimes.com/india-news/mandi-kullu-hit-hardest-in-himachal-as-monsoon-fury-continues-imd-predicts-more-rain-101754265648650.html>

Case Study 4: Monsoon-Induced Landslides, Land Sinking, and Flash Flood Events in Solan District, 2025

1. Introduction

Solan district, situated in the south-western part of Himachal Pradesh, is characterized by hilly terrain, complex drainage systems, and fragile slopes, making it highly vulnerable to hydro-meteorological disasters during the monsoon season. The district receives most of its annual rainfall between July and September under the influence of the southwest monsoon.

While monsoon rainfall is essential for agriculture and groundwater recharge, it also triggers hazards such as landslides, flash floods, land subsidence, erosion, and infrastructure failures. Over recent years, Solan has witnessed increasing monsoon-related disasters, indicating growing climate vulnerability and increasing anthropogenic pressure on fragile hill ecosystems.

The monsoon season of 2025 emerged as one of the most destructive in recent years, resulting in widespread damage to houses, roads, water supply systems, electricity infrastructure, livestock, and agricultural land.

2. Overview of Disaster Event

2.1 Seasonal Overview

During the monsoon period from July to September 2025, District Solan recorded approximately 17% above-normal rainfall, resulting in multiple hydro-meteorological disaster incidents across the district. The persistent and high-intensity rainfall triggered flash floods, repeated landslides, land sinking incidents, and widespread road blockages, causing extensive damage to both public and private infrastructure. The most severely affected subdivisions included Nalagarh, Baddi, Solan, Arki, Kandaghat, and Kasauli, where continuous rainfall disrupted normal life and emergency response operations.

2.2 Hydro-Meteorological Drivers

The disaster events in Solan during the monsoon season were primarily driven by intensified southwest monsoon activity, supported by low-pressure systems over north-west India, which enhanced moisture transport into the region. Rising temperatures have increased atmospheric moisture retention, resulting in short-duration but high-intensity rainfall events. These hydro-meteorological conditions significantly increased runoff, slope instability, and flood risks across the district.

2.3 Geographical Vulnerability

District Solan is characterized by hilly terrain, varied topography, and complex drainage systems, making it highly vulnerable to monsoon-related disasters. The district is intersected by important seasonal streams and river systems, including the Ashwani Khad, Giri River, Sirsa River, and Gambhir River, which play an important role in agriculture and water supply. However, during periods of extreme rainfall, these river systems often experience overflow and flash flooding, causing erosion, infrastructure damage, and slope destabilization in nearby areas.

2.4 Land Sinking Incidents in Nalagarh and Baddi

One of the most significant disaster events during the monsoon season of 2025 was the occurrence of land sinking and subsidence in the Nalagarh and Baddi subdivisions. Prolonged and intense rainfall led to excessive saturation of sub-surface soil layers, causing gradual ground sinking and structural instability. The incidents resulted in major cracks in residential buildings, tilting of structures, fissures in agricultural land, and displacement of affected families. A total of 237 families were directly affected, highlighting the urgent need for geotechnical assessments, slope stabilization measures, and long-term rehabilitation planning.

Case Study 5: Monsoon-Induced Land Subsidence, Landslides, and Waterlogging Incidents in District Una, Himachal Pradesh, 2025

1. Introduction

The monsoon season of 2025 brought exceptionally heavy rainfall across Himachal Pradesh, causing widespread hydro-meteorological disasters including landslides, land subsidence, flash floods, and waterlogging. District Una, located in the south-western part of Himachal Pradesh, experienced significant impacts due to above-normal rainfall, particularly in the Bangana Sub-Division and urban areas of Una.

The district witnessed severe land sinking, landslides, and waterlogging incidents, resulting in damage to public infrastructure, agricultural land, private property, and disruption of essential services. The South-West Monsoon of 2025 highlighted the increasing vulnerability of low-hill and foothill regions to rainfall-induced disasters.

2. Climate Change Context and Monsoon Extremes

Recent climatic trends indicate a noticeable increase in the frequency, intensity, and unpredictability of short-duration extreme rainfall events across the Himalayan and sub-Himalayan regions, reflecting the growing influence of climate change on regional weather systems. The South-West Monsoon season of 2025 was marked by high-intensity rainfall events, localized cloudburst-like conditions, prolonged soil saturation, excessive surface runoff accumulation, and flash flooding in low-lying urban and rural areas.

In District Una, one of the most extreme rainfall events occurred on 1 August 2025, when approximately 222.8 mm of rainfall was recorded within a span of just six hours, far exceeding the normal rainfall pattern and placing immense pressure on drainage systems, slopes, and infrastructure. These extreme weather conditions triggered multiple disaster events, including landslides, land subsidence, flooding, waterlogging, and extensive infrastructure damage across the district. The increasing climate variability, coupled with anthropogenic pressures such as unplanned urbanization, drainage encroachments, and land-use changes, has significantly amplified disaster risks and vulnerability in District Una.

3. Study Area Profile - District Una

District Una is located in the lower Shivalik foothills of Himachal Pradesh and serves as a transitional geographical zone between the Himalayan hill terrain and the adjoining plains. The district is characterized by undulating topography, seasonal streams, drainage channels, and loose alluvial and colluvial deposits, which make the region vulnerable to hydro-meteorological hazards such as flooding, land subsidence, and slope instability during intense monsoon conditions. Human settlements in several parts of the district are situated close to vulnerable slopes, low-lying areas, and natural drainage lines, increasing their exposure to disaster risks.

The major affected sub-divisions during the South-West Monsoon season of 2025 included Bangana, Una, Haroli, and Amb, where heavy rainfall caused widespread waterlogging, flooding, and land instability. Among these, the Bangana sub-division emerged as one of the most severely affected areas due to unstable slopes, deforestation, weak soil formations, and inadequate drainage systems, making it highly susceptible to landslides and land subsidence.

4. Hazard Profile and Contributing Factors

4.1 Geological and Terrain Factors

District Una is geologically characterized by loose sedimentary formations, weathered soil layers, weak slope structures, and erosion-prone terrain, particularly in the Bangana sub-division. The presence of unstable hill slopes, shallow soil depth, and unconsolidated deposits makes the district highly vulnerable to slope failures and land subsidence during periods of prolonged rainfall. Continuous infiltration of rainwater increases pore water pressure within the soil strata, significantly reducing slope stability and triggering landslides and land sinking incidents.

4.2 Anthropogenic Factors

Human-induced activities have further aggravated disaster vulnerability in the district. Unplanned construction on unstable slopes, indiscriminate hill cutting for road widening and infrastructure development, deforestation, and encroachment upon natural drainage channels have disturbed the ecological and geomorphological balance. In addition, inadequate stormwater drainage systems in urban and semi-urban areas have intensified waterlogging and runoff concentration, increasing both flood and subsidence risks.

4.3 Hydro-Meteorological Drivers

The primary hydro-meteorological drivers during the South-West Monsoon Season 2025 included intense short-duration rainfall, high runoff accumulation, prolonged soil saturation, and inadequate drainage management. The extreme rainfall event of 1 August 2025, when Una recorded approximately 222.8 mm rainfall within six hours, acted as a major triggering factor for flash floods, landslides, land subsidence, and waterlogging across multiple sub-divisions. The combination of excessive rainfall intensity and fragile terrain conditions significantly amplified disaster impacts across the district.

Table 16: District wise impact of monsoon-induced landslides, land sinking, and flash flood events

Impact Category	Chamba	Kangra	Shimla	Solan	Una
Human Impact	16,000 pilgrims stranded in Bharmour; 9,500 on trekking route; medical emergencies; psychological distress	14 families (50–60 persons) displaced; psychological stress	Deaths, injuries, and displacement reported (figures not specified)	3 deaths	30 deaths; 442 families displaced
Housing Damage	Not specifically reported	14 houses damaged	Residential and commercial structures threatened	58 fully damaged; 368 partially damaged houses	100+ houses and shops inundated
Road/Transport Impact	NH-154 blocked for 15 days; 314 roads blocked	Local roads and access pathways damaged	Road and highway disruptions	410 out of 692 roads affected; NH-05 damaged	NH and local roads disrupted
Power Impact	390 transformers affected	Not reported	Electricity infrastructure damaged	1,967 transformers affected	Transformers damaged (number not specified)
Water Supply Impact	729 schemes disrupted	Not reported	Water pipelines damaged	210 out of 716 schemes affected	Water supply pipelines damaged
Communication Impact	Mobile and internet services disrupted for 96 hours	Not reported	Not reported	Not reported	Not reported
Economic Impact	Pilgrimage economy, tourism, logistics, and local trade disrupted	Livelihood disruption	Tourism losses, restoration expenses, business disruption	Private property losses, livestock losses, infrastructure restoration costs	Agricultural losses, commercial losses, restoration costs
Public Infrastructure Loss	Public assets and utilities damaged (amount not specified)	Local infrastructure damaged	Public infrastructure damaged (amount not specified)	₹2,27,70,34,087	₹344,63,85,946
Land/ Environmental Impact	Landslides and slope failures	Land subsidence over 1 km radius; sinking up to 10 feet	Soil erosion, vegetation loss, land degradation	Land sinking affecting 237 families	2676.35 bigha agricultural land damaged; 41 subsidence locations
Special Impact	Manimahesh Yatra crisis; high administrative burden	Ground fissures and geotechnical instability	Urban slope vulnerability and dense settlement risk	234 cows/sheep damaged; 15 livestock deaths	Urban waterlogging and migrant rescue operations

Source: Himachal Pradesh State Disaster Management Authority (HPSDMA).

Possible Causes / Reasons

The analysis of disaster incidents across the districts of Chamba, Kangra, Shimla, Solan, and Una indicates that the disasters were caused by a combination of hydro-meteorological, geological, environmental, and anthropogenic factors. The major contributing causes are as follows:

1. Excessive and Intense Monsoon Rainfall

Heavy and prolonged monsoon rainfall emerged as the primary trigger across all affected districts. Extreme rainfall events caused rapid soil saturation, increased surface runoff, and excessive groundwater pressure, leading to landslides, flash floods, waterlogging, and land subsidence. In some districts such as Una and Solan, above-normal rainfall significantly aggravated disaster intensity.

2. Fragile Geological and Terrain Conditions

The Himalayan terrain, characterized by steep slopes, weathered rock formations, loose sedimentary deposits, and fragile geological structures, remains highly vulnerable to slope instability. Districts such as Kangra and Una, dominated by Shivalik formations, showed increased susceptibility to land sinking and subsidence due to weak subsurface conditions.

3. Soil Saturation and Water Infiltration

Continuous rainfall resulted in excessive water infiltration into soil and rock layers, reducing cohesion and shear strength. This weakened slope stability and triggered landslides, slope failures, and ground subsidence, particularly in hilly and geologically weak regions.

4. Inadequate Drainage Infrastructure

Poorly maintained drainage systems, blocked stormwater channels, and inadequate water diversion mechanisms contributed significantly to water accumulation and infiltration. Urban waterlogging and slope failures in several districts were intensified due to drainage failures.

5. Unplanned Construction and Slope Cutting

Road widening, hill cutting, excavation activities, and unscientific construction practices disturbed the natural slope equilibrium. In urbanized districts such as Shimla and Solan, infrastructure development without adequate geotechnical safeguards increased slope vulnerability.

6. Deforestation and Land Use Change

Loss of vegetation cover due to construction activities, agriculture expansion, and deforestation reduced natural root reinforcement and soil-binding capacity, thereby accelerating soil erosion and increasing landslide risk.

7. Pilgrimage and Human Exposure During Peak Monsoon

In Chamba, the scheduling of the Manimahesh pilgrimage during the peak monsoon season significantly increased human exposure to hydro-meteorological hazards, resulting in large-scale stranding and operational challenges.

8. Weak Communication and Disaster Preparedness Systems

In Chamba, communication systems remained highly vulnerable due to dependence on terrestrial fibre infrastructure, resulting in prolonged communication failure. Limited integration of real-time weather intelligence into event planning also reduced preparedness and response effectiveness.

9. Riverbank Encroachments and Natural Drainage Obstruction

Encroachments on riverbanks and natural drainage channels, particularly in Solan and Una, reduced the carrying capacity of water bodies and increased flood vulnerability during intense rainfall.

10. Seismic and Tectonic Vulnerability

Districts like Kangra and Shimla lie in active tectonic and seismic zones. Existing faults, fractures, and geological discontinuities increase terrain instability and may amplify landslide risks under heavy rainfall conditions.

11. Limited Forecast Precision and Warning Lead Time

Although meteorological advisories were issued, district-level forecast precision and warning lead time were inadequate in some cases, limiting the ability of district authorities to take preventive and evacuation measures.

12. Climate Change and Increasing Extreme Weather Events

Changing climatic patterns and increasing frequency of short-duration, high-intensity rainfall events have significantly amplified hydro-meteorological hazards across Himachal Pradesh. Climate variability is increasingly emerging as a major risk multiplier for mountain disasters.

Response and Relief Measures

The district administrations of Chamba, Kangra, Shimla, Solan, and Una implemented a range of emergency response and relief measures to manage the impacts of monsoon-induced disasters. These interventions focused on rescue, evacuation, restoration of essential services, and humanitarian assistance.

1. Activation of Emergency Operations Centres (EOC/DEOC)

District-level Emergency Operations Centres were activated on a 24×7 basis to ensure continuous monitoring, coordination, and information management during the disaster period. These centres functioned as the primary hubs for inter-departmental coordination, field reporting, and operational decision-making.

2. Administrative Coordination and Institutional Response

District administrations and District Disaster Management Authorities (DDMAs) led the overall response through coordinated decision-making, resource mobilization, and inter-departmental collaboration. Multiple line departments worked in coordination to ensure unified disaster response and relief management.

3. Rescue and Evacuation Operations

Immediate rescue and evacuation operations were undertaken in affected areas to safeguard stranded and vulnerable populations. In Chamba, large-scale evacuation of stranded pilgrims was carried out through ground-based and air rescue operations. In other districts, vulnerable households in landslide-prone and flood-affected areas were evacuated as a precautionary measure.

4. Deployment of Multi-Agency Emergency Response Teams

A coordinated multi-agency response was mobilized involving Police, Fire Services, Home Guards, National Disaster Response Force (NDRF), State Disaster Response Force (SDRF), local administration, and trained volunteers. These teams supported rescue, evacuation, law-and-order management, and field-level emergency operations.

5. Air Rescue Support in Inaccessible Areas

In highly inaccessible and critical locations, air rescue support was deployed. In Chamba, the Indian Air Force conducted helicopter-based evacuation using heavy-lift aircraft to rescue stranded pilgrims from inaccessible high-altitude locations.

6. Temporary Relief Shelter Arrangements

Temporary relief shelters and safe accommodation facilities were established for displaced families and stranded individuals. These shelters provided immediate protection and temporary habitation support until conditions stabilized.

7. Food, Drinking Water, and Medical Assistance

Relief measures included the provision of food, drinking water, essential supplies, and emergency medical care to affected populations. Community kitchens, relief camps, and mobile medical support systems were arranged to address immediate humanitarian needs.

8. Road Clearance and Restoration of Connectivity

Road clearance operations were initiated on priority to remove landslide debris, restore blocked roads, and re-establish transport connectivity. Heavy machinery and departmental teams were deployed to facilitate movement of relief teams, essential

supplies, and evacuees.

9. Restoration of Essential Public Utilities

Line departments undertook immediate restoration of disrupted public utilities, including electricity supply systems and water supply infrastructure. Restoration of these services was prioritized to reduce hardship and restore normalcy in affected communities.

10. Emergency Communication and Information Systems

Alternative communication systems such as VSAT networks, police wireless communication, public announcement systems, and digital coordination platforms were used to maintain operational continuity and facilitate emergency communication during infrastructure failures.

11. Damage Assessment and Technical Surveys

Revenue officials, engineering teams, and technical experts conducted field assessments to evaluate structural damage, infrastructure loss, land subsidence extent, and risk conditions. These assessments supported relief distribution and rehabilitation planning.

12. Continuous Monitoring and Risk Assessment

Affected zones, especially those impacted by land subsidence and slope instability, were placed under continuous observation to monitor further ground movement and emerging risks. This helped guide ongoing response measures and future mitigation planning.

13. Early Warning Dissemination and Public Information

Weather advisories, warning alerts, and public safety information were disseminated through district control rooms and departmental communication systems to vulnerable communities and field agencies for preparedness and timely preventive action.

14. Capacity Building and Preparedness Measures

Some districts strengthened disaster preparedness through regular mock drills, awareness campaigns, and capacity-building initiatives for departmental staff, volunteers, and local communities to improve future emergency response capabilities.

Issues, Challenges, and Concerns

The disaster events across Chamba, Kangra, Shimla, Solan, and Una exposed several structural, operational, and institutional challenges that affected emergency response, preparedness, and long-term disaster risk reduction. The key issues identified are as follows:

1. Communication Disruptions and Blackouts

One of the major operational challenges during the disasters was the disruption of communication networks. Mobile and internet failures, especially in remote and mountainous areas, significantly affected coordination between field teams, emergency

responders, and district authorities. The absence of robust backup communication systems further weakened response efficiency.

2. Limited Precision and Weak Dissemination of Early Warnings

Although weather advisories were issued, district-specific forecasting and last-mile dissemination remained inadequate. Generalized warnings without sufficient lead time limited the ability of local authorities and communities to undertake preventive measures, regulate movement, and initiate timely evacuation.

3. Absence of Localized Monitoring and Early Warning Systems

There remains a significant gap in localized hazard monitoring systems such as lanosQlide early warning systems, rainfall threshold monitoring, ground movement sensors, and geotechnical surveillance mechanisms. This reduced the ability to detect early signs of slope instability and land subsidence.

4. Continuous Rainfall During Response Operations

Persistent rainfall during the disaster response period created major operational difficulties by increasing the risk of fresh lanosQlides, slowing debris clearance, restricting field mobility, and endangering rescue personnel.

5. Difficult Terrain and Accessibility Constraints

Mountainous terrain, steep slopes, unstable ground conditions, and damaged access routes created severe logistical challenges for rescue teams, relief vehicles, and technical personnel. In several cases, difficult terrain delayed rescue and assessment operations.

6. Recurrent and Secondary LanosQlides

Repeated slope failures after initial clearance emerged as a major operational concern. Secondary lanosQlides disrupted restoration works, endangered response personnel, and increased resource deployment requirements.

7. Infrastructure Vulnerability

Critical infrastructure such as roads, highways, retaining walls, water pipelines, electricity networks, and communication systems proved highly vulnerable to extreme rainfall and slope instability. Frequent infrastructure failure disrupted mobility, public services, and emergency logistics.

8. Drainage Infrastructure Deficiencies

Poorly designed, undersized, clogged, or poorly maintained drainage systems significantly aggravated urban flooding, waterlogging, and slope instability. Inadequate drainage management emerged as a recurring vulnerability across districts.

9. Shortage of Specialized Equipment and Machinery

Response operations highlighted shortages of specialized equipment such as heavy earth-

moving machinery, mountain rescue gear, and satellite communication devices. Limited equipment availability reduced operational speed, particularly during simultaneous incidents across multiple locations.

10. Human Resource Constraints

Shortages of trained manpower in police, health, and administrative departments affected emergency response capacity. Limited staffing reduced field presence, rescue support, medical assistance, and administrative coordination during peak emergency periods.

11. Weak Inter-Agency Preparedness and Coordination

The disasters revealed gaps in pre-established inter-agency protocols, crisis communication mechanisms, and integrated emergency planning. Initial coordination challenges affected the efficiency of multi-departmental response.

12. Psychological and Social Distress

Displacement, uncertainty regarding rehabilitation, fear of further disasters, and loss of homes and livelihoods caused significant psychological stress and social disruption among affected families.

13. Settlements in Geologically Vulnerable Areas

The presence of human settlements in hazard-prone zones such as unstable hill slopes, landslide-prone terrain, and subsidence-prone areas significantly increased disaster exposure and vulnerability, highlighting weaknesses in hazard-sensitive land-use planning.

14. Unplanned Development and Weak Land Use Regulation

Unregulated construction, road cutting, slope excavation, and encroachments on natural drainage channels have increased the vulnerability of settlements and infrastructure. Weak enforcement of land-use regulations remains a major concern.

15. Environmental Degradation

Deforestation, vegetation loss, and ecological disturbances caused by developmental activities weakened slope stability and increased soil erosion, further aggravating disaster risks in fragile hill ecosystems.

16. Risk Mapping and Hazard Zonation Deficiency

The absence of detailed micro-level hazard zonation maps and vulnerability assessments limited the ability of district administrations to identify high-risk areas, prioritize mitigation measures, and regulate unsafe development.

17. Long-Term Land Subsidence and Geotechnical Risks

Land sinking and ground instability in affected districts emerged as a major long-term concern, posing risks to settlements, buildings, infrastructure, and agricultural land. These areas require scientific geotechnical investigation and long-term stabilization planning.

18. Regulatory and Procedural Constraints in Rehabilitation

Post-disaster rehabilitation and relocation planning faced procedural constraints, particularly in areas involving forest land, land ownership disputes, and environmental clearances, delaying long-term recovery efforts.

Lessons Learned

The monsoon-induced disaster events across Chamba, Kangra, Shimla, Solan, and Una provided several critical lessons for strengthening disaster preparedness, response systems, and long-term resilience in mountainous and disaster-prone regions. The key lessons learned are as follows:

1. Importance of Localized Hazard Mapping and Scientific Risk Assessment

The disasters reinforced the importance of district-specific and micro-level hazard zonation mapping for landslide-prone, flood-prone, and land subsidence-prone areas. Scientific risk assessment and geotechnical investigations are essential for identifying vulnerable locations, guiding land-use planning, and prioritizing mitigation measures.

2. Need for Strengthened Early Warning Systems

The events highlighted the importance of robust, localized, and impact-based early warning systems. Timely weather forecasts, rainfall threshold-based alerts, and localized hazard monitoring systems can significantly improve preparedness and reduce disaster impacts. Strengthening last-mile dissemination remains equally critical.

3. Critical Role of Resilient Communication Systems

Communication failures during emergency situations significantly affected coordination and situational awareness. The experience underscored the need for redundant communication systems such as satellite phones, VSAT networks, and wireless backup systems to ensure continuity of communication during disasters.

4. Importance of Pre-Monsoon Preparedness and Preventive Maintenance

The disasters demonstrated that proactive pre-monsoon preparedness including drainage cleaning, slope inspections, infrastructure maintenance, and vulnerability assessment is essential to reduce disaster risks and strengthen operational readiness before the onset of heavy rainfall.

5. Drainage Infrastructure as a Critical Risk Reduction Component

Urban flooding, waterlogging, and slope instability highlighted that inadequate drainage systems can significantly aggravate disaster impacts. Proper design, regular maintenance, and restoration of drainage systems and natural water channels are crucial for effective disaster risk reduction.

6. Necessity of Preventive Slope Stabilization Measures

Repeated landslides and land subsidence incidents emphasized the importance of

preventive slope stabilization through retaining walls, bioengineering measures, drainage regulation, and geotechnical reinforcement. Preventive interventions are more effective and economical than post-disaster restoration.

7. Risk-Sensitive Land Use Planning is Essential

Unplanned construction, slope cutting, and development in hazard-prone zones increased exposure and vulnerability. The incidents demonstrated the need for strict enforcement of hazard-based land-use planning and mandatory geotechnical safety assessments in hill areas.

8. Community-Based Disaster Preparedness Improves Response Effectiveness

Local community participation, volunteer support, and community-based preparedness mechanisms proved valuable in supporting response operations. Strengthening village-level preparedness systems, awareness programmes, and community volunteer networks can significantly improve resilience.

9. Multi-Agency Coordination is Critical for Effective Disaster Response

The response across districts highlighted the importance of strong inter-departmental coordination among district administration, police, public works, water supply, electricity, disaster response forces, and local volunteers. Institutionalized coordination mechanisms improve operational efficiency during emergencies.

10. Need for Specialized Resources in Mountain Disaster Response

Mountainous terrain requires specialized rescue equipment, trained personnel, and technical support systems. The events highlighted the importance of maintaining dedicated mountain rescue capabilities, specialized machinery, and trained disaster response teams in vulnerable districts.

11. Rehabilitation Planning Must Begin Early

Land subsidence and slope instability incidents showed that rehabilitation and resettlement planning should begin early, particularly in high-risk habitations where repeated hazard exposure makes continued habitation unsafe.

12. Climate Change is Increasing Disaster Intensity and Frequency

The increasing occurrence of high-intensity rainfall events and associated disasters reinforced the reality that climate variability is amplifying hydro-meteorological risks. Disaster planning must increasingly incorporate climate adaptation and resilience-building strategies.

13. Protection of Critical Infrastructure Requires Priority Attention

Damage to roads, highways, water supply systems, electricity networks, and

communication infrastructure highlighted the need for strengthening critical infrastructure resilience through climate-adaptive engineering and regular vulnerability audits.

14. Technology Integration Enhances Disaster Risk Management

The disaster response demonstrated the importance of integrating modern technologies such as GIS, remote sensing, drone surveys, and real-time monitoring systems for hazard identification, monitoring, and operational decision-making.

15. Institutional Preparedness Must Move from Reactive to Preventive

A key lesson across all districts is the need to shift from a reactive response model to a preventive and preparedness-based disaster management approach. Investing in preparedness, mitigation, and resilience-building can substantially reduce disaster losses and improve recovery outcomes.

Recommendations

Based on the impact assessment, operational challenges, and district-level observations from Chamba, Kangra, Shimla, Solan, and Una, the following integrated recommendations are proposed to strengthen disaster preparedness, risk reduction, and climate resilience:

1. Strengthening Early Warning Systems

Localized and high-resolution early warning systems should be strengthened through rainfall threshold-based alerts, slope movement sensors, water-level monitoring systems, and district-specific weather nowcasts. Integration of meteorological intelligence into district disaster management systems should be institutionalized to enable timely preventive action.

2. GIS-Based Hazard Zonation and Vulnerability Mapping

Detailed GIS-based hazard zonation maps should be prepared for landslide-prone, flood-prone, and land subsidence-prone areas. Micro-level vulnerability mapping should be undertaken to support scientific land-use planning, evacuation planning, and targeted mitigation measures.

3. Comprehensive Geotechnical Investigations

Detailed geotechnical and geological investigations should be conducted in vulnerable zones to assess slope stability, soil conditions, groundwater behaviour, and subsurface vulnerabilities. Scientific assessments should guide stabilization, rehabilitation, and future settlement planning.

4. Strengthening Slope Stabilization Measures

Engineering interventions such as retaining walls, breast walls, rock bolting, slope reinforcement, and surface protection works should be undertaken in vulnerable locations. Bioengineering techniques should also be integrated to improve long-term slope stability.

5. Climate-Resilient Infrastructure Development

Roads, bridges, retaining walls, drainage systems, water supply infrastructure, and power systems should be upgraded using climate-resilient and disaster-resistant design standards to withstand extreme rainfall events and slope instability.

6. Improvement of Drainage Infrastructure

Urban stormwater drainage systems and natural drainage channels should be upgraded, desilted, restored, and maintained regularly to reduce waterlogging, improve runoff management, and prevent excessive water infiltration into slopes.

7. Regulation of Construction and Land Use

Strict enforcement of land-use regulations should be ensured to prevent unplanned construction, slope cutting, excavation, and encroachments in geologically vulnerable and flood-prone areas. Mandatory geotechnical assessment should be made compulsory before approving construction activities in hilly terrain.

8. Pilgrimage-Specific Disaster Management Planning

A dedicated disaster management framework for pilgrimage events should be developed, especially for high-risk seasonal religious gatherings, incorporating weather-based regulation, crowd management protocols, and contingency evacuation planning.

9. Strengthening Emergency Communication Infrastructure

Resilient and redundant communication systems such as satellite phones, VSAT systems, HAM radio networks, and microwave-enabled mobile towers should be established to maintain operational continuity during communication blackouts.

10. Pre-Monsoon Preparedness and Maintenance

Comprehensive pre-monsoon inspections should be institutionalized, including desilting drains, clearing nallahs, inspecting vulnerable roads, slope stabilization checks, and maintaining essential infrastructure before the onset of the monsoon.

11. Community Awareness and Capacity Building

Regular awareness programmes should be conducted to educate local communities about disaster risks, warning signs, evacuation procedures, and preparedness measures. Community participation should be strengthened through structured training and local preparedness planning.

12. Mock Drills and Simulation Exercises

District-level, block-level, and village-level mock drills should be conducted before every monsoon season to test preparedness systems, improve coordination, and familiarize communities and departments with emergency response protocols.

13. Strengthening Local Disaster Management Committees

Village-level disaster management committees and community volunteer networks should be strengthened and trained to improve local preparedness, early response, and last-mile communication.

14. Human Resource Strengthening

Vacancies in critical response departments such as police, health, revenue, and emergency management should be filled on priority to improve field response capacity, medical support, and administrative coordination.

15. Technological Integration in Disaster Monitoring

Advanced technologies such as GIS, remote sensing, drone-based surveys, real-time geotechnical monitoring systems, and predictive risk analytics should be integrated into district disaster management systems for proactive risk management.

16. Ecological Restoration and Afforestation

Afforestation and ecological slope stabilization should be promoted using deep-rooted native species to improve soil-binding capacity, reduce erosion, and restore ecological resilience in vulnerable hill slopes.

17. Protection and Restoration of Natural Drainage Channels

Natural drainage channels, streams, and nallahs should be protected from encroachment and restored to maintain natural water flow and reduce flood and waterlogging risks.

18. Long-Term Rehabilitation and Resettlement Planning

Structured rehabilitation and resettlement plans should be prepared for families living in high-risk landslide and subsidence-prone zones. These plans should include safe housing, livelihood restoration, and social support mechanisms.

19. Special Focus on Critical Transport Corridors

Special slope stabilization and hazard mitigation measures should be implemented along highly vulnerable transport corridors such as national highways and major district roads to ensure uninterrupted connectivity and safe movement.

20. Strengthening Institutional Coordination

A formalized multi-agency coordination framework should be institutionalized with clearly defined roles, resource-sharing mechanisms, unified command protocols, and periodic review mechanisms to improve operational efficiency during disasters.

21. Policy Support for Rehabilitation in Restricted Land Areas

Administrative and procedural mechanisms should be simplified for rehabilitation and resettlement in cases where forest land regulations and land allocation procedures delay urgent recovery measures.

References

- District Disaster Management Authority. District Monsoon Reports, Incident Reports, and Landslide Hazard Management Reports (Chamba, Kangra, Shimla, Solan, Una), 2025.
- District Administrations of Chamba, Kangra, Shimla, Solan, and Una. Detailed Damage Assessment Reports and Administrative Coordination Records, 2025.
- District Emergency Operations Centre (DEOC). Daily Situation Reports (SITREP), Incident Reports, and Emergency Coordination Records, 2025.
- India Meteorological Department (IMD). Monsoon Forecasts, Rainfall Records, Nowcast Reports, Heavy Rainfall Warning Bulletins, and District Rainfall Analysis, 2025.
- Himachal Pradesh State Disaster Management Authority (HPSDMA). State Monsoon Situation Reports, Relief Monitoring Reports, and Disaster Status Reports, 2025.
- Government of India. (2005). The Disaster Management Act, 2005. Ministry of Home Affairs. <https://www.mha.gov.in/sites/default/files/202209/The%20Disaster%20Management%20Act%20C%202005%5B1%5D.pdf>
- India Meteorological Department. (2025). Report on southwest monsoon 2025: Himachal Pradesh. Meteorological Centre, Shimla, Ministry of Earth Sciences, Government of India. <https://mausam.imd.gov.in/shimla/mcdata/monsoon/main2025.html>
- National Disaster Management Authority. (2019, September). National landslide risk management strategy. Ministry of Home Affairs, Government of India. <https://ndma.gov.in/sites/default/files/PDF/Guidelines/NLRMS.pdf>
- National Disaster Management Authority. (2009, June). Management of landslides and snow avalanches. Ministry of Home Affairs, Government of India. <https://ndma.gov.in/sites/default/files/PDF/Guidelines/landslidesnowavalanches.pdf>
- Prashar, R. (2025, August 5). With two months of monsoon left, will Himachal create new records of natural disasters? Down To Earth. <https://www.downtoearth.org.in/natural-disasters/with-two-months-of-monsoon-left-will-himachal-create-new-records-of-natural-disasters>
- Ray, S. (2025, July 8). Death toll in Himachal Pradesh rises to 80 as devastating monsoon continues in state. Hindustan Times. <https://www.hindustantimes.com/india-news/death-toll-in-himachal-pradesh-rises-to-80-as-devastating-monsoon-continues-in-state-101751948826592.html>
- Ray, S. (2025, July 14). 98 killed in Himachal Pradesh as monsoon rains wreak havoc. Hindustan Times. <https://www.hindustantimes.com/india-news/98-killed-in-himachal-pradesh-as-monsoon-rains-wreak-havoc-101752477857021.html>
- Sphere India. (2025, July 16). Situation report 4 - HP cloudbursts, flash floods, landslides, date: 15th July 2025, time: 10:00 AM. ReliefWeb. <https://reliefweb.int/report/india/situation-report-4-hp-cloudbursts-flash-floods-landslides-date-15th-july-2025-time-1000am>

- The Hindu. (2025, August 24). Himachal Pradesh: 298 people dead since onset of monsoon, says SDMA. <https://www.thehindu.com/news/national/himachal-pradesh/sdma-report-on-himachal-pradesh-monsoon-deaths-august-24-2025/article69971427.ece>

5. Floods in Punjab

1. Introduction

Punjab, located in the northwestern part of India, forms a part of the Indo-Gangetic alluvial plains, composed primarily of sediments deposited by rivers originating from the Himalayas and the Shivalik ranges. The state's geographical setting, characterized by flat terrain, extensive river systems, and a dense canal irrigation network, makes it inherently vulnerable to riverine flooding. Major rivers such as the Sutlej, Beas, and Ravi traverse the state and are integral to agricultural productivity, yet they also pose recurrent flood risks during periods of intense rainfall. Punjab receives an average annual rainfall of approximately 648.8 mm, of which nearly 75 percent occurs during the southwest monsoon season (July-September). Variations in rainfall patterns, influenced by the Himalayan mountain system in the north and the Thar Desert in the south-west, often result in localized hydrometeorological extremes. In recent years, climate variability has contributed to more frequent and intense rainfall events, particularly in the north-western Himalayan region.

