

A Study on Flood Management in India**Waseem Ahmad Khan and Rajeev Sharma**¹Department of Civil Engineering, Mangalayatan University, Aligarh, UP²Institute of Business Management & Commerce, Mangalayatan University, Aligarh, UP

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Abstract: As a result of significant investments in flood prevention and ongoing efforts in India, socioeconomic losses and deaths are still a significant concern for many people. Because of a wide range of socio-hydro climatological elements, including climate change, sea-level rise, and socioeconomic dynamics, flood management in India is a difficult task. Only a limited amount of protection is provided by factors directly related to flooding management processes, such as a failure to implement traditional structural measures properly, an inability to implement schemes properly, and an inability to manage the entire process from start to finish. This article examines India's regional flood concerns and the efforts made by the country's primary flood management agencies, focusing on the country's present flood control policies. We examine the long-term efficacy of various methods while also pointing out some essential weaknesses. To help stakeholders and policymakers formulate and implement sustainable flood control plans, this article provides a set of guidelines that may be useful.

Keywords: Flood, Flood management programmes, Flood resilience, Policymakers, Socio-economic problems, Structural measures

Introduction:

Floods have a devastating effect on people around the world. Floods caused more than 40 percent of all known disasters between 2008 and 2017, according to the recently released World Disaster Report by the International Federation of Red Cross and Red Crescent Societies 'IFRC.' A staggering 730 million individuals have been affected, making about a third of the projected 2 billion people who have been adversely affected by natural disasters. Floods have caused the most damage to the economy of any natural disaster. India is one of the worst-hit countries in Asia regarding flooding (Fig. 1). In a world where one-fifth of all flood deaths occur and 12% of the land area is vulnerable to flooding, the situation is dire. Between 1953 and 2016, floods

killed an average of 1650 people per year, according to the CWC-2017. When it comes to Asian countries, India has the highest mortality toll from floods, according to Ashraf et al. The economic losses have been confirmed by the data (7 billion USD). Since they occur almost daily and vary greatly from place to region, floods are not a new phenomenon in India [1]. Floods in India are caused by monsoon rains, riverbank erosion and siltation, poor natural drainage in flood-prone areas, cloudbursts, and many other meteorological phenomena. As a result of increased urbanisation and land-use changes in recent decades, urban floods have emerged as another sort of 'disaster': Several devastating floods in India have occurred during the past several years; among them are those in Mumbai (2005, 2005, 2007 and 2008), Bihar (2007 and 2008), Assam (2012 and 2013), Uttarakhand (2013 and 2014), and most recently Kerala (2018). Managing floods in India is a difficult task due to the complex nature of the problem. Since independence, many precautions have been taken by the Government of India (GoI) to lessen the risk of flooding and minimise the damage they cause. Examples include the GoI's creation of numerous task forces and working groups and policy formulations that have guided flood management and other aspects of managing water resources. These plans took a normative approach, emphasising various structural improvements and emergency actions to minimise flood impacts. Stakeholder participation must be increased to make the management system more logical and responsive to change. The policies were developed with short-term aims in mind, depending significantly on a small number of structural reforms. For example, the Dam Safety Organization (DSO) was established to design a standardised dam safety process for all of the country's major dams.. This will help the state governments identify the possible sources of distress and prescribe appropriate corrective actions in the case of a dam collapse. Every state was required to establish a set of emergency action plans (EAPs) & operating manuals (OPs) that would help maintain a flood cushion and minimise damage in the event of dam failure. EAPs and operational plans for just 349 of the 4,862 major dams had been completed as of March 2016. Only two of the 17 states/union territories (UTs) had fully completed the pre-and post-monsoon inspections of dams. In comparison, three states had only partially completed the inspections, and the remaining 12 states could not begin the examinations. Another example is the RashtriyaBarhAayogh (RBA), established in 1976 to map flood-prone areas throughout the country. Recommendations were sent to all states/UTs/ministries in September 1981 as guidelines and directions for execution after it filed a report in March 1980. The RBA only

