



National Conference on Sustainable Developments in Engineering,
Science, Humanities and Management (NCSDESHM – 2025)

28th December, 2025, Raipur, Chhattisgarh, India.

CERTIFICATE NO: NCSDESHM /2025/ C1225907

An Overview of Flood Hazards with Focus on Causes, Effects and Control

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ABSTRACT

Floods are among the most frequent and catastrophic natural disasters that have a global impact on human societies. Cyclonic storms, cloudbursts, river overflow, snowmelt, and topographical conditions are among the natural causes of intense and protracted rainfall. In recent decades, the frequency and intensity of floods have been substantially increased by human-induced factors, including deforestation, unplanned urbanization, encroachment on floodplains, poor drainage systems, dam failures, and climate change. Transportation, communication networks, education, and healthcare services are also disrupted by floods, which impedes sustainable development. Environmentally, floods have the potential to alter river morphology, contaminate water sources, and degrade ecosystems. In this article, an overview of flood hazards with focus to causes, effects and control has been discussed.

Keywords: Flood Hazards, Causes, Effects, Control.

INTRODUCTION

Floods are among the most frequent and devastating natural hazards affecting human societies across the world. A flood occurs when water overflows or inundates land that is normally dry, resulting from excessive rainfall, river overflow, storm surges, rapid snowmelt, or failure of dams and embankments. In countries like India, floods are a recurring phenomenon due to monsoonal rainfall patterns, extensive river systems, and diverse topographical features.

Flood hazards pose serious threats to life, property, infrastructure, agriculture, and the environment. Regions located in river basins such as the Ganga–Brahmaputra plains are particularly vulnerable because of heavy rainfall, silt deposition, and changing river courses. Rapid urbanization, deforestation, encroachment on floodplains, and inadequate drainage systems have further intensified flood risks in both rural and urban areas.

The exposure of flood hazards extends beyond immediate physical damage. They disrupt livelihoods, cause displacement of populations, spread water-borne diseases, damage crops, and weaken economic stability. At the same time, floods can also have certain ecological benefits, such as replenishing soil fertility and recharging groundwater, though these benefits are often overshadowed by their destructive consequences.

Understanding flood hazards requires a comprehensive examination of their causes, effects, and control measures. Effective flood management includes structural measures such as dams, embankments, and drainage systems, as well as non-structural approaches like early warning systems, land-use planning,

watershed management, and community preparedness. In the context of climate change and increasing extreme weather events, scientific planning and sustainable development strategies are essential to minimize flood risks (Sanjrani, M. A. et al., 2022).

FLOOD HAZARDS

Flood hazards refer to the potential threats to life, property, infrastructure, environment, and economic activities caused by the overflow or accumulation of water beyond its normal limits. These hazards occur when excessive rainfall, river overflow, storm surges, dam failure, rapid snowmelt, or drainage congestion leads to inundation of normally dry land. Flood hazards may result in loss of human life, displacement of populations, destruction of crops and livestock, damage to buildings and transportation networks, contamination of water supplies, and long-term ecological degradation. The severity of flood hazards depends on factors such as intensity and duration of rainfall, topography, land use patterns, urbanization, and preparedness measures. Thus, flood hazards represent not only a natural phenomenon but also a socio-economic risk when human settlements and activities are exposed to flood-prone areas.

There are two types of floods: natural floods and man-made floods. India is one of the fewest countries in the world where natural floods are floods. Flooding is classified as a single event, but it has many consequences, such as primary and secondary flooding hazards, which are service interruptions, primary and secondary flooding hazards, which are primary and secondary flooding hazards. (Wang, L. et al., 2022).

CAUSES

There are measures to limit the consequences and train the people to adapt to the consequences of flooding. The consequences of flooding which stem from Heavy rainfall, overflowing rivers, deforestation, poor urban planning and poor drainage systems have also shown a poor range. To cope with the problem, various methods, both structural and non-structural, are used. One of the methods used is to regulate the undesired flow of water by building levees, dams, and reservoirs. Alternate methods include zoning of floodplains, use of vegetation, and creation of early warning and evacuation systems. Flood hazards occur when water overflows onto normally dry land, causing damage to life, property, agriculture, and infrastructure. The causes of floods can be classified into natural causes and human-induced causes (Simonovic, S.P. et al., 2020).

Natural Causes:

Heavy Rainfall: Intense or prolonged rainfall due to monsoon systems, cyclones, or depressions increases surface runoff and leads to river overflow.

River Overflow (Fluvial Flooding): When rivers such as the Ganga River and Brahmaputra River exceed their carrying capacity, adjacent floodplains are inundated.

Cyclones and Storm Surges: Coastal regions experience flooding due to tropical cyclones. For example, areas around the Bay of Bengal are highly vulnerable to storm surges.

Snowmelt and Glacier Melt: Rapid melting of snow in mountainous regions such as the Himalayas increases river discharge, causing floods downstream.

Cloudburst: Sudden, extremely heavy rainfall in a short duration, often in hilly areas, leads to flash floods.

Tsunamis: Undersea earthquakes can generate massive waves that inundate coastal areas.

Human-Induced Causes:

Deforestation: Removal of forest cover reduces water absorption and increases runoff, leading to floods.

Urbanization: Rapid urban growth with concrete surfaces reduces infiltration and increases surface runoff, causing urban floods.

Poor Drainage Systems: Blocked or inadequate drainage systems lead to water accumulation during heavy rainfall.