Historically, Punjab has experienced several major flood events, notably in 1988, 2010, 2019, and 2023, each causing extensive damage to infrastructure, agriculture, and livelihoods. Despite investments in flood protection measures such as embankments, drainage systems, and reservoirs, vulnerabilities remain due to siltation of rivers, encroachment of floodplains, and growing socio-economic exposure. The Punjab Floods of 2025 represent one of the most severe hydrometeorological disasters in the state in recent decades. Triggered by extreme monsoon precipitation and compounded by upstream hydrological pressures from Himalayan catchments, the floods resulted in widespread inundation across multiple districts. The event caused significant human displacement, loss of lives, damage to crops and infrastructure, and disruption of essential services. This case study provides an evidence-based analysis of the 2025 floods, examining the hazard profile, impacts, institutional response, and lessons for future flood risk reduction, in line with national disaster management priorities.

2. Overview of the Disaster Event

The 2025 flood event occurred during the southwest monsoon season (June - September 2025) when Punjab experienced unusually high rainfall across several districts. According to the India Meteorological Department (IMD), the state recorded approximately 622.1 mm of rainfall, representing about 41 percent above the long-term climatological average. Heavy rainfall in the upper catchments of Himachal Pradesh and Jammu & Kashmir significantly increased inflows into the major rivers of Punjab. Cloudbursts and multi-day rainfall events in these upstream areas generated rapid runoff, landslides, and increased river discharge downstream. Consequently, water levels in major reservoirs such as Bhakra Dam, Pong Dam, and Ranjit Sagar Dam approached critical thresholds.

To ensure structural safety of the dams, authorities were required to release substantial volumes of water within a short period. These releases coincided with already swollen river

channels and saturated soils, resulting in severe flooding in downstream districts. More than 2,000 villages across districts including Gurdaspur, Amritsar, Ferozepur, Rupnagar, and Patiala were affected by floodwaters. Agricultural lands, rural settlements, transport networks, and public infrastructure were inundated for several days. The floods were characterized by compound risk factors, where meteorological, hydrological, and operational elements interacted to amplify the magnitude of flooding. In particular, intense rainfall, reduced river carrying capacity due to sedimentation, and near-synchronous dam releases created a cascading hazard scenario.

Table 17: Disaster Identification Table

Parameter	Details
Disaster Type	Riverine Flood
Period	July - August 2025
Major Rivers	Sutlej, Beas, Ravi
Average Annual Rainfall	648.8 mm
Rainfall during 2025 Monsoon	622.1 mm
Rainfall Deviation	41% above normal
Major Reservoirs Involved	Bhakra, Pong, Ranjit Sagar
Villages Affected	>2,000
People Displaced	~350,000
Fatalities	40

Source: <https://sandrp.in/2025/08/01/june-july-2025-district-wise-rainfall-in-in-indias-sw-monsoon/>
<https://sandrp.in/2025/09/12/june-aug-2025-district-wise-rainfall-in-indias-sw-monsoon/>



Figure 23: Worst affected districts in Punjab floods, 2025.

Source:<https://indianexpress.com/article/cities/chandigarh/punjab-floods-2025-1988-redux-man-made-activities-natural-calamities-10225383/>

Table 18: Timeline of the Punjab FloodsQ

Date	Event	Hydrometeorological Status	Key Developments
20-22 July 2025	Onset of heavy rainfall in Himalayan catchments	Active Monsoon Phase	Intense rainfall recorded in the upstream catchments of the Sutlej River and Beas River in Himachal Pradesh, increasing inflow into downstream rivers.
23 July 2025	Rising river levels	Rivers approaching warning level	Monitoring by the Central Water Commission indicated rising discharge in major rivers entering Punjab.
24 July 2025	Water releases from reservoirs	Flood moderation releases	Increased inflow into Bhakra Dam required controlled releases to maintain dam safety.
25 July 2025	Rivers cross danger level	Riverine flooding begins	The Sutlej and Beas rivers crossed danger levels in several monitoring stations in Rupnagar and Kapurthala districts.
26-27 July 2025	Breach of embankments and village flooding	Peak flood stage	Floodwaters entered multiple villages in districts such as Rupnagar, Hoshiarpur, and Jalandhar. ThousanosQ of residents were evacuated.
28 July 2025	Urban flooding intensifies	Surface runoff and drainage congestion	Heavy rainfall caused severe waterlogging in urban centres including Ludhiana and Jalandhar.
29-30 July 2025	Large-scale rescue operations	Emergency response phase	Deployment of the National Disaster Response Force and Punjab State Disaster Management Authority for evacuation and relief operations.
31 July - 2 August 2025	Floodwaters begin receding	Recession stage	River discharge gradually declined as rainfall decreased in upstream catchments.
Early August 2025	Damage assessment and recovery	Relief and rehabilitation phase	Government initiated compensation assessments for crop losses, damaged houses, and infrastructure restoration.

Sources:[https://www.sphereindia.org.in/sites/default/files/2025-07/SitRep_4_HP_Cloudburst%20and%20Flashflood.pdf#:~:text=As%20of%2015%20July%202025%2C%20a%20total,\(91\)%2C%20Thalout%20\(30\)%2C%20Dharampur%20\(11\)%2C%20and%20others.](https://www.sphereindia.org.in/sites/default/files/2025-07/SitRep_4_HP_Cloudburst%20and%20Flashflood.pdf#:~:text=As%20of%2015%20July%202025%2C%20a%20total,(91)%2C%20Thalout%20(30)%2C%20Dharampur%20(11)%2C%20and%20others.)



Figure 24: An aerial view of an area partially submerged in floodwater at Ghanaur village, in Patiala district, Punjab, Thursday, September 4, 2025.

Source: <https://indianexpress.com/article/explained/why-punjab-keeps-flooding-10232974/>

Districts worst-hit by floods in Punjab			
District	Villages affected	Population affected	Crop area affected (ha)
Gurdaspur	329	145,000	40,169
Amritsar	190	135,880	26,701
Kapurthala	144	5,728	17,807
Fazilka	77	24,212	17,786
Ferozepur	102	38,594	17,221
Tarn Taran	70	60	12,828
Mansa	95	178	11,042
Hoshiarpur	168	2,465	8,322
Jalandhar	64	1,090	4,800
Pathankot	88	15,503	2,442
Patiala	85	600	600
Barnala	121	1,252	0

Figure 25: District-wise affected villages, population and crop area.

Source: <https://indianexpress.com/article/explained/why-punjab-keeps-flooding-10232974/>

"Figures 23 and 25 present the worst flood-affected districts in Punjab, highlighting affected villages, population, and crop area. Gurdaspur was the worst-affected district, with 329 villages, approximately 145,000 people, and 40,169 hectares of crop area affected. Amritsar and Kapurthala also experienced significant impacts, particularly in terms of population and crop damage. The data indicates considerable variation in flood impacts across districts, with Gurdaspur, Amritsar, and Kapurthala among the most severely affected.

3. Impact

The floods had multi-sectoral impacts, affecting human settlements, agriculture, infrastructure, and essential services.

Table 19: District-Wise Flood Impact

District	Infrastructure Damage	Key Observations
Rupnagar	Damage to rural roads, embankments, and irrigation channels	District located along the Sutlej River floodplain, experienced heavy inundation due to high discharge from upstream catchments.
Hoshiarpur	Village roads damaged; several bridges and culverts affected	Flash flooding from hill torrents originating in the Himachal Pradesh foothills.
Jalandhar	Urban waterlogging; road damage and drainage congestion	Floodwaters from the Beas River overflowed into agricultural land.
Kapurthala	Damage to rural roads and embankments	Prolonged water stagnation affected paddy cultivation.
Patiala	Flooding of rural settlements and drainage infrastructure	Flooding associated with the Ghaggar River basin.
Sangrur	Damage to irrigation systems and rural roads	Seasonal flooding along Ghaggar river channels.
Ferozepur	Embankment erosion and localized road damage	Flooding linked to downstream flows of the Sutlej River.

Table 20: Sector-wise Impact Assessment

Sector	Impact
Population Displaced	350,000 persons
Fatalities	40
Villages Affected	>2,000
Cropped Area Damaged	193,000 hectares
Houses Damaged	>14,000
Schools Damaged/Used as Camps	>3,300
Livestock Affected	2.52 lakh
Poultry Affected	5.88 lakh
Health Infrastructure Loss	₹780 crore

Source: https://www.sphereindia.org.in/sites/default/files/2025-09/SDAR_Punjab_Flood_Sep%202025.pdf

Punjab's economy, being highly dependent on agriculture, was significantly impacted as floodwaters inundated vast areas of paddy fields, resulting in substantial crop losses and delays in harvest cycles. The impacts were particularly severe in districts located along the Sutlej and Beas river systems, where floodplain areas experienced the highest levels of inundation. The floods also exposed critical infrastructure vulnerabilities, especially in rural roads, irrigation canals, and embankments, underscoring the need for more resilient infrastructure planning. Additionally, emerging urban flood risks became evident, as cities like Jalandhar and Ludhiana faced severe waterlogging due to inadequate drainage systems.

3.1 Human Impact

More than 350,000 people were displaced and relocated to temporary shelters established in schools, community halls, and relief camps. Vulnerable groups such as women, children, elderly persons, and persons with disabilities were disproportionately affected. Approximately 40 fatalities were reported, primarily due to drowning and snake bites during flood inundation.



Figure 26: A waterlogged road in Kharar, Mohali .

Source: <https://indianexpress.com/article/cities/chandigarh/man-made-floods-punjab-chose-encroached-water-bodies-drains-8911299/>

3.2 Agricultural Impact

Agriculture, which forms the backbone of Punjab's economy, suffered severe losses. Nearly 193,000 hectares of cropped area were damaged, particularly paddy crops nearing harvest. Floodwaters destroyed standing crops and deposited sediment layers that reduced soil productivity.

Housing and Infrastructure

Over 14,000 houses were partially or fully damaged, particularly kutchra and semi-pucca structures located in low-lying floodplain areas. Damage to roads, bridges, and drainage systems further hampered relief and recovery efforts.



Figure 27: Residents wait for aid at a village cut off by flooding in Kapurthala.

Source: <https://indianexpress.com/article/cities/chandigarh/punjab-declares-all-23-districts-flood-hit-crops-damaged-3-5-lakh-people-affected-10226930/>



Figure 28: Overflowing Budha nullah water enters houses at Ludhiana.

Source: <https://indianexpress.com/article/cities/chandigarh/punjab-declares-all-23-districts-flood-hit-crops-damaged-3-5-lakh-people-affected-10226930/>

3.3 Social Infrastructure

Floodwaters inundated health and educational facilities, disrupting essential services. Health sector losses were estimated at approximately ₹780 crore, including damage to hospitals and primary health centres. Flood conditions increased risks of water-borne and vector-borne diseases. More than 3,300 schools were damaged or converted into relief camps, resulting in prolonged educational disruption.



Figure 29: Flooded roads in Jalandhar.

Source: <https://indianexpress.com/article/cities/chandigarh/punjab-declares-all-23-districts-flood-hit-crops-damaged-3-5-lakh-people-affected-10226930/>

3.4 Livestock and Livelihoods

Floods had a significant impact on the livestock and poultry sectors, with approximately 2.52 lakh livestock animals and 5.88 lakh poultry birds affected. These losses not only disrupted immediate income sources but also had long-term implications for dairy production and the sustainability of rural livelihoods.



Figure 30: The entire state machinery, along with the NDRF, SDRF, Army and Punjab Police, is working round-the-clock to safeguard lives and property.

Source: <https://www.hindustantimes.com/india-news/punjab-floodsQ-29-lives-lost-2-56-lakh-people-impacted-in-one-month-101756729146448.html>

4. Possible Causes / Reasons

The severity of the 2025 floodsQ in Punjab can be attributed to a combination of hydrometeorological conditions, upstream catchment dynamics, river management challenges, and anthropogenic pressures. These interacting factors intensified flooding across several districts and prolonged the duration of waterlogging in low-lying areas.

4.1 Extreme Monsoon Rainfall

One of the primary causes of the flooding was unusually intense monsoon rainfall during the 2025 monsoon season. Several districts in Punjab experienced rainfall levels significantly above the seasonal average. Heavy rainfall over short durations generated large volumes of surface runoff, which rapidly entered rivers, canals, and drainage channels. When rainfall intensity exceedsQ the natural infiltration capacity of soil and the drainage capacity of rivers, flooding becomes inevitable. The situation was further aggravated by the spatial concentration of rainfall events, which caused multiple rivers to rise simultaneously. Weather monitoring and rainfall observations from the India Meteorological Department indicated that several areas experienced intense precipitation events during the peak monsoon period.



Figure 31: Volunteers rescue stranded residents using a boat to evacuate through the flooded waters of the Beas river, in Kapurthala

Source: <https://www.thehindu.com/news/national/punjab/punjab-floodsQ-congresss-warring-alleges-mismanagement-of-dams/article69995625.ece>

4.2 Upstream Hydrological Pressures

Punjab's river systems are strongly influenced by upstream hydrological conditions in the Himalayan region. Heavy rainfall in the mountainous catchments of Himachal Pradesh and Jammu and Kashmir significantly increased inflows into major rivers flowing into Punjab.

The rivers most affected included:

- Sutlej River
- Ravi River
- Beas River

These rivers originate in the Himalayan region, where steep slopes and intense rainfall generate rapid runoff. When large volumes of water flow downstream within a short period, river levels in Punjab rise quickly, increasing the likelihood of flooding in low-lying districts.

4.3 Reservoir Operations and Controlled Water Releases

Major dams and reservoirs located in upstream regions play an important role in regulating river flows. However, during extreme rainfall events, reservoirs can reach near-capacity levels. In such situations, dam authorities must release large volumes of water to ensure structural safety and prevent overtopping. Significant releases from reservoirs such as the

Bhakra Dam and the Pong Dam increased downstream discharge levels. Although these releases are essential for dam safety, they can intensify flooding conditions downstream, particularly when river channels are already carrying high flows due to rainfall.

4.4 River Siltation and Reduced Carrying Capacity

Another important factor contributing to the floods was sediment accumulation in river channels. Over time, rivers naturally transport sediments such as sand, silt, and gravel from upstream catchments. However, excessive sediment deposition reduces the effective depth and carrying capacity of river channels, making them more prone to overflow during high discharge conditions. In Punjab, sedimentation in the Sutlej, Ravi, and Beas rivers has gradually raised riverbeds in certain stretches. This reduces the ability of rivers to safely convey large volumes of floodwater, increasing the risk of embankment breaches and overflow into nearby settlements and agricultural fields.

4.5 Floodplain Encroachment and Land Use Changes

Rapid expansion of urban areas, agricultural settlements, and infrastructure projects within natural floodplains has significantly increased flood vulnerability in Punjab. Floodplains serve as natural buffers that temporarily store excess floodwater during periods of high discharge. However, when these areas are occupied by residential colonies, commercial establishments, or agricultural activities, the natural flood absorption capacity of the landscape is reduced. Encroachment into flood-prone areas also exposes more people, infrastructure, and economic assets to flood hazards. As a result, even moderate floods can lead to severe economic and social impacts.

4.6 Inadequate Drainage Infrastructure

In many districts of Punjab, drainage systems were unable to cope with the unusually high runoff generated during the flood event.

Several factors contributed to drainage failures, including:

- Insufficient capacity of stormwater drains
- Blocked or poorly maintained drainage channels
- Encroachment on natural drainage pathways
- Limited pumping capacity in low-lying urban areas

As a result, floodwaters remained stagnant in many locations for extended periods, causing prolonged waterlogging. This not only damaged infrastructure but also affected agricultural fields and disrupted daily life for local communities.

4.7 Climate Change and Increasing Extreme Rainfall Events

Climate change is increasingly influencing monsoon dynamics across South Asia. Scientific evidence suggests that warming atmospheric conditions allow the air to hold more moisture, which can lead to more intense rainfall events. These changes are contributing to higher

variability in monsoon rainfall patterns, including sudden extreme precipitation episodes. As a result, regions like Punjab are likely to experience more frequent flooding events in the future. This underscores the need for integrating climate resilience into flood management strategies, including improved forecasting systems, adaptive reservoir management, and climate-resilient infrastructure planning.



Figure 32: Agricultural land submerged under floodwaters.

Source: <https://www.outlookindia.com/national/punjab-floodsQ-is-2025-a-repeat-of-the-1988-catastrophe>

5. Response

The response to the floodsQ involved multi-level coordination between state and central agencies.

5.1 Evacuation and Rescue

Large-scale evacuation operations were conducted by the National Disaster Response Force (NDRF), State Disaster Response Force (SDRF), Armed Forces, and district authorities. Boats and specialized rescue equipment were deployed to evacuate residents from submerged villages.



Figure 33: Local residents assisting in the evacuation of flood-affected populations to safer locations as floodwaters inundate villages in Ajnala, near Amritsar.

Source: <https://www.outlookindia.com/national/when-the-five-rivers-turn-fierce-punjab-floodsQ-and-the-2025-catastrophe>



Figure 34: NDRF personnel conducting rescue operations for flood-affected residents in Punjab.

Source: <https://www.outlookindia.com/national/punjab-weather-update-flood-crisis-continues-across-23-districts>

5.2 Relief Camps

Temporary relief camps were established in schools and community buildings to shelter displaced populations. Camps provided food, drinking water, sanitation facilities, and medical services.

5.3 Medical and Public Health Response

Mobile medical teams were deployed to provide emergency care and prevent disease outbreaks. Public health interventions included:

- Water chlorination
- Disease surveillance
- Vector control measures

5.4 Financial Assistance

Compensation and relief assistance were provided under State Disaster Response Fund (SDRF) and National Disaster Response Fund (NDRF) norms for affected households, crop losses, and livestock damage.

6. Issues / Challenges / Concerns

The 2025 flood in Punjab exposed several systemic challenges in flood risk management, early warning dissemination, infrastructure preparedness, and post-disaster response. These issues highlight the need for improved institutional coordination and basin-level flood management strategies.

6.1 Fragmented Early Warning and Communication Systems

Although meteorological forecasts and river flow warnings were issued by agencies such as the India Meteorological Department and the Central Water Commission, the information was not always translated into clear, impact-based advisories for district authorities and local communities. Multiple agencies operate independent monitoring systems, which sometimes lead to delays in consolidating warnings and communicating actionable guidance to local administrations. As a result, communities in vulnerable floodplain areas may receive limited advance notice of potential flooding.

6.2 Infrastructure and Drainage Limitations

Floodwaters overwhelmed existing drainage infrastructure in several districts. Many drainage channels and canals were unable to carry excess runoff due to sedimentation, reduced capacity, and poor maintenance. In addition, the manual operation of dam gates and barrage structures limited the ability of authorities to dynamically regulate water releases during periods of intense inflow. This reduced operational flexibility during peak flood conditions.

6.3 Floodplain Encroachments and Land-Use Changes

Rapid urbanization and agricultural expansion have resulted in the encroachment of floodplains, wetlands, and natural drainage channels. These areas historically functioned as natural buffers that absorbed excess floodwaters. The reduction of these natural retention zones increased surface runoff and amplified flood impacts in downstream settlements.

6.4 Relief Camp Management and Humanitarian Coordination

Although relief camps were established in several affected districts, variations were observed in the quality of shelter, sanitation facilities, and supply distribution. The absence of standardized humanitarian response protocols sometimes led to uneven service delivery, highlighting the need for improved coordination among local administration, relief agencies, and volunteers.

6.5 Damage Assessment and Data Collection Challenges

Accurate and timely damage assessment proved difficult due to flooded roads, limited accessibility to remote villages, and inconsistencies in field-level reporting. The lack of integrated digital platforms for real-time data collection slowed the compilation of damage reports and delayed compensation and relief distribution.

6.6 Inter-State River Management Challenges

Several rivers flowing through Punjab originate in upstream states or neighbouring regions. Coordination between upstream and downstream authorities is essential for effective flood management. However, differing operational priorities and limited data sharing between jurisdictions sometimes complicate basin-level flood response planning.

7. Lessons Learned

The 2025 flood in Punjab offers important lessons for strengthening flood risk management and improving preparedness in riverine states.

7.1 Need for Integrated Flood Forecasting Systems

Flood management requires better integration of meteorological forecasts, river discharge data, and reservoir operation information. Developing impact-based flood forecasting systems that combine data from the India Meteorological Department, Central Water Commission, and state agencies can provide clearer guidance for district-level decision making.

7.2 Basin-Level Water Management is Essential

Flood risks cannot be managed effectively through isolated interventions. Basin-wide planning that considers upstream rainfall, reservoir storage levels, and downstream discharge capacity is necessary to reduce flood impacts.

7.3 Importance of Protecting Natural Flood Buffers

Wetlands, floodplains, and natural drainage channels play a crucial role in moderating flood flows. The disaster highlighted the need to protect and restore these natural ecosystems as part of sustainable flood management strategies.

7.4 Strengthening Urban Drainage and Infrastructure

Rapid urbanization has increased surface runoff and pressure on drainage systems. Cities and towns in flood-prone regions must invest in modern drainage networks, flood-resistant infrastructure, and improved stormwater management systems.

7.5 Community Awareness and Preparedness

Communities living in flood-prone regions must be better informed about flood risks and evacuation procedures. Expanding community-based disaster preparedness programmes and local volunteer networks can significantly enhance early response and reduce casualties.

7.6 Importance of Digital Damage Assessment and Data Systems

The challenges faced during post-disaster damage assessments underline the importance of digital platforms for real-time reporting and geospatial mapping of damage. Such systems can improve transparency and speed up relief and compensation processes.

7.7 Building Climate Resilience in Flood Management

Increasing climate variability is likely to intensify rainfall patterns and river flooding in northern India. Flood management strategies must therefore incorporate climate-resilient planning, adaptive infrastructure design, and long-term watershed management.

References

- Bajwa, H. (2025, August 28). Flood situation remains grim in eight districts of Punjab; dams near capacity. The New Indian Express. <https://www.newindianexpress.com/nation/2025/aug/28/flood-situation-remains-grim-in-eight-districts-of-punjab-dams-near-capacity-2609534.html>
- Dhar, A. (2025, August 29). Punjab haunted by 1988 nightmare: HundreosQ died, bodies flowed into Pakistan, and an assassination. Hindustan Times. <https://www.hindustantimes.com/india-news/ghost-of-1988-haunts-punjab-when-floosQ-killed-hundreosQ-led-to-an-assassination-101756396455145.html>
- Economic Times Online. (2025, December 27). Year 2025: Punjab braved worst floosQ in decades. The Economic Times. <https://m.economictimes.com/news/india/year-2025-punjab-braved-worst-floosQ-in-decades/articleshow/126200175>.

cms

- India Meteorological Department. (2025, October 27). South west monsoon season report 2025: Punjab main highlights. Ministry of Earth Sciences, Government of India.
- Kamal, N. (2025, September 3). Punjab declared disaster-hit state; over 1,200 submerged in worst floods in decades. The Times of India. <https://timesofindia.indiatimes.com/city/chandigarh/punjab-declared-disaster-hit-state-over-1200-submerged-in-worst-floods-in-decades/articleshow/123669222.cms>
- Moudgil, M. (2025, September 9). Lives, homes and crops lost as Punjab faces the worst flood in decades. Mongabay-India. <https://india.mongabay.com/2025/09/lives-homes-and-crops-lost-as-punjab-faces-the-worst-flood-in-decades/>
- National Disaster Response Force. (2025, September 5). Punjab: NDRF teams provide relief materials in flood-affected Fazilka, rescue 1,500 villagers. Ministry of Home Affairs, Government of India.
- Press Information Bureau. (2025, September 9). PM undertakes aerial survey of flood affected areas of Punjab (Release ID: 2164996). Government of India. <https://www.pib.gov.in/PressReleaseDetailm.aspx?PRID=2164996>
- ReliefWeb. (2025, September 12). Punjab floods: Secondary data analysis report (September 2025). Sphere India. <https://reliefweb.int/report/india/punjab-floods-secondary-data-analysis-report-september-2025>
- Singh, S. (2025, September 15). The 2025 Punjab floods are a sum total of extreme rain, weak embankments, and obstruction of natural drainage. Down To Earth. <https://www.downtoearth.org.in/natural-disasters/the-2025-punjab-floods-are-a-sum-total-of-extreme-rain-weak-embankments-floodplain-encroachment-and-obstruction-of-natural-drainage>
- The Hindu Bureau. (2025, August 31). Punjab floods: Congress's Warring alleges mismanagement of dams. The Hindu. <https://www.thehindu.com/news/national/punjab/punjab-floods-congresss-warring-alleges-mismanagement-of-dams/article69995625.ece>
- The Indian Express Bureau. (2025, August 27). Flood situation in Punjab: All about the state's rivers, dams and headworks. The Indian Express. <https://indianexpress.com/article/cities/chandigarh/punjab-floods-rivers-dams-headworks-explained-9534123/>
- The Tribune Bureau. (2025, September 3). Entire state declared flood-hit. The Tribune. <https://www.tribuneindia.com/news/punjab/punjab-floods-entire-state-declared-flood-hit-654321>

6. Cyclone Ditwah

1. Introduction

Tropical cyclones in the Bay of Bengal region frequently affect the coastal areas of South Asia, including Sri Lanka and the eastern coast of India. While many cyclones weaken before making landfall, even moderate or weak cyclonic systems can produce extreme rainfall, flooding, and landslides, especially in geographically vulnerable regions. Sri Lanka, an island nation located in the northern Indian Ocean, lies along major tropical cyclone tracks originating in the Bay of Bengal. Although severe cyclonic storms occur less frequently than in India, the country remains highly vulnerable due to its low-lying coastal plains, densely populated river basins, and steep central highlands prone to landslides. Monsoon interactions with cyclonic disturbances often intensify rainfall events, increasing disaster risk. In late November 2025, Cyclone Ditwah developed over the southwest Bay of Bengal and moved across Sri Lanka before weakening near the southeast coast of India. Despite being categorized as a relatively weak cyclonic storm in terms of wind intensity, the system generated extremely heavy rainfall exceeding 200–500 mm in several districts, triggering widespread flooding and landslides across Sri Lanka. The disaster affected over 2 million people, caused significant loss of life, and severely disrupted infrastructure and livelihoods. It became one of the most destructive flood-related disasters in Sri Lanka since the 2004 Indian Ocean tsunami. This report provides an analytical overview of Cyclone Ditwah, examining its meteorological characteristics, impacts, response mechanisms, and key lessons for strengthening disaster risk reduction.

2. Overview of the Disaster Event

Cyclone Ditwah originated as a low-pressure system over the southwest Bay of Bengal near Sri Lanka on 25 November 2025. Favorable oceanic and atmospheric conditions enabled rapid intensification into a deep depression by 26 November and subsequently into Cyclonic Storm Ditwah on 27 November, as classified by the India Meteorological Department (IMD). The system tracked along the southern and eastern coasts of Sri Lanka, bringing prolonged heavy rainfall and strong winds. It made landfall near the eastern coast of Sri Lanka on 28 November 2025, maintaining cyclonic storm intensity. After crossing Sri Lanka, the storm re-entered the Bay of Bengal, moved northward parallel to the Coromandel Coast of India, and gradually weakened due to increasing wind shear and cooler sea surface temperatures. By 3 December 2025, it had weakened into a well-marked low-pressure system before dissipating near the Tamil Nadu coast. Although wind speeds were moderate compared to stronger tropical cyclones, the storm produced extremely high rainfall totals, triggering flash floods and landslides across multiple districts. The India Meteorological Department (IMD) issued regular forecasts and warnings, while alert systems such as the NDMA's SACHET platform helped disseminate early warnings.

Table 21: Disaster Identification Table

Parameter	Details
Cyclone Name	Ditwah
Basin	Bay of Bengal
Formation Date	25 November 2025
Intensification	Cyclonic Storm (27 November 2025)
Landfall	Eastern Sri Lanka (28 November 2025)
Maximum Rainfall	>540 mm in some districts
Dissipation	3 December 2025
Affected Countries	Sri Lanka, India

Source: IMD, 2025; UN OCHA, 2025

https://internal.imd.gov.in/press_release/20251128_pr_4506.pdf

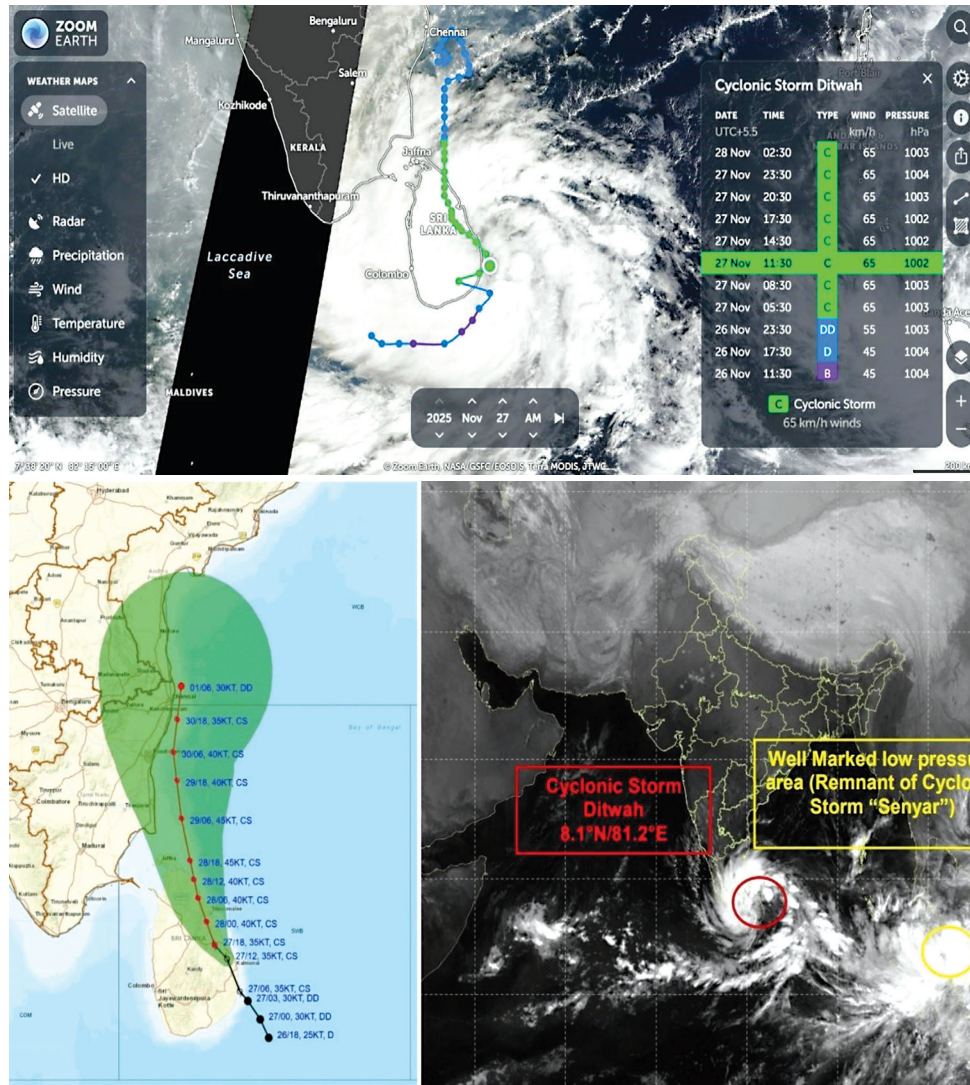


Figure 35: IMD map showing Cyclone Ditwah's track.