validated Flood-prone zones in Assam and Uttar Pradesh; the RBA recommendations were not implemented in other states because of bureaucratic problems. The Central Water Commission and the Ganga Flood Control Commission were unable to conduct a test check in the areas identified on the RBA flood map, preventing the preparation of a full flood atlas. The implementation of passive flood management projects has also failed. Limited financial resources, difficulties with project implementation, and a lack of frequent dam monitoring and benefit evaluation are a few of the likely explanations for this. Community participation and non-structural solutions must be considered in the current management system to create flood-resistant communities and reduce the compounding risk. In a country like India, several socioeconomic circumstances have made it difficult to foster a culture of community involvement. Ethnic and religious minorities and majorities have found that their social structures do not participate equally on a shared platform on numerous occasions. People who live in more racially divided communities are less likely to engage. Additionally, evidence suggests that higher or comparable income groups are more likely to engage in civic life. Female engagement in flood management efforts is hindered by a lack of gender equality, resulting in potential human resources and knowledge loss. There are discussions of non-structural solutions in flood-related policies. Still, they have yet to be applied significantly by the States, even though these measures have been implemented in some areas.

It is now clear that India's floods are a multidimensional problem. A hierarchical structure was developed to deal with the wide range of flood threats across the country. The centrally based organisation serves as the core and guides many state-level agencies. Even though the highest authority has been granted to organisations at the federal level, states have the same freedom to develop and implement their programmes as needed. In this way, the hierarchy of the flood management system gains a dynamic feature from the coherence between the two levels. Flood catastrophe preparedness, recovery, & management have made significant improvements since the country's independence. Flood-prone areas are growing at an unprecedented rate due to various factors, including climate change and human activity, making it difficult for these organisations to implement their plans and policies to minimise damages to people and businesses during and after natural catastrophes.

To put it another way: Success is only a success if it keeps going. This is why it is imperative to assess these activities and seek scientific techniques to make them more valuable for the future. This article provides a comprehensive and systematic evaluation of India's current flood management strategies, highlights their flaws, and predicts potential future difficulties that may be addressed. This page presents. The study's goals are to: (1) identify India's region-specific flood problems; (2) understand the flood management system and organisations operating at the central and state levels; (3) recognise the shortcomings that have hampered the successful implementation of the various flood control plans; and (4) highlight future directions through equally plausible recommendations that can be incorporated into flood management Research on flood control at all levels is studied in previous studies, technical documents, audit reports and official websites of different water resource and disaster management organisations to perform a comprehensive review of the literature. The review's main contribution to aggregate pertinent statistics and data trends that cannot be detected by looking at any one study in particular. Flood management plans are evaluated for applicability, efficiency, and effectiveness in the study's findings and suggestions for flood risk management. This study might serve as a helpful basis to better understand the current management methods and identify areas for improvement in flood risk management. The second portion focuses on India's flood-prone regions and their features. The third segment explains the existing flood management system and how it works at various levels. Aside from the intended flood management strategies, this section also focuses on the successes and limitations of various ongoing development efforts. In the fourth section, recommendations for future flood management are proposed. Non-structural solutions, collaborative participation between government agencies and stakeholders, and the judicious use of resources must be emphasised in the transition from passive to progressive. Toward the end of the article, you'll find the summary and closing remarks.

