Evaluating the Effectiveness of India's Flood Management Laws

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ABSTRACT

The Brahmaputra River, which flows from China to India and Bangladesh too always has been the focus of flood vulnerability for years. Heavy rains, climate change, unplanned placement of human life, deforestation are some core reasons which have made this region one of the most flood prone areas in India. Back from 2012 to 2022, regular number of floods have caused massive destruction which resulted in taking lives, displacement families, ruining agricultural land and produce, damaging property and infrastructure, etc. wildlife, specially in places like Kazi Ranga National Park has also suffered greatly. Poor drainage system, temporary embankment fails and glacial melting like situations merely worsened the situation and just added fuel to the existing miserable conditions. This flood situation also contaminated the water bodies and rivers which eventually resulted in disease out breaks, food shortages, insecurity of resources, and economic hardships. But, to prevent the future disasters, better management pf all resources, early warning systems, planned human settlement and sustainable environment practices or maintenance of ecosystem are critical than ever.

INTRODUCTION

The Ganga and Brahmaputra basins are the most flood – prone areas in India. The flood affecting areas in Ganga – Brahmaputra Plain have been increasing.[1] (NRSC, 2023)Brahmaputra is a cross – national river which traverses through southwestern China, northeastern India and Bangladesh. It starts from the north side of Himalayas and goes down to Lake Mansarover. It enters India from Arunachal Pradesh and moves in to assam valley, and then to the Southwest. It joins the Ganges in the expansive Gangas Delta which is known as Padma in Bangladesh and transforms into Meghna then finally discharges in the bay of Bengal.

The flood prone regions in India are primarily kmown for the Ganga and Brahmaputra. The areas of Ganga – Brahmaputra Plain that get affected by floods are increasing the detrimental impact caused by floods on people and property is increasing as well. There is a dire need for timely flood warning systems and mitigation strategies in place, especially for the most vulnerable regions. In this context, the "Satellite Based All India Flood Affected Areas Atlas" prepared by NRSC is extremely useful.

The catastrophic floods in India along the banks of Brahmaputra River and its tributaries in 2012 and the following years is what is known as the Brahmaputra Floods. Monsoon rains in Bangladesh, Myanmar, and India caused the historic Brahmaputra floods of 2012. Flooding also killed 540 animals, including 16 rhinos, in Kazi Ranga National Park. The primary cause of rising siltation levels and soil erosion, particularly in Assam, is deforestation. Flooding shut off the roadway access, so food was delivered by helicopter.

[1] *National Remote Sensing Centre (2023)*

In 2013, Arunachal Pradesh experienced flooding as a result of excessive rainfall. Twelve districts were inundated by this flood series, affecting almost one million people. This caused almost 7000 hectares of land to be damaged, and many people to suffer from a lack of food and clean drinking water. For the shelter, eight relief camps were established.The flood victims said that river embankments that had been broken by a previous flood had either not been restored or were absent in several locations.

The 2015 Assam flood was brought on by Arunachal Pradesh's severe rainfall. In 2021, the flood affected 16.5 lakh people, killed 42 individuals, and blocked many roads due to landslides.

2016 Assam floods affected over 18 lakh people. the rainfall resulted in flooding of various rivers and the Brahmaputra River crossed its danger mark level in the seven districts of the state and around 4,90,000 acres of farming land. The Assam Branch Indian Tea Association (ABITA) has estimated a 30% crop loss of Assam tea from 63.1 crore kg of tea in a year. About 300 makeshift camps were erected to rehabilitate people displaced by the flooding, seven public sector oil companies donated a total 15 crore rupees towards chief minister relief fund.

The 2017 flood caused by overflowing of river in the state Assam, Arunachal Pradesh, Nagaland and Manipur. 85 people were dead and 4 lakh people have been affected and 5,00,000 have been homeless several animals died. The state government of Assam set up 128 relief camps under the surveillance Chief minister Sarbananda Sonowal for people displaced, and has made arrangement for drinking water, food, medicine and rescue goods.[2] (kalita, 2017)

The 2018 flood caused substantial destruction in the state. It affected around 450,000 across the different districts, as stated by Assam State Disastra Management Authority (ASDMA). Unfortunately, 12 people died in the flood and roughly 11,243 hectare of agriculture land was devastated.

In 2020, the floods were a result of the alarming rise in the water levels of the Brahmaputra. Over 30,000 people across five districts were severely affected along with crops. As of July, the flood coupled with landslides have worsened the condition, bringing it up to about 16 million people impacted across 22 districts of Assam. The water submerged over 2200 villages and the crop water-logged stood to around 87000 hectares with certain cities panic stricken for the amount of water level. More than fifty percent of Kazi Ranga National Park and Pobitora Wildlife Century was not spared by the floods, disturbing the wildlife to run to higher grounds.