Source: <https://indianexpress.com/article/india/cyclone-ditwah-news-update-red-orange-alerts-tamil-nadu-andhra-10390427/>

Table 22: Timeline of Cyclone Ditwah

Date	Event	Meteorological Status	Key Observations
25 November 2025	Formation of low-pressure area	Low Pressure Area	A low-pressure system formed over the southwest Bay of Bengal near Sri Lanka, monitored by the India Meteorological Department.
26 November 2025	System intensification	Depression	The system intensified into a depression over the southwest Bay of Bengal, producing heavy rainfall over northern Sri Lanka and adjoining seas.
27 November 2025 (Morning)	Further strengthening	Deep Depression	Favourable conditions such as warm sea surface temperature and low wind shear allowed further intensification.
27 November 2025 (Afternoon)	Naming of the system	Cyclonic Storm "Ditwah"	IMD upgraded the system to Cyclonic Storm Ditwah; the name was provided by Yemen under the WMO/ESCAP cyclone naming list.
28 November 2025	First land interaction	Landfall over Sri Lanka	The cyclone crossed the eastern coast of Sri Lanka, bringing intense rainfall, floods, and landslides.
29 November 2025	Re-emergence over sea	Cyclonic Storm	After crossing Sri Lanka, the system moved back into the Bay of Bengal, maintaining cyclonic intensity.
30 November 2025	Coastal impact phase	Cyclonic Storm / weakening	The cyclone moved northward parallel to the Tamil Nadu coast, causing heavy rainfall and coastal flooding.
1 December 2025	Weakening phase	Deep Depression	The system weakened but continued to produce heavy rainfall across Tamil Nadu and Puducherry.
2 December 2025	Inland rainfall impacts	Depression	Remnant system caused urban flooding in Chennai and surrounding districts.
3 December 2025	Dissipation	Well-marked low pressure	The system weakened into a remnant low-pressure area over the Bay of Bengal, ending the cyclone's lifecycle.

Source: <https://vajiramandravi.com/current-affairs/cyclone-ditwah/>

https://internal.imd.gov.in/press_release/20251125_pr_4498.pdf



Figure 36: Waves crash against the rocks during rough sea conditions triggered by Cyclone Ditwah in Ramanathapuram, Tamil Nadu.

Source: <https://indianexpress.com/article/india/cyclone-ditwah-landfall-chennai-tamil-nadu-weather-red-alert-sri-lanka-10392343/>



Figure 37: Strong winds bend palm trees and waves crash against a seawall during rough sea conditions triggered by Cyclone Ditwah, in Ramanathapuram, Tamil Nadu, Friday, Nov. 28, 2025.

Source: <https://indianexpress.com/article/india/tamil-nadu-heavy-rain-cyclone-ditwah-landfall-updates-10392564/>



Figure 38: Damage to flora and fauna in Glenfall; before and after Ditwah.

Source: <https://news.mongabay.com/2025/12/cyclone-ditwah-takes-heavy-toll-on-sri-lankas-biodiversity-rich-central-highlands/>

3. Impact

Cyclone Ditwah generated significant humanitarian, economic, infrastructural, and environmental impacts across the South Asian region. The most severe consequences were experienced in Sri Lanka, where the cyclone made landfall and produced intense rainfall, strong winds, and widespread flooding. The disaster also affected parts of southern India, particularly the coastal districts of Tamil Nadu, where the cyclone's associated rainbands caused heavy precipitation, localized flooding, and disruptions to infrastructure and economic activities. The scale and diversity of the impacts highlight the multidimensional nature of tropical cyclone disasters, which affect human populations, economic systems, infrastructure networks, and ecological environments simultaneously.

3.1 Human Impact

The humanitarian consequences of Cyclone Ditwah were particularly severe in Sri Lanka, where widespread flooding and landslides caused substantial loss of life and displacement. Official assessments reported 635 confirmed fatalities, while 192 individuals were listed as missing during the immediate aftermath of the disaster. In addition to these casualties, the cyclone affected more than 1.15 million people across multiple provinces, disrupting livelihoods and daily life for a significant portion of the population. Approximately 230,000 individuals were displaced from their homes, many of whom sought refuge in government-managed relief centres. At the peak of the emergency, nearly 180,000 people were sheltered in temporary camps, where authorities and humanitarian agencies provided food, medical assistance, and essential supplies.

The humanitarian impact was unevenly distributed across social groups. Vulnerable populations—including women, children, elderly individuals, and persons with disabilities—were disproportionately affected because they often had limited mobility, fewer economic resources, and greater dependency on external support during emergencies. In several communities, evacuation and relief operations had to be carefully coordinated to ensure that these groups received adequate assistance.

In India, the human toll was comparatively limited because the cyclone weakened after crossing Sri Lanka. Nevertheless, heavy rainfall and storm-related incidents in Tamil Nadu and nearby regions resulted in three fatalities and several injuries. Flooding in low-lying areas forced local authorities to temporarily evacuate residents and relocate them to cyclone shelters and relief camps. Although the scale of casualties was far lower than in Sri Lanka, the event still underscored the vulnerability of densely populated coastal regions to rainfall-induced flooding and extreme weather events.

Table 23: Human Impact Summary

Indicator	Sri Lanka	India
People Affected	1.15 million	Several districts
Deaths	635	3
Missing Persons	192	—
Displaced Population	230,000	Limited
Relief Camp Residents	180,000	Limited

Source: Disaster Management Centre and United Nations Office for the Coordination of Humanitarian Affairs (2025)

<https://www.unocha.org/publications/report/sri-lanka/sri-lanka-cyclone-ditwah-situation-report-no-09-06-march-2026#:~:text=Cyclone%20Ditwah%20has%20triggered%20the,25%20districts%20of%20the%20country.>

3.2 Housing Damage

Cyclone Ditwah caused extensive destruction to residential structures, particularly in areas characterized by high population density and vulnerable housing conditions. Strong winds, intense rainfall, and landslides resulted in the partial or complete damage of more than 100,000 houses in Sri Lanka. Informal settlements and low-income communities experienced the most severe impacts because their dwellings were often constructed using lightweight materials that offered limited resistance to extreme weather conditions.

In mountainous areas of the country, heavy rainfall triggered landslides that buried houses and destroyed entire settlements in some locations. These landslides not only caused structural damage but also increased the difficulty of rescue operations, as access roads were blocked and debris covered residential areas. The destruction of housing infrastructure created significant challenges for post-disaster recovery, as thousands of families required temporary shelter and long-term reconstruction assistance.

3.3 Infrastructure Damage

The cyclone also caused widespread disruption to critical infrastructure networks that support transportation, energy supply, and communication systems. Flooding and landslides damaged major roadways and railway lines, particularly in mountainous regions where slope instability increased the likelihood of landslide events. Several transport routes

were temporarily blocked, complicating rescue operations and delaying the delivery of relief supplies to affected communities. Energy infrastructure was also severely affected. Large portions of Sri Lanka experienced power outages during the disaster, with approximately 30 percent of the country’s electricity supply disrupted at various stages of the event. Some hydropower plants were forced to temporarily shut down due to safety concerns and excessive water inflows into reservoirs. Communication networks also suffered disruptions as telecommunications infrastructure was damaged by strong winds and flooding.

These infrastructure failures had cascading impacts on emergency response operations, economic activity, and public safety. The restoration of electricity, transportation routes, and communication networks became a priority for authorities during the immediate response phase.

3.4 Economic Impact

Cyclone Ditwah generated substantial economic losses across several sectors of the Sri Lankan economy. According to a Rapid Damage and Needs Assessment conducted by the World Bank, the total direct damage caused by the disaster was estimated at approximately US\$4.1 billion, representing nearly four percent of Sri Lanka’s Gross Domestic Product. This level of economic loss illustrates the profound financial consequences that major natural disasters can have on national economies, particularly in developing countries.

The most heavily affected sectors included infrastructure, housing, agriculture, and non-residential buildings such as schools, hospitals, and commercial establishments. Infrastructure damage accounted for the largest share of total losses, reflecting the widespread destruction of roads, bridges, and public facilities. The housing sector also suffered major losses due to the extensive destruction of residential buildings. Agricultural production declined significantly in affected regions as floods and landslides damaged farmland, irrigation systems, and crop fields.

Table 24: Sector-wise Economic Damage

Sector	Estimated Damage
Infrastructure	\$1.73 billion
Housing	\$985 million
Agriculture	\$814 million
Non-residential buildings	\$562 million
Total Estimated Damage	\$4.1 billion

Source: Global Rapid Post-Disaster Damage Estimation (GRADE) Report: Cyclone Ditwah 2025 - Sri Lanka

<https://reliefweb.int/report/sri-lanka/global-rapid-post-disaster-damage-estimation-grade-report-cyclone-ditwah-2025-sri-lanka#:~:text=Damage%20from%20Cyclone%20Ditwah%20in,services%2C-%20and%20the%20broader%20economy.>

3.5 Environmental Impact

Cyclone Ditrwah also produced significant environmental consequences, particularly in ecologically sensitive regions. One of the most severely affected areas was the Knuckles Mountain Range, an internationally recognized biodiversity hotspot known for its rich ecological diversity and unique forest ecosystems. Intense rainfall triggered numerous landslides in this mountainous region, resulting in the loss of forest cover and extensive soil erosion. The cyclone also damaged natural habitats that support a variety of plant and animal species. Sediment deposition and debris flows altered local hydrological patterns, potentially affecting watershed stability and water quality. In coastal regions, strong winds and storm surges may have contributed to the degradation of coastal ecosystems, including mangroves and wetlands that serve as natural barriers against storms. These environmental impacts highlight the interconnected nature of disaster risks, where ecological degradation can increase long-term vulnerability to future hazards.

4. Impact in India

Although Cyclone Ditrwah weakened significantly after crossing Sri Lanka, its associated rainbands continued to influence weather conditions along the southeastern coast of India. Parts of Tamil Nadu experienced heavy rainfall, strong winds, and localized flooding as the storm system moved across the region. Urban centres such as Chennai faced temporary disruptions due to waterlogging and drainage overflow. The cyclone caused several storm-related fatalities in India and resulted in injuries, property damage, and temporary displacement in low-lying communities. Local authorities implemented precautionary evacuations and relocated vulnerable residents to relief shelters to reduce the risk of casualties.

Infrastructure damage in India was moderate compared to Sri Lanka but still significant in localized areas. Heavy rainfall caused urban flooding, which disrupted transportation systems and affected road and rail connectivity. Several districts experienced temporary power outages as electrical infrastructure was damaged by strong winds and waterlogging. Educational institutions and government offices were temporarily closed in some areas as a precautionary measure. Agricultural areas in coastal and delta regions of Tamil Nadu also suffered damage. Crops such as rice, banana, cashew, and vegetables were affected by flooding and prolonged waterlogging. Farmers reported losses due to damaged crops, soil erosion, and disruptions to irrigation systems. Although the overall economic losses in India were smaller than those recorded in Sri Lanka, the event demonstrated that even a weakened cyclone can cause significant disruption through intense rainfall and flooding.

5. Possible Causes / Reasons

The impacts of Cyclone Ditrwah in India were influenced by a combination of meteorological conditions, oceanic processes, environmental vulnerabilities, and socio-economic factors. These interacting drivers shaped the formation and behaviour of the storm system and amplified its impacts on coastal and urban areas of southern India, particularly in Tamil Nadu.

5.1 Warm Sea Surface Temperatures

One of the most important factors contributing to the development of the cyclone was the unusually warm sea surface temperatures in the Bay of Bengal. Tropical cyclones derive their energy from warm ocean waters, which supply heat and moisture necessary for storm formation and intensification. During the period preceding the cyclone, sea surface temperatures in the Bay of Bengal remained significantly above the threshold required for cyclone formation. These elevated temperatures enhanced evaporation from the ocean surface and increased the amount of moisture in the lower atmosphere. As the storm system developed, this abundant moisture contributed to the formation of intense rainbands and heavy precipitation over coastal regions. Even after the cyclone weakened following its passage over Sri Lanka, the moisture-laden rainbands continued to influence weather conditions along the southeastern coast of India.

5.2 Favourable Atmospheric Conditions

Atmospheric dynamics also played a crucial role in supporting the formation and persistence of the cyclone. The presence of favourable atmospheric circulation patterns and relatively low vertical wind shear allowed the storm system to organize and maintain a coherent structure while moving across the Bay of Bengal. Low wind shear conditions enable the vertical alignment of storm circulation, which is necessary for the strengthening of tropical cyclones. In the case of Cyclone Ditrup, these atmospheric conditions allowed the system to sustain strong convection and widespread rainfall. Although the cyclone weakened after landfall in Sri Lanka, the residual atmospheric circulation continued to transport large amounts of moisture toward the southeastern coast of India, resulting in sustained rainfall over several districts.

5.3 Slow Movement of the Storm System

Another important factor that amplified the impacts of the cyclone was its relatively slow movement across the region. Slow-moving storm systems tend to produce prolonged rainfall over affected areas because the rainbands remain concentrated over the same locations for extended periods. In southern India, the slow progression of the cyclone resulted in persistent rainfall over several districts of Tamil Nadu. This extended duration of rainfall increased the likelihood of flooding and waterlogging, particularly in low-lying and urban areas where drainage capacity was limited. Prolonged precipitation also led to the saturation of soils, which further aggravated flooding and disrupted transportation and daily activities.

5.4 Coastal and Urban Vulnerability

The vulnerability of coastal and urban areas significantly amplified the impacts of heavy rainfall associated with the cyclone. Many parts of Tamil Nadu, including major urban centres such as Chennai, are characterized by dense population concentrations and rapid urban expansion. These conditions place considerable pressure on urban infrastructure and natural drainage systems. Over time, the encroachment of wetlands, lakes, and natural drainage channels for urban development has reduced

the capacity of the landscape to absorb excess rainfall. In addition, inadequate drainage infrastructure in some areas limits the ability of stormwater systems to quickly remove large volumes of rainwater. As a result, even moderate rainfall events can cause severe waterlogging and urban flooding, which disrupt transportation networks, damage property, and affect economic activities.

5.5 Climate Change and Extreme Rainfall

Climate change is increasingly recognized as a factor influencing the behaviour and impacts of tropical cyclones. Scientific research indicates that rising global temperatures are altering atmospheric and oceanic conditions in ways that can intensify rainfall associated with storms. Warmer air can hold greater amounts of moisture, which increases the potential for heavy precipitation during cyclonic events. In the context of the Bay of Bengal region, climate change may be contributing to an increase in the intensity of rainfall produced by tropical cyclones. This means that even storms with moderate wind speeds can generate extreme rainfall capable of triggering flooding and infrastructure disruption. The experience of Cyclone Dityah illustrates this emerging pattern, where rainfall-induced flooding played a significant role in the disaster's impacts despite the cyclone weakening after landfall.

6. Response

The response to Cyclone Dityah in India involved coordinated preparedness and emergency actions undertaken by national, state, and district authorities. Government institutions activated disaster management mechanisms to minimize casualties, protect vulnerable populations, and restore essential services in affected areas. These measures focused on early warning dissemination, precautionary evacuations, emergency response operations, and coordinated relief distribution, particularly in the coastal districts of Tamil Nadu.

6.1 Early Warning and Forecasting

Early warning and meteorological monitoring played a crucial role in reducing the potential impact of the cyclone. The India Meteorological Department closely monitored the development of the storm system over the Bay of Bengal and issued regular cyclone bulletins and weather forecasts regarding its trajectory, intensity, and potential rainfall impacts. These forecasts provided critical information for government authorities and disaster management agencies to initiate preparedness measures in advance of the storm's arrival. Warnings and advisories were disseminated through multiple communication channels, including television broadcasts, radio announcements, mobile phone alerts, and social media platforms. These communication strategies ensured that both government agencies and the general public were informed about the evolving weather situation and the possible risks associated with heavy rainfall and strong winds. Early dissemination of forecasts enabled authorities to initiate precautionary measures such as evacuations and emergency planning before the cyclone affected coastal regions.

6.2 Preparedness and Evacuation Measures

State authorities in Tamil Nadu implemented several precautionary measures to reduce the risk to human life and infrastructure. Local administrations identified vulnerable areas, particularly low-lying coastal settlements and flood-prone urban neighbourhoods, and began evacuating residents who were considered at risk. These residents were relocated to temporary cyclone shelters and relief camps established by the government to provide safe accommodation during the storm. As part of preparedness efforts, educational institutions such as schools and colleges were temporarily closed to ensure the safety of students and staff. Authorities also suspended fishing activities along the coast to prevent fishermen from venturing into hazardous sea conditions. District administrations mobilized disaster response teams, emergency equipment, and relief materials in advance to ensure rapid response capability once the cyclone made landfall. These preparedness measures helped reduce the potential loss of life and enabled authorities to manage the situation more effectively once heavy rainfall and flooding began affecting several districts.

6.3 Search and Rescue Operations

Following the arrival of the cyclone and the onset of heavy rainfall, emergency response teams were deployed to conduct rescue and relief operations in affected areas. These teams included personnel from local administrations, police units, and specialized disaster response forces. Their primary objective was to assist residents who had been stranded due to flooding, waterlogging, or damaged infrastructure.

Rescue operations involved evacuating people from inundated neighbourhoods, clearing debris and fallen trees from blocked roads, and restoring access to critical transport routes. Emergency teams also worked to repair damaged electricity infrastructure and restore power supply in affected districts. In addition, relief materials such as food, drinking water, medical supplies, and essential commodities were distributed to affected communities through temporary relief centres. These operations were particularly important in urban areas where intense rainfall caused waterlogging and disrupted transportation networks.

6.4 Role of Disaster Management Agencies

Specialized disaster management agencies played a crucial role in supporting response efforts during Cyclone Dittwah. Teams from the National Disaster Response Force were deployed or placed on standby in vulnerable districts to assist state authorities in emergency operations. These teams are trained in disaster rescue techniques and equipped with specialized equipment for handling flood and cyclone-related emergencies. At the state level, disaster management units coordinated response activities, including evacuation planning, relief distribution, and infrastructure restoration. Local authorities worked closely with emergency services, police, and community volunteers to ensure that rescue operations were conducted efficiently and that relief assistance reached affected populations.

The coordinated actions of meteorological agencies, disaster management institutions, and local administrations helped mitigate the overall impact of the cyclone and facilitated the rapid restoration of essential services in affected regions.



Figure 39: NDRF personnel undertake relief operations in close coordination with local authorities in areas affected by flooding caused by Cyclone Ditwah in Sri Lanka.

Source: <https://indianexpress.com/article/explained/explained-sci-tech/cyclone-ditwah-sri-lanka-10398601/>



Figure 40: A consignment of Indian humanitarian aid being handed over to cyclone-hit Sri Lanka as part of 'Operation Sagar Bandhu'.

Source: <https://indianexpress.com/article/world/india-aid-operation-sagar-bandhu-sri-lanka-cyclone-ditwah-death-toll-updates-10392478/>

7. Issues / Challenges / Concerns

Despite significant preparedness measures and timely warnings issued by the India Meteorological Department, the impacts of Cyclone Dityah revealed several structural and operational challenges in disaster risk management across affected regions.

7.1 Urban Flooding and Drainage Constraints

One of the major challenges observed during the cyclone was severe urban flooding in major coastal cities, particularly Chennai. Intense rainfall over a short duration overwhelmed existing drainage systems, leading to widespread waterlogging in residential areas, roads, and commercial zones. Rapid urban expansion, the reduction of natural drainage channels, and the covering of stormwater drains with infrastructure projects have reduced the ability of cities to efficiently discharge excess water during extreme rainfall events.

7.2 Infrastructure Vulnerability in Coastal Areas

Many roads, bridges, electricity networks, and communication systems in coastal regions remain vulnerable to cyclonic rainfall and flooding. Prolonged waterlogging damaged road surfaces, disrupted transportation networks, and affected electricity distribution infrastructure. Power outages and communication disruptions in several areas highlighted the need for more resilient infrastructure systems capable of withstanding extreme weather events.

7.3 Environmental Degradation and Loss of Natural Buffers

Environmental degradation significantly increased the vulnerability of affected regions. Encroachment on wetlands, deforestation in catchment areas, and the loss of coastal vegetation have reduced the natural capacity of ecosystems to absorb excess rainfall and mitigate flooding. Wetlands and natural drainage systems historically served as hydrological buffers, but their degradation has increased the risk of flooding during intense rainfall events.

7.4 Economic Vulnerability of Coastal and Rural Communities

The cyclone severely affected livelihoods in coastal and rural communities. Small-scale farmers, fishermen, and informal sector workers were particularly vulnerable due to their dependence on weather-sensitive economic activities. Agricultural losses occurred due to waterlogging and crop damage, while fishing activities were disrupted because of rough sea conditions and restrictions on marine operations.

7.5 Last-Mile Communication Challenges

Although cyclone warnings were issued in advance, effective dissemination of warnings to all communities remained a challenge. In some rural and coastal areas, last-mile communication gaps limited the timely understanding of risk information and preparedness measures. Improving the translation of technical forecasts into clear and actionable advisories for local communities remains an important challenge.

7.6 Pressure on Emergency Response Systems

Heavy rainfall, flooding, and road disruptions placed pressure on emergency services and disaster response teams such as the National Disaster Response Force and state disaster response agencies. Access to certain flood-affected areas became difficult due to waterlogged roads and damaged infrastructure. These challenges highlight the importance of strengthening logistics, emergency transport systems, and decentralized response capacities.

8. Lessons Learned

The experience of Cyclone Dityah provides several key lessons for improving disaster preparedness, urban planning, and climate resilience in cyclone-prone regions.

8.1 Importance of Accurate and Timely Early Warning Systems

The cyclone demonstrated the critical role of timely forecasts issued by the India Meteorological Department in enabling authorities to undertake preparedness measures such as evacuations, suspension of fishing activities, and pre-positioning of disaster response teams. However, strengthening impact-based forecasting and last-mile dissemination mechanisms remains essential to ensure that warnings translate into effective community action.

8.2 Rainfall-Induced Flooding Can Be More Damaging than Wind

Cyclone Dityah showed that extreme rainfall associated with tropical cyclones can sometimes cause greater damage than wind speeds. Even after the cyclone weakened, heavy rainfall caused widespread flooding, waterlogging, and infrastructure damage. Future disaster planning must therefore address multi-hazard impacts, including rainfall, flooding, and landslides, rather than focusing solely on wind damage.

8.3 Urban Flood Risk is Increasing in Coastal Cities

The waterlogging experienced in Chennai highlights the growing flood vulnerability of rapidly expanding coastal cities. Inadequate drainage systems, loss of wetlands, and unplanned urban development significantly increase urban flood risk. Urban planning must integrate stormwater management, floodplain protection, and sustainable land-use practices to reduce such risks.

8.4 Vulnerability of Coastal and Agricultural Livelihoods

The cyclone highlighted the vulnerability of farmers and fishermen whose livelihoods depend heavily on weather conditions. Crop damage, fishing restrictions, and disruption of transport networks caused significant economic losses. Strengthening climate-resilient agriculture, crop insurance schemes, and livelihood diversification can help reduce economic vulnerability.

8.5 Importance of Institutional Coordination

Effective coordination between national agencies, state governments, and local administrations helped minimize casualties during the cyclone. Response operations involving the National Disaster Response Force, State Disaster Management Authorities, and local authorities played a crucial role in evacuation and relief operations. Strengthening institutional coordination mechanisms will further enhance disaster response efficiency.

8.6 Role of Ecosystems in Reducing Disaster Risk

Natural ecosystems such as wetlands, mangroves, and coastal vegetation provide critical protection against flooding and cyclone impacts. The degradation of these ecosystems increases exposure to disasters. Integrating ecosystem-based disaster risk reduction approaches into coastal zone management policies can significantly enhance resilience.

8.7 Need for Climate-Resilient Development

Cyclone Ditrwah reinforces the importance of integrating climate change adaptation and disaster risk reduction into development planning. Infrastructure, urban systems, and economic activities must be designed to withstand the increasing frequency and intensity of extreme weather events.

References

- Down To Earth. (2025, November 27). Cyclone Ditrwah may intensify bringing heavy rainfall to India. <https://www.downtoearth.org.in/natural-disasters/cyclone-ditrwah-may-intensify-bringing-heavy-rainfall-to-india>
- Economic Times Online. (2025, November 28). Cyclone Ditrwah tracker: IMD warns of heavy rainfall for Tamil Nadu and Andhra Pradesh. The Economic Times. <https://m.economictimes.com/news/india/cyclone-ditrwah-tracker-imd-warns-of-heavy-rainfall-for-tamil-nadu-and-andhra-pradesh/articleshow/121045678.cms>
- Hindustan Times Correspondent. (2025, November 30). Cyclone Ditrwah: Homes and crops destroyed in Tamil Nadu as storm remnants bring rain. Hindustan Times. <https://www.hindustantimes.com/india-news/cyclone-ditrwah-impact-tamil-nadu-101732944210332.html>
- India Meteorological Department. (2025, November 29). Press release: The cyclonic storm Ditrwah over southwest Bay of Bengal & adjoining north Sri Lanka. Ministry of Earth Sciences, Government of India. https://internal.imd.gov.in/press_release/20251129_pr_4508.pdf
- International Federation of Red Cross and Red Crescent Societies. (2025, December 4). IFRC launches emergency appeal as Sri Lanka faces worst floods in decades. <https://www.ifrc.org/press-release/ifrc-launches-emergency-appeal-sri-lanka-faces-worst-floods-decades>

- Ministry of External Affairs. (2025, December 9). Operation Sagar Bandhu continues providing emergency HADR support to Sri Lanka following Cyclone Ditwah. Government of India. <https://www.mea.gov.in/press-releases.htm?dtl/40420/>
- National Disaster Response Force. (2025, November 28). NDRF teams deployed across Tamil Nadu and Puducherry for precautionary operations ahead of Cyclone Ditwah. Ministry of Home Affairs, Government of India. <https://ndrf.gov.in>
- NDTV News Desk. (2025, November 28). Cyclone Ditwah: IMD issues heavy rain alert for southern states; schools closed. NDTV. <https://www.ndtv.com/india-news/cyclone-ditwah-imd-issues-heavy-rain-alert-for-southern-states-7123456>
- Press Trust of India. (2025, December 8). Operation Sagar Bandhu: Indian Navy deploys four more warships to deliver 1,000 tons of HADR material to Sri Lanka. Press Information Bureau, Government of India. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2200316>
- Reuters. (2025, December 2). Cyclone Ditwah delays Sri Lanka's economic recovery as floods hit key sectors. Reuters. <https://www.reuters.com/world/asia-pacific/cyclone-ditwah-delays-sri-lankas-economic-recovery-2025-12-02/>
- The Indian Express. (2025, November 29). Cyclone Ditwah tracker: Rainfall alerts issued for Andhra Pradesh and Puducherry. The Indian Express. <https://indianexpress.com/article/india/cyclone-ditwah-tracker-rainfall-alerts-issued-9694123/>
- The New Indian Express Bureau. (2025, December 1). Cyclone Ditwah remnant brings heavy rainfall to Chennai; waterlogging reported. The New Indian Express. <https://www.newindianexpress.com/cities/chennai/2025/dec/01/cyclone-ditwah-remnant-brings-heavy-rainfall-to-chennai>
- United Nations Children's Fund. (2026, January 15). Sri Lanka humanitarian situation report: Post-Cyclone Ditwah recovery. <https://www.unicef.org/reports/sri-lanka-humanitarian-situation-report-cyclone-ditwah>
- United Nations Office for the Coordination of Humanitarian Affairs. (2025, December 11). Sri Lanka humanitarian priorities plan: Cyclone Ditwah (December 2025 – April 2026). <https://www.unocha.org/publications/report/sri-lanka/sri-lanka-humanitarian-priorities-plan-cyclone-ditwah>
- World Bank. (2025, December 22). Damage from Cyclone Ditwah in Sri Lanka estimated at \$4.1 billion. <https://www.worldbank.org/en/news/press-release/2025/12/22/damage-from-cyclone-ditwah-in-sri-lanka-estimated-at-4-1-billion>

7. Prayagraj Kumbh Stampede

1. Introduction

India regularly hosts some of the largest religious gatherings in the world. Among them, the Kumbh Mela is recognized as the largest peaceful congregation of pilgrims globally. Held periodically at four sacred locations-Prayagraj, Haridwar, Ujjain, and Nashik, the event attracts millions of devotees who gather to perform ritual bathing in sacred rivers. The Maha Kumbh Mela, which occurs approximately every 12 years at Prayagraj, is considered the most significant of these gatherings. Devotees believe that bathing at the sacred confluence of rivers known as the Triveni Sangam, where the Ganga, Yamuna, and the mythical Saraswati meet, purifies the soul and grants spiritual merit. However, the scale of the event poses significant challenges for disaster risk management. High crowd densities, narrow access pathways, intense ritual urgency during auspicious bathing dates, and temporary infrastructure increase the risk of accidents such as stampedes. On 29 January 2025, during the Mauni Amavasya bathing ritual, a tragic crowd crush occurred near the riverbank at Prayagraj, resulting in the loss of lives and injuries to several pilgrims. The incident highlighted the continuing vulnerabilities associated with managing large-scale religious gatherings and underscored the need for improved crowd management strategies.



Figure 41: Rush of devotees at the Sangam during the ongoing Maha Kumbh Mela 2025, in Prayagraj, Uttar Pradesh, Thursday, Feb. 6, 2025.

Source: <https://indianexpress.com/article/cities/lucknow/pilgrim-surge-at-maha-kumbh-again-traffic-measures-back-in-prayagraj-9822035/>

2. Overview of the Disaster Event

The stampede occurred in the early hours of 29 January 2025, when millions of pilgrims gathered for the Mauni Amavasya ritual, considered one of the most auspicious bathing days of the Kumbh festival. During the early morning hours, large numbers of devotees began moving toward the bathing ghats at the Triveni Sangam. The movement of pilgrims intensified as the auspicious time for ritual bathing approached. According to reports, a barricade along one of the access routes collapsed, triggering a sudden surge in the crowd. As people rushed forward, several individuals fell to the ground. The dense crowd behind them continued to move forward, leading to trampling and suffocation. Panic spread rapidly as devotees attempted to escape the congested area. The absence of sufficient escape routes and the overwhelming crowd density worsened the situation. Emergency response teams quickly arrived at the site and began rescue operations. Injured individuals were transported to nearby hospitals and temporary medical camps established for the event. Initial reports confirmed approximately 30 fatalities and more than 60 injuries, although later assessments suggested that the number of affected individuals may have been higher due to missing persons and unreported casualties. The incident temporarily disrupted the ritual bathing schedule and prompted authorities to reassess crowd management measures at the ongoing Kumbh Mela.

Table 25: Key Details of the Prayagraj Kumbh Stampede

Parameter	Details
Disaster Type	Crowd crush / stampede
Date	29 January 2025
Location	Prayagraj, Uttar Pradesh
Event	Maha Kumbh Mela - Mauni Amavasya ritual
Estimated Crowd	Several million pilgrims
Fatalities	~30-40 (initial reports)
Injuries	60+
Major Cause	Crowd surge following barricade collapse

Source: <https://www.thehindu.com/news/national/maha-kumbh-mela-2025-stampede-in-prayagraj-on-mauni-amavasya-live-updates/article69153214.ece>

3. Timeline of the Incident

The following timeline summarizes key events leading to the stampede and the subsequent emergency response.

Table 26: Prayagraj Kumbh Stampede Timeline

Time	Event
Early morning	Millions gathered for Mauni Amavasya bathing ritual
Around 5:00 AM	Barricade failure triggered crowd surge
Minutes later	Crowd collapse and trampling near riverbank
Morning	Emergency response and evacuation initiated
Afternoon	Injured pilgrims transported to hospitals

Source: <https://www.bhaskarenglish.in/originals/news/10-lakh-people-gathered-at-sangam-nose-1000-police-officers-couldnt-control-the-crowd-stampede-triggered-by-rumors-of-naga-sadhus-arrival-134382154.html>



Figure 42: Hindu devotees look for their belongings after a stampede before the second “Shahi Snan” (royal bath) at the “Maha Kumbh Mela” or the Great Pitcher Festival, in Prayagraj, India, January 29, 2025.

Source: <https://indianexpress.com/article/cities/lucknow/on-night-of-maha-kumbh-stampede-pressure-of-5-cr-people-in-mela-area-says-cm-yogi-adityanath-9845435/>

4. Impact

The stampede during the Prayagraj Kumbh Mela had significant human, social, health, and administrative consequences. Given the extremely large number of pilgrims present at the ghats during the ritual bathing period, the incident created widespread disruption and placed considerable pressure on emergency services and local administration.

4.1 Human Casualties

The most severe impact of the stampede was the loss of human life and injuries among pilgrims. Official reports indicated that approximately 30-40 people lost their lives, while more than 60 individuals sustained injuries during the incident. Many victims suffered injuries caused by crowd pressure, trampling, and suffocation, including fractures, head injuries, and breathing difficulties. Elderly pilgrims, women, and children were particularly vulnerable due to the intense crowd density and limited mobility during the surge. Beyond the immediate casualties, the tragedy caused significant emotional distress among families of victims and survivors, many of whom had travelled long distances to participate in the sacred ritual bathing.

4.2 Medical and Health Impacts

The incident placed significant pressure on the medical facilities deployed to support the massive gathering at the Kumbh site. Medical teams stationed near the ghats responded quickly by providing emergency first aid and stabilizing injured pilgrims. Temporary medical camps and nearby hospitals in Prayagraj treated victims suffering from:

- Crush injuries and fractures
- Head trauma and soft tissue injuries
- Dehydration and exhaustion
- Suffocation-related complications due to crowd pressure

Ambulances and emergency medical teams were mobilized to transfer severely injured individuals to hospitals for advanced treatment. The sudden influx of injured persons temporarily strained the healthcare infrastructure supporting the Kumbh Mela.