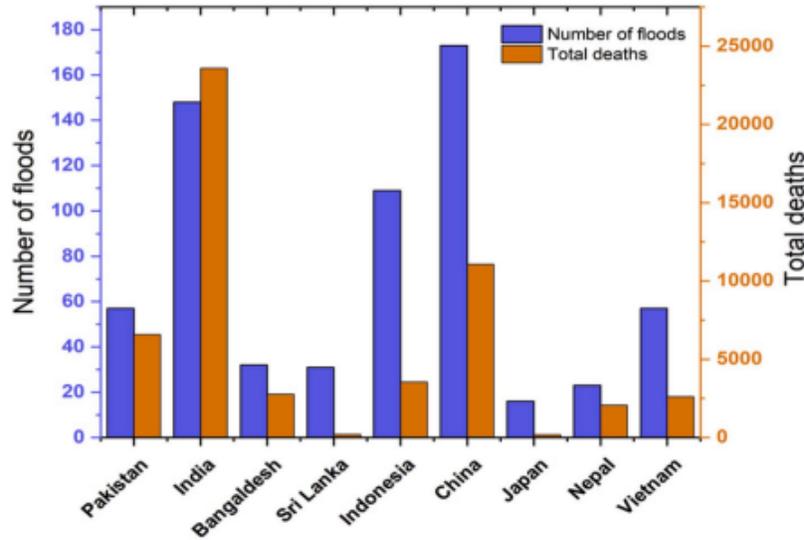


Figure 1: Between 2000 and 2010, the number of floods and the number of deaths in selected Asian countries

Areas in India that are prone to flooding:

There are more people in India than in any other country. It is located on the Indian Plate, which is part of the Indo-Australian Plate. – The Indian Ocean, the Arabian Sea to the west, and the Bay of Bengal to the east form the country's southern boundaries, while the Himalayan mountain range encircles the country's north [2]. The middle of the country lies in the path of the Tropic of Cancer. Different types of floods may be caused by these natural variations in the country's topography and geomorphology and the river systems and precipitation patterns. Continuous rain and flash flooding are the most common flooding causes during the monsoon season. The Ganges and Brahmaputra rivers have the most floods of all major river basins. India is divided into four central regions based on the kind of floods. The Brahmaputra River region, the north-west river region, the Ganga river region, and the central India and Deccan region. There is only one Brahmaputra River basin, located in India's northeast. These regions are plagued by constant rain, which causes floods regularly. Frequently occurring earthquakes and landslides disrupt the ordinary course of the river in a considerable portion of the region. If you live in a flood-prone area, you might want to reconsider. As the name suggests, the North-west River region is located in India's North-West states. Even though this location has a low danger of flooding, the problem

is exacerbated by poor surface drainage and water-logged areas [3]. More than half of India's North and a few Western states are within the Ganga river basin. However, those in the northern section of the state have been particularly hard hit by the flooding. The two fundamental causes of high flood risk are drainage congestion caused by excessive rain and river erosion caused by significant silt accumulation. Every state in India's southernmost section lies within the boundaries of Central India and the Deccan River region. During cyclonic disturbances, tidal flooding is expected in the region's coastal states. Only in their lower reaches and even in the delta area, where the average bed slope is very flat, do most rivers in this region have enough river water carrying capacity inside their natural banks. Due to the opposing tidal intrusion, the river water cannot simply drain into the sea [4]. This exacerbates the flooding problem. The following sections go into great detail about the features of each of these areas.

India's flood control system:

Flood management systems in the country have evolved. When Bihar was devastated by an unusual and disastrous flood in 1954, the necessity for a plan to protect the floodplain was recognised. There have been considerable investments in the construction of dams, detention reservoirs and river basin drainage improvements to reduce the risk of floods from riverine flooding [5]. Despite these precautions, the number of flood-prone areas in the country has expanded over the previous five decades, indicating that they have not been as effective as initially hoped. Schedule-7 of the Indian constitution mentions "water" and "water resource management" as an integral aspect of the state's list of legislative authorities. It gives states the freedom to design, implement, and maintain their water resource management plans [6]. Because flood management is a subset of the management of water resources, the state government and state agencies are responsible for implementing work linked to it, such as the building and maintenance of flood control systems. The federal government develops flood management policies and programmes for the benefit of state governments. It is the role of the central government and its agencies to provide financial and technical help to the states following various committees' instructions. As a result, India's flood control system is divided into two levels: the state government and the central government. Each level has several active agencies responsible for certain flood-control activities [7]. The organisation's structure necessitates

cooperation and coordination among numerous organisations at various levels. In the next sections, we'll go over the various levels of the organization's hierarchy.