In May 2022, the floods, which wiped out 600,000 people and took 25 lives, were a direct consequence of excessive rainfall. The Assam state disaster management authority (ASDMA) has declared that all the villages, along with over sixty thousand hectares of crop area, have been severely impacted negativeley. Authorities are running several relief camps and institution centre across the state sheltering thousands of people Railway lines were also affected due to flooding and landslides.[3] (india, 2022)

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[2] *Kalita, Prabin (5 July 2017). "Assam floods: 4 lakh people affected, over 41,000 in relief camps". The Times of India*

[3] "Assam: Assam floods: 26 killed, 5.8 lakh affected across 17 districts". The Times of India. 24 May 2022. Retrieved 25 May 2022.

FACTORS WHICH CAUSED DISASTER

What's the main and primary reason for the causing of disaster :-

The main reason for the flood in Ganga-Brahmaputra river basin is:

Deforestation And Land Use :-

Deforestation in the Forest region for agriculture and urbanization has significantly reduced the natural capacity of the ecosystem to absorb excess water. Trees and forests act as natural sponges, intercepting rainfall and allowing it to slowly infiltrate the ground. Their removal leads to increased surface runoff, carrying large amounts of soil and sediment into the rivers, increasing flood risk as well as the tree roots bind the soil together which prevents soil erosion. Deforestation leaves the soil exposed, making it vulnerable to erosion by rainfall and runoff. Eroded soil is then carried into rivers which reduces their capacity to carry water.

Climate Change :-

Climate Change is the global reason or cause for any disaster caused and the human activities are the primary driver for climate change. The burning of fossil fuels, deforestation industrial activities to complete the unnatural demands of humans and urbanisation have increased greenhouse gas concentrations in the atmosphere which leads to rise in temperatures and pollution in the atmosphere. This has resulted in more intense rainfall events, increased glacial melting and rising sea levels, all of which contribute to increased flood risk in the Ganga Brahmaputra river basin.

Urbanization And Infrastructure Development :-

Increasing in rapid and unplanned urbanization near the basin which has increased the risk of flooding. Like construction of roads, buildings and other infrastructure reduces the land's ability to absorb water, leading to faster runoff and increased flood situations. The primary need of urbanization held because of growing population which led to the development of settlements of people in flood prone areas or construction of buildings and houses near river basins or lands where construction or settlement of people was not allowed.

Agricultural Practices :-

Intensive agricultural practices such as over irrigation or over reliance on chemical fertilizers can leads in degradation of soil health and increase run off leads to flood risk as well as the excessive irrigation in agricultural lands leads to water logging and increases the risk of flooding and contributes to overwhelming river systems. With this we also notes to the situations where farmers often cultivate crops on river banks and floodplains due to fertile alluvial soil, this actions reduces the room available for rivers to expand during high flow or monsoons.

Monsoon Patterns :-

Monsoon mostly influences the Indian climate conditions which leads to create impacts on environment, economy and livelihoods with this unpredicted monsoons disrupt the agricultural

planning and leading in rotting of crops and water logging. Uneven rainfall can leads to droughts in some regions as well as floods in others.

Factors of Human Intervention :-

The human activities which leads to the flood conditions:

Dams:-

Dams basically alter the natural flow regime of the river, disrupting the seasonal flow patterns. Sudden fluctuations in water levels due to dam operations can destabilise riverbanks. Poorly maintained dams or extreme weather conditions can cause dam failure, leading to flood. Construction of dams reduces the river's capacity to maintain its channel and raise the riverbed and overtime this can lead to flooding during high flows. Dams may disrupt natural drainage patterns and flows of water.

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Climate Change:-

Extreme conditions contributes significantly to climate change through emissions of methane and nitrous oxide from the fertilizers and other hazardous gases which can intensify the monsoon rains and glacial melting, exacerbating flooding. Bad agricultural activities increase both the likelihood and the impact of flooding by destabilizing natural systems, reducing the river's capacity to handle excess water, with human vulnerability.

Construction Of Embankments:-

The construction of embankments for temporary purposes can increase the flood chances through obstruction of natural flow which can alter the natural course of river or restricting the real water movement which can rise the water level. Also the increased water pressure because of embankments construction it really makes water flow faster and more forceful which leads to sudden and more severe flooding. Mainly it has risk of breaching or collapse of embankments when it made mostly of temporary purposes cause these often made of weaker materials like sand bags, loose soil, etc. which makes them prone to breaks.