4.3 Social and Psychological Impact

The stampede caused widespread fear, panic, and emotional distress among pilgrims present at the site. In the chaos that followed the incident, many individuals were separated from family members and fellow pilgrims, creating confusion and anxiety. Survivors and witnesses reported psychological trauma, including shock and grief. Families of victims experienced profound emotional loss, while the broader community of pilgrims and devotees was deeply affected by the tragedy. Such incidents during religious gatherings can have long-lasting psychological impacts on survivors and may affect public confidence in the safety of large-scale pilgrimage events.

4.4 Disruption of Religious Activities

Following the stampede, authorities temporarily suspended ritual bathing activities at key ghats to restore order and prevent further crowd congestion. Additional police and security personnel were deployed to regulate crowd movement and ensure safer access to the riverfront areas. Crowd control measures were strengthened to prevent further incidents during the ongoing religious event. The disruption also affected the scheduled religious activities and pilgrim movement patterns within the Kumbh Mela area.

4.5 Administrative and Governance Impact

The disaster triggered intense public scrutiny and debate regarding crowd management practices at large religious gatherings. Questions were raised about the adequacy of infrastructure, crowd monitoring mechanisms, and coordination among authorities responsible for managing the event. In response, the government ordered a judicial inquiry to investigate the causes of the stampede, assess administrative lapses, and recommend measures to prevent similar incidents in the future. The incident reinforced the need for improved planning, risk assessment, and technological support for managing mass gatherings, especially during large religious festivals such as the Kumbh Mela, which attract millions of devotees.



Figure 43: Crowd surge at the Mahakumbh grounds.

Source: <https://indianexpress.com/article/india/mahakumbh-stampede-live-updates-9804809/>

5. Possible Causes / Contributing Factors

The stampede during the Prayagraj Kumbh Mela was likely the result of multiple interacting factors rather than a single trigger. Large religious gatherings often involve complex crowd dynamics, where sudden disturbances can escalate into dangerous situations.

5.1 Extreme Crowd Density

The most significant contributing factor was the extremely high concentration of pilgrims during the auspicious Mauni Amavasya bathing ritual. Millions of devotees attempted to access the bathing ghats within a limited time window, leading to very high crowd densities in key access corridors and riverfront areas. When crowd density exceeds safe thresholds, even minor disturbances can trigger crowd turbulence and panic movement, significantly increasing the risk of trampling incidents.

5.2 Infrastructure Limitations

Although extensive temporary infrastructure was installed for the event, structures such as barricades, pedestrian corridors, and walkways may not always be designed to withstand sudden surges of extremely dense crowds. Reports suggested that the collapse or displacement of a barricade may have triggered the sudden forward surge of people, resulting in loss of balance and subsequent trampling.

5.3 Crowd Surge Behaviour

Religious urgency and the desire to perform ritual bathing at the most auspicious moment often encourage pilgrims to move rapidly toward the ghats simultaneously. Such collective movement can quickly escalate into crowd surges, especially when individuals attempt to move faster than the flow capacity of the available pathways.

5.4 Inadequate Crowd Segregation

In certain sections of the event area, segregation between incoming and outgoing pilgrims was insufficient, leading to congestion and the formation of bottlenecks. The lack of clearly separated pedestrian routes can create counter-flow movements, which significantly increases the risk of crowd pressure and instability.

5.5 Communication and Information Gaps

Effective crowd management requires clear, timely, and continuous communication with attendees. During the incident, delayed announcements and the absence of immediate crowd guidance may have contributed to confusion and panic among pilgrims, further intensifying the situation.

6. Response

Following the stampede, authorities initiated immediate emergency response measures to rescue victims, provide medical assistance, and restore order at the Kumbh Mela site in Prayagraj.

6.1 Emergency Rescue Operations

Police personnel, security forces, and trained volunteers responded promptly to the situation by managing crowd movement and establishing safe evacuation corridors. Rescue teams focused on clearing congested pathways, assisting injured pilgrims, and evacuating victims from the affected areas. Rapid crowd dispersal measures were also implemented to prevent further escalation and ensure the safety of those present.

6.2 Medical Response

Medical teams stationed across the Kumbh grounds immediately provided first aid and emergency medical treatment to the affected individuals. The response included the deployment of emergency medical teams, treatment through temporary medical camps, and the transportation of critically injured persons to hospitals via ambulance services. Nearby hospitals in Prayagraj were placed on high alert to effectively manage the sudden influx of patients.

6.3 Administrative Measures

The Government of Uttar Pradesh ordered a judicial inquiry to investigate the incident, identify the causes of the stampede, and determine any administrative lapses. Authorities also announced financial compensation for the families of the deceased and injured victims. Additional safety measures were implemented to regulate crowd movement during the remaining days of the festival.

6.4 Role of Disaster Management Agencies

Disaster management institutions coordinated with local authorities to strengthen response operations. Agencies such as the National Disaster Management Authority and the National Disaster Response Force provided guidance and support for emergency management and safety measures. Their involvement helped reinforce preparedness and improve crowd safety protocols for subsequent bathing events.

7. Issues / Challenges / Concerns

The stampede highlighted several structural and operational challenges associated with managing extremely large religious gatherings.

7.1 Massive Crowd Size

Events such as the Kumbh Mela attract millions of pilgrims within a short period, creating unprecedented crowd densities. Managing such massive gatherings requires highly sophisticated planning, crowd modeling, and real-time monitoring systems.

7.2 Real-Time Crowd Monitoring Limitations

Although surveillance technologies such as CCTV cameras and drones were deployed, monitoring crowd density across the vast event area in real time remains a significant challenge. Detecting dangerous crowd build-up early enough to implement preventive measures continues to be difficult in highly dynamic environments.

7.3 Inter-Agency Coordination Challenges

Managing a mega-event of this scale requires effective coordination among multiple agencies, including police and security forces, disaster management authorities, health and emergency services, municipal bodies, and volunteer organizations. Ensuring seamless communication and coordination among these stakeholders during emergency situations remains a complex operational challenge, often affecting the efficiency and timeliness of response efforts.

7.4 Infrastructure and Access Constraints

Despite extensive temporary infrastructure development, narrow access routes, temporary walkways, and barricaded corridors can become critical choke points during peak crowd movement. Such constraints increase the likelihood of congestion and sudden crowd surges.

7.5 Balancing Religious Practices with Safety Measures

Authorities often face challenges in balancing the religious sentiments of pilgrims with safety requirements. Restricting access during auspicious bathing periods or regulating crowd flow may sometimes encounter resistance from devotees eager to participate in sacred rituals. This creates a delicate situation where cultural sensitivity must be balanced with strict safety enforcement.

8. Lessons Learned

The Prayagraj Kumbh Stampede underscores the critical importance of proactive planning, scientific crowd management, and coordinated institutional response during large religious gatherings. Events such as the Kumbh Mela attract millions of pilgrims within a short time span, making them among the largest periodic mass gatherings in the world. The incident highlights several key lessons for improving safety and disaster preparedness in such environments.

8.1 Advanced Crowd Modelling and Risk Forecasting

Authorities should adopt advanced crowd modelling and simulation tools to predict crowd movement patterns and identify potential congestion zones in advance. Artificial Intelligence (AI)-based predictive models can analyse historical data, pilgrim flow trends, and spatial layouts to forecast crowd density in real time. Such tools can support planners in identifying high-risk areas and implementing preventive crowd control measures before dangerous congestion develops.

8.2 Real-Time Crowd Monitoring and Surveillance

Continuous monitoring of crowd density is essential during large gatherings. The deployment of drones, CCTV networks, and GIS-enabled surveillance systems can provide real-time situational awareness. Automated crowd-density analytics can trigger early warning alerts when thresholds are exceeded, enabling authorities to take immediate corrective action such as redirecting crowd flows or temporarily restricting entry.

8.3 Infrastructure Planning and Design

Infrastructure at mass gathering venues must be carefully planned to safely accommodate large pedestrian volumes. This includes minimising choke points and bottlenecks, ensuring adequate entry and exit routes, designing wider pedestrian corridors, and providing clearly marked evacuation pathways. Temporary structures such as barricades, bridges, and viewing platforms should be properly designed and tested to withstand high crowd pressure and dynamic loads, ensuring structural safety during peak periods.

8.4 Pilgrim Flow Management

Effective management of pedestrian movement is essential to prevent overcrowding. Authorities should implement segregated pathways for incoming and outgoing pilgrims to avoid conflicting crowd flows. The use of digital tools-such as online registration systems, staggered entry schedules, and electronic queue management-can further help regulate the arrival of pilgrims and distribute crowds more evenly across time and space.

8.5 Public Awareness and Risk Communication

Public awareness plays a crucial role in reducing crowd-related risks. Pilgrims and visitors should be educated about safe behaviour in crowded environments, such as avoiding sudden movements or pushing, following designated routes, and complying with official instructions. Clear signage, multilingual announcements, and effective public communication systems can guide crowd movement and help prevent panic situations.

8.6 Institutional Coordination and Implementation of Guidelines

Effective crowd management requires strong coordination among multiple agencies, including local administration, police, health services, and disaster management authorities. Authorities should ensure strict implementation of mass gathering safety guidelines issued by the National Disaster Management Authority. These guidelines emphasise comprehensive risk assessment, crowd density monitoring, emergency preparedness planning, and inter-agency coordination. Institutionalising these practices within event management frameworks can significantly reduce the likelihood of crowd disasters during large-scale religious gatherings.



Figure 44: Police personnel carry an injured woman following a stampede before the 'Amrit Snan'.

Source: <https://www.hindustantimes.com/india-news/mahakumbh-2025-mauni-amavasya-prayagraj-live-updates-101738108036228.html>



Figure 45: Rescue personnel carry an injured pilgrim following a stampede, which broke out on Mauni Amavasya during the Maha Kumbh at Sangam in Prayagraj on January 29, 2025.

Source: <https://www.thehindu.com/news/national/uttar-pradesh/stampede-breaks-out-at-maha-kumbh-mela-at-sangam-during-mauni-amavasya/article69153202.ece>



Figure 46: A devotee being rescued following a stampede before the 'Amrit Snan' on the occasion of Mauni Amavasya at the Maha Kumbh Mela 2025, in Prayagraj on January 29, 2025.

Source: <https://www.thehindu.com/news/national/maha-kumbh-stampede-cji-asks-petitioner-to-make-a-request-in-sc-registry-for-early-listing-of-plea/article69158219.ece>

References

- Official directive on crowd management and coordination post-Mauni Amavasya incident. Government of Uttar Pradesh.
- Department of Information & Public Relations. (2025, January 29). State government orders judicial inquiry into Maha Kumbh stampede; announces ex-gratia for victims. Government of Uttar Pradesh.
- Hindustan Times Correspondent. (2025, January 30). Mauni Amavasya tragedy: 30 dead in Maha Kumbh stampede as crowd breaks barricades. Hindustan Times. <https://www.hindustantimes.com/india-news/maha-kumbh-stampede-prayagraj-101738201455420.html>
- National Disaster Management Authority. (2014). Managing Crowd at Events and Venues of Mass Gathering. Government of India. <https://ndma.gov.in/sites/default/files/PDF/Reports/managingcrowosQguide.pdf>
- National Disaster Response Force. (2026, March 2). Maha Kumbh Mela- 2025 at Distt-Prayagraj, Uttar Pradesh: Operational summary and rescue statistics. Ministry of Home Affairs, Government of India. <https://www.ndrf.gov.in/en/operations/maha-kumbh-mela-2025-distt-prayagraj-uttar-pradesh>
- Press Trust of India. (2025, January 29). Prayagraj stampede updates: Judicial probe ordered; 25 victims identified. The Hindu. <https://www.thehindu.com/news/national/maha-kumbh-mela-2025-stampede-in-prayagraj-live-updates/article69153214.ece>
- The Indian Express Bureau. (2025, January 30). Why the 7-tier security failed: An analysis of the Mauni Amavasya stampede at Sangam. The Indian Express. <https://indianexpress.com/article/india/prayagraj-kumbh-stampede-analysis-security-failure-9751234/>
- Times News Network. (2025, January 30). 30 dead, 60 injured in Maha Kumbh stampede; Helpline 1920 issued for families. The Times of India. <https://timesofindia.indiatimes.com/india/30-dead-60-injured-in-maha-kumbh-stampede-in-prayagraj/articleshow/117691302.cms>

8. Delhi Railway Station Stampede

1. Introduction

India has one of the largest railway networks in the world and serves as the backbone of the country's transportation system. The Indian Railways carries millions of passengers daily through a vast network of railway stations, trains, and associated infrastructure. Major metropolitan stations such as New Delhi Railway Station are among the busiest transport hubs in the country. Passenger traffic at railway stations increases dramatically during major religious festivals and pilgrimage events. One such event is the Kumbh Mela, which attracts millions of devotees travelling from across India to the holy city of Prayagraj for ritual bathing at the sacred confluence of rivers known as the Triveni Sangam. The sudden surge of pilgrims during these periods places significant pressure on railway infrastructure and crowd management systems. Inadequate crowd control measures, delays in train services, and insufficient passenger information can create hazardous conditions that increase the risk of accidents such as stampedes. On 15 February 2025, a tragic stampede occurred at New Delhi Railway Station when thousands of passengers gathered to board trains travelling to Prayagraj for the Kumbh festival. The incident took place on an overcrowded footbridge connecting railway platforms and resulted in multiple fatalities and injuries. The disaster highlighted critical gaps in crowd management and infrastructure planning at major railway stations during high-demand travel periods.

2. Overview of the Disaster Event

The stampede occurred during the evening hours at New Delhi Railway Station, one of the busiest railway stations in India. Large number of passengers had gathered to board trains travelling to Prayagraj for the ongoing Kumbh Mela. Due to delays in several train services, passengers accumulated on platforms and footbridges while waiting for updates regarding train arrivals and departures. The situation became increasingly congested as more passengers arrived at the station. The incident reportedly occurred on a foot overbridge connecting railway platforms, which was already overcrowded with passengers attempting to move between platforms to board their trains. According to reports, confusion regarding train announcements and the arrival of multiple trains at similar times led to a sudden surge of passengers toward the bridge. During this movement, one or more individuals slipped or fell, triggering a pile-up in the tightly packed crowd. The high density of passengers made it difficult for people to maintain balance or escape the area. As panic spread, individuals were pushed forward, resulting in trampling and suffocation. Railway authorities and emergency services responded quickly to the incident. Rescue teams evacuated injured passengers and transported them to nearby hospitals. Official reports confirmed at least 18 fatalities and more than 15 injuries, making it one of the most serious crowd-related incidents at a railway station in recent years.

Table 27: Disaster Identification Table

Parameter	Details
Disaster Type	Crowd crush / stampede
Date	15 February 2025
Location	New Delhi Railway Station
Event Trigger	Passenger surge for Kumbh Mela trains
Fatalities	18
Injuries	15+
Primary Cause	Overcrowding and footbridge congestion

Source: https://en.wikipedia.org/wiki/2025_New_Delhi_railway_station_crowd_crush#:~:text=Article,79%2Dyear%2Dold%20woman.

<https://www.thehindu.com/news/cities/Delhi/delhi-railway-station-stampede-maha-kumbh-mela-updates-february-16/article69225392.ece#:~:text=Northern%20Railway%20has%20decided%20to,males%20and%20six%20are%20females.>

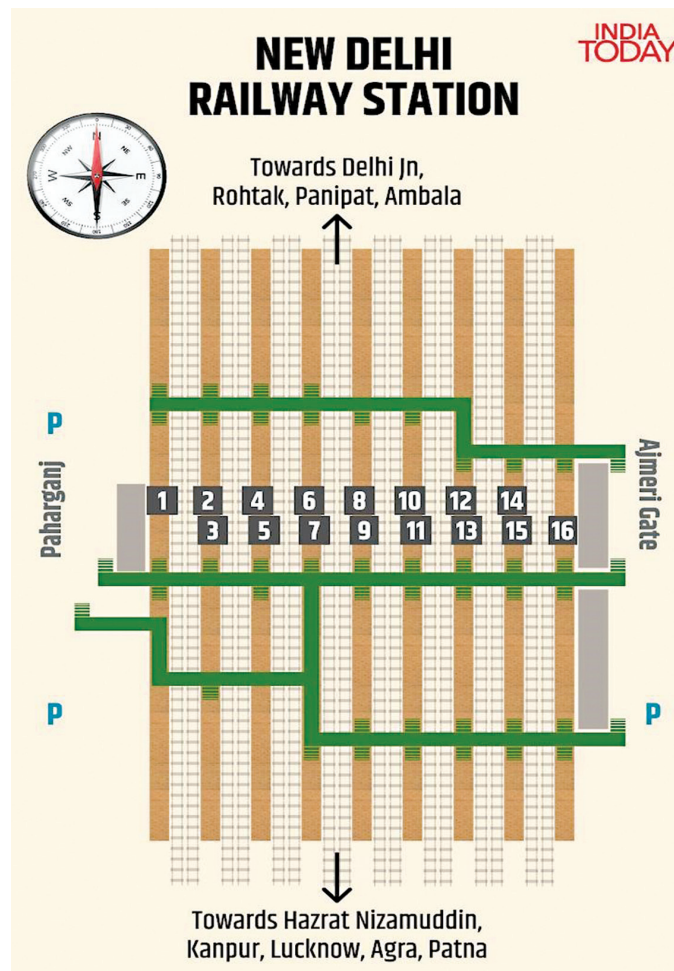


Figure 47: Map showing the layout of New Delhi Railway Station.

Source: <https://www.indiatoday.in/india/story/not-just-railways-others-might-be-to-blame-for-new-delhi-railway-station-stampede-rpf-grp-delhi-police-special-train-2681708-2025-02-18>

On the night of the stampede on February 15, the platforms on the Ajmeri Gate side of New Delhi Railway Station (12 to 16) became dangerously overcrowded. That was because multiple eastbound trains, including those heading to or via Prayagraj for the Maha Kumbh, and scheduled to arrive there, got delayed. The passengers planning to take these trains bunched up on the platforms.

3. Timeline of the Incident

The following timeline summarizes key developments before and after the incident.

Table 28: Delhi Railway Stampede Timeline

Time	Event
Evening	ThousanosQ of passengers gathered for trains to Prayagraj
Train delays	Passengers accumulated on platforms
9:15-9:30 PM	Crowd surge on footbridge connecting platforms
Shortly after	Individuals slipped causing pile-up
9:55 PM	Emergency response initiated

Sources: <https://www.deccanherald.com/india/delhi/passengers-got-confused-between-prayagraj-express-prayagraj-special-causing-stampede-3408260>



Figure 48: Heavy rush of passengers to catch a train for Mahakumbh, at the New Delhi railway station.

Source: <https://www.hindustantimes.com/india-news/kumbh-rush-delayed-trains-blocked-staircase-what-led-to-stampede-at-new-delhi-railway-station-101739668848661.html>



Figure 49: Heavy rush of passengers to catch a train for Maha Kumbh, at the New Delhi railway station on Saturday, February 15, 2025.

Source: <https://www.indiatoday.in/india/story/new-delhi-railway-station-stampede-huge-crowd-lack-of-police-presence-behind-ruckus-eyewitnesses-2680683-2025-02-16>



Figure 50: Heavy passenger congestion at New Delhi Railway Station during travel for the Maha Kumbh, observed on February 15, 2025.

Source: <https://timesofindia.indiatimes.com/city/delhi/maha-kumbh-rush-how-a-special-train-announcement-led-to-stampede-at-new-delhi-station/articleshow/118292320.cms>

4. Impact

The stampede at New Delhi Railway Station had serious human, operational, and institutional consequences. As one of the busiest transport hubs in India, the station handles extremely large passenger volumes daily, and the sudden surge of crowds during the incident exposed the vulnerability of major transportation nodes to crowd-related disasters. The event not only resulted in loss of life and injuries but also disrupted railway operations, triggered public concern regarding passenger safety, and raised questions about the adequacy of crowd management systems in high-density transport environments.

4.1 Human Casualties

The most severe consequence of the stampede was the loss of human life and the injuries sustained by several passengers. Official reports confirmed 18 fatalities, while more than 15 individuals were injured during the incident. The victims were primarily passengers caught in the intense crowd pressure that developed when large numbers of people attempted to move through restricted platform and staircase areas simultaneously. Many of the injured suffered serious physical trauma, including fractures, head injuries, and breathing difficulties caused by compression in the crowd. In high-density crowd situations, individuals often lose the ability to move independently, and the pressure generated by surrounding bodies can lead to suffocation and trampling. Emergency medical teams responded to the incident and transported injured passengers to nearby hospitals for treatment and observation. The casualties highlighted the severe risks associated with overcrowding in confined public spaces, particularly at transportation hubs where large numbers of passengers converge during peak travel periods.

4.2 Psychological Impact

Beyond the immediate physical injuries, the disaster also had significant psychological consequences for survivors and witnesses. Passengers who experienced the stampede reported intense fear, panic, and emotional distress during the incident. The sudden collapse of order within a crowded environment can create a traumatic experience, particularly when individuals feel trapped and unable to escape the crowd pressure. Several survivors experienced symptoms of anxiety and stress after the incident. Families of the victims also faced emotional trauma as they awaited confirmation regarding the safety and identification of their relatives. The process of rescue, medical treatment, and identification of victims further intensified the emotional burden on affected families. Such psychological impacts are common in crowd disasters and may persist long after the physical injuries have healed, emphasizing the need for psychological support and counseling services following major public safety incidents.

4.3 Disruption of Railway Operations

The stampede significantly disrupted railway operations at New Delhi Railway Station. In the immediate aftermath of the incident, emergency response measures required authorities to temporarily halt or delay train services while rescue and medical operations were conducted. Passenger movement within the station was restricted to allow emergency personnel to reach affected areas and to prevent further crowd accumulation. Railway

authorities also implemented temporary crowd control measures, including limiting access to certain platforms and regulating entry into the station. These disruptions affected multiple train schedules and caused inconvenience to thousands of passengers traveling through the station. The incident demonstrated how crowd-related emergencies at major transport hubs can rapidly escalate into large-scale operational disruptions affecting regional transportation networks.

4.4 Public and Institutional Impact

The stampede generated widespread public concern regarding passenger safety at railway stations across the country. The incident prompted discussions among policymakers, transportation authorities, and the public about the adequacy of safety measures and crowd management strategies at large railway stations. Several critical issues came under scrutiny, including the effectiveness of crowd monitoring systems, the preparedness of railway authorities for sudden passenger surges during peak travel periods and festivals, and the capacity of existing station infrastructure to safely accommodate large volumes of passengers. The disaster also prompted calls for improvements in infrastructure design, passenger flow management, and emergency response mechanisms within railway stations. Strengthening these systems is essential to prevent similar incidents in the future and to ensure that major transportation hubs can safely manage large passenger volumes.



Figure 51: Passengers jostle with each other to board a train at the New Delhi Railway station.

Source: <https://www.hindustantimes.com/india-news/16-dead-several-injured-in-stampede-due-to-maha-kumbh-rush-at-new-delhi-railway-station-10-points-101739665639472.html>

5. Possible Causes / Reasons

The stampede at the railway station resulted from a combination of operational, infrastructural, and behavioural factors that collectively led to dangerous crowd conditions. Large transport hubs often experience sudden surges in passenger movement, and inadequate crowd management can rapidly escalate such situations into disasters.

5.1 Train Delays and Passenger Accumulation

One of the primary contributing factors was the delay of scheduled train services, which caused large numbers of passengers to accumulate on platforms and footbridges. As waiting passengers increased, crowd density exceeded safe limits, particularly in areas connecting platforms such as stairways and foot overbridges. When delayed trains arrive simultaneously or announcements indicate imminent arrivals, passengers often move rapidly toward specific platforms, increasing congestion and the likelihood of crowd surges.

5.2 Confusion Due to Train Announcements

Passengers reportedly experienced confusion due to announcements regarding trains with similar names, routes, or destinations. This created uncertainty about platform allocations and train schedules. As a result, large groups of passengers suddenly moved toward particular platforms or staircases, creating abrupt crowd movements that intensified congestion in already crowded areas.

5.3 Overcrowding on the Foot Overbridge

The foot overbridge connecting multiple platforms became heavily congested, as passengers attempted to move between platforms simultaneously. Footbridges in many railway stations are relatively narrow and may not always be designed to handle extreme peak-hour passenger volumes, particularly when passengers carrying luggage attempt to move in opposite directions. The resulting congestion significantly increased the risk of individuals losing balance and falling.

5.4 Inadequate Crowd Segregation and Flow Management

Effective crowd management requires clear segregation of passenger movement, including separate routes for incoming and outgoing passengers. In this case, the lack of well-defined pedestrian flow systems resulted in counter-flow movement, where passengers moving in opposite directions shared the same pathways. Such conditions often create bottlenecks and pressure points, which can trigger crowd turbulence and sudden surges.

5.5 Panic and Rumour-Driven Behaviour

In extremely crowded environments, panic behaviour can spread rapidly. Rumours, sudden pushing, or individuals falling in dense crowds can trigger a chain reaction. Once a few individuals fell on the overcrowded bridge, the tightly packed crowd behind them was unable to stop or change direction, resulting in trampling and crush injuries.

6. Response

Following the stampede at New Delhi Railway Station, authorities initiated immediate rescue, medical, and administrative response measures to control the situation, assist affected passengers, and restore order within the station premises. Given the high passenger density and the critical role of the station as a major transportation hub in New Delhi, coordinated action among railway authorities, emergency services, police personnel, and medical teams was essential to manage the crisis effectively. The response focused on evacuating injured passengers, providing urgent medical care, restoring railway operations, and initiating an official investigation into the causes of the incident.

6.1 Emergency Rescue Operations

Immediately after the stampede occurred, railway staff, police personnel, and volunteers present at the station responded quickly to assist passengers trapped in the congested area. The primary priority of the rescue teams was to clear the affected bridge and surrounding platforms to prevent further injuries and restore safe movement within the station. Emergency responders helped evacuate injured individuals who had fallen during the stampede and created temporary safe passageways to move victims away from the crowded area. Passengers who were unable to move due to injuries or crowd pressure were carefully lifted and transported to safer locations within the station premises. Railway staff also worked to regulate the movement of the crowd and prevent additional passengers from entering the already congested area. The rapid mobilization of personnel helped bring the situation under control and prevented further escalation of the incident.

6.2 Medical Assistance and Evacuation

Medical assistance was provided promptly to injured passengers. Ambulances were deployed to the railway station to transport victims to nearby hospitals for emergency treatment. Medical teams present at the site provided immediate first aid and stabilised injured individuals before transferring them to healthcare facilities. Many victims sustained injuries commonly associated with crowd disasters, including fractures, crush injuries, breathing difficulties caused by suffocation, and symptoms of shock or trauma resulting from the sudden and chaotic event. Several hospitals in the surrounding areas were placed on alert to receive and treat the injured passengers. Medical personnel worked to ensure that all victims received timely treatment and necessary medical support. The prompt evacuation and treatment of injured individuals played an important role in reducing the severity of the medical consequences following the incident.

6.3 Railway Operational Measures

In the aftermath of the stampede, Indian Railways implemented several operational measures aimed at reducing congestion within the station and restoring normal train services. Additional trains were deployed to accommodate stranded passengers and manage the overflow of travellers present at the station. Security arrangements and crowd control

measures were strengthened, with additional personnel deployed to regulate passenger movement across platforms, staircases, and foot overbridges. Railway authorities also increased monitoring and surveillance at major stations to detect potential crowd build-up and intervene before dangerous congestion levels were reached. These operational steps were necessary to stabilize passenger movement and prevent the recurrence of similar incidents in the immediate aftermath of the disaster.

6.4 Government Action and Investigation

Following the incident, the Ministry of Railways ordered an official investigation to determine the precise sequence of events that led to the stampede. The inquiry was tasked with identifying any lapses in crowd management, infrastructure planning, or operational protocols that may have contributed to the tragedy. The government also announced compensation for the families of the deceased victims as well as financial assistance for injured passengers. These measures were intended to provide immediate relief to affected families while acknowledging the gravity of the incident.

In addition to compensation and investigation, authorities emphasized the importance of strengthening passenger safety mechanisms at major railway stations across the country. The incident prompted renewed attention to crowd management strategies, infrastructure capacity, and emergency preparedness in high-traffic transport hubs to prevent similar tragedies in the future.

Key measures for crowd management at Railway Stations

KEY MEASURES FOR CROWD MANAGEMENT AT RAILWAY STATIONS	
FOCUS AREA	KEY MEASURES
1. Station Management & Governance	• Senior officers (IRTS officials of Selection Grade) will be appointed as Station Directors at major stations • Station Directors will have financial authority and decision-making power to take immediate action • All departments at respective stations will report to the Station Director, responsible for regulating ticket sales based on station capacity and available trains • The move is aimed at prevention of overcrowding at stations and ensuring safer passenger flow
2. Communication & Information Systems	• Walkie-talkies and modern digital communication tools will be provided to railway personnel • Announcement and public address systems will be installed at high-traffic stations
3. Staff Identification & Security	• All railway staff will receive newly-designed uniforms for easy identification during emergency situations • Staff and service personnel will be issued new ID cards to restrict unauthorised entry into railway stations
4. Focus on High Footfall Stations	• Measures will be implemented at 60 high-footfall stations, especially during festive seasons • Pilot projects in this regard have already started at New Delhi, Anand Vihar, Varanasi, Ayodhya, and Patna

5. Passenger Access Regulation	• Only confirmed ticket holders will be allowed on platforms; others must wait in designated holding areas • Unauthorised entry points at stations will be completely sealed off with strict vigil—only passengers with confirmed tickets will be allowed direct entry.
6. Infrastructure Upgrades	• Two new standard designs for foot overbridges being developed: 12 meters wide and 6 meters wide • These wider overbridges, which proved effective during Maha Kumbh, will be installed at all major stations
7. CCTV Surveillance	• Large-scale CCTV installations will be taken up in stations and surrounding areas across the country • Sophisticated cameras enabled with latest tech will assist in real-time crowd monitoring and management
8. Control & Emergency Management	• Dedicated control centers will be set up to manage heavy crowds and respond to emergencies

Figure 52: Key measures for crowd management at Railway Stations.

Source: <https://www.newindianexpress.com/cities/delhi/2025/Mar/10/railway-safety-test-begins-in-new-delhi>

7. Issues / Challenges / Concerns

The stampede incident highlighted several systemic challenges associated with managing large passenger flows at major railway stations. These challenges relate to infrastructure limitations, operational management, information dissemination, and inter-agency coordination.

7.1 Extreme Passenger Volumes

Major railway stations often experience extremely high passenger volumes, particularly during festivals, holidays, and peak travel seasons. During such periods, passenger numbers can exceed the designed capacity of platforms, stairways, and footbridges, significantly increasing crowd density. When large groups of passengers attempt to move simultaneously toward platforms or exits, the risk of crowd congestion, surges, and stampede incidents increases substantially.

7.2 Infrastructure Constraints

Many railway stations across India were constructed several decades ago and were not originally designed to accommodate the current scale of passenger traffic. Narrow platforms, limited entry and exit points, and insufficiently wide foot overbridges can become critical bottlenecks during peak travel periods. Upgrading infrastructure to meet modern safety standards remains a major challenge for Indian Railways, particularly at older and high-traffic stations.

7.3 Real-Time Crowd Monitoring Limitations

Effective crowd management requires continuous monitoring of passenger density and movement patterns. However, monitoring large crowds in complex and rapidly changing environments such as railway stations remains challenging. Although surveillance technologies such as CCTV systems are deployed in many stations, real-time crowd analytics and predictive monitoring systems are still limited, making it difficult to detect dangerous crowd build-up in advance.

7.4 Information and Communication Management

Clear, accurate, and timely communication is essential for managing passenger movement during peak travel periods. Confusing or delayed announcements regarding train arrivals, platform changes, or delays can lead to sudden crowd movements and congestion. Improved passenger information systems, including digital displays, mobile alerts, and coordinated announcements, are necessary to reduce confusion and maintain orderly crowd flow.

7.5 Inter-Agency Coordination

Managing large crowds in transport hubs requires close coordination between multiple agencies, including railway authorities, police, medical services, and disaster management organizations. Ensuring effective communication and rapid decision-making among agencies such as National Disaster Management Authority, local police forces, and railway authorities is essential for preventing and responding to emergencies.

8. Lessons Learnt

The New Delhi Railway Station Stampede highlights significant challenges associated with managing extremely high passenger volumes at major transport hubs, particularly during festival seasons and large pilgrimage movements. The incident underscores the importance of proactive planning, improved infrastructure, and coordinated institutional responses to ensure passenger safety. Several key lessons can be derived from the disaster.

8.1 Importance of Real-Time Crowd Monitoring

One of the primary lessons from the incident is the need for continuous monitoring of passenger density within railway stations. The use of AI-enabled CCTV systems, sensors, and data analytics can help authorities detect overcrowding in real time. Such technologies enable railway officials to identify high-risk zones such as footbridges, stairways, and platforms, allowing them to take preventive actions before crowd pressure reaches dangerous levels.