- **Organizations at the national level:**

The country's catastrophe management procedure is under the control of the national government. Coordinating with other agencies, the central government implements disaster preparedness and protection measures. As a result, flood management necessitates cooperation and coordination across various agencies. The central coordinator and supervisor is the Department of Water Resources, River Development, & Ganga Rejuvenation, under the Ministry of Jal Shakti. The central government has set up other groups and committees to monitor the flooding thoroughly.

- **Organizations at the state level:**

State agencies are in charge of planning, building, maintaining, and operating all flood prevention and mitigation measures, because flood management falls under states' authority. Some states have also established a state flood control board in this regard. The Public Works Department (PWD) builds and maintains flood control infrastructure [8], whereas the Irrigation Department is often in charge of water resource management and planning. Developing an integrated flood control system at the local level necessitates a joint effort from various authorities. Therefore disaster management authorities & disaster response teams are responsible for post-flood relief and recovery operations throughout the states of the US River basin authorities should be established in each state by MoWR, who recommend that they be staffed by people with administrative experience who can oversee and execute responsibilities on time.

- **Flood management programme (FMP):**

Funding for flood-protection infrastructure for states was approved as part of the XI five-year plan, with an outlay of INR 8000 crores. The FMP covers river management and flood control projects. The FMP also covers drainage development and anti-sea erosion projects. The FMP also covers rehabilitation and restoration work. MoWR approves the projects suggested by the states if they meet the requirements outlined in the FMP standards. In addition to project approval, the standards for FMP cover fund sharing between federal and state agencies and other factors including reimbursement and audit of expenditures. As part of the XII five-year plan, the

funding was increased to INR 10,000 crores, and 517 projects were sanctioned under the programme (till March 2014).

In the XI five-year plan, 420 projects were approved; in the XII five-year plan, the number dropped to 97. Projects were completed just 297 of 517 times in the last ten years, even though they were supposed to be completed within 2–3 years of the approved budget. According to the storey, it also says that the states were unable to provide their fair portion of the project's funding. As a result, the project's budget was cut, which caused delays. The release of money from MoWR was delayed in several cases because the states failed to submit project proposals on time or at all. The FMP's guidelines are likely to have been ignored by the states. States are mandated to transfer monies obtained from the federal government to the implementing agency within 15 days of receiving them. States should also avoid rushing to spend money on the project towards the conclusion of the fiscal year. These regulations and principles were broken numerous times. States were not fined or penalised for the violations either. Several instances of monies diversion and parking point to poor financial management. The states did not timely submit project completion reports and utilisation certifications for projects approved under FMP. States ignored national Water Policy-2012 and earlier working groups' recommendations in their proposal submissions. There was a lack of integration and scientific reasoning in the project proposals and thorough project reports submitted by governments. In addition, project proposals were often delayed, causing project reports to be out of date when they were filed. In addition, the projects' cost-benefit ratios were questionable in several instances.

•Reservoirs and dams are two different things.

India currently boasts the world's third-largest number of major dams. In 1979, the GoI established the Dam Safety Organization in CWC after identifying possible dangers linked with big dams. With the National Committee on Dam Safety in 1982, a new organisational structure was put in place to monitor dam safety in India. For creating and implementing Emergency Action Plans (EAPs), the NCDS established recommendations in 2005. There are still no EAPs, let alone dam/embankment break studies or studies on optimal operating procedures, for many of the 5761 (as of 2017) big dams even though these rules have been in place for more than a decade. Only 231 of the 4862 big dams had an operating and maintenance manual as of March 2016. Any unforeseen incident or flood-related calamity is not adequately prepared for. Dams

must be inspected before and after the monsoon season, and a complete report must be submitted to the Dam Safety Organization [9]. The DSO checks to see if the proposed activity is completed to the satisfaction of the DSO. But just a few states carry out the inspection properly, while the rest of the states are only making minimal efforts. However, none of the states that produced inspection reports ensured the implementation of the remedial steps recommended by an expert committee on dam safety in light of a lack of funding. Post-flood mitigation methods are more accessible for state authorities to invest in than flood preparedness and damage prevention.