Factors which affected this vulnerability :-

The factors which basically affected this flooding conditions:

Heavy Rainfall:-

Rainfall usually brings the flood vulnerability or often it's the main reason behind flood vulnerabilities but here by overwhelming the natural resources and not up to mark man made drainage systems leads to severe environmental consequences. When rainfall intensity increases, the capacity of soil absorption often losses and excess water accumulates resulting in water logging and floods.

Additionally, heavy rainfall accelerates soil erosion, reduce agricultural productivity and leads to flooding conditions. Now, the contaminated water from bad sewage systems increases the risks of water borne diseases and looses the hands on public health. The extreme rainfall events due to climate change makes government more reliable for managing the conditions by taking preventive actions like flood management authorities, improved infrastructure or drainage systems, sustainable land use, and more strategies to mitigate the risks.

Glacial Melt:-

More frequent and intense floods leads cause of glacial melting which can triggered by environment pollution, global warming and climate change due to sudden temperature raise and heatwaves which impacts with melting or out bursts of glaciers. This also leads to increased river flow which combines with heavy rainfall and leads to flood vulnerability as well overloaded river systems especially dangerous to cause flash floods and they happen very quickly with very little warning which can be equally disastrous for human or any living life, property and nature.

Inadequate Drainage:-

Basically to cut costs especially in urban areas, poor drainage systems majorly opted to prevent rivers from overflow and mainly to handle heavy rainfall but it works oppositely and leads to water accumulation which helps to make floods more worse. Blocked, undersized and poorly designed drainage systems fails to divert excess water from rivers even reduce ability of water to soak into the ground, also leads to water logging which increases risks of property collapses and at lasts result as a contributor to flood vulnerability.

Embankments:-

Generally, these are constructed to prevent flood conditions but it's overwhelming to know that these are one of the reason which leads to flood vulnerability as weak or poorly constructed embankments can not handle heavy rainfalls or high river water discharge and rushes to collapse of embankments and uncontrollable floods. These leads to keep millions of life in a very dangerous situations or basically in a vulnerable situations.

Deforestation:-

Forests are the most essential part to prevent flood which stabilizes soil and helps in absorbing rain water and significantly decreases the risks of flood but due to deforestation or when trees are removed rainwater flows rapidly on the ground and leads to rivers overflow very easily. Forests also called off as natural flood protection cause it works as a natural stoppage for overflow of river water but large scale deforestation results in sustainable management of nature and flood risks, it even affects the climate patterns and rainfall patterns with unreasonable or sudden season changes.

Climate Change:-

Climate change is the basic reason behind any natural vulnerability as it leads to stronger storms which results in more heavy rainfall and increases the risk of river overflows and creates an overwhelming situation of flood exposures. Sudden global temperature raise and rising sea levels expands the sea water which leads to create flood risks especially at the coastal areas oncoming time.

IMPACTS CREATED ON HUMANS AND ENVIRONMENT

Direct impact created on humans:-

Mentioned flood disaster directly affected given aspects on humans or any other living life, property, infrastructure and nature:-

Loss Of Life:-

Increasing flood disasters and mainly high frequency of this flood vulnerability leads to hundreds of deaths of humans as well as animals through drowning and injuries due to high volume floods or led to health crises cause of contaminated water which spread diseases and increase fatalities. This also results in land slides and property collapses of houses, bridges, roads, etc. and basically these all situations leads to one and only end which is poverty and competition for resources or conflicts over food and water resources which put pressure on already scarce resources, and left with no other option then shutting down of businesses or job losses and migration.

Homelessness And Displacement Of People:-

Destruction is just another word to define vulnerability occurs through natural disasters but clearly this created a lot of fatality and accidents and displacement of people or loosing their houses is just another example of their miserable conditions. Flood vulnerability majorly leads

to job loss and downfall of local businesses which eventually affects people's standard of living. Sometimes, most of the population lost their houses due to the disaster and have to settle or start a living from scratch and or a completely different place which at last affects their living standards and even can absolutely exhaust their savings too.

Food Insecurity:-

Floods usually resulting in submerging of the fields or wash away all the agricultural produce which eventually destroy the crops and vegetables produced. With this also creates a loss of livestock or fisheries due to disrupting natural aquatic ecosystems which reduce the cattle's population. Thus, which bring in the chaotic condition of evacuation and disease outbreaks in animals. Ultimately, it contaminates the food and water resources used by humans and brings up the waterborne diseases which usually results in destruction of crops and food supplies.