8.2 Regulated Passenger Entry and Access Control

Unrestricted entry to platforms during peak travel periods can quickly lead to overcrowding and dangerous crowd conditions. A key lesson from the incident is the importance of controlled passenger entry through ticket verification systems, regulated access gates, and

crowd flow management measures. Restricting entry when platforms reach safe capacity levels can significantly reduce the risk of crowd surges.

8.3 Effective Passenger Information and Communication Systems

Confusion regarding train arrivals, platform numbers, or delays can trigger sudden movements of passengers within railway stations. The incident demonstrates the need for clear and reliable passenger information systems, including digital display boards, automated announcements, and real-time updates. Accurate communication helps reduce panic and prevents large groups of passengers from rushing toward specific platforms.

8.4 Infrastructure Adequacy and Capacity Planning

The tragedy also highlights the limitations of existing railway infrastructure in handling increasing passenger volumes. Railway stations must regularly assess infrastructure capacity and expand facilities where necessary. This includes wider foot overbridges, additional staircases, larger waiting areas, and improved passenger circulation spaces to ensure safe movement of large crowds.

8.5 Training and Preparedness of Railway Personnel

Effective crowd management requires well-trained personnel capable of managing large passenger flows during emergencies. Railway staff, security personnel, and volunteers should receive specialized training in crowd control, evacuation procedures, and emergency response. Incorporating the mass gathering safety guidelines issued by the National Disaster Management Authority into railway operational practices can significantly strengthen preparedness.

8.6 Comprehensive Disaster Management Planning

Another key lesson is the importance of having integrated disaster management plans for major railway stations. Such plans should include clearly marked evacuation routes, rapid medical response systems, and coordination protocols between railway authorities, police, health services, and disaster management agencies. Regular mock drills and emergency simulations can further improve readiness for crowd-related incidents.

8.7 Inter-Agency Coordination and Institutional Responsibility

Managing large crowds in transport hubs requires coordination between multiple agencies, including railway authorities, local police, health services, and disaster management organisations. The incident highlights the need for clear roles, responsibilities, and communication channels among these agencies to ensure a rapid and coordinated response during emergencies.

References

- Dutta, A. (2025, February 16). New Delhi railway station stampede: 18 dead, several injured. The Hindu. <https://www.thehindu.com/news/cities/Delhi/delhi-railway-station-stampede-news/article69224272.ece>
- Economic Times Online. (2025, February 16). New Delhi Railway Station stampede: 'Never seen a crowd this big, it happened within seconosQ.' Eyewitnesses recount harrowing night. The Economic Times. <https://m.economictimes.com/news/india/new-delhi-stampede-eyewitnesses-recount-harrowing-night/articleshow/118292321.cms>
- Hindustan Times Correspondent. (2025, February 16). New Delhi Railway Station stampede live updates: Maha Kumbh rush turns into tragedy; 18 dead. Hindustan Times. <https://www.hindustantimes.com/india-news/new-delhi-railway-station-stampede-live-updates-101739640299766.html>
- Ministry of Railways. (2025, February 16). Special trains from New Delhi to Prayagraj to depart from Platform 16 to the extent possible; Passengers to use Ajmeri Gate for entry/exit (Release ID: 2103844). Press Information Bureau, Government of India <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2103844>
- Ministry of Railways. (2025, February 18). Clarification on certain misleading media reports relating to ongoing inquiry of Saturday's unfortunate incident at New Delhi Railway Station (Release ID: 2104489). Press Information Bureau, Government of India. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2104489>
- Ministry of Railways. (2025, March 19). Indian Railways strengthens crowd management and infrastructure to enhance passenger safety following New Delhi stampede (Release ID: 2112830). Press Information Bureau, Government of India. <https://www.pib.gov.in/PressReleseDetailm.aspx?PRID=2112830>
- National Disaster Management Authority. (2014). Managing Crowd at Events and Venues of Mass Gathering. Government of India. <https://ndma.gov.in/sites/default/files/PDF/Reports/managingcrowosQguide.pdf>
- The Federal. (2025, February 17). Platform change announcement at Delhi station led to stampede, says RPF report. <https://thefederal.com/states/north/delhi/rpf-report-on-delhi-station-stampede-172364>

9. IPL Bengaluru Stampede

1. Introduction

India is widely regarded as one of the most passionate sporting nations, particularly in the context of cricket. Major cricket tournaments often attract massive crowds, both inside stadiums and in surrounding public areas. The Indian Premier League (IPL) is among the most popular cricket leagues globally, drawing millions of spectators and fans. In June 2025, celebrations erupted across Bengaluru after the victory of the local franchise team, the Royal Challengers Bengaluru. The team's success triggered widespread celebrations, with thousands of supporters gathering outside the M. Chinnaswamy Stadium to participate in the victory celebrations. While public celebrations following major sporting victories are common, they can also pose significant risks when large crowds gather spontaneously without adequate planning or crowd management measures. In this case, rumours regarding free entry passes and limited stadium access triggered a sudden rush of fans toward the stadium gates. On 4 June 2025, an uncontrolled crowd surge outside the stadium resulted in a tragic stampede that caused multiple fatalities and injuries. The incident highlighted the risks associated with spontaneous mass gatherings and underscored the need for improved planning, crowd control measures, and emergency preparedness during large public celebrations.

2. Overview of the Disaster Event

The stampede occurred on 4 June 2025 outside the M. Chinnaswamy Stadium in Bengaluru, where fans had gathered to celebrate the IPL victory of the Royal Challengers Bengaluru. Earlier in the day, reports circulated that the team would participate in a victory parade and celebrations at the stadium. This announcement attracted thousands of fans to the area. As the evening progressed, the number of fans outside the stadium increased significantly. Many supporters gathered near the stadium gates hoping to gain entry into the venue. Rumours reportedly spread among the crowd that free entry passes or tickets were being distributed at certain gates, which triggered a sudden rush of fans toward those access points. As more people attempted to move toward the stadium entrances, crowd congestion intensified. The limited number of access gates created choke points where large numbers of people attempted to enter simultaneously. The crowd pressure caused individuals to lose balance and fall near the gates, leading to a pile-up. Once people began to fall, the dense crowd behind them continued pushing forward, resulting in trampling and suffocation. Panic spread quickly as fans attempted to escape the congested area. Police and emergency response teams arrived at the scene and began rescue operations. Injured individuals were transported to nearby hospitals, while authorities attempted to disperse the crowd and restore order. Initial reports confirmed 11 fatalities and more than 40 injuries, making the incident one of the most serious crowd-related disasters associated with a sporting event in India.

Table 29: Disaster Identification Table

Parameter	Details
Disaster Type	Crowd crush / stampede
Date	4 June 2025
Location	M. Chinnaswamy Stadium, Bengaluru
Event	IPL Victory Celebration
Estimated Crowd	ThousanosQ of fans
Fatalities	11
Injuries	50
Trigger	Crowd surge due to rumours of free entry

Source: <https://www.thehindu.com/news/cities/bangalore/rcb-ipl-victory-celebrations-stampede-bengaluru-death-toll/article69656538.ece>



Figure 53: Schematic map depicting the location and entry/exit gates of M. Chinnaswamy Stadium, Bengaluru.

Source: <https://maps-bangalore.com/chinnaswamy-stadium-map>



Figure 54: An aerial view of M Chinnaswamy Stadium in Bengaluru on 4 June 2025.

Source: <https://indianexpress.com/article/cities/bangalore/rcb-victory-parade-stampede-among-dead-son-of-pani-puri-vendor-14-yr-old-school-girl-10048888/>



Figure 55: Crowd gathering during the RCB victory parade.

Source: <https://www.indiatoday.in/cities/bengaluru/story/bengaluru-district-commissioner-summons-45-people-in-chinnaswamy-stadium-stampede-inquiry-2737903-2025-06-09>



Figure 56: Approximately 300,000 people gathered at M. Chinnaswamy Stadium, exceeding its seating capacity of around 35,000.

Source: <https://timesofindia.indiatimes.com/city/bengaluru/rcb-fan-frenzy-turns-fatal-11-dead-75-injured/articleshow/121632555.cms>

3. Timeline of the Incident

The sequence of events leading to the stampede illustrates how quickly crowd situations can escalate during spontaneous public gatherings.

Table 30: IPL Bengaluru Stampede Timeline

Time / Phase	Event Description
Morning	Fans begin gathering in large numbers around the stadium following the cricket team's IPL victory celebration announcement.
Early Afternoon	Crowd density increases significantly around the stadium gates and surrounding roads.
Around 3:00 PM	Confusion regarding entry passes and stadium access leads to crowd agitation.
~3:30 PM	Large crowd surge toward stadium entry gates as fans attempt to enter the venue.
Minutes later	Barricades collapse under pressure; individuals fall near entry points.
Immediately after	Crowd crush and trampling occur near gates and surrounding barricaded areas.
4:00 PM onwards	Police, volunteers, and medical teams begin rescue operations and transport injured persons to hospitals.
Evening	Authorities announce investigation and compensation for victims' families.

Source: <https://www.outlookindia.com/sports/cricket/bengaluru-stampede-timeline-how-it-all-unfolded>



Figure 57: A crowd of fans gather in large numbers during Royal Challengers Bengaluru’s felicitation ceremony after winning the Indian Premier League (IPL) 2025, in front of Vidhana Soudha, in Bengaluru on June 4, 2025.

Source: <https://frontline.thehindu.com/society/bengaluru-stadium-stampede-rcb-event-tragedy-inquiry/article69663977.ece>

4. Impact

The stampede that occurred during the victory celebrations of the Indian Premier League team Royal Challengers Bengaluru in Bengaluru resulted in significant human, psychological, and administrative consequences. The incident highlighted the risks associated with managing extremely large crowds during public celebrations and sporting events.

4.1 Human Casualties

The most severe consequence of the disaster was the loss of human lives and injuries caused by intense crowd pressure and trampling. Official reports confirmed 11 fatalities and more than 50 individuals injured. Many victims sustained serious injuries, including fractures, crush injuries, head trauma, and breathing difficulties due to suffocation in densely packed crowds. Several of the injured required immediate hospitalization and emergency medical care, placing additional strain on nearby hospitals and emergency services.

Table 31: Human Impact

Impact Category	Bengaluru Stampede
Fatalities	11
Injured	50
Vulnerable groups affected	Youth, women
Hospitalisation	Multiple hospitals in Bengaluru
Psychological trauma	Significant among fans and families

Source: <https://www.thehindu.com/news/cities/bangalore/rcb-ipl-victory-celebrations-stampede-bengaluru-death-toll/article69656538.ece>

Table 32: Crowd Density Risk Table

Density Level	Persons per m ²	Crowd Behaviour	Risk Level
Low	1–2	Free movement	Safe
Moderate	3–4	Limited movement	Moderate risk
High	5–6	Physical contact unavoidable	High risk
Critical	7+	Crowd turbulence and crushing pressure	Extreme risk

Source: [https://www.gkstill.com/Support/crowd-density/CrowdDensity-1.html#:~:text=Static%20crowd%20density%20\(general\),4.5%20people%20per%20square%20metre](https://www.gkstill.com/Support/crowd-density/CrowdDensity-1.html#:~:text=Static%20crowd%20density%20(general),4.5%20people%20per%20square%20metre)

Research shows that crowd disasters often occur when density exceeds 6–7 persons per square meter.

4.2 Psychological and Social Impact

The incident caused significant emotional and psychological distress among spectators, fans, and families who had gathered to celebrate the team's achievement. Witnesses reported panic, confusion, and fear as the crowd surge occurred. Survivors and bystanders experienced shock and trauma, while the families of victims faced grief and long-term psychological stress. The tragedy also deeply affected the fan community that had assembled to celebrate the sporting victory.

4.3 Disruption of Public Celebrations

Following the incident, authorities immediately suspended the planned victory celebrations and public parade events organised for the team. This decision was necessary to prevent further crowd build-up, ensure public safety, and enable emergency services to carry out rescue and medical operations without obstruction. The abrupt halt of the celebrations transformed what was intended to be a festive public event into a significant public safety emergency.

4.4 Administrative and Governance Impact

The stampede triggered widespread public concern and policy debate regarding the safety planning of large public gatherings and sporting celebrations. Questions were raised about the adequacy of crowd management planning, the level of coordination between event organisers, police authorities, and municipal agencies, and the preparedness of emergency medical and disaster response systems. The incident underscored the need for comprehensive risk assessments, scientific crowd modelling, and the strict implementation of safety protocols prior to organising large-scale public celebrations associated with sporting events.

5. Possible Causes / Reasons

The stampede during the victory celebrations of Royal Challengers Bengaluru following the Indian Premier League tournament in Bengaluru resulted from a combination of operational, behavioural, and infrastructural factors. Large celebratory gatherings often develop rapidly and can become hazardous when crowd density exceeds safe limits.

5.1 Rumours and Misinformation

One of the immediate triggers of the crowd surge was the circulation of rumours that free entry passes or tickets were being distributed at certain stadium gates. This misinformation quickly spread among fans through informal communication channels, prompting large groups of people to rush toward those entry points. The sudden concentration of people at specific gates significantly increased crowd pressure and congestion.

5.2 Massive Crowd Turnout

The immense popularity of the Indian Premier League and the enthusiasm surrounding the team's victory attracted thousands of supporters, many of whom gathered spontaneously around the stadium area. Since many fans arrived without prior registration or controlled entry arrangements, the crowd size exceeded the safe capacity of the stadium surroundings and access routes, creating highly dense crowd conditions.

Table 33: Infrastructure and Event Management Assessment

Parameter	Bengaluru Event
Venue capacity	35,000 stadium capacity
Estimated attendance	Up to 300,000 people
Entry points	Limited gates
Crowd control measures	Barricades and police presence
Emergency access	Restricted due to crowd density

Source: <https://www.hindustantimes.com/india-news/rcb-event-turns-deadly-what-led-to-the-bengaluru-stampede-killing-11-cricket-fans-101749087650141.html>

5.3 Limited Entry Points and Bottlenecks

The availability of a limited number of entry gates to the stadium resulted in significant congestion as large numbers of fans attempted to enter simultaneously. These restricted access points created bottlenecks, where crowd flow slowed down or stopped completely. When pressure from the crowd behind continued to increase, the likelihood of individuals losing balance and falling rose sharply.

5.4 Inadequate Crowd Management Planning

The celebrations following the team's victory appear to have attracted larger-than-anticipated crowds, and the crowd management arrangements may not have been sufficient to handle such a large and rapidly assembling gathering. Insufficient deployment of crowd control barriers, limited personnel for crowd regulation, and lack of clearly designated entry and exit pathways may have contributed to the situation escalating.

5.5 Panic and Crowd Surge Behaviour

In extremely dense crowds, even a minor disturbance can lead to panic. Once a few individuals fell near the entry gates, panic spread quickly through the tightly packed

crowd. Due to the lack of available space for movement, people behind continued pushing forward, resulting in crowd crush and trampling incidents.

6. Response

Following the stampede during the celebrations related to the Indian Premier League victory of Royal Challengers Bengaluru in Bengaluru, authorities and emergency services initiated immediate response measures to rescue victims, provide medical assistance, and restore order in the affected area.

Table 34: Emergency Response Structure

Agency	Role in Disaster Response
Local Police	Crowd control and rescue
District Administration	Coordination of emergency response
Medical Services	Treatment and evacuation of injured
Disaster Management Authorities	Support and coordination
Volunteers	Immediate assistance and evacuation

Source: https://dcentral.delhi.gov.in/sites/default/files/generic_multiple_files/response_and_relief_measures.pdf

6.1 Emergency Rescue and Crowd Control Operations

Local police personnel, stadium security staff, and volunteers were rapidly deployed to manage the situation and assist those affected by the crowd surge. Rescue teams worked to evacuate injured individuals from densely packed areas, clear access routes, and disperse the gathering to prevent further crowd pressure. Authorities also established temporary safety corridors to facilitate the safe movement of emergency vehicles and rescue teams within the congested area.

6.2 Medical Assistance and Emergency Care

Emergency medical services responded promptly by deploying ambulances and medical personnel to the site. Injured individuals were quickly transported to nearby hospitals for treatment. Medical teams provided immediate care for a range of injuries, including fractures and crush injuries, breathing difficulties caused by suffocation, and trauma and shock. Hospitals in Bengaluru were placed on high alert to manage the sudden influx of patients and ensure timely medical intervention.

6.3 Government Action and Investigation

The Government of Karnataka ordered a formal investigation into the incident to determine the sequence of events and identify potential lapses in crowd management and safety arrangements. Authorities also announced financial compensation for the families of the deceased and injured victims. The investigation aimed to assess responsibilities among event organizers, stadium authorities, and local administrative agencies.

6.4 Review and Strengthening of Safety Protocols

Following the incident, authorities initiated a comprehensive review of crowd management and safety protocols at major stadiums and public event venues across the state. The review focused on improving key areas such as crowd capacity planning, entry and exit management systems, deployment of security and emergency personnel, and coordination between event organisers and public authorities. These measures were aimed at enhancing preparedness and reducing the risk of similar incidents during large sporting events and public celebrations in the future.

7. Issues / Challenges / Concerns

The stampede during the victory celebrations of Royal Challengers Bengaluru following the Indian Premier League tournament in Bengaluru highlighted several critical challenges associated with managing large spontaneous public gatherings and sporting celebrations.

7.1 Underestimation of Crowd Size

One of the major challenges was the underestimation of the number of fans likely to gather for the celebrations. Sporting victories often attract large and enthusiastic crowds, many of whom assemble spontaneously without formal invitations or controlled entry systems. The absence of accurate crowd projections and risk assessments resulted in insufficient preparation for managing the scale of the gathering, which increased the risk of overcrowding near stadium entry points.

7.2 Coordination Challenges Among Stakeholders

Effective crowd management requires close coordination between multiple stakeholders, including event organisers, stadium authorities, police forces, and local administration. In this case, coordination among the organisers of the celebration event, stadium management, and public authorities appears to have been limited, which affected the implementation of comprehensive crowd control strategies and emergency response planning.

7.3 Infrastructure Constraints

The stadium entry gates, surrounding roads, and pedestrian pathways were not designed to accommodate extremely large and sudden gatherings of fans. Limited entry points and narrow access routes created bottlenecks as large numbers of people attempted to enter the venue simultaneously. Such infrastructure constraints significantly increase the risk of crowd congestion, pressure build-up, and potential stampede situations.

7.4 Limited Emergency Access and Evacuation Routes

The dense crowd and congestion around the stadium created significant challenges for emergency responders. Ambulances and rescue teams faced difficulties reaching injured individuals due to blocked or overcrowded access routes. Limited emergency access corridors delayed rapid evacuation and medical assistance, highlighting the importance of maintaining clear emergency routes during large public events.

8. Lessons Learnt

The tragic crowd crush during the IPL victory celebrations in Bengaluru highlights several systemic weaknesses in the planning and management of large public gatherings. The incident demonstrated that spontaneous celebrations, amplified through social media and public enthusiasm, can rapidly exceed the planned capacity of venues and surrounding infrastructure. The lessons derived from this event are critical for strengthening crowd safety during future sports celebrations and similar mass gatherings.

8.1 Pre-Event Planning and Coordination

One of the most significant lessons is the need for early coordination between police authorities and event organisers. Before granting permission for large gatherings, authorities must collect detailed information regarding the nature of the event, expected attendance, assembly and dispersal strategies, and permit status. Coordination with allied departments such as fire services and health authorities is also essential to ensure adequate emergency preparedness. Following the Bengaluru incident, new Standard Operating Procedures emphasised that police must conduct simulation-based risk assessments, venue safety audits, and detailed event planning prior to approving large-scale gatherings.

Police must liaise with Event Organisers to gather the following critical details	
Nature, date, and time of the event	QUEUE MANAGEMENT Use barricades and floor markings to guide attendees. Provide real-time updates on wait times. Designate accessible lines for the differently-abled.
Expected footfall	
Assembly and dispersal plans	
Permit status and coordination with allied departments (fire, health)	
Possibility of Counter protests and demonstrations Risk to nearby vital installations	
Past behaviour at similar events	
Availability of emergency services and mutual aid	

Figure 58: Standard Operating Procedures (SOPs) for crowd management issued by the Karnataka Police following the stampede.

Source: <https://www.newindianexpress.com/states/karnataka/2025/Jul/02/post-chinnaswamy-stadium-stampede-police-issue-sop-for-crowd-management>

8.2 Accurate Crowd Estimation and Capacity Management

A major contributing factor to the tragedy was the mismatch between the expected crowd size and the capacity of the venue and surrounding areas. Authorities must conduct realistic footfall assessments and strictly enforce capacity limits for public events. Crowd modelling techniques and predictive analytics can help estimate attendance and identify potential congestion zones, enabling organisers to regulate entry and prevent overcrowding.

8.3 Effective Queue and Entry Management

The incident highlighted the importance of structured queue systems at entry points. Proper queue management using barricades, floor markings, and designated waiting areas can regulate crowd movement and prevent sudden surges toward entry gates. Real-time updates regarding waiting times and access restrictions can also reduce frustration and disorder among attendees.

8.4 Inclusive and Safe Crowd Movement

Mass gatherings should ensure safe movement for all participants, including vulnerable groups such as children, elderly individuals, and persons with disabilities. Dedicated entry lines and accessible pathways should be created to avoid crowd pressure on vulnerable individuals.

8.5 Real-Time Monitoring and Situational Awareness

The Bengaluru stampede demonstrated the need for continuous real-time monitoring of crowd density. Authorities should integrate technologies such as drone surveillance, AI-enabled CCTV systems, and GIS-based crowd monitoring platforms. These tools can detect dangerous crowd densities and allow authorities to intervene before a crowd surge develops into a disaster.

8.6 Emergency Preparedness and Response Planning

Effective emergency planning is critical for mass gatherings. Event organisers must develop detailed emergency response plans including evacuation routes, medical aid stations, and designated emergency access corridors. The Bengaluru tragedy also showed that emergency vehicles must have clear access routes to reach victims quickly.

8.7 Communication and Information Management

Misinformation and confusion regarding entry passes and event access contributed to crowd congestion at the stadium gates. Clear and timely communication from organisers and authorities is essential to prevent panic and misinformation. Public announcements, digital displays, and coordinated messaging through official channels can guide crowd behaviour and reduce uncertainty.

8.8 Accountability and Institutional Responsibility

The incident also underscores the importance of institutional accountability in managing large public events. Organisers, venue authorities, and law enforcement agencies must follow established safety protocols and legal procedures before conducting mass gatherings. Failure to implement adequate crowd control measures can result in preventable tragedies and legal consequences for responsible stakeholders.

References

- Business Standard. (2025, June 5). RCB's glory march turns tragic: What led to stampede at Chinnaswamy Stadium. https://www.business-standard.com/india-news/rcb-ipl-celebration-stampede-chinnaswamy-deaths-crowd-mismanagement-125060500260_1.html
- D'Cunha, J. M. (2025, July 17). Report of the judicial commission of inquiry into the stampede at M. Chinnaswamy Stadium on June 4, 2025. Government of Karnataka.
- HindustanTimesCorrespondent. (2025, June 5). Bengaluru stampede: What led to deadly crush at RCB's IPL victory event? Hindustan Times. <https://www.hindustantimes.com/india-news/bengaluru-stampede-rcb-ipl-victory-celebrations-101749112455420.html>
- National Disaster Management Authority. (2014). Managing Crowd at Events and Venues of Mass Gathering . Government of India. <https://ndma.gov.in/sites/default/files/PDF/Reports/managingcrowosQguide.pdf>
- Reuters. (2025, June 4). At least 11 die in crowd chaos outside Indian cricket stadium. <https://www.reuters.com/world/india/at-least-11-die-crowd-chaos-outside-indian-cricket-stadium-2025-06-04/>
- Official statement on the Chinnaswamy Stadium tragedy and announcement of ex-gratia for victims' families. Chief Minister's Office, Government of Karnataka. <https://www.thehindu.com/news/cities/bangalore/stampede-karnataka-govt-increases-ex-gratia-to-kin-of-deceased-to-25-lakh/article69669391.ece>
- The Hindu Bureau. (2025, July 17). Karnataka government report blames RCB, DNA Network and KSCA for stampede outside Chinnaswamy stadium. The Hindu. <https://www.thehindu.com/news/cities/bangalore/karnataka-government-report-blames-rcb-dna-network-and-ksca-for-stampede/article69822445.ece>
- The Indian Express Bureau. (2025, June 5). Bengaluru stampede: Hospital recorosQ show first death occurred before RCB felicitation. The Indian Express. <https://indianexpress.com/article/cities/bangalore/bengaluru-stampede-hospital-recorosQ-rcb-felicitations-9512345/>
- The New Indian Express. (2026, February 24). Karnataka HC closes suo motu PIL on Chinnaswamy Stadium stampede, directs state to implement crowd control SOP. <https://www.newindianexpress.com/states/karnataka/2026/Feb/24/karnataka-hc-closes-suo-motu-pil-on-chinnaswamy-stadium-stampede>

10. Karur Rally Crowd Crush

1. Introduction

Political rallies in India frequently attract large numbers of supporters, especially when prominent political leaders participate in public gatherings. Such events often involve dense crowd formations, long waiting periods, and heightened emotional enthusiasm among participants. When not properly managed, these factors can significantly increase the risk of crowd-related disasters such as stampedes and crowd crush incidents. Large political gatherings pose complex crowd-management challenges, particularly when they are organised in confined spaces or when crowd size exceeds the planned capacity of the venue. Effective crowd control mechanisms, safety barriers, emergency evacuation routes, and real-time monitoring are therefore essential to ensure public safety. On 27 September 2025, a tragic crowd crush occurred during a political rally in Karur, located in the southern Indian state of Tamil Nadu. The incident took place when a large number of supporters surged toward the stage upon the arrival of a political leader. The sudden crowd movement resulted in people being pushed against barricades, causing crushing and trampling. The disaster resulted in approximately 36–40 fatalities and several injuries, highlighting once again the dangers associated with poorly managed mass gatherings.

2. Overview of the Disaster Event

The political rally was organised in Karur as part of a public outreach programme that attracted thousands of supporters from nearby districts. Large crowds began assembling at the venue several hours before the scheduled arrival of the political leader. As the rally progressed, the number of attendees gradually exceeded the planned capacity of the venue. The absence of clearly defined crowd-control zones and limited access pathways contributed to increasing crowd density near the stage area. When the political leader arrived at the rally site, a significant surge of supporters moved toward the stage in an attempt to get closer to the leader. The sudden movement created intense crowd pressure near the barricades that had been installed in front of the stage. Due to the extremely high crowd density, several individuals lost balance and fell. Once people began falling, others behind them were unable to stop due to the forward pressure from the crowd. This resulted in a crowd crush and trampling incident. Emergency services and police personnel quickly responded to the situation and initiated rescue operations. Injured individuals were transported to nearby hospitals, while authorities attempted to disperse the crowd and secure the area. Preliminary reports indicated that approximately 36–40 people lost their lives and at least 40 others sustained injuries during the incident.

Table 35: Disaster Identification Table

Parameter	Details
Date	27 September 2025
Location	Karur
Event Type	Political rally
Event Trigger	Political campaign rally
Organising Context	Public political gathering
Estimated Crowd	27,000-50,000 participants
Fatalities	41
Injured	100
Key Authorities Involved	District administration, police

Source: <https://www.hindustantimes.com/india-news/tvk-vijay-rally-stampede-live-updates-vijay-thalapathy-tvk-party-karur-rally-death-toll-tamil-nadu-news-101758991674950.html>

Table 36: Karur Rally Crowd Crush Timeline (27 September 2025)

Time	Event
Morning (9:30 AM)	Vijay lands at Tiruchy International Airport, already delayed by several hours.
10:00 AM – 5:00 PM	Convoy moves slowly through Nochiyam, Ayyampalayam, Musiri, and Thottiyam due to large crowds gathering along the route.
11:00 AM onwards	Supporters begin assembling at the rally ground near Karur–Erode Highway, well before the permitted time.
12:00 PM	Official announcement indicates arrival by noon, increasing crowd inflow at the venue.
Afternoon (3:00 PM – 6:30 PM)	Crowd size exceeds permitted capacity; attendees wait for hours in heat without adequate food or water.
Early Evening (around 7:30 PM)	Vijay arrives at the venue more than seven hours late and begins addressing the crowd from the campaign bus.
7:35 PM	Crowd surges forward; multiple individuals faint; distress signals observed; appeal made for police assistance.
7:40 PM	Overcrowding near barricades intensifies; crowd crush develops and extends toward nearby drainage areas.
Stampede Phase (7:40 PM onwards)	People fall due to pressure waves in the crowd, leading to a fatal crush situation.
8:00 PM onwards	Emergency response initiated; police and volunteers disperse crowd; injured transported to hospitals in Karur, Erode, and nearby districts.
Night	Casualties confirmed; 41 deaths reported, including children; hospitals manage large number of injured victims.

Source: <https://www.oneindia.com/chennai/karur-stampede-timeline-how-a-tvk-rally-turned-deadly-what-followed-7890475.html>



Figure 59: Karur stampede: A visual timeline

Source: <https://www.thehindu.com/news/national/tamil-nadu/karur-stampede-september-27-2025-tvk-vijay-visual-timeline/article70126058.ece>

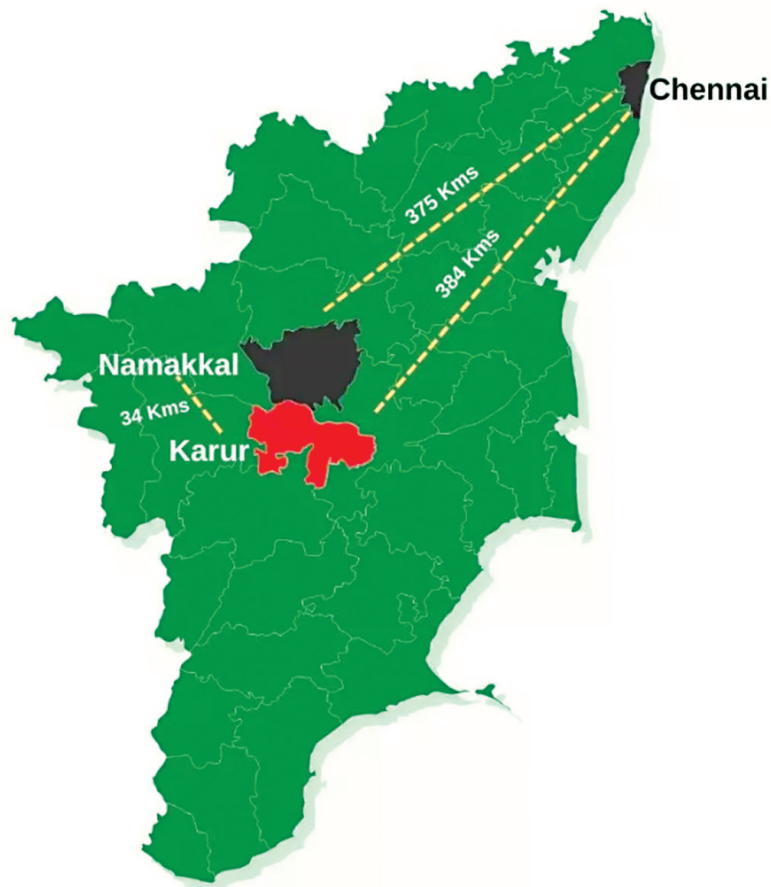


Figure 60: Map of Tamil Nadu showing the stampede site and its proximity to the state capital, Chennai.

Source: <https://thefederal.com/category/states/south/tamil-nadu/stampede-at-vijays-karur-rally-all-you-need-to-know-208947>



Figure 61: At the rally of Tamilaga Vetti Kazhagam president and actor Vijay in Namakkal district, Tamil Nadu.

Source: <https://indianexpress.com/article/india/deeply-saddening-parties-condole-karur-stampede-deaths-ask-cadres-to-extend-help-10275704/>



Figure 62: Stampede incident during an election campaign rally of Tamilaga Vетtri Kazhagam, led by Vijay, in Karur.

Source: <https://www.thehindu.com/news/national/tamil-nadu/karur-stampede-where-there-was-no-way-out/article70121911.ece>



Figure 63: Overcrowding observed during a public rally led by Tamilaga Vетtri Kazhagam chief Vijay in Karur district, Tamil Nadu, on September 27, 2025.

Source: <https://www.newindianexpress.com/states/tamil-nadu/2025/Sep/28/karur-stampede-top-tvk-functionaries-booked-for-endangering-human-life-disregarding-police-orders>

3. Impact

The Karur rally disaster had significant human, social, and administrative consequences.

3.1 Human Casualties

The most severe consequence of the disaster was the loss of human lives due to extreme crowd pressure. Reports indicate that approximately 36-39 people lost their lives in the crowd crush, while at least 40 individuals sustained injuries, many of whom required medical treatment. Victims suffered from fractures, head trauma, and breathing difficulties caused by intense compression in densely packed conditions. Notably, children were also among the victims, underscoring the severity of the incident and the heightened vulnerability of certain groups in overcrowded gatherings.