•predicting floods

In 1958, a single CWC unit in the Yamuna River began providing flood forecasts. There are currently 226 (as of May 2018) flood forecasting stations in India, which have grown and increased over time. Local & reservoir operating agencies use this information to plan flood mitigation operations, such as assessing water levels and forecasting water discharge. There isn't as much of a forecasting network in place as we had hoped. As a non-structural measure, it has long been recognised and plans for its growth are constantly drawn up. There must be real-time transmission of information from telemetry sites to make accurate forecasts. Due to a lack of financial backing and ongoing maintenance expenditures, Indian authorities have difficulty implementing their recommended plan. Only 56 of the 222 new telemetry stations planned for the XI five-year plan (2007–2012) were installed by August 2016.

Flood forecasting in India is currently in a terrible state because of delays in the construction of new telemetry stations and the failure of those already in place. A lack of stations and a broken system have caused several problems. To make matters worse, just 41% of the existing telemetry stations are fully operational at this time. The current facilities cannot provide accurate forecasts due to the improper setup of water level gauges and malfunctioning equipment. It is not uncommon for equipment to be stolen from not properly monitored or secured locations.

• Flood control committees:

Structural flood management methods, like drainage and embankment construction, are only included in the state's list of flood prevention measures. This is why many states have a lengthy history of building considerable barriers to protect against flooding. Since independence, more than 35,000 kilometres of embankments and nearly 40,000 kilometres of drainage channels have

been built. State governments are responsible for protecting their citizens from flooding, but the federal government has set up numerous institutions and committees to aid them in their efforts. Working groups such as the task force for flood control and many other committees were established by the government of India throughout the XI and XII five-year plans. National Water Policy in 1987, 2002 and 2012 laid the foundation for a long-term flood control strategy. According to the policy recommendations and rules, states were meant to follow when conducting flood management activities. However, the states did not implement these guidelines and suggested policies. According to RBA, states should identify flood-prone locations and estimate the amount of land they can safely safeguard. Every five years, it was suggested, this process of identification and evaluation should be carried out. The problem is that no one in the states took action to address it, and no one could identify or assess it. National Water Policy-2012 recommended morphological analyses of the major rivers to carry out the planning and building of flood control measures more effectively. Similarly.

As a result, no research was done in any state. National Water Policy-2012 recommends the production of frequency-based flood maps for the flood-prone zones so that effective strategies may be established for dealing with floods. Forecasting models from CWC were used for inundation mapping by states in the United States. A lack of finances supposedly prevented states from receiving the requisite Digital Elevation Model (DEM) from the National Oceanic and Atmospheric Administration (NOAA). As a result, that recommendation was never carried out.' The governmental agencies in charge of flood management need to realise the value of soft measures in protecting against flood damage. Until recently, state authorities were mainly concerned with structural methods to manage to flood and guard against them, while neglecting the long-term effectiveness of non-structural measures.

Recommendations:

Floods are now known to be unexpected and it is not always possible to provide total protection and control their occurrences. Unfortunately, India's current flood control system does not adequately safeguard people and property from the devastating effects of floods regularly. As a result, as passive flood control methods appear insufficient, a progressive management approach is required. Based on the extensive literature analysis, it is essential to point out that the chances of success of various flood management strategies are still a long way off. They were unable to

be successfully managed on multiple occasions, resulting in significant delays than the proposed timeline. As a result, it is critical to ensure that the resources allotted are being used effectively. In addition to completing new projects on schedule, it is critical to pay close attention to the results of previously completed initiatives.