Disease Outbreaks:-

Flood vulnerability always has crucial affect on disease out breaks because of contaminated water which led to water borne diseases like cholera, typhoid, bacterial infections, etc. With this poor sanitation conditions of Indian waterbodies or water resources are the significant contributor to disease outbreaks. This flood disaster created a larger impact on disruption of food supplies and crops which eventually resulted in malnutrition and weakened immunity of people.

Direct impact created on environment:-

Mentioned flood vulnerability directly created impacts on given aspects on nature or any other living being and development of the country too:-

Infrastructure Damage:-

Precisely, infrastructure damaged due to this flood vulnerability resulting in submersion of roads or affecting bridges and private properties like buildings, houses, etc. this also affected the power and communication or telecom networks due to flood causes. Floods can even leads to wash out the railway tracks and making them unstable or may trigger the land slides after all which leads to become a accident prone aspect for living lives of any kind as well as a danger for properties too.

Water Pollution:-

Floods majorly leads to chemical contamination into water resources and disease sharing through contaminated water which can erode industrial waste sites from where hazardous toxics release like lead, mercury, etc. this disaster posses risks to human health or any living life includes in the eco system and equally dangerous to nature or environment.

Business Disruptions:-

Exactly, flood conditions can severely damages the local businesses through disrupting the supply chains and other required managements which can led to economic instability, monetary losses and job losses and to fix the things again at a certain level it will take a long time and a lot of economic resources. And physical damages to buildings, property, equipment and infrastructure force business to shut down or job losses on individual level.

Increased Poverty:-

This vulnerability significantly causes destruction to infrastructure and loss of livelihoods which eventually brings up the human sufferings and substantially contributes to poverty and economical resource depletion and wastage leading to economic setbacks and trapping the people in the vicious cycle of poverty and they were not able to rebuild source of income and a decent standard of living so easily. Even, investors avoid to start businesses to flood prone areas which ultimately results in job reduction, no economic expansions, food insecurity, displacement of people and after all makes it harder for every individuals to recover from the losses.

Habitat Destruction:-

Strong floods like the mentioned one led to the disruption of animal and natural habitat add in displacement of human beings along with damaging natural ecosystem of the environment. Flood waters excessively carry pollutants and toxic elements like chemicals and toxins into the water bodies, rivers, lakes which severely affects the aquatic life and is also leads to contamination of water sources.

Soil Erosion And Sedimentation:-

Floods basically accelerates the removal of topsoil which is equally crucial for plant growth and land stability eventually it results in agricultural losses, insecurity of resources and land slides due to which property, human life and animal habitat disrupted after all in the end it duly affects the natural environment and ecosystem. And depositing large amounts of sediments into the rivers, lakes or any kind of water bodies leads to clogging of waterways and reducing water flow capacity.

SUGGESTIONS

Some of the suggestions were given as follows to keep always a step ahead from the conditions underscored in the above flood vulnerability or to just protect humans, living lives and nature from natural disasters like floods as it always requires a blend of planning, preparedness, awareness of people, help from government, and planned human settlements. So, to understand the suggestion we have divided it into two parts of modifications or measures are structural and non structural measure.

Structural Measures:-

1. A balanced and planned human settlement is the need of the society as to keep human beings and other living lives to be safe without making unnecessary alterations in the nature's ecosystem. And according to needs and laws of society it is the duty of government to carry out the planned population settlement and also to take measures for emergency planning or to make people aware about these vulnerabilities and disasters.

2. Building dams and reservoirs can help to regulate water flow and store excess water during the monsoon season as now it plays an important role in managing the flood conditions from a future perspective and to control water flow of rivers or lakes by storing excess of the water in to the reservoirs with this it can even divert the excess water to some of the safer options of any area or for controlled release but again it is an obligation for public institutions or authorities to construct permanent and high quality dams or reservoirs by putting in required investment or costs while duly maintaining it properly to rescue it from being collapse or other failures.

3. Redirecting excess waters from overflowing river bodies can really protect from natural vulnerabilities and helps to restore the damages. Diverting water process to safer areas usually designed to direct excess water from rivers to lakes or reservoirs to prevent the population as well as other living lives.

4. Channel construction and channel management is the another technique to prevent humans and nature from destructions through improving the flow of water and expanding the width of river which can allow it to carry more water mostly at the times of heavy monsoons and reduce the risks of flooding. Sometimes adding to it, constructing the artificial or bypass channels also aids from the risk of flooding and keep the excess waters away from high risk zones.