Table 37: Human Impact

Impact Category	Karur Rally Crush
Fatalities	41
Injured	100
Vulnerable groups affected	Women, elderly, children
Psychological trauma	Severe among survivors and families

Source: <https://www.hindustantimes.com/india-news/tvk-vijay-rally-stampede-live-updates-vijay-thalapathy-tvk-party-karur-rally-death-toll-tamil-nadu-news-101758991674950.html>

3.2 Psychological and Social Impact

The incident caused emotional trauma among survivors, families of victims, and local communities. Witnesses reported scenes of panic and chaos as individuals attempted to escape the crowd. Families of victims experienced significant emotional distress and uncertainty during rescue operations and identification processes.

Table 38: Infrastructure and Event Management Assessment

Parameter	Karur Rally
Venue capacity	Rally ground designed for ~10,000
Estimated attendance	>27,000 people
Entry points	Limited controlled access points
Police personnel were deployed	500
Crowd control measures	Temporary barricades
Emergency access	Delayed ambulance access

Source: <https://www.firstpost.com/india/triple-the-crowd-half-the-security-cops-reveal-lapses-behind-vijays-karur-rally-deaths-13937536.html>

3.3 Political and Administrative Impact

The disaster triggered widespread debate regarding the adequacy of safety protocols at political gatherings in India. It raised serious concerns about the planning and logistics of political rallies, the effectiveness of crowd capacity management, and the adequacy of safety infrastructure and emergency preparedness measures.

4. Possible Causes / Reasons

The crowd crush during the political rally resulted from a combination of organisational, environmental, and behavioural factors. Large political gatherings often attract massive crowds, and inadequate crowd management measures can quickly lead to hazardous conditions when crowd density exceeds safe limits.

Table 39: Crowd Density Risk Table

Density Level	Persons per m ²	Crowd Behaviour	Risk Level
Low	1–2	Free movement	Safe
Moderate	3–4	Limited movement	Moderate risk
High	5–6	Physical contact unavoidable	High risk
Critical	7+	Crowd turbulence and crushing pressure	Extreme risk

Source: [https://www.gkstill.com/Support/crowd-density/CrowdDensity-1.html#:~:text=Static%20crowd%20density%20\(general\),4.5%20people%20per%20square%20metre](https://www.gkstill.com/Support/crowd-density/CrowdDensity-1.html#:~:text=Static%20crowd%20density%20(general),4.5%20people%20per%20square%20metre)

Research shows that crowd disasters often occur when density exceeds 6–7 persons per square meter.

4.1 Lack of Adequate Buffer Zones Near the Stage

One of the key contributing factors was the absence of sufficient buffer zones between the stage and the audience area. In large public gatherings, buffer spaces are essential to prevent excessive crowd pressure near focal points such as stages where leaders or speakers are present. Without clearly defined barricaded zones and controlled access areas, supporters were able to move very close to the stage, leading to dangerously high crowd densities in the front sections of the venue.

4.2 Extremely High Crowd Density

The number of attendees at the rally reportedly exceeded the safe capacity of the venue, resulting in extreme crowd pressure. When crowd density surpasses safe thresholds, even minor disturbances - such as pushing, sudden movements, or individuals losing balance—can trigger crowd turbulence and trampling incidents. High crowd density significantly restricts individual movement and reduces the ability of people to react safely during emergencies.

4.3 Delay in the Arrival of the Political Leader

The delayed arrival of the main political leader resulted in a prolonged waiting period for attendees. Such delays can increase crowd impatience, restlessness, and movement toward focal points, particularly when supporters attempt to move closer to the stage to improve visibility. The anticipation and excitement associated with the leader's arrival may have intensified crowd movement and contributed to congestion near the stage area.

4.4 Heat Stress, Fatigue, and Physical Exhaustion

Environmental conditions also played a role in increasing the vulnerability of the crowd. High temperatures, prolonged standing, and limited access to water or shade may have caused several attendees to experience fatigue, dehydration, or fainting. If individuals collapse or lose balance in extremely dense crowds, it can trigger a chain reaction of falls and trampling, which often initiates crowd crush incidents.

4.5 Limited Emergency Exit and Evacuation Routes

The rally venue reportedly lacked sufficient emergency exit routes and clearly marked evacuation pathways. In large gatherings, multiple wide exit corridors are essential to allow safe dispersal of crowds. Limited exits can create bottlenecks during emergencies, making it difficult for individuals to move away from dangerous areas once a crowd surge begins.

5. Response

Following the crowd crush during the political rally in Chennai, authorities and emergency services initiated immediate response measures to rescue victims, provide medical assistance, and restore order at the venue. The response involved coordinated efforts from medical teams, police forces, and state authorities.

5.1 Emergency Medical Response

Emergency medical services were rapidly mobilised to assist those injured during the crowd crush. Medical teams promptly reached the site and began administering first aid while stabilising affected individuals. Ambulances were deployed to transport victims to nearby hospitals for further treatment. Many individuals were treated for injuries such as fractures and crush injuries, breathing difficulties caused by intense crowd pressure, dehydration and exhaustion, as well as trauma and shock. Hospitals in Chennai were placed on high alert to ensure timely and effective medical care for the injured.

5.2 Police and Security Response

Local police forces and security personnel were deployed to control the crowd, disperse the gathering, and secure the rally venue. Authorities established safety corridors to facilitate the movement of emergency vehicles and rescue teams.

Police personnel also worked to prevent additional crowd build-up and ensure the safe evacuation of attendees from the affected area.

5.3 Government Action and Investigation

The Government of Tamil Nadu ordered an official investigation to determine the sequence of events and identify potential lapses in event planning, crowd management, and safety arrangements. Authorities also announced financial compensation for the families of the deceased and injured victims. The investigation aimed to assess administrative responsibilities and recommend measures to prevent similar incidents at large public gatherings in the future.

6. Lessons Learned

The crowd crush during the political rally in Karur highlights several important lessons for improving safety management at large public gatherings. These lessons emphasize the need for stronger planning, technology integration, and coordinated disaster risk reduction strategies.

6.1 Importance of Comprehensive Mass Gathering Risk Assessment

Large political rallies often attract massive crowds, many of whom may arrive spontaneously. The incident demonstrates that comprehensive risk assessments must be conducted prior to major events to estimate expected attendance, identify potential hazards, and develop appropriate crowd management strategies. Implementation of guidelines issued by the National Disaster Management Authority is essential to ensure systematic planning and risk mitigation.

6.2 Need for Real-Time Crowd Monitoring Systems

Effective management of large gatherings requires continuous monitoring of crowd density and movement. The disaster highlights the need for advanced technological tools such as CCTV analytics, drone surveillance, and AI-based crowd density monitoring systems to detect dangerous crowd build-up and allow authorities to take preventive action before conditions become critical.

6.3 Capacity-Based Crowd Control and Access Regulation

One of the key lessons is the importance of strict capacity control at event venues. Entry should be regulated through controlled access points, and crowd numbers should not exceed the safe capacity of the venue. Without such controls, crowd density can quickly reach unsafe levels, significantly increasing the risk of crowd crush incidents.

6.4 Safety-Oriented Infrastructure and Venue Design

The disaster highlights the importance of designing event venues with crowd safety considerations, including wider access routes, clearly marked emergency exits, and segregated pathways for entry and exit. Adequate buffer zones near focal points such as stages can reduce crowd pressure and improve overall safety during large gatherings.

6.5 Effective Public Communication and Information Dissemination

Clear communication plays a critical role in preventing panic and managing crowd movement. Timely announcements, visible signage, and well-informed volunteers can help guide participants and reduce confusion during high-density situations. Effective communication systems can significantly enhance crowd control and emergency response.

6.6 Preparedness Training and Mock Drills

Regular training programs and simulation exercises for police personnel, volunteers, and event organisers are essential to prepare for emergencies during mass gatherings. Mock drills help improve coordination among stakeholders and ensure that emergency response procedures are implemented quickly and efficiently.

6.7 Integration with National and Global Disaster Risk Reduction Frameworks

Mass gathering safety planning should be integrated with broader disaster risk reduction strategies. Aligning event management practices with frameworks such as the Sendai Framework for Disaster Risk Reduction and the National Disaster Management Authority guidelines can help strengthen preparedness, risk assessment, and resilient event management systems.

References

- Chowdhury, S. (2025, September 28). Stampede at actor-politician Vijay's rally described in haunting visuals. NDTV. <https://www.ndtv.com/india-news/stampede-at-actor-politician-vijays-rally-described-in-haunting-visuals-1234567>
- Dhar, A. (2025, September 29). Massive tragedy at Vijay's Karur rally in Tamil Nadu, toll now 41 in 'stampede-like crush'. Hindustan Times. <https://www.hindustantimes.com/india-news/massive-tragedy-in-tamil-nadu-as-41-dead-at-vijays-karur-rally-101758989763650.html>
- The Hindu Bureau. (2025, October 8). Aruna Jagadeesan Commission to fix responsibility for lapses that led to Karur stampede: Tamil Nadu government. The Hindu. <https://www.thehindu.com/news/national/tamil-nadu/aruna-jagadeesan-commission-to-fix-responsibility-for-lapses-that-led-to-karur-stampede-tamil-nadu-government/article70135269.ece>
- National Disaster Management Authority. (2014). Managing Crowd at Events and Venues of Mass Gathering. Government of India. <https://ndma.gov.in/sites/default/files/PDF/Reports/managingcrowosQguide.pdf>
- Rankin, J. (2025, September 28). At least 40 dead and 124 injured in crush at Vijay rally in India. The Guardian. <https://www.theguardian.com/world/2025/sep/28/at-least-40-dead-and-124-injured-in-crush-at-vijay-rally-in-india>

- The Hindu Bureau. (2025, October 6). Karur stampede: A visual timeline on how the tragedy unfolded. The Hindu. <https://www.thehindu.com/news/national/tamil-nadu/karur-stampede-september-27-2025-tvk-vijay-visual-timeline/article70126058.ece>
- The Indian Express. (2025, October 1). Evidence, timeline and warnings: After Vijay's challenge to Stalin, Tamil Nadu govt responosQ to Karur stampede fact and fiction. The Indian Express. <https://indianexpress.com/article/cities/chennai/karur-stampede-vijay-stalin-govt-response-9584321/>
- Times News Network. (2026, March 16). Karur stampede case: Vijay appears before Central Bureau of Investigation; leaves Delhi HQ after 7-hour questioning. The Times of India. <https://timesofindia.indiatimes.com/entertainment/tamil/movies/news/karur-stampede-case-vijay-appears-before-cbi-leaves-delhi-hq-after-7-hour-questioning/articleshow/129599179.cms>

11. Telangana Chemical Factory Explosion

1. Introduction

Industrial disasters constitute a significant category of technological hazards that can result in severe loss of life, environmental contamination, and socio-economic disruption. India's rapid industrialization and expanding chemical and pharmaceutical sectors have increased the importance of robust industrial safety mechanisms and disaster preparedness. Incidents such as chemical plant explosions underscore the need for stronger regulatory compliance, risk assessment, and emergency response frameworks. On 30 June 2025, a major industrial accident occurred at a pharmaceutical chemical manufacturing facility operated by Sigachi Industries Ltd. in Pashamylaram Industrial Estate, Sangareddy district of Telangana. The accident involved a powerful explosion and subsequent fire in a production unit of the plant, resulting in a large number of casualties and extensive structural damage. The disaster is widely regarded as one of the worst industrial accidents in Telangana's history, raising concerns about industrial safety standards in chemical and pharmaceutical manufacturing units. This report provides a comprehensive overview of the event, including the disaster timeline, impacts, possible causes, response actions, challenges encountered, and lessons for improving industrial disaster risk management.

2. Overview of the Disaster Event

The Sigachi Industries Pharmaceutical Plant Explosion was a major industrial accident that occurred at a pharmaceutical ingredient manufacturing facility operated by Sigachi Industries Limited in Telangana. The plant is involved in the production of microcrystalline cellulose (MCC), a widely used pharmaceutical excipient that acts as a binding and stabilizing agent in tablets, capsules, and several food products. The explosion reportedly occurred within a spray dryer unit, a critical component of the MCC manufacturing process. Spray dryers are used to convert liquid or slurry-based raw materials into fine powder through rapid drying with hot air. This process can generate high concentrations of combustible dust particles, which, under certain conditions, can lead to dust explosions if ignition sources are present. During routine production operations, a sudden and powerful explosion occurred inside the spray dryer section of the facility. Preliminary reports indicated that the blast may have been triggered by the ignition of combustible cellulose dust within the drying system, leading to a rapid pressure build-up. The explosion was powerful enough to cause the collapse of a significant portion of the production building, severely damaging the surrounding infrastructure and triggering a fire that spread across the affected unit. At the time of the incident, more than 140 workers were present within the industrial premises, including operators, maintenance personnel, and support staff. Many of them were working inside or near the affected production block when the explosion occurred. The sudden collapse of structural elements, combined with the fire and dense smoke, trapped several workers inside the damaged facility.

The blast caused extensive structural damage, with debris scattered across the industrial compound. Rescue operations were particularly challenging due to collapsed concrete structures, intense heat from the fire, and unstable building components, which increased risks for emergency responders. Firefighters and rescue teams had to carefully navigate through the wreckage to search for survivors and recover victims. The disaster resulted in 44 fatalities and at least 33 injuries, making it one of the most severe industrial accidents in the region. Several individuals were initially reported missing following the incident. Due to the intensity of the explosion and the severity of burn injuries suffered by many victims, forensic identification procedures, including DNA analysis, were required to confirm the identities of some of the deceased. The incident raised serious concerns regarding industrial safety practices, dust explosion risks, maintenance of high-temperature processing equipment, and occupational safety protocols in chemical and pharmaceutical manufacturing facilities. Authorities subsequently initiated investigations to determine the precise cause of the explosion and assess compliance with industrial safety regulations. The disaster highlights the potential hazards associated with combustible dust in industrial processes, emphasizing the importance of robust safety systems, proper ventilation, dust control mechanisms, and strict operational safety standards in manufacturing plants handling fine particulate materials.

Table 40: Disaster Identification Table

Parameter	Details
Disaster Type	Industrial explosion and fire
Date	30 June 2025
Time	Around 9:00 AM IST
Location	Pashamylaram Industrial Estate, Sangareddy District, Telangana
Facility	Sigachi Industries Ltd.
Industry Type	Pharmaceutical ingredient manufacturing
Unit Affected	Spray dryer unit
Fatalities	44
Injured	33
Workers present	140
Nature of Damage	Building collapse, fire, severe structural damage

Sources:<https://www.newindianexpress.com/states/te/2025/Jul/09/grief-deepens-at-sigachi-with-mounting-death-toll>



Figure 64: Map of Telangana showing the location of Sigachi Chemicals at Pashamylaram Industrial Estate in Sangareddy district.

Source: <https://mailchi.mp/americangeo/dailygeo-11826307>

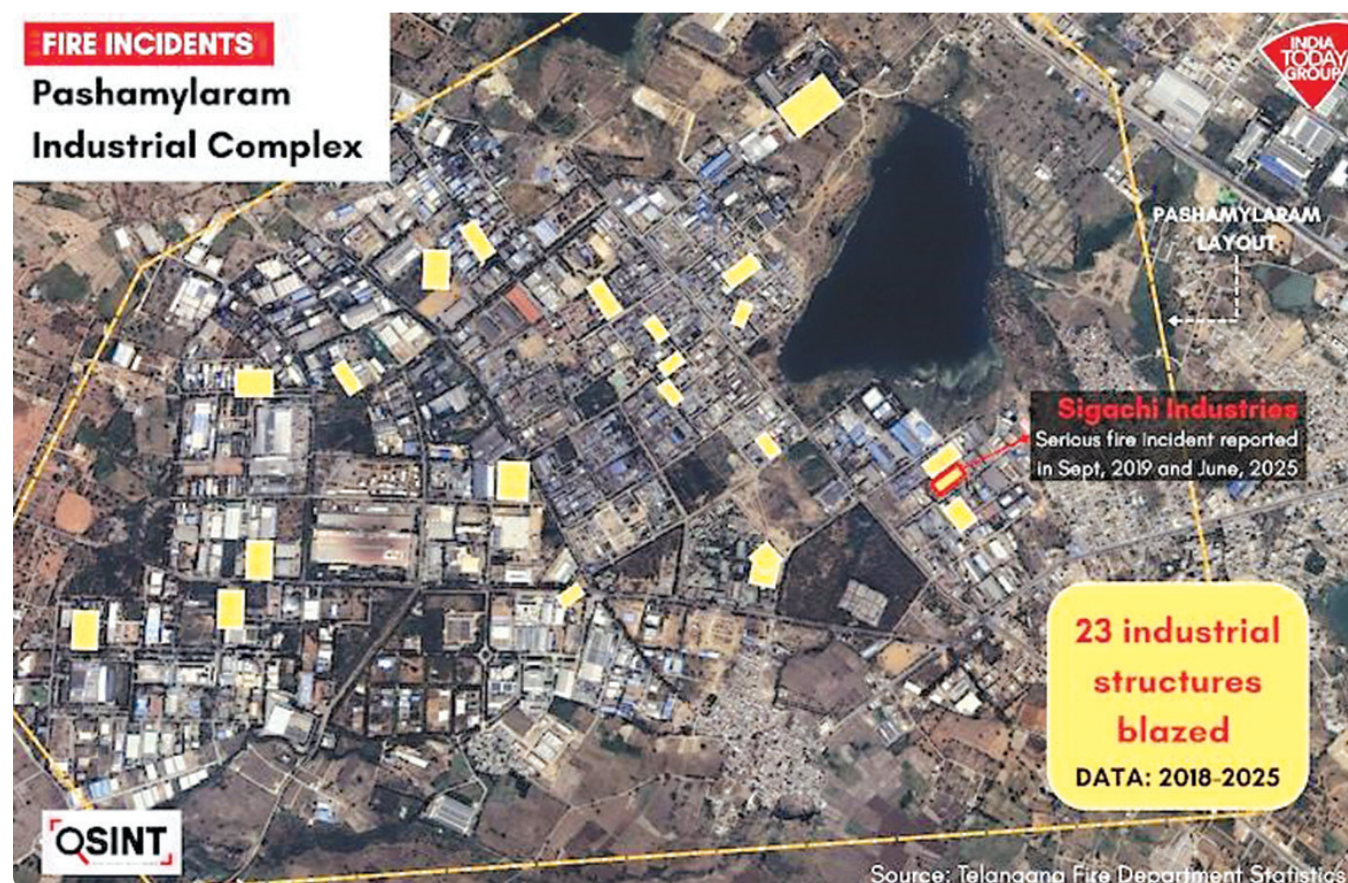


Figure 65: Pashamylaram Industrial Estate in Sangareddy District.

Source: <https://www.indiatoday.in/india/story/telangana-sigachi-pharma-plant-blast-regulatory-gaps-ignored-alarms-2749621-2025-07-02>

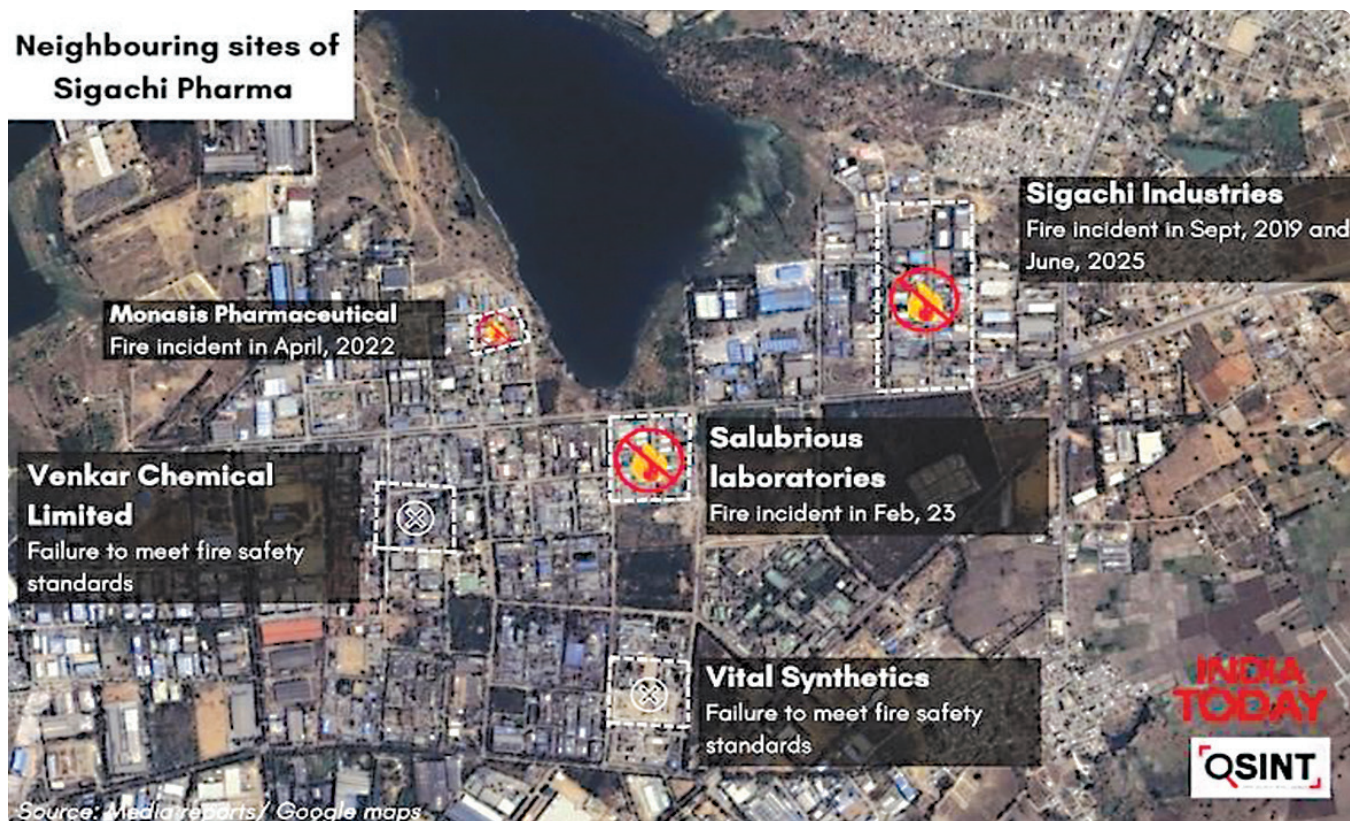


Figure 66: Neighbouring sites of Sigachi Pharma.

Source: <https://www.indiatoday.in/india/story/telegana-sigachi-pharma-plant-blast-regulatory-gaps-ignored-alarms-2749621-2025-07-02>

Table 41: Timeline of Telangana Chemical Factory Explosion

Time/Date	Event
30 June 2025 – ~9:00 AM	Explosion occurs in spray dryer unit of the chemical factory.
Immediately after blast	Fire breaks out and spreads rapidly through the production block.
30 June 2025	Local emergency services, fire brigade, and police reach the site and initiate rescue operations.
30 June – 1 July 2025	Search and rescue operations continue amid debris and fire damage.
Early July 2025	Casualty figures rise as injured workers succumb to burn injuries.
3 July 2025	State authorities halt plant operations and issue prohibitory orders pending investigation.
July 2025	Expert committee and regulatory agencies begin detailed investigation into causes and safety compliance.

Source: https://www.greentribunal.gov.in/sites/default/files/news_updates/OA%20No.%20115%20of%202025%20Additional%20Report%20of%20R-7.pdf



Figure 67: The extent of the explosion was such that entire portions of the factory collapsed.

Source: <https://indianexpress.com/article/cities/hyderabad/rarest-of-rare-overheating-likely-explosion-telangana-factory-10101844/>



Figure 68: NDRF personnel conducting rescue operations at the explosion site.

Source: <https://www.newindianexpress.com/states/telegana/2025/Jul/02/sigachi-industries-refutes-reactor-blast-as-cause-of-tragedy-confirms-38-dead>

3. Impact

The Sigachi Industries Pharmaceutical Plant Explosion resulted in extensive human, infrastructural, economic, and regulatory impacts. The severity of the explosion, combined with the collapse of major structural components of the facility, led to significant casualties and major disruptions to industrial operations.

3.1 Human Impact

The disaster caused substantial loss of life and injuries among factory workers, many of whom were present in the affected production block during operational hours. Several workers were trapped under collapsed structural elements or exposed to intense heat and smoke following the explosion and subsequent fire. The nature of the accident resulted in severe burn injuries, trauma from structural collapse, and smoke inhalation, making rescue and medical response extremely challenging. In several cases, the extent of burn injuries made visual identification difficult, necessitating forensic identification through DNA testing. The scale of casualties was further aggravated by the high number of workers present at the facility during active production, as well as the rapid structural collapse that followed the blast.

Table 42: Human Impact

Impact Category	Details
Fatalities	44 workers
Injured	33 workers
Missing	Several initially reported missing
Nature of injuries	Severe burns, trauma, inhalation injuries
Identification challenges	DNA testing required due to extensive burns

Source: <https://www.newindianexpress.com/states/telangana/2025/Jul/09/grief-deepens-at-sigachi-with-mounting-death-toll>

3.2 Infrastructure and Industrial Impact

The explosion caused extensive structural damage to the manufacturing facility, particularly the production block where the spray drying process was taking place. The powerful blast destroyed large sections of the building and severely damaged industrial equipment and support infrastructure within the plant. The spray dryer unit and associated processing machinery were completely destroyed, resulting in major operational losses. Debris from the collapsed structure complicated rescue operations and further delayed recovery and assessment efforts. Following the incident, plant operations were immediately suspended pending investigation and safety inspections, leading to a halt in production activities.

Table 43: Infrastructure Impact

Impact Category	Description
Building damage	Production block completely collapsed
Machinery	Spray dryer and associated equipment destroyed
Production loss	Significant disruption to manufacturing
Plant shutdown	Operations suspended for investigation

Source: <https://frontline.thehindu.com/society/sigachi-blast-telangana-safety-failure/article69795292.ece>

The affected facility represented a substantial portion of the company's manufacturing capacity, accounting for roughly one-fourth of total production. The destruction of the unit therefore had serious implications for the company's operational continuity.

3.3 Economic and Industrial Impact

Beyond the immediate physical damage, the explosion had broader economic and industrial implications. Disruptions in the production of microcrystalline cellulose affected supply chains linked to pharmaceutical manufacturing and related industries. The incident also triggered financial and reputational impacts for Sigachi Industries Limited, including fluctuations in market confidence and temporary decline in share value following the accident.

Table 44: Economic and Industrial Impact

Sector	Impact
Pharmaceutical supply chain	Temporary disruption in MCC production
Corporate losses	Decline in company share value and operational losses
Employment	Workers affected due to suspension of plant operations
Industrial confidence	Increased scrutiny of industrial safety practices

Source: <https://frontline.thehindu.com/society/sigachi-blast-telangana-safety-failure-article69795292.ece>

4. Possible Causes / Reasons

Preliminary investigations into the Sigachi Industries Pharmaceutical Plant Explosion suggest that the accident may have resulted from a combination of technical failures, combustible dust hazards, and possible gaps in industrial safety systems. While the exact cause requires detailed forensic and engineering analysis, early findings and inspection reports indicate several contributing factors.

4.1 Dust Explosion in the Spray Dryer System

One of the most likely causes of the explosion is a combustible dust explosion within the spray dryer unit. Spray dryers used in the production of microcrystalline cellulose generate fine organic powder particles, which can become suspended in the air during the drying process. When such dust accumulates in confined spaces and is exposed to an ignition source- such as heat, sparks, or friction-it can lead to a rapid dust explosion. Dust explosions are a well-recognized industrial hazard in facilities handling fine particulate materials. In such cases, a small ignition event can trigger a chain reaction of pressure buildup and secondary explosions, causing severe structural damage and fires.

4.2 Overheating and Failure of Temperature Control Systems

Preliminary assessments by authorities indicated that the explosion may have originated from overheating within the spray dryer unit. Spray dryers operate at high temperatures to remove moisture from raw materials, and failure of temperature regulation systems can result in excessive heat buildup. If temperature sensors, control systems, or pressure relief mechanisms malfunction, heat accumulation inside the drying chamber can ignite combustible dust particles. This can rapidly escalate into a powerful explosion due to pressure buildup inside the equipment.

4.3 Safety and Compliance Deficiencies

Inspection reports following the incident reportedly identified several deficiencies in fire safety and industrial safety infrastructure within the facility. These included:

- Lack of automatic fire detection and alarm systems
- Absence or inadequate coverage of automatic sprinkler systems
- Insufficient fire pumps and water storage capacity to handle large industrial fires
- Limited real-time safety monitoring and hazard detection systems

The absence of these safety measures may have delayed detection and response to the initial fire or ignition source, allowing the situation to escalate into a large-scale explosion.

4.4 Equipment Maintenance and Operational Concerns

Another possible contributing factor relates to equipment condition and maintenance practices. Reports from workers suggested concerns about aging machinery, inadequate maintenance schedules, and delayed replacement of critical equipment. Industrial processing equipment such as spray dryers requires regular inspection, cleaning, and maintenance to prevent dust accumulation, overheating, and mechanical failures. Inadequate maintenance may lead to malfunctioning sensors, blocked ventilation systems, or worn-out components, which can increase the risk of operational accidents.

4.5 Inadequate Dust Management and Ventilation Systems

Effective dust management and ventilation systems are essential in industries dealing with fine powders. Without proper dust extraction, filtration, and ventilation mechanisms, combustible dust can accumulate within equipment and surrounding workspaces. If dust control systems were insufficient or malfunctioning, the concentration of airborne particles could have reached explosive levels, significantly increasing the risk of ignition and blast propagation.

5. Response

The explosion at Sigachi Industries Pharmaceutical Plant Explosion triggered a coordinated emergency response involving multiple agencies, including fire services, police, medical teams, and district administration. The primary objectives of the response were to control the fire, rescue trapped workers, provide urgent medical assistance, and initiate investigations into the causes of the incident.

5.1 Emergency Rescue Operations

Immediately after the explosion, emergency services were mobilized to the site to conduct search, rescue, and firefighting operations. Due to the collapse of sections of the production building and the presence of burning debris, rescue teams faced significant operational challenges.

Key response actions included:

- Deployment of fire brigades and disaster response teams to control the fire and secure the affected area
- Intensive search and rescue operations to locate workers trapped under collapsed concrete structures and debris
- Use of heavy equipment and cutting tools to remove rubble and access trapped individuals
- Deployment of ambulances to transport injured workers to nearby medical facilities for immediate treatment

Rescue operations continued for several hours and required careful coordination due to the unstable structure, residual heat, and risk of secondary fires.



Figure 69: Firefighters try to extinguish a fire that broke out in a chemical factory, at Pashamylaram, in Medak district, Telangana.

Source: <https://indianexpress.com/article/india/telangana-blast-explosion-pharma-plant-sigachi-deaths-10097269/>



Figure 70: Rescue workers look for survivors after an explosion and fire at a chemical factory, in Sangareddy, in the southern state of Telangana, India, June 30, 2025.

Source: <https://www.reuters.com/world/india/forty-dead-over-33-injured-india-factory-fire-sigachi-says-2025-07-02/>



Figure 71: Personnel of NDRF, police and the fire department search for human remains at the blast site in Sigachi.

Source: <https://frontline.thehindu.com/society/sigachi-blast-telangana-safety-failure/article69795292.ece>

5.2 Medical Response

Medical teams responded rapidly to treat victims suffering from severe burn injuries, trauma, and smoke inhalation. Injured workers were transported to hospitals in Hyderabad and nearby districts where emergency treatment was provided. Hospitals activated emergency protocols to manage the large number of casualties. Medical staff provided burn care, trauma management, respiratory support, and critical care services. In cases involving severe burn injuries, specialized treatment and intensive care were required.

5.3 Government and Institutional Response

Following the incident, the Government of Telangana and relevant regulatory agencies initiated several administrative and legal measures to address the disaster and investigate the causes.

Key government actions included:

- Immediate suspension of plant operations pending safety inspections and investigation
- Formation of expert committees to examine the causes of the explosion and assess compliance with industrial safety regulations
- Issuance of show-cause notices to the factory management regarding possible safety violations
- Announcement of financial compensation for the families of deceased workers and injured victims

In addition, regulatory bodies-initiated inquiries to evaluate environmental and industrial safety compliance at the facility.

Table 45: Institutional Response

Authority	Action Taken
Government of Telangana	Constituted investigation committee
Department of Factories	Issued prohibitory orders to halt plant operations
National Green Tribunal	Initiated suo motu inquiry into the incident
Telangana Fire Services	Conducted fire safety inspections
District Administration	Coordinated rescue, relief, and emergency response

Source: <https://www.thehindu.com/news/national/telangana/sigachi-report-production-enhancement-without-trained-staff-and-safety-measures-led-to-the-explosion/article70307963.ece>

https://www.greentribunal.gov.in/sites/default/files/news_updates/OA%20No.%20115%20of%202025%20Additional%20Report%20of%20R-7.pdf

<https://www.deccanchronicle.com/southern-states/telangana/report-on-sigachi-explosion-released-sigachi-ordered-to-stop-manufacturing-1894828>

6. Issues, Challenges, and Concerns

The Sigachi Industries Pharmaceutical Plant Explosion exposed several systemic weaknesses in industrial safety governance, regulatory oversight, and disaster preparedness within high-risk manufacturing facilities. The scale of the accident highlighted the vulnerabilities associated with handling combustible materials and operating complex industrial processes without robust safety mechanisms.