As a result, we discovered that the standard structural measures were being used more frequently to reduce flood damage in the area. Even while non-structural solutions have been addressed at some point, they have not been adequately implemented, despite being equally important. A critical component of flood control is the participation of the public and stakeholders in managing flood protection structures and the training of emergency responders. It is imperative to shift from a passive response (relying mainly on structural measures) to a progressive response that emphasises non-structural methods such as flood prediction, land-use planning and flood alerts as well as participatory cooperation among government agencies and other stakeholders (people, public, and private organisations in the affected areas) with timely vigilance of the utilisation of resources in these situations. Government entities and the public should be able to collaborate more effectively through a framework that encourages participation. The current global paradigm emphasises the creation of policies with several goals in mind. In this way, flood risk, management of water resources, development, and environmental preservation can all be considered when devising a flood control strategy. The following sections offer suggestions for improving India's flood management system based on that country's analysis findings.

- **Acknowledging the lingering danger:**

The flood control systems are designed to handle occurrences of typical occurrence, but there is no guarantee that a future catastrophe will be disastrous. That's why it's vital to understand that passive measures can only provide limited protection. As a result, a large investment is required to maintain and operate flood control structures at a consistently high level of protection. Structural measures can accept some residual risk in the management of economic resources. With the help of non-structural measures, the danger of flooding can be minimised by ensuring a greater level of flood readiness and preventing flooding. Non-structural measures have been overlooked in the flood-prone Brahmaputra and Ganga river areas, where structural measures have been heavily invested. Still, little attention has been paid to non-structural ones. A flood-

proof approach for future flood events will be assured with a secure connection between architectural and non-structural measures. This will significantly reduce the current risk.

• **Increased efficiency in government:**

Bridge the governance gap and create a framework that allows states and the federal government to collaborate with equal responsibilities. In the past, India's flood control was not up to snuff on numerous occasions. A lack of coordination between the states and the federal government could make it difficult to enforce the National Water Framework Law and River Basin Management Bill, according to experts from the World Wild Fund for Nature, India; the Centre for Energy, Environment & Resources, New Delhi, CWC, and other non-profit organisations.. The central government must be involved in the flood management process and provide laws to the central government. There was a suggestion from the Standing Committee for Water Resources (2016-17) to examine adding 'water' as an additional concurrent legislative power. Before the Chitale committee, which was founded to monitor large-scale desilting activities in the Ganga river region, many rapid response teams had been established to function as a catalyst in strengthening the interaction between central and state entities in charge of flood-control efforts. Efforts should be made to ensure a transparent system between the two flood management levels in the future.

Conclusion:

Despite decades of flooding and countless attempts to lower flood risk, the area's susceptibility to disasters has not lessened to the extent expected. State and local governments carry out FRM planning and disaster relief functions with the help of the central government. Despite this, there is a pressing need to improve government administrations. Agencies must work together and form stronger links with the people they serve. Only a limited amount of progress has been made in India's efforts to adopt flood policy principles. When enforcing policy guidelines and suggestions, a fool-proof system is needed now. The construction of massive structures depletes the flood risk management budgets, which are scarce in the first place. Flood risk management can be improved by increasing funding for structural and nonstructural infrastructure development and better dividing these monies. There is still a lot of work to improve flood risk management in India. Policymakers and practitioners would benefit significantly from the government taking a few steps to encourage research in this area. A flood management plan should fix current system flaws before putting money into significant new projects. There are

only a few managerial issues that need to be addressed in the current system. Poor upkeep of flood-control systems is the main problem. After sufficient training, communities should take on the responsibility of maintaining and operating their facilities. This strategy will enhance community involvement while also allowing for on-time maintenance.

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