Non-Structural Measures :-

1. Flood forecasting and pre-warning systems is just a way of make people aware about the calamity or it's disastrous results for reducing the damages and giving people time to get prepared or to evacuate or to shift to a more safer place. As the systems are advance and keeps up the real-time monitoring to predict the floods and serve the timely alerts. That's why regularly data collection and monitoring of water level/ soil or moisture sensors/ flood predictions which all were equally necessary and crucial.

2. Land use planning is a very important step while making planned settlements of populations and even when policies were made about funds investments or yojna's were made in which kind of housing/ properties assistance granted by government authorities. Expanding wetlands and green spaces can be fairly a

support system for natural ecosystem to recreate or prevent the vegetation/ crops/ agricultural produce/ etc. and even help to absorb flood water or excess water.

3. Flood insurance is a financial help received from the side of public authorities that helps the individuals, communities or businesses to recover from the damages and loses created because of flood conditions which generally provides coverage from property repairs/ protect their belongings or other compensations to asper the loss created to victims. However, emotional and family loss can never be compensated through any kind or monetary help but than also to encourage faster recovery or to reduce any financial burden quick funds were accessed by the government.

4. Now, the community-based preparedness is also an essential approach to manage the flood risk conditions. This elucidate in a way that in this approach local communities were involved in disaster planning, response, awareness to others, etc. with that necessary recovery efforts were created too. It focuses on awareness of every body/ early warning systems/ infrastructure improvements/ and majorly education in every field or discipline of learning. Even, coordinated emergency responses were taken to minimise the flood damages and to protect lives.

5. However, we cannot forget to mention the technique of afforestation or reforestation with that awaking and advising people regarding evacuation process and how to get the early alarms served by news channels.

REMEDIES

Constructing Embankments, Flood Walls & Flood Levees :-

The river's embankment structure keeps the water from spilling the banks and confines it to its current cores.Embankments are the most popular methods of flood protection and they have been constructed extensively. Where the adequate space is not available, expensive concrete or masonry floodwalls are constructed.

Dams, Reservoirs & Other Water Storage :-

Another structural method for flood management is constructing dams, reservoirs and other water storage. The river's embankment structure keeps the water from spilling the banks and confines it to its current core with this signified amount of flood waters stored in reservoirs or other water bodies which subsequently releases when ever necessary which can be used for agricultural needs and electricity generation.

Dredging/ Distillation :-

The basic aim of dredging is to remove silt, silt is a sedimentary material made of fine sand, clay and small sized particles of rock silt forms the reverse bed therefore by dredging or removal of silt it can increase the capacity of river to carry water downstream the process of

dredging involves a vacuum pump that is used to remove silt from the riverbed Silt builds up on river bed over time, during heavy rain, river floods. Diggers or vacuum pumps can be used to remove silt and increase river capacity. But after an extreme flood, river accumulates more silt as flow slows down.

Diversion of Flood Waters:-

This process involves diverting all or a part of discharged water into a natural or artificially constructed channel. Diverted water may be taken away from the river without returning in it further downstream or it may be returned to the river some distance downstream or directly to a lake or sea.

Afforestation :-

Increasing the vegetative cover serves as an effective measure to control floods which expressly explains the process of planting trees in the areas where there were no forests previously and even it plays a very crucial role in managing floods as it absorbs large amount of waters which eventually prevents water bodies like rivers or lakes to gets overflowed but after all this is not a very effective measure during large floods.

Flood Zoning :-

Flood plain zoning is a concept which regulate land use in the flood areas in order to restrict damage due to floods. It restricts construction too in high risk areas of flood calamity to prevent collapsing of building mid way or reduces the property or human lives damages by restricting the flood prone areas or regions which are frequent or severe to flooding.

Flood Proofing :-

It consists of providing raised platforms for human and cattle raising public unity installation and preventing water in filtration as basically it raises houses or buildings above expected flood level prevents water from entering into the property or using water proof coatings or barriers prevents water seepage which after all reduces the damaging results of flood disasters.

Flood Forecasting and Warning :-

Investing in advanced technology to provide accurate and timely flood forecasts can help people prepare and evacuate. Flood forecasting and pre-warning systems is just a way of awaking people about the calamity or it's disastrous results for reducing the damages and giving people time to get prepared or to evacuate or to shift to a more safer place.

Integrated water resources management system :-

Restricting construction in flood-prone areas and promoting sustainable land use practices can reduce vulnerability. However, this aids in managing water supply or just enhances the flood

control infrastructure which equally made asper the sustainable views over saving natural ecosystems too.

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