6.1 Industrial Safety Compliance

One of the primary concerns revealed by the incident is the inadequate compliance with industrial and fire safety regulations. Inspection reports and preliminary investigations pointed to deficiencies in critical safety systems such as fire detection, suppression mechanisms, and hazard monitoring equipment. In industries dealing with combustible powders and high-temperature processes, strict adherence to safety standards is essential. Failure to maintain adequate safeguards can allow minor operational faults to escalate into major industrial disasters.



Figure 72: Industrial safety norms.

Source: <https://www.indiatoday.in/india/story/telangana-sigachi-pharma-plant-blast-regulatory-gaps-ignored-alarms-2749621-2025-07-02>

6.2 Emergency Preparedness and Evacuation Challenges

The explosion caused a rapid structural collapse, trapping many workers inside the facility. This situation highlighted the lack of effective emergency preparedness measures, including clearly defined evacuation protocols and emergency response systems within the plant. In industrial environments where accidents can escalate quickly, facilities must ensure the availability of well-marked evacuation routes, alarm systems, and regular emergency drills to enable workers to evacuate safely.

6.3 Gaps in Regulatory Oversight and Monitoring

Despite the presence of regulatory frameworks governing industrial safety, the incident indicates potential gaps in monitoring, compliance verification, and enforcement mechanisms. Safety lapses identified after the accident suggest that inspections may not have adequately detected or addressed existing hazards. Strengthening regulatory oversight through more frequent inspections, digital monitoring systems, and stricter enforcement actions is critical to preventing such accidents.

6.4 Limited Worker Safety Awareness and Training

Worker safety awareness and training are essential components of industrial risk management. Many industrial accidents are exacerbated when workers lack adequate knowledge of workplace hazards, emergency procedures, and safe operating practices. The disaster highlights the need for comprehensive training programs that equip workers with the skills required to recognize hazards, respond to emergencies, and follow proper evacuation procedures.

6.5 Risks Associated with Industrial Clustering

Industrial estates often host multiple manufacturing units operating in close proximity. While such clustering improves economic efficiency, it can also increase disaster risks, particularly when facilities handle hazardous chemicals or combustible materials. In such environments, accidents in one plant may trigger secondary incidents or cascading failures affecting nearby facilities.

Key risk factors associated with industrial clustering include:

- Storage of hazardous chemicals and combustible materials
- Presence of high-temperature processing equipment
- Interconnected utilities and production systems
- Potential for fire or explosion to spread across adjacent facilities

7. Lessons Learned

The Sigachi Industries Pharmaceutical Plant Explosion highlights several critical lessons for strengthening industrial safety management, regulatory governance, and disaster risk reduction in hazardous manufacturing sectors. The incident demonstrates how technical failures, inadequate safety systems, and gaps in emergency preparedness can rapidly escalate into catastrophic industrial disasters. The following key lessons emerge from the event.

7.1 Industrial Safety Compliance Must Be Strictly Enforced

One of the most important lessons from the incident is the critical importance of strict compliance with industrial safety regulations. Manufacturing facilities handling combustible materials or operating high-temperature processing equipment must adhere to rigorous safety standards. Compliance should include proper installation of fire detection systems, functioning safety alarms, pressure control mechanisms, and adequate fire suppression infrastructure. Failure to comply with these safety requirements significantly increases the risk of explosions, fires, and large-scale industrial accidents.

7.2 Early Detection Systems Are Essential for Hazard Prevention

The explosion highlights the need for advanced technological monitoring systems capable of detecting hazardous conditions in real time. Industrial plants handling fine powders or combustible dust must implement automated monitoring systems that track parameters such as temperature, pressure, dust concentration, and equipment performance. Early detection of abnormal conditions can enable operators to intervene before hazards escalate into major accidents.

7.3 Combustible Dust Hazards Require Specialized Risk Management

The disaster demonstrates the serious risks associated with combustible dust generated during industrial processes. In facilities producing powdered materials such as microcrystalline cellulose, suspended dust particles can create highly explosive environments. Effective dust management strategies—including proper ventilation, dust extraction systems, regular cleaning of processing equipment, and explosion venting mechanisms—are essential to reduce the likelihood of dust explosions.

7.4 Worker Safety Training and Awareness Are Critical

Another key lesson is the importance of comprehensive worker safety training. Workers operating in hazardous industrial environments must be trained to recognize potential hazards, follow safe operating procedures, and respond effectively during emergencies. Regular safety drills, evacuation training, and awareness programs can significantly improve workers' ability to react quickly during accidents, potentially reducing casualties.

7.5 Emergency Preparedness and Evacuation Planning Must Be Strengthened

The large number of casualties indicates the need for stronger emergency preparedness systems within industrial facilities. Factories should maintain clearly marked evacuation routes, emergency exits, and alarm systems that allow workers to evacuate rapidly in the event of a fire or explosion. Regular mock drills and coordination with local emergency services can enhance response capacity and ensure quicker evacuation during emergencies.

7.6 Stronger Regulatory Oversight and Inspection Systems Are Needed

The incident also highlights the need for more effective regulatory oversight of industrial facilities. Regular safety inspections, third-party safety audits, and digital monitoring systems can help ensure that factories maintain compliance with industrial safety standards. Strengthening inspection mechanisms and enforcing strict penalties for safety violations can encourage industries to adopt safer operational practices.

7.7 Integration of Industrial Risk Management into Disaster Planning

Industrial accidents involving chemical or pharmaceutical manufacturing can have wide-ranging consequences for workers, communities, and the environment. Therefore, industrial risk management should be integrated into broader disaster risk reduction strategies. District and State authorities should include industrial hazard assessments in District Disaster Management Plans (DDMPs) and maintain updated inventories of hazardous industries. This integration can improve preparedness, emergency coordination, and response planning.

7.8 Accountability and Institutional Transparency Are Crucial

Finally, the disaster underscores the importance of accountability and transparency in industrial safety governance. Investigations into such accidents should lead to concrete policy reforms, improved safety regulations, and stronger enforcement mechanisms. Holding industrial operators accountable for negligence can help create a culture of safety and prevent recurrence of similar incidents.

References

- AP News. (2025, July 1). Death toll rises to 36 after explosion at a pharmaceutical factory in southern India. <https://apnews.com/article/india-pharmaceutical-factory-fire-telangana-e914c229736d1b2af3d4565d0e227cb1>
- Dhar, A., & Singh, S. K. (2025, July 1). Telangana pharma factory blast: Death toll reaches 36, rain hampers rescue operations. The Hindu. <https://www.thehindu.com/news/national/telangana/telangana-pharma-factory-blast-sangareddy-death-toll-live-updates-july-1-2025/article69758348.ece>
- Economic Times Online. (2025, December 29). Telangana plant explosion: Sigachi Industries CEO held. <https://hr.economictimes.indiatimes.com/news/industry/telangana-plant-explosion-sigachi-industries-ceo-held/126222754>
- Government of Telangana. (2025, September). Report of the technical expert committee on the major explosion and fire at Sigachi Industries Ltd, Pashamylaram. Department of Factories. https://www.greentribunal.gov.in/sites/default/files/news_updates/OA%20No.%20115%20of%202025%20Additional%20Report%20of%20R-7.pdf
- National Green Tribunal. (2025, September 12). Tribunal on its own motion (Suo Motu) based on news item in Times of India regarding Sigachi Industries factory blast (Original Application No. 115 of 2025). https://www.greentribunal.gov.in/sites/default/files/news_updates/OA%20No.%20115%20of%202025%20Additional%20Report%20of%20R-7.pdf
- NewsClick Report. (2026, March 10). Sigachi incident exposes huge gaps in new OSH code. <https://www.newsclick.in/sigachi-incident-exposes-huge-gaps-new-osh-code>

- Press Trust of India. (2025, July 08). Telangana pharma plant explosion: Death toll rises to 44. The New Indian Express. <https://www.newindianexpress.com/states/telangana/2025/Jul/08/telangana-pharma-plant-explosion-death-toll-rises-to-44>
- Rao, S. (2025, July 3). Panel to probe Sigachi blast, says Telangana; toll now 40: Factory. Hindustan Times. <https://www.hindustantimes.com/india-news/panel-to-probe-sigachi-blast-says-t-gana-toll-now-40-factory-101751482232788.html>
- Sigachi Industries Limited. (2025, July 2). Clarification on the industrial accident at Pashamylaram facility. <https://www.sigachi.com/investors/announcements>
- The Federal. (2025, July 1). Telangana govt tears into Sigachi bosses for vanishing act after blast. <https://thefederal.com/category/states/south/telangana/telangana-govt-tears-into-sigachi-bosses-for-vanishing-act-after-blast-194692>
- The Times of India. (2025, September 12). National Green Tribunal takes up suo motu probe into blast at Sigachi factory in Hyderabad. <https://timesofindia.indiatimes.com/city/hyderabad/national-green-tribunal-takes-up-suo-motu-probe-into-blast-at-sigachi-factory-in-hyderabad/articleshow/123836398.cms>

12. Arpora Nightclub Fire, Goa

1. Introduction

Urban fires in entertainment venues pose serious risks due to crowd density, combustible interiors, and inadequate safety compliance. Globally, several nightclub fires-such as those in Rhode Island (2003) and Bucharest (2015) - have highlighted systemic failures in fire safety regulation and emergency preparedness. India has also experienced similar tragedies in public spaces, including the Kamala Mills fire (Mumbai, 2017) and the Gulzar Houz fire (Hyderabad, 2025). The Arpora Nightclub Fire of 6 December 2025 emerged as one of the deadliest fire incidents in Goa's history, raising serious concerns about the enforcement of fire safety standards in tourism establishments. The blaze occurred at the Birch by Romeo Lane nightclub in Arpora village, a popular nightlife hub in North Goa. The incident resulted in 25 fatalities and around 50 injuries, with most victims being staff members trapped in service areas and the basement of the venue. This report examines the event chronology, causes, impacts, response mechanisms, and systemic challenges, and proposes recommendations aligned with disaster risk reduction frameworks relevant for India.

2. Overview of the Disaster Event

The Goa Nightclub Fire was a tragic fire incident that occurred late at night during a crowded entertainment event in Arpora, a well-known tourist area in the state of Goa. The incident took place at a popular nightclub that was hosting a large dance event attended by tourists, staff members, and performers. The fire reportedly broke out around 11:45 PM on 6 December 2025 during peak activity at the venue. At the time of the incident, the nightclub was operating at near-full capacity, with a large number of visitors inside the building. Within minutes of the initial ignition, flames spread rapidly through the structure, aided by the presence of decorative materials, lighting installations, and combustible interior furnishings commonly used in entertainment venues. The confined indoor environment and dense crowd further accelerated the spread of smoke and fire, creating a hazardous situation for occupants.

Preliminary reports indicated that the fire may have originated near the kitchen area on the ground floor of the establishment. Early investigations suggested that the improper use of indoor fireworks or pyrotechnic effects during the event could have triggered the blaze, possibly igniting nearby flammable materials. Once ignited, the fire quickly intensified and spread to other sections of the building, producing thick smoke that rapidly filled the interior spaces. The nightclub was located in a narrow and congested lane near Arpora village, which significantly complicated the emergency response. Fire engines and emergency vehicles were unable to reach the building directly and had to be stationed at some distance from the site. Firefighters had to carry hoses and equipment through crowded streets to reach the venue, resulting in delays during the initial firefighting operations.

Many of the casualties occurred due to smoke inhalation and suffocation, particularly among staff members and workers who were present on the lower floors and in

basement areas. These spaces reportedly had limited ventilation and restricted escape routes, making evacuation difficult once the fire spread and smoke accumulated inside the building. Emergency response teams, including fire services, police, and medical personnel, were deployed to the site to extinguish the fire, rescue trapped individuals, and transport injured victims to nearby hospitals. The incident caused widespread shock and attracted national attention, raising serious concerns about fire safety compliance, emergency preparedness, and regulatory oversight of entertainment venues in major tourist destinations. The disaster prompted authorities to initiate investigations into the cause of the fire, licensing status of the establishment, adherence to fire safety regulations, and the use of pyrotechnic devices inside enclosed public venues. The incident also renewed calls for stricter enforcement of fire safety standards in nightclubs, restaurants, and other high-occupancy entertainment establishments.

Table 46: Disaster Identification Table

Parameter	Details
Disaster Type	Urban Fire / Structural Fire
Event Name	Arpora Nightclub Fire
Date	6 December 2025
Time	Approximately 11:45 PM IST
Location	Arpora Village, North Goa
Venue	Birch by Romeo Lane Nightclub
Fatalities	25 persons
Injuries	Approximately 50 persons
Primary Victims	Club employees and tourists
Immediate Cause (Preliminary)	Indoor fireworks / pyrotechnic ignition
Key Agencies Involved	Goa Fire & Emergency Services, Goa Police, District Administration

Source: <https://www.thehindu.com/news/national/goa/several-killed-in-fire-nightclub-goa-arpora-village-updates/article70366965.ece>

Table 47: Timeline of Key Events

Time / Date	Event
Evening, 6 Dec 2025	Nightclub hosts a dance event with tourists and staff present
11:45 PM	Fire breaks out inside the nightclub near kitchen area
12:04 AM	Emergency services receive distress call
Shortly after midnight	Flames engulf major portions of the building
12:30–2:00 AM	Firefighting and evacuation operations underway
Early morning, 7 Dec	Fire brought under control after approximately two hours

Morning, 7 Dec	Victims transported to Goa Medical College
7 Dec	Government orders magisterial inquiry
Following week	Fire safety audits ordered for nightclubs across Goa

Source: <https://www.thehindu.com/news/national/goa/goa-club-cylinder-blast-midnight-blaze-arpura-village-pramod-sawant-live-updates/article70368040.ece>

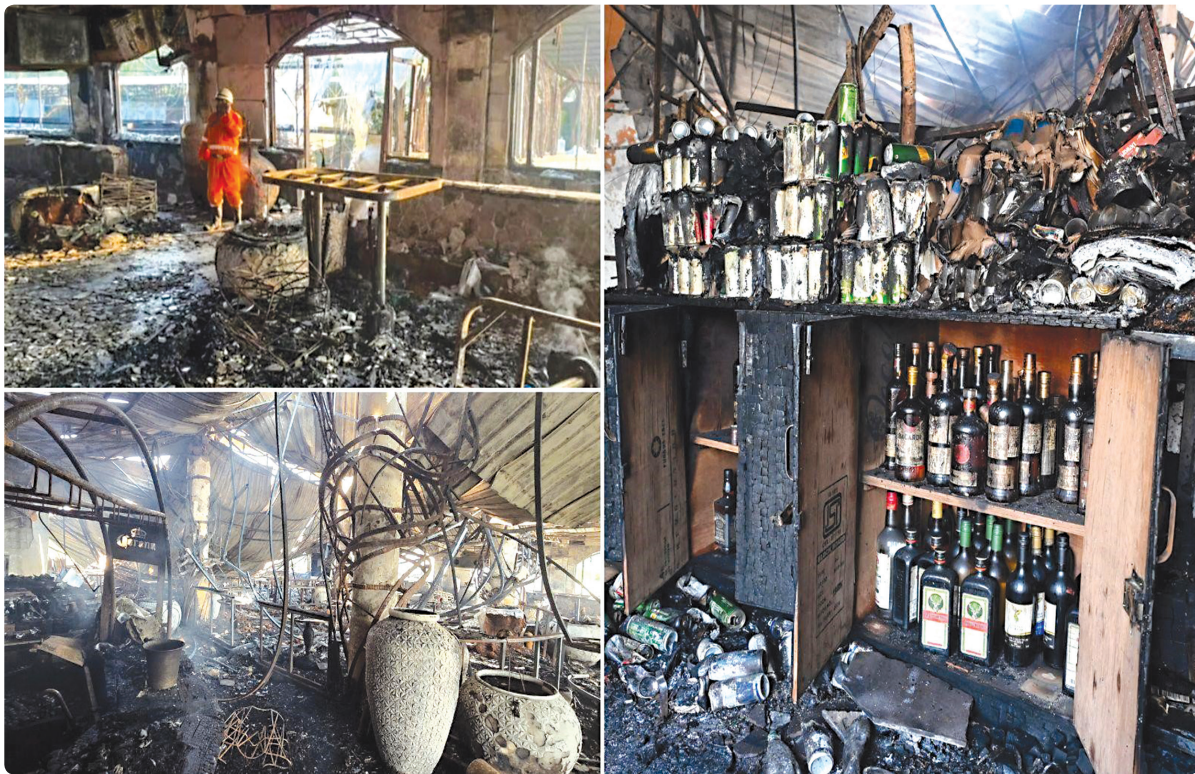


Figure 73: Fire incident at a nightclub in Arpora, Goa.

Source: <https://indianexpress.com/article/india/goa-club-fire-investigators-exploring-theories-cause-killer-blaze-10424909/>





Figure 74: Aftermath of the Arpora nightclub fire showing structural damage.

Source: <https://indianexpress.com/article/india/exclusive-under-scanner-the-string-of-approvals-that-made-killer-go-a-nightclub-a-reality-10417712/>

3. Impact

The Goa Nightclub Fire resulted in significant human, economic, tourism, and socio-psychological impacts. The disaster not only caused tragic loss of life but also raised broader concerns about safety standards in nightlife establishments across Goa, one of India's most prominent tourism destinations.

3.1 Human Impact

The fire led to substantial casualties among both employees and tourists present at the nightclub during the event. Reports indicate that 25 people lost their lives, while approximately 50 others sustained injuries of varying severity. A large proportion of the victims were staff members working in service areas, including the kitchen, bar counters, and basement storage sections. These locations reportedly had limited access to emergency exits, making evacuation difficult once smoke rapidly filled the interior spaces. Several victims were trapped in lower floors and enclosed sections of the building where visibility quickly deteriorated due to thick smoke.

Most deaths occurred due to smoke inhalation and suffocation, rather than direct burn injuries. This highlights the critical importance of smoke control systems, emergency ventilation, and clearly marked evacuation routes in enclosed entertainment venues. Injured individuals suffered from burn injuries, respiratory distress caused by smoke inhalation, and trauma injuries sustained during attempts to escape the fire or due to crowd congestion. Emergency medical teams transported victims to nearby hospitals for treatment, with some requiring intensive care.

Table 48: Casualty Details

Category	Numbers
Total Fatalities	25
Total Injured	50
Staff among deceased	Majority
Primary cause of death	Suffocation and burns

Source: <https://www.theguardian.com/world/2025/dec/06/several-tourists-among-killed-in-blaze-at-go-a-nightclub>

3.2 Economic and Tourism Impact

The incident had significant economic and tourism-related consequences, particularly as it occurred at the onset of the peak tourist season in Goa. The state’s economy is heavily dependent on tourism, hospitality services, and nightlife entertainment, making such safety incidents especially damaging. In the immediate aftermath of the fire, authorities carried out extensive inspections and safety audits of nightclubs, bars, and entertainment establishments across major tourist areas. Several venues were temporarily shut down due to non-compliance with fire safety regulations, disrupting business operations.

In the short term, the incident led to the temporary closure of multiple nightlife establishments, loss of revenue in the hospitality and tourism sectors, increased regulatory scrutiny, and higher compliance costs for business owners. It also resulted in reputational damage to Goa’s tourism industry. Additionally, concerns regarding visitor safety had the potential to affect tourist confidence, particularly among international travellers visiting during the peak winter holiday season.

3.3 Psychological and Social Impact

Beyond physical and economic damage, the disaster caused significant psychological and social distress among affected communities. Families of victims experienced profound grief and emotional trauma following the sudden loss of loved ones. Survivors of the fire, including workers and tourists who witnessed the incident, may face long-term psychological impacts such as post-traumatic stress, anxiety, and fear associated with crowded indoor environments. The disaster also deeply affected workers in the hospitality and nightlife industry, many of whom rely on such venues for employment. Concerns about workplace safety and job security increased following the incident. Furthermore,

first responders and emergency personnel involved in rescue and recovery operations were exposed to distressing scenes, which can also contribute to psychological stress. The incident underscored the importance of integrating mental health support and psychosocial care into disaster response frameworks, particularly in events involving mass casualties and public venues.

4. Possible Causes / Reasons

Although the final investigation report into the Goa Nightclub Fire is pending, preliminary findings and early assessments by authorities suggest that the disaster likely resulted from a combination of ignition sources, combustible materials, and safety management failures. The interaction of these factors contributed to the rapid escalation of the fire and the high number of casualties.

4.1 Pyrotechnic Ignition

Early investigation reports indicated that indoor electric firecrackers or pyrotechnic devices may have been used during the dance event as part of stage effects or entertainment performances. Such devices are commonly used in nightclubs and concert venues to enhance visual effects. However, the use of pyrotechnics inside enclosed spaces requires strict adherence to fire safety protocols, including adequate clearances, fire-resistant materials, and prior approval from safety authorities. If these precautions are not followed, sparks or hot particles generated by pyrotechnics can easily ignite nearby combustible materials. In this case, investigators suspect that sparks from the pyrotechnic effects may have ignited decorative materials or nearby fixtures, triggering the initial fire.

4.2 Combustible Interior Materials

The rapid spread of the fire was reportedly intensified by the presence of highly flammable interior decorations and furnishings within the nightclub. Reports suggest that decorative materials such as dried palm leaves, wooden panels, synthetic fabrics, and decorative lighting installations were extensively used in the interior design. Such materials can act as highly combustible fuel sources, allowing flames to spread quickly across ceilings, walls, and stage areas. In enclosed entertainment venues where lighting and electrical equipment generate heat, these materials can significantly increase fire risk. Once the fire ignited, these decorations likely accelerated flame propagation, producing dense smoke and toxic gases, which contributed to the high number of casualties due to suffocation.

4.3 Structural and Safety Violations

Preliminary assessments also highlighted multiple structural and regulatory safety deficiencies in the nightclub's layout and safety infrastructure. Reports indicated that the establishment may have been operating with limited emergency exits and congested entry routes, which severely hindered evacuation once the fire spread.

Several key safety concerns were identified:

- Insufficient emergency exits, making it difficult for large crowds to evacuate quickly
- Narrow and congested entry/exit pathways, which caused crowd bottlenecks during the emergency
- Basement occupancy, where staff members and service areas were located with limited ventilation
- Inadequate fire detection and suppression systems, which may have delayed early fire containment

Authorities also reported that the establishment had previously received regulatory notices regarding structural and safety violations, raising concerns about compliance with fire safety standards.



Figure 75: The first-floor exit opens onto a narrow bridge on two sides, the front and rear, and is surrounded by khazans – low-lying lands used for agriculture and aquaculture – near the Baga River.

Source: <https://indianexpress.com/article/india/goa-nightclub-where-fire-killed-25-came-under-scrutiny-more-than-once-but-evaded-action-10408060/>

Table 49: Contributing Risk Factors

Risk Factor	Description
Use of indoor fireworks	Likely ignition source for the fire
Flammable decorations	Accelerated fire spread inside the venue
Narrow entry/exit pathways	Created evacuation difficulties and crowd congestion
Basement occupancy	Increased risk of entrapment and smoke accumulation
Regulatory non-compliance	Lack of adequate safety infrastructure and enforcement

Source: <https://www.deccanchronicle.com/southern-states/telangana/goa-fire-brings-fire-safety-back-on-agenda-1922504>

5. Response

The response to the Goa Nightclub Fire involved rapid mobilization of fire services, police, medical teams, and district administration authorities in Goa. Emergency operations focused on fire suppression, rescue of trapped individuals, medical treatment of victims, and investigation into the causes of the incident.

5.1 Emergency Response

Emergency services were alerted shortly after the fire broke out around midnight. The Goa Fire and Emergency Services responded promptly to the distress call and dispatched multiple fire tenders and rescue teams to the incident site in Arpora.

Key emergency response actions included:

- Fire suppression operations to control and extinguish the rapidly spreading flames
- Search and rescue operations to locate and evacuate individuals trapped inside the nightclub building
- Evacuation of survivors from smoke-filled areas, particularly from service zones and basement sections
- Medical triage at the scene, where first responders assessed the condition of injured victims and prioritized evacuation to hospitals

However, firefighting operations faced significant logistical challenges. The nightclub was located in a narrow and congested lane, which prevented fire engines from reaching the building directly. As a result, emergency responders had to park vehicles at a distance and transport firefighting equipment through the crowded streets. This situation delayed initial response efforts and complicated rescue operations. Police personnel and local volunteers also assisted in crowd management, evacuation, and securing the affected area to allow emergency teams to operate effectively.

5.2 Medical Response

Medical response operations were coordinated by local health authorities to ensure the rapid treatment of injured victims. Most of the injured were transported to Goa Medical College and Hospital, the largest tertiary care facility in the state. Medical teams provided emergency care, including burn management and wound care for victims with thermal injuries, respiratory support and oxygen therapy for patients affected by smoke inhalation, and trauma management for individuals injured during evacuation or structural collapse. Hospitals activated emergency response protocols by mobilising additional doctors, nurses, and trauma specialists to manage the sudden influx of patients. Critically injured individuals were admitted to intensive care units for advanced treatment and continuous monitoring.

5.3 Government Response

Following the incident, government authorities initiated several administrative and regulatory measures aimed at investigating the disaster and preventing similar incidents in the future.

Key actions included:

- Ordering a magisterial inquiry to determine the exact cause of the fire and identify accountability
- Arrest of individuals associated with the nightclub management on charges related to safety violations and negligence
- Statewide fire safety inspections and audits of nightclubs, bars, restaurants, and entertainment venues
- Ban on the use of indoor fireworks and pyrotechnic effects in enclosed entertainment establishments without strict safety clearance

The government also announced financial assistance and compensation packages for families of the deceased and injured victims. Authorities emphasized the need for stricter enforcement of fire safety regulations in high-occupancy public venues, particularly in tourist areas where large crowds gather for entertainment events.

6. Issues / Challenges / Concerns

The Goa Nightclub Fire exposed several systemic weaknesses in safety governance, regulatory enforcement, and disaster preparedness within entertainment venues in Goa. The incident highlighted how gaps in compliance, infrastructure planning, and emergency preparedness can significantly amplify the impact of disasters in crowded public spaces.

6.1 Regulatory Enforcement Failures

One of the major concerns revealed by the incident was the failure of effective regulatory enforcement. Reports indicated that the nightclub had previously received notices related to structural and safety violations, yet the establishment continued operating. This situation suggests weaknesses in monitoring mechanisms and follow-up enforcement actions.

Regulatory agencies often issue notices for non-compliance, but without consistent inspections and strict penalties, establishments may continue operations without addressing safety deficiencies. Such enforcement gaps increase the risk of accidents in high-occupancy venues where large numbers of people gather.

6.2 Lack of Fire Safety Compliance

The disaster also revealed serious deficiencies in fire safety infrastructure and compliance with safety regulations. Preliminary findings suggested that the venue lacked several essential fire safety provisions required for public entertainment facilities.

Key deficiencies reportedly included:

- Insufficient number of emergency exits, limiting safe evacuation during emergencies
- Absence or inadequacy of automatic fire detection and alarm systems
- Lack of fire suppression systems, such as sprinklers and fire extinguishers in strategic locations
- No clearly defined evacuation plans or safety signage for occupants

The absence of these critical safety measures allowed the fire to spread rapidly and reduced the chances of timely evacuation.

6.3 Urban Planning Constraints

Another significant challenge was related to urban infrastructure and accessibility of emergency services. The nightclub was located in a congested lane near Arpora, where narrow roads restricted the movement of firefighting vehicles and emergency equipment. Such urban planning constraints can delay critical response operations during emergencies. Fire engines were reportedly forced to park at a distance from the site, requiring responders to manually transport hoses and equipment to the scene. These delays can be particularly dangerous in rapidly spreading fires where every minute is crucial for saving lives. The incident highlights the importance of ensuring adequate access routes for emergency vehicles when approving construction or licensing high-occupancy entertainment venues.

6.4 Disaster Preparedness in Tourism Infrastructure

The tragedy also underscored broader issues related to disaster preparedness within tourism and hospitality infrastructure. Many entertainment establishments operate without comprehensive safety management systems.

Common shortcomings in such venues include:

- Lack of trained safety personnel responsible for emergency response
- Absence of regular evacuation drills and safety training for staff
- Inadequate crowd management systems during large events
- Limited awareness among employees and visitors about emergency procedures

In tourist destinations like Goa, where nightlife venues often attract large crowds, these deficiencies can significantly increase disaster risks.

7. Lessons Learned

The Goa Nightclub Fire provides several critical lessons for disaster risk reduction, fire safety governance, and management of public entertainment venues in tourist destinations such as Goa. The tragedy illustrates how a combination of regulatory gaps, unsafe infrastructure, and inadequate emergency preparedness can transform a localized fire incident into a mass-casualty disaster. The following lessons are particularly significant for policymakers, urban planners, tourism authorities, and disaster management agencies.

7.1 Importance of Strict Enforcement of Fire Safety Regulations

One of the most important lessons from the incident is that existing safety regulations are only effective when consistently enforced. India already has comprehensive fire safety provisions under the National Building Code of India and other fire safety regulations governing public buildings. However, the disaster demonstrated that regulatory notices or compliance certificates alone are insufficient if inspections are irregular or enforcement actions are weak. Entertainment venues hosting large crowds must be subject to periodic safety audits, strict licensing conditions, and immediate closure in cases of non-compliance. Effective enforcement mechanisms can significantly reduce the risk of fire disasters in high-density public spaces.

7.2 Risks Associated with Indoor Pyrotechnics and Special Effects

The suspected use of indoor pyrotechnic devices highlights the dangers of using fire-based visual effects in enclosed spaces. Pyrotechnics, fireworks, and flame-based effects can easily ignite decorative materials, lighting installations, or electrical equipment when used in confined environments. This incident underscores the need for strict regulation or prohibition of indoor fireworks in nightclubs, restaurants, and event venues. Where such devices are permitted, they must be operated only under licensed supervision with proper safety clearances, fire-resistant materials, and fire suppression systems. Without these safeguards, pyrotechnic displays can rapidly escalate into catastrophic fires.

7.3 Critical Role of Safe Building Design and Emergency Infrastructure

The disaster demonstrated that building design and safety infrastructure play a decisive role in determining casualty levels during fires. In many public entertainment venues, overcrowding, narrow corridors, and poorly marked exits significantly hinder evacuation. The incident reinforces the need for multiple clearly marked emergency exits, unobstructed evacuation routes, smoke ventilation systems, and automatic fire detection and suppression systems. These features must be incorporated into building design and maintained throughout the operational life of the establishment. Effective architectural planning and compliance with fire safety norms can dramatically improve evacuation efficiency and reduce fatalities during emergencies.

7.4 Importance of Urban Planning and Emergency Access

The location of the nightclub in a congested lane in Arpora created significant challenges for emergency responders. Narrow roads and restricted access delayed firefighting operations, highlighting the importance of urban planning considerations in disaster management. Licensing authorities should ensure that large entertainment venues are located in areas with adequate road width, emergency vehicle access, and open spaces for evacuation and firefighting operations. Urban planning regulations must integrate disaster risk considerations to ensure that emergency services can respond quickly during crises.

7.5 Need for Disaster Preparedness in the Hospitality and Tourism Sector

The tragedy also revealed that many entertainment establishments lack institutionalized disaster preparedness mechanisms. Staff members often have limited knowledge of evacuation procedures or emergency response protocols, which can increase confusion during crises. Regular training programs, mock drills, and emergency preparedness exercises are essential to ensure that employees know how to respond effectively during fires or other emergencies. Establishments hosting large crowds must designate trained safety officers responsible for coordinating evacuation and communicating with emergency services. Developing a culture of safety within the hospitality sector is crucial for minimizing disaster risks.

7.6 Importance of Crowd Management and Capacity Regulation

Nightclubs and entertainment venues frequently operate near or above their safe capacity limits, particularly during major tourist seasons or special events. Overcrowding can obstruct evacuation routes and create panic during emergencies. This incident highlights the need for strict monitoring of venue occupancy limits and real-time crowd management systems. Technologies such as digital occupancy monitoring, surveillance systems, and automated alarm systems can help authorities and venue operators track crowd density and respond promptly to safety risks. Effective crowd management policies are essential for ensuring safe evacuation during emergencies.

7.7 Integration of Disaster Risk Reduction in Tourism Governance

Tourism hubs attract large numbers of visitors, often unfamiliar with local infrastructure and emergency procedures. Therefore, disaster risk management must be integrated into tourism governance frameworks. Authorities responsible for tourism development should work closely with fire departments, municipal authorities, and disaster management agencies to establish safety standards for hotels, clubs, restaurants, and event venues. Safety certification, periodic inspections, and risk assessments should become mandatory components of tourism licensing processes. Integrating disaster risk reduction into tourism planning will help ensure safer experiences for visitors and workers alike.