Encroachment on Floodplains: Construction on natural floodplains restricts river flow and increases flood intensity.

Dam Failure: Structural failure or sudden release of water from dams can result in catastrophic flooding.

Climate Change: Global warming increases the frequency of extreme weather events, heavy rainfall, and sea-level rise.

EFFECTS

Because of floodwaters, the erosion can weaken the bridges and levees and other structures, causing them to collapse. Water damage can occur when the water enters the man-made structures. Just a little water in a house can ruin furniture and damage the floors, walls, and anything that comes in contact with the water. Flooding cars can be irreversibly damaged. The fast moving floodwaters carry a greater quantity of silt in addition to the larger rocks and when the water recedes, the flow slows dramatically and sediment is left. For this reason, there is a lot of mud left when the floodwaters recede, and this can be mud that has come from the houses. When the fields are flooded, this can destroy the crops. Pets, livestock and other animals can be swept away and often drown. People who are caught in floodwaters being swept away by the strong current can drown, and this happens often. Floods are among the most destructive natural hazards, causing wide-ranging impacts on human life, the environment, and the economy (Kreibich, H. et al., 2022). The major effects of flood hazards are discussed below:

Loss of Life and Human Suffering: Floods often result in deaths due to drowning, building collapse, electrocution, and waterborne diseases. Displacement of people leads to homelessness, trauma, and disruption of daily life. Vulnerable groups such as children, women, and the elderly suffer the most.

Damage to Property and Infrastructure: Floodwaters destroy houses, roads, bridges, railways, schools, hospitals, and communication systems. In India, states like West Bengal, Assam, and Bihar frequently face severe infrastructural damage due to annual flooding.

Agricultural Loss: Flooding submerges croplands, damages standing crops, erodes fertile topsoil, and kills livestock. This leads to food shortages, loss of farmers' income, and increased rural poverty.

Economic Impact: Floods disrupt trade, transportation, industry, and business activities. Governments must spend heavily on relief, rehabilitation, and reconstruction, affecting national and regional economies.

Environmental Degradation: Floods can cause soil erosion, landslides, and sediment deposition. They may also contaminate water bodies with sewage, chemicals, and waste. However, in some cases, floods replenish groundwater and deposit nutrient-rich silt, improving soil fertility.

Health Hazards: Stagnant water becomes a breeding ground for mosquitoes, leading to diseases such as malaria and dengue. Contaminated water can spread cholera, typhoid, and diarrhea. Poor sanitation during floods worsens public health conditions.

Social and Psychological Effects: Flood victims often experience stress, anxiety, and long-term psychological trauma. Displacement disrupts education and community life, weakening social stability.

CONTROL

To protect the public & to protect the private, there must be some control of the floodplain concerning flood-related work and residence activities. To protect people from flood-related injuries and fatalities, flood proofing must also be done. The area of flood forecasting must be expanded, especially to areas where forecasting has not previously been done. The area of flood forecasting must be improved for more precise and useful forecasts. To better control reservoirs, inflow forecasting is essential (Mohanty, M.P. et al., 2020).

Structural Measures (Engineering Methods):

These involve physical constructions to control floodwater.

Dams and Reservoirs: Large dams such as the Bhakra Nangal Dam help store excess water during heavy rainfall and release it gradually, reducing flood peaks.

Embankments and Levees: Raised riverbanks prevent floodwaters from overflowing into nearby settlements and agricultural lands.

Floodwalls: Concrete barriers built along riverbanks to protect urban areas.

Channel Improvement: Deepening and widening river channels to increase water-carrying capacity.

Drainage Improvement: Urban storm water drainage systems help prevent waterlogging during heavy rainfall.

Non-Structural Measures (Management & Planning):

These focus on planning and preparedness rather than construction.

Flood Forecasting and Early Warning Systems: Agencies like the Central Water Commission monitor river levels and provide advance flood warnings.

Floodplain Zoning: Restricting construction and settlement in flood-prone areas.

Afforestation: Planting trees reduces surface runoff and soil erosion.

Insurance Schemes: Flood insurance reduces financial loss for affected people.

Public Awareness and Disaster Preparedness: Community training, mock drills, and evacuation planning reduce casualties.

Modern & Sustainable Approaches:

Rainwater harvesting

Wetland conservation

Integrated river basin management

Climate-resilient urban planning

For example, wetland restoration projects in regions like Kolkata (East Kolkata Wetlands) naturally absorb excess rainwater and reduce flooding.

CONCLUSION

Flood hazards are the consequence of both natural processes and human activities. Sustainable land use planning, enhanced drainage systems, afforestation, early warning systems, and climate-resilient infrastructure are all essential components of effective flood management. Flood hazards have a multifaceted impact, including humanitarian, economic, environmental, and social consequences. To

mitigate their detrimental effects, it is imperative to implement sustainable land-use practices, early warning systems, effective flood management, and appropriate drainage planning. Flood control encompasses the strategies and interventions implemented to mitigate the detrimental consequences of floods on infrastructure, agriculture, human life, and property. A combination of structural and non-structural measures is necessary for effective flood management. A combination of engineering solutions, environmental management, and community participation is necessary for flood control. It is imperative to implement effective governance and long-term sustainable planning to mitigate flood risks and safeguard property and lives. In summary, floods are not entirely preventable; however, their catastrophic consequences can be mitigated through scientific planning, responsible environmental management, government intervention, and active community involvement. A coordinated effort at the local, national, and global levels is essential to establish resilience and guarantee long-term safety and sustainability.

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