7.8 Strengthening Multi-Agency Coordination

Finally, the incident demonstrates the importance of coordinated response among multiple agencies, including fire services, police, medical authorities, municipal bodies, and disaster management departments. Establishing integrated emergency response frameworks, communication systems, and joint training exercises can significantly improve preparedness and response capacity. Multi-agency collaboration ensures that emergencies are addressed rapidly and efficiently, reducing the potential for loss of life.

References

- Department of Information & Publicity. (2025, December 8). Revenue department issues advisory for night clubs, bars following Arpora fire (DIP/NB/AXP/SAG/SM/2025/998). Government of Goa. <https://www.goa.gov.in/wp-content/uploads/2025/12/REVENUE-DEPARTMENT-ISSUES.pdf>
- Chadha, P. S. (2026, January 1). Goa club fire: Probe report is out, exposing series of missteps and collusion. The Indian Express <https://indianexpress.com/article/india/goa-club-fire-probe-report-is-out-exposing-series-of-missteps-and-collusion-10449222/>
- Hindustan Times Correspondent. (2025, December 7). Goa nightclub fire: 25 killed in Arpora midnight blaze; CM Pramod Sawant orders magisterial probe. Hindustan Times. <https://www.hindustantimes.com/india-news/goa-nightclub-fire-arpورا-101733560299766.html>
- LiveMint News Desk. (2025, December 8). Goa nightclub fire highlights: Electric firecrackers likely caused blaze, says CM Sawant. LiveMint. <https://www.livemint.com/news/india/goa-nightclub-fire-live-update-11765070993759.html>
- Monteiro, L. (2025, December 10). Arpora nightclub tragedy: 21 died of 'inhalation of asphyxiant gases'. The Times of India. <https://timesofindia.indiatimes.com/city/goa/arpورا-nightclub-tragedy-21-died-of-inhalation-of-asphyxiant-gases/articleshow/125876472.cms>
- NDTV News Desk. (2025, December 7). Narrow exit, palm leaves, big DJ night: What led to Goa nightclub inferno. NDTV. <https://www.ndtv.com/india-news/goa-nightclub-fire-investigation-key-developments-7123456>
- The Hindu Bureau. (2025, December 8). Goa Government constitutes four-member panel to probe nightclub fire. The Hindu. <https://www.thehindu.com/news/national/goa/goa-government-constitutes-four-member-panel-to-probe-nightclub-fire/article70372192.ece>

13. Indore Water Contamination Crisis

1. Introduction

Access to safe drinking water is a fundamental requirement for public health and urban resilience. Rapid urbanization, aging infrastructure, and inadequate maintenance of municipal water systems often increase the risk of contamination in urban water supply networks. In December 2025, a serious drinking water contamination crisis occurred in the Bhagirathpura locality of Indore, Madhya Pradesh, leading to a widespread outbreak of waterborne disease and multiple fatalities. The crisis was particularly alarming because Indore had been consistently ranked among the cleanest cities in India under the National Swachh Survekshan initiative. The contamination event exposed vulnerabilities in urban water supply infrastructure and highlighted the need for improved surveillance, monitoring, and accountability in municipal water management systems. The incident resulted in significant morbidity and mortality due to gastrointestinal infections caused by contaminated drinking water. Laboratory testing confirmed the presence of bacterial pathogens such as *Escherichia coli* and cholera-causing organisms in the municipal water supply, indicating sewage infiltration into the potable water pipeline. This report examines the disaster event, its causes, impacts, response mechanisms, challenges, and key lessons for strengthening urban water safety and disaster preparedness.

2. Overview of the Disaster Event

The Indore Water Contamination Crisis emerged as a major urban public health emergency in Indore, one of the largest and fastest-growing cities in Madhya Pradesh. The incident primarily affected the Bhagirathpura locality, a densely populated residential area where municipal piped water is the primary source of drinking water for thousands of residents. The crisis began in mid-December 2025, when local residents started reporting that the tap water supplied through municipal pipelines had developed a foul smell, unusual colour, and muddy appearance. Several households also complained about sediments and impurities in the water supply. Despite these early warning signs and complaints to municipal authorities, the water distribution reportedly continued without immediate suspension or corrective action. Within a few days, a growing number of residents began experiencing gastrointestinal symptoms, including vomiting, diarrhoea, abdominal pain, dehydration, and general weakness after consuming the contaminated water. As more people fell ill, local clinics and hospitals started receiving a surge of patients with acute gastroenteritis and waterborne illness symptoms, indicating a possible contamination of the drinking water supply. By late December 2025, the outbreak had spread rapidly across several neighbourhood blocks in the Bhagirathpura area, affecting hundreds of residents across multiple households. The sudden increase in patients placed significant pressure on nearby healthcare facilities, forcing local health authorities to activate emergency medical response measures.

Subsequent technical inspections by municipal engineers and public health officials revealed that sewage contamination had entered the municipal drinking water pipeline. Investigations indicated that a leaking water pipeline running beneath or near a public toilet structure had allowed sewage to infiltrate the potable water supply network. In addition, damaged and aging water distribution lines, poor pipeline maintenance, and possible negative pressure in the supply system further facilitated the mixing of sewage with drinking water. The contamination event highlighted serious infrastructure vulnerabilities in the urban water supply system, particularly in older pipeline networks that run in close proximity to sewage lines and sanitation facilities. Once the contamination was identified, authorities initiated large-scale health surveillance operations, including door-to-door medical screening of residents, distribution of medicines, and emergency chlorination of water supply systems.

Health teams conducted rapid epidemiological assessments, collected water samples for laboratory testing, and issued public advisories warning residents to avoid drinking untreated tap water. Temporary measures such as water tankers, supply of packaged drinking water, and emergency medical camps were also deployed to manage the crisis. The incident soon evolved into a major urban public health emergency, highlighting the risks associated with aging urban infrastructure, inadequate maintenance of water distribution systems, and delayed response to early warning complaints from residents. It also raised broader concerns about water safety, sanitation management, and urban disaster risk governance in rapidly growing Indian cities.

Table 50: Disaster Identification Table

Parameter	Details
Disaster Name	Indore Water Contamination Crisis
Location	Bhagirathpura locality, Indore
State	Madhya Pradesh
Disaster Type	Water contamination / Waterborne disease outbreak
Period	Mid-December 2025
Primary Cause	Sewage infiltration into drinking water pipeline
Major Pathogens	E. coli and cholera-causing bacteria
Confirmed Deaths	15 deaths
Hospitalizations	Over 450 cases
Suspected Cases	Over 2,400 identified during screening

Source: <https://www.downtoearth.org.in/water/contaminated-drinking-water-case-cag-report-found-serious-flaws-but-indore-remained-unconcerned>

Table 51: Timeline of the Indore Water Contamination Crisis

Date	Event
Mid-December 2025	Residents notice foul smell and discoloration in municipal drinking water.
25 December 2025	Multiple households report bitter taste and strong odour in tap water.
27–28 December 2025	First wave of illness reported; residents develop vomiting and diarrhoea.
29 December 2025	Local authorities confirm initial deaths linked to contaminated water.
31 December 2025	State government acknowledges the outbreak; hospitalizations increase rapidly.
Early January 2026	Large-scale medical screening and water testing initiated.
January 2026	Pipeline repairs undertaken; compensation announced for affected families.

Source: <https://www.ndtv.com/health/indore-contaminated-water-crisis-explained-how-it-triggered-a-diarrhoea-outbreak-claiming-lives-symptoms-and-prevention-tips-10190342>

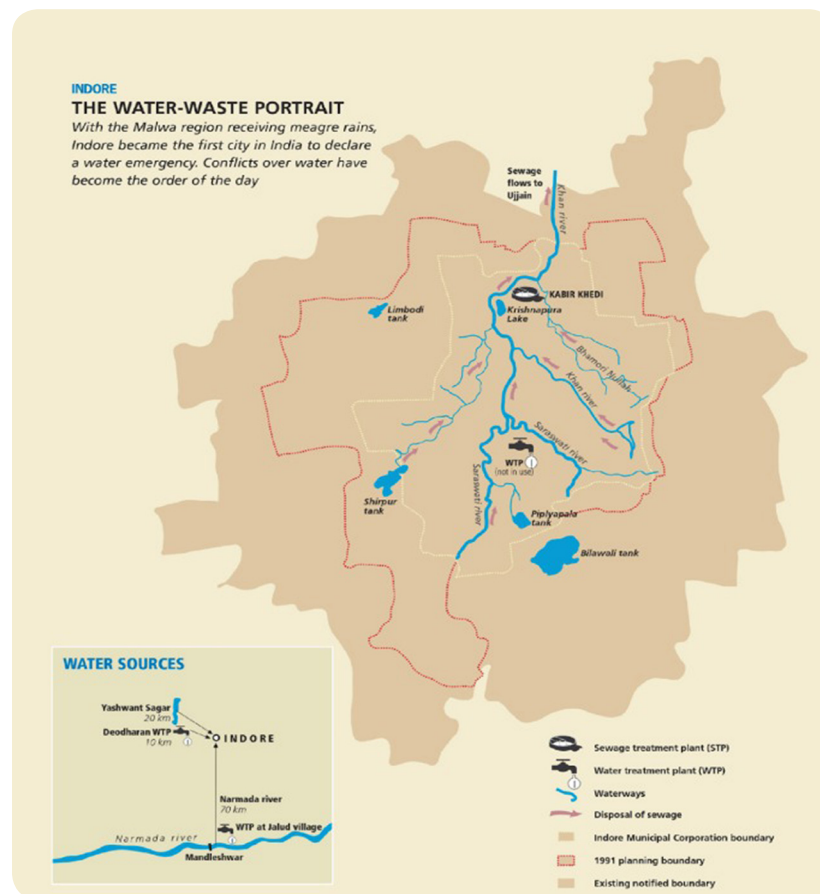


Figure 76: Schematic map depicting the drinking water supply and drainage network of Indore.

Source: City Water-Excreta Survey, 2005-06, Centre for Science and Environment, New Delhi

3. Impact of the Disaster

The Indore Water Contamination Crisis resulted in significant health, social, economic, and administrative consequences in the affected areas of Indore. The incident quickly evolved into a serious urban public health emergency, highlighting vulnerabilities in municipal water supply systems and sanitation infrastructure in Madhya Pradesh.

3.1 Health Impacts

The most severe consequences of the contamination were related to public health. Laboratory analysis of water samples confirmed the presence of bacterial contamination, indicating that sewage had entered the drinking water supply network. As a result, a large number of residents developed waterborne illnesses, particularly acute gastroenteritis. Health authorities reported that more than 459 residents required hospitalization due to severe symptoms such as dehydration, vomiting, diarrhoea, abdominal pain, and weakness. Many patients required intravenous fluids and medical monitoring to prevent complications. In addition to hospitalized patients, over 2,400 suspected cases were identified during large-scale door-to-door health screening campaigns conducted by public health teams. These surveys aimed to identify affected individuals early and provide medical treatment to prevent further deterioration of health conditions. The outbreak also resulted in approximately 15 reported deaths, according to official government figures. The fatalities were largely associated with severe dehydration and complications arising from prolonged gastrointestinal illness.

Certain groups were particularly vulnerable to the contaminated water supply, including:

- Children, who are more susceptible to dehydration
- Elderly individuals, whose immune systems may be weaker
- Immunocompromised patients, who face greater risks of severe infection

The incident placed significant pressure on local healthcare facilities, requiring the establishment of emergency treatment wards and temporary medical camps to manage the sudden surge in patients.



Figure 77: Contaminated drinking water has led to a severe outbreak of diarrhoea and vomiting in Indore's Bhagirathpura area.

Source: <https://timesofindia.indiatimes.com/city/indore/water-contamination-kills-7-crowned-cleanest-city-8-times-indore-now-faces-tap-water-crisis/articleshow/126281587.cms>



Figure 78: Residents affected by the contaminated water at Bhagirathpura in Indore on Friday.

Source: <https://indianexpress.com/article/india/what-contaminated-indores-water-toilet-still-top-possibility-but-engineers-spread-out-to-look-for-other-culprits-10454053/>

3.2 Social Impacts

The crisis created widespread anxiety and loss of public trust in the municipal drinking water system. Residents of the affected locality became increasingly concerned about the safety of tap water supplied through government pipelines. As a precautionary measure, many households stopped using municipal water for drinking and cooking, instead relying on bottled water, packaged drinking water, or privately supplied tanker water. This sudden shift increased household expenses and created logistical challenges for families, particularly those with limited financial resources. The incident also generated public protests and strong political reactions, as residents demanded accountability for the failure to prevent contamination and for delays in responding to initial complaints. Concerns were raised regarding urban infrastructure maintenance, sanitation management, and the effectiveness of municipal governance systems. The disaster highlighted the social consequences of infrastructure failures, particularly when essential public services such as drinking water supply are compromised.

3.3 Economic Impacts

Although the disaster did not cause large-scale physical infrastructure destruction, it resulted in significant indirect economic losses for households and public authorities.

Affected families faced multiple financial burdens, including:

- Medical expenses for treatment, hospitalization, and medication
- Loss of wages or workdays due to illness among earning members
- Additional costs for safe drinking water, including bottled water purchases or tanker supply

The state government also announced financial compensation for families of deceased victims, adding to the fiscal costs associated with the disaster response.

Table 52: Estimated Impact

Category	Estimated Impact
Deaths	15
Hospitalized	459
Suspected Cases	2,400
Population Screened	40,000 residents
Area Affected	Bhagirathpura locality

Source: <https://timesofindia.indiatimes.com/city/indore/water-contamination-kills-7-crowned-cleanest-city-8-times-indore-now-faces-tap-water-crisis/articleshow/126281587.cms>

4. Possible Causes / Reasons

Investigations into the Indore Water Contamination Crisis identified multiple technical, infrastructural, and administrative factors that contributed to the outbreak. The crisis appears to have resulted from a combination of sewage infiltration, aging water infrastructure, inadequate monitoring, and high urban population density in the affected area of Indore.

4.1 Sewage Infiltration into Drinking Water Pipeline

The primary cause of the contamination was the infiltration of sewage into the municipal drinking water pipeline. Technical inspections revealed that a leaking water distribution pipeline passed beneath or near a public toilet structure in the Bhagirathpura locality. Due to structural damage to the pipeline and the absence of an adequately designed septic or drainage system, sewage from the toilet facility gradually seeped into the water supply line. When pressure fluctuations occurred within the pipeline, contaminated water was drawn into the distribution network, mixing with potable water supplied to households. Such cross-contamination is a common risk in urban areas where water supply pipelines run close to sewer lines or sanitation facilities, especially when maintenance and monitoring are inadequate.



Figure 79: Sewage and solid waste flowing into the Kanh River in Indore near Goari Nagar bridge.
 Source: <https://www.downtoearth.org.in/water/indores-clean-image-masks-a-liquid-waste-crisis>

4.2 Infrastructure Failures and Aging Water Distribution Network

Another major contributing factor was the condition of the urban water distribution infrastructure. The municipal water network in Indore extends across thousands of kilometres and includes many aging pipelines that have been in service for several decades. Over time, pipelines may develop cracks, corrosion, joint failures, and leakages, particularly in densely populated areas where construction activities, ground settlement, or traffic loads place additional stress on underground infrastructure. In the affected locality, damaged distribution lines and inadequate preventive maintenance increased the vulnerability of the system to contamination. Once sewage entered the pipeline, it spread rapidly through connected distribution lines supplying multiple households.



Figure 80: An exposed water pipeline in Indore's Bhagirathpura area.

Source: <https://www.hindustantimes.com/india-news/across-india-patchy-supply-raises-risk-of-contamination-in-water-line-101767553967963.html>

4.3 Inadequate Monitoring and Delayed Administrative Response

Another critical factor was the delay in responding to early warning signals from residents. Several households reportedly noticed foul smell, discoloration, and unusual taste in the tap water before the outbreak escalated. Despite these complaints, immediate corrective measures such as water quality testing, suspension of supply, or pipeline inspection were not promptly undertaken. This delay allowed contaminated water to continue flowing through the distribution system for several days, exposing a large number of residents to health risks. The incident highlights weaknesses in water quality monitoring systems, complaint redress mechanisms, and rapid response protocols for municipal water utilities.

4.4 Urban Density and Lack of Alternative Water Sources

The high population density of the Bhagirathpura area also played a significant role in amplifying the crisis. The locality is characterized by closely built residential areas where municipal piped water is the primary source of drinking water for most households. When the contamination occurred, residents had limited access to alternative safe water sources such as groundwater wells or community water supply points. As a result, many people continued to consume contaminated water before the health risks became widely known. This dependency on a single centralized water supply system increased the scale of exposure and contributed to the rapid spread of waterborne illness.



Figure 81: Bhagirathpura residents fill water from tankers being supplied by the local authorities.

Source: <https://indianexpress.com/article/upsc-current-affairs/upsc-essentials/how-indore-water-contamination-brings-groundwater-issues-to-the-surface-10482937/>

5. Response

Following the outbreak associated with the Indore Water Contamination Crisis, government agencies and local authorities implemented a series of public health, water supply, and administrative measures to control the spread of illness and restore safe drinking water in Indore, located in Madhya Pradesh. The response involved coordinated actions by health departments, municipal authorities, and district administration.

5.1 Health Response

The first priority for authorities was to contain the public health emergency and provide medical treatment to affected residents. Rapid response teams consisting of doctors, nurses, and health workers were deployed to the affected areas to identify and treat patients suffering from symptoms of waterborne illness.

Key health response measures included:

- Rapid deployment of medical teams to conduct field-level medical assessments in the Bhagirathpura locality
- Establishment of temporary treatment centres and medical camps to manage the surge in patients
- Distribution of Oral Rehydration Solution (ORS), antibiotics, and other essential medicines to affected households
- Door-to-door health screening campaigns conducted by public health workers to identify symptomatic individuals early

During the outbreak response, health teams reportedly screened more than 40,000 residents, allowing authorities to detect suspected cases quickly and provide timely medical intervention. This large-scale surveillance helped prevent further escalation of the outbreak and reduced the risk of severe complications among vulnerable groups.



Figure 82: Medicines being distributed at a camp in Indore.

Source: <https://indianexpress.com/article/india/what-contaminated-indores-water-toilet-still-top-possibility-but-engineers-spread-out-to-look-for-other-culprits-10454053/>

5.2 Water Supply Measures

Municipal engineers and technical teams simultaneously worked to identify and eliminate the source of contamination in the drinking water network. Emergency infrastructure interventions were carried out to prevent further mixing of sewage with potable water.

Major technical actions included:

- Isolation of the contaminated pipeline section to prevent further distribution of unsafe water
- Repair and replacement of damaged pipeline segments that had allowed sewage infiltration
- Chlorination and chemical disinfection of the municipal water supply system to eliminate bacterial contamination
- Temporary suspension of water supply from affected pipelines until water quality standards were restored

To ensure residents had access to safe drinking water during the crisis, authorities also arranged alternative water supply through tanker services and emergency water distribution points in the affected locality.



Figure 83: Indore Municipal Corporation workers conduct a cleanliness drive.

Source: <https://indianexpress.com/article/india/what-contaminated-indores-water-toilet-still-top-possibility-but-engineers-spread-out-to-look-for-other-culprits-10454053/>

5.3 Administrative Measures

The Government of Madhya Pradesh initiated administrative actions in response to the incident. These measures aimed to ensure accountability and improve management of urban water infrastructure.

Key administrative steps included:

- Initiation of inquiries into the causes of the contamination and identification of responsible officials
- Disciplinary action against municipal personnel found responsible for negligence or delayed response
- Financial compensation announced for families of deceased victims affected by the outbreak

Authorities also emphasized the need to strengthen urban water supply monitoring systems, infrastructure maintenance, and public health surveillance mechanisms to prevent similar incidents in the future.

6. Issues / Challenges / Concerns

The Indore Water Contamination Crisis exposed several systemic weaknesses in urban infrastructure management, water quality monitoring, and public health preparedness in Indore. Despite emergency response measures, the incident highlighted broader structural challenges that increase the vulnerability of rapidly growing cities in Madhya Pradesh.

6.1 Weak Infrastructure Management

One of the most critical issues revealed by the crisis was the poor maintenance and management of urban water infrastructure. Many sections of the municipal water distribution network consist of aging pipelines that have been in service for several decades. Over time, these pipelines can develop cracks, corrosion, and leakages due to ground movement, traffic loads, or construction activities. In the affected locality, lack of regular inspections, delayed repairs, and inadequate preventive maintenance allowed structural weaknesses in the pipeline system to persist. These conditions created opportunities for sewage infiltration into drinking water lines, ultimately leading to contamination of the supply network. The incident underscores the urgent need for systematic infrastructure monitoring, scheduled maintenance programs, and modernization of aging urban water distribution systems.

6.2 Poor Early Warning Systems

Another major challenge identified during the crisis was the absence of real-time water quality monitoring systems. Municipal water utilities largely depend on periodic laboratory testing rather than continuous monitoring, which can delay the detection of contamination events. Although residents had reported foul smell, discoloration, and unusual taste in the water, there was no automated system capable of quickly detecting contamination in the

pipeline network. Without such early warning mechanisms, contaminated water continued to circulate through the supply system for several days before authorities initiated corrective action. This highlights the importance of deploying sensor-based monitoring technologies, automated alert systems, and digital water quality surveillance mechanisms in urban water networks.

6.3 Governance and Accountability Issues

The incident also raised concerns regarding institutional coordination and administrative accountability. Reports suggested that residents had raised complaints regarding water quality prior to the outbreak, yet the response from authorities was delayed and insufficient during the early stages of the crisis. Such delays in responding to public complaints can allow small technical failures to escalate into major public health emergencies. The incident highlights the need to strengthen complaint redress mechanisms, administrative coordination, and emergency response protocols within municipal governance systems. Strengthening accountability frameworks, improving coordination among departments, and establishing rapid response mechanisms are essential for preventing similar crises in the future.

6.4 Urban Public Health Vulnerability

The contamination incident also highlighted the high vulnerability of densely populated urban areas to waterborne disease outbreaks. In cities with large populations dependent on centralized piped water supply, even a localized contamination event can quickly affect thousands of residents. Rapid urbanization in Indore has increased pressure on existing infrastructure systems, including water supply, sanitation, and waste management networks. When these systems fail or are poorly maintained, the consequences can escalate into large-scale public health emergencies. This incident demonstrates the need to integrate urban infrastructure planning with public health risk management, particularly in rapidly expanding cities.

7. Lessons Learned

The Indore Water Contamination Crisis provides important lessons for urban disaster risk management, public health protection, and water supply governance in rapidly growing cities such as Indore, located in Madhya Pradesh. The incident demonstrates how failures in essential urban services-particularly drinking water infrastructure-can quickly escalate into a large-scale public health emergency affecting thousands of residents. The following lessons are particularly relevant for policymakers, municipal authorities, urban planners, and disaster management agencies.

7.1 Urban Water Infrastructure as a Critical Lifeline System

One of the most important lessons from the crisis is that urban water supply systems are critical lifeline infrastructure that require constant monitoring and maintenance. When these systems fail, the consequences can extend far beyond technical disruptions, directly affecting public health, social stability, and economic activities. Aging pipelines, poorly

maintained distribution networks, and inadequate separation between sewer lines and drinking water pipelines can create conditions for contamination. Cities must therefore prioritize regular inspection, maintenance, and modernization of water infrastructure as part of long-term urban resilience planning.

7.2 Importance of Early Detection and Real-Time Monitoring

The Indore incident highlighted the dangers of relying solely on periodic water testing rather than continuous monitoring systems. In this case, contamination was only detected after a large number of residents had already fallen ill. Modern urban water systems should incorporate real-time monitoring technologies, including water quality sensors capable of detecting microbial contamination, chemical pollutants, and abnormal pressure changes within pipelines. Integration of such sensors with digital monitoring platforms and automated alert systems can significantly reduce response time and prevent large-scale outbreaks. Early detection mechanisms act as critical early warning systems for public health emergencies.

7.3 Need for Rapid Response Mechanisms

Another major lesson is the importance of rapid administrative response to early warning signals and citizen complaints. Residents had reportedly noticed unusual water quality before the outbreak escalated, but the response from authorities was delayed. Municipal governance systems must establish fast-response protocols that trigger immediate investigation whenever unusual water quality complaints are received. Such protocols should include immediate water sampling, pipeline inspection, and temporary suspension of supply if contamination is suspected. Quick intervention at the early stage can prevent the spread of disease and significantly reduce the scale of public health impacts.

7.4 Integration of Water Safety into Disaster Risk Reduction

Traditionally, disaster management frameworks have focused primarily on hazards such as floods, earthquakes, or cyclones. However, the Indore incident demonstrates that infrastructure-related public health emergencies can also have disaster-like consequences. Cities should therefore integrate water safety planning into disaster risk reduction strategies and include water contamination scenarios in urban emergency preparedness plans. This includes incorporating water safety risks into District Disaster Management Plans (DDMPs) and municipal contingency plans. Such integration will enable authorities to mobilize resources more effectively when waterborne disease outbreaks occur.

7.5 Public Health Preparedness and Surveillance

The outbreak underscored the importance of robust public health surveillance systems capable of detecting unusual clusters of illness at an early stage. Health departments must maintain strong coordination with municipal water authorities so that epidemiological signals can be quickly linked to potential environmental sources such as contaminated water supply. Regular health surveillance, community-level disease monitoring, and rapid epidemiological investigations are essential for preventing localized outbreaks from becoming large-scale health crises.

7.6 Role of Community Participation and Citizen Reporting

Residents of the affected locality were among the first to notice signs of contamination, including foul smell, discoloration, and unusual taste in the water supply. This demonstrates the importance of community participation in monitoring essential services. Municipal authorities should establish community-based reporting platforms, such as mobile applications, helplines, or digital dashboards, where citizens can report water quality issues in real time. Encouraging community engagement helps authorities identify problems earlier and respond more effectively. Public awareness campaigns on safe water practices—such as boiling water, using chlorine tablets, and avoiding contaminated sources—can also reduce health risks during outbreaks.

7.7 Importance of Institutional Coordination

The crisis required coordinated action among municipal engineering departments, public health agencies, district administration, and disaster management authorities. Effective coordination is essential when infrastructure failures lead to health emergencies. This incident highlights the need for institutional frameworks that enable seamless communication and collaboration among different departments responsible for water supply, sanitation, health surveillance, and emergency response. Developing integrated urban governance systems can significantly improve preparedness for similar crises in the future.

7.8 Building Resilient Urban Water Systems

Finally, the crisis underscores the need to build resilient urban water supply systems capable of withstanding infrastructure failures and preventing contamination events. Resilient water systems should include:

- Redundant water supply sources to reduce dependence on a single pipeline network
- Separation of sewer and drinking water infrastructure
- Regular pipeline replacement and modernization programs
- Advanced monitoring and automated control systems

Such measures can significantly reduce the risk of contamination and ensure reliable access to safe drinking water for urban populations.

References

- Dhar, A. (2026, January 2). Indore water contamination: How a deadly outbreak began after toilet sewage mixed with the drinking water line. The Economic Times. <https://m.economictimes.com/news/new-updates/indore-water-contamination-reason-how-a-deadly-outbreak-began-after-toilet-sewage-mixed-with-the-drinking-water-line/articleshow/126297995.cms>
- Dwary, A. (2026, January 2). Stalled contracts, contamination: How 11 died in Indore water tragedy. NDTV. <https://www.ndtv.com/india-news/stalled-contracts-contamination-how-11-died-in-indore-water-tragedy-10186184>
- High Court of Madhya Pradesh. (2026, January 22). Order in W.P. No. 50641/2025: Mahesh Garg and Others v. State of Madhya Pradesh and Others. Indore Bench. https://s3hvtw.courtbook.in/2026/01/Mahesh_Garg_and_Others_v__State_of_Madhya_Pradesh_and_others.pdf
- India Water Portal. (2026, January 9). The science of safe water is clear. Why did Indore still get it wrong? <https://www.indiawaterportal.org/water-quality-and-pollution/the-science-of-safe-water-is-clear>
- National Human Rights Commission. (2026, January 1). NHRC, India takes suo motu cognizance of the reported death of 7 persons after consuming contaminated water in Indore, Madhya Pradesh (Press Release). Press Information Bureau, Government of India. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2210551®=3&lang=1>
- The Federal. (2026, January 13). Indore diarrhoea outbreak: Audit report links 15 of 21 deaths to contaminated water. The Federal. <https://thefederal.com/category/states/north/madhya-pradesh/indore-diarrhoea-outbreak-audit-15-of-21-deaths-contaminated-water-225311>
- The Wire Staff. (2026, January 13). Indore water contamination: Audit report reveals 15 deaths linked to vomiting and diarrhoea outbreak. The Wire. <https://m.thewire.in/article/government/indore-water-contamination-audit-report-reveals-15-deaths-linked-to-vomiting-and-diarrhoea-outbreak>

Annexure:

Other Disasters in 2025

Sr. No.	Date	Disaster Event	Location	Type	Key Impacts	Source
1	January 2025	Winter Avalanches	J&K, Himachal Pradesh	Avalanche	Road closures, rescue operations	IMD: https://mausam.imd.gov.in ; NDMA: https://ndma.gov.in
2	January 7, 2025	Tibet-Sikkim Earthquake (M7.1)	Sikkim, Bihar, West Bengal (tremors)	Earthquake	Strong tremors across East India	NCS: https://seismo.gov.in
3	February 2025	Cold Wave	North India	Cold wave	Severe cold alerts issued	IMD Cold Wave: https://mausam.imd.gov.in
4	February 17, 2025	Delhi Earthquake (M4.0)	Delhi-NCR	Earthquake	Shallow tremors, panic	NCS: https://seismo.gov.in
5	February 22, 2025	Srisailem Left Bank Canal (SLBC) Tunnel Collapse	Nagarkurnool district, Telangana	Infrastructure Failure (Tunnel Collapse)	Eight workers trapped and died.	Indian Express: https://indianexpress.com/article/cities/hyderabad/telangana-tunnel-collapse-rescuers-rescue-crisis-trapped-workers-9853822/
6	March-April 2025	Early Heatwave	Central & Western India	Heatwave	Crop stress, high temperatures	IMD Heatwave: https://mausam.imd.gov.in
7	April 2025	Severe Heatwave	Rajasthan, Gujarat, Delhi, UP	Heatwave	Temperature >45°C; health alerts	IMD: https://mausam.imd.gov.in
8	May 2025	Lightning & Thunderstorms	Bihar, Jharkhand, West Bengal	Lightning	Fatalities, crop damage	IMD: https://mausam.imd.gov.in ; Lightning India: https://lightningindia.org
9	June 2025	Monsoon FloosQ	Assam, Bihar, Northeast	Flood	River overflow; displacement	CWC Flood Info: https://cwc.gov.in ; Assam SDMA: https://asdma.gov.in
10	June 12, 2025	Pharmaceutical Plant Gas Leak	Jawaharlal Nehru Pharma City, Anakapalle district, Andhra Pradesh	Industrial Disaster / Toxic Gas Leak	3 workers killed	Indian Express: https://indianexpress.com/article/india/andhra-pradesh-pharmaceutical-plant-gas-leak-10062000/
11	July 2025	LanosQlides	Himachal Pradesh, Uttarakhand	LanosQlide	Road blockages, infrastructure loss	NDMA: https://ndma.gov.in
12	July 9, 2025	Gambhira Bridge Collapse	Gujarat	Infrastructure Failure	22 deaths; injuries	PIB: https://pib.gov.in ; Indian Express: https://www.newindianexpress.com/nation/2025/Jul/09/11-killed-as-vehicles-plunge-into-river-after-gambhira-bridge-collapse-in-vadodara
13	July 25, 2025	Government School Roof Collapse (Piplodi)	Jhalawar district, Rajasthan	Infrastructure Failure / Building Collapse	7 students killed and 27 injured;	Indian Express: https://indianexpress.com/article/india/rajasthan-school-building-collapse-jhalawar-children-trapped-toll-rescue-ops-10148248/
14	September 23, 2025	Kolkata Cloudburst	West Bengal	Flash Flood	Urban flooding	IMD: https://mausam.imd.gov.in ; https://indianexpress.com/article/cities/kolkata/3rd-highest-single-day-rainfall-in-kolkata-after-1978-1986-cloudburst-imd-10266813/
15	October 29, 2025	Cyclone (Montha)	East Coast India	Cyclone	Flooding, crop damage	IMD Cyclone: https://rsmcnewdelhi.imd.gov.in ;

The India Disaster Report 2025 is a compilation of information from publicly available secondary sources, including official reports and other credible publications. Every effort has been made to ensure accurate compilation and presentation of the information. As the report relies on secondary sources, NIDM has not independently verified all the facts, figures, and findings reported in the original references. This report is intended as a reference resource for research, policy, and knowledge dissemination only. The Editors do not claim any authorship for this compilation.

[illegible]

[illegible]

[illegible]



nidm

Resilient India - Disaster Free India

National Institute of Disaster Management (NIDM)
Ministry of Home Affairs, Government of India
Plot No. 15, Pocket-3, Block-B, Sector-29, Rohini, Delhi – 110042
Website: <https://nidm.gov.in>