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Flooded Cities: A Comparative Analysis of Flood Management Policies in Indian states

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Abstract

Flooding is a critical issue affecting many countries worldwide with severe consequences on the lives of their residents. In this paper, we conduct a case study of the flood management policies of India by evaluating their implementation in six Indian states that are affected by recurrent flooding every year. The states selected have major cities located near water bodies and have experienced flooding leading to deaths and displacement besides slowing down economic and community development. We evaluate how each of the states align their policies to the national level disaster management guidelines for flood management. We find that for policies established at the state level, implementation within the various regions can vary with some urban areas going beyond the state and national guidelines. We find that not all Indian states follow the established national guidelines, and this poses questions on the challenges on having uniform flood management policies for addressing a complex issue.

Keywords: India flood policies; disaster management; flood governance

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1. Introduction

Flooding has become one of the most devastating and recurring natural disasters affecting the lives of millions worldwide (Albrecht, 2017; Hossain & Meng, 2020). Over the last 30 years, more than 2.8 billion people have been affected by flooding and more than 200,000 died (Milojevic et al., 2012). Flooding has no prejudice to who it affects; from the rich to the poor, the young and the old. Whole communities are affected by flooding (Potluka & Slavikova, 2010), from the loss of homes and personal belongings to the loss of life (Albrecht, 2017).

Taking the case of Guwahati city in Assam, a northeastern state of India, which deals with annual flooding, we attempt to explore the problem of recurring floods and forward solutions from a multidisciplinary perspective. In this paper, we present the findings of our study where we evaluate how federal level flood management policies included within the national Disaster Management policies are adopted at the state level in India through a comparative analysis of flood management policies across states. Our primary research question is: "What is the state of the flood management policies in India?"

The purpose of this study is to address the question of whether any of the states in India with major flooding issues have policies which have advanced beyond national guidelines, and could thus become models for other states in India and at the federal level. This study is an attempt to evaluate the policy measures initiated at the national and state levels to address the issue of flooding and thus can contribute to understanding the variance in policy design as well as policy execution. We focus on those states that are similar in terms of having big cities that experience annual flooding resulting in severe socio-economic impacts.

The Disaster Management Act of 2005 in India was established to prevent as well as effectively manage disasters. By focusing on prevention, mitigation, preparedness, response, rehabilitation, and capacity building, it provides an action plan to the state and local governments to design and implement disaster management plans (Sarkar and Sarma, 2006). It also provides for a three-tier mechanism for disaster management: the National Disaster Management Authority, State Management Authority, and District Management Authority. This law provides a critical role to local authorities (districts, municipalities) to be able to govern, plan, implement, and manage disasters. The governance of disaster management policies was thus delegated to various levels of government for effective application.

Disaster governance, according to Tierney (2012, p. 344) consists of "the interrelated sets of norms, organizational and institutional actors, and practices (spanning pre-disaster, trans-disaster, and post-disaster periods) that are designed to reduce the

impacts and losses associated with disasters arising from natural and technological agents and from intentional acts of terrorism." Other researchers (Thieken et al., 2007) argued that flood related disaster governance consists of a preparatory or risk reduction phase which tends to be over a long period, a flood response phase which occurs immediately when a disaster occurs, and a flood recovery phase that begins after the emergency event (Thieken et al., 2007). During these phases, several institutions, citizens and civil society are involved in decision-making highlighting the importance of inter-governmental and inter-agency coordination, privatization, public-private partnerships, and multi-actor governance in addressing complex social issues (Armitage et al., 2012; Driessen et al., 2012; Huitema & Meijerink, 2014).

The Disaster Management Act of 2005 and the subsequent formation of the national disaster management guidelines are thus meant to assist state and local governments to effectively design, execute and govern programs and policies for flood and other disaster management. This paper focuses on flood management in India.

Literature Review & Research Question:

1.1. Causes

There are multiple causes to the increase in flooding over the years. Climate change has had a large impact on flooding (Karamouz et al., 2010; Kendon et al., 2012; Dong et al, 2017; Avashia & Garg, 2020). The flooding and intensity of the floods will likely grow over time (Ali et al., 2019; Bresinger et.al, 2016; Mukherjee et al., 2018). Between 2010 and 2050, research estimate a twofold to threefold increase in exposure to river and coastal flooding (Huong & Pathirana, 2013; Januriyadi et al., 2018; Jongman et al., 2012). Increases in population and rampant construction of buildings and roads to address the growing population needs regularly contribute to water logging after a heavy downpour. Geographic location and the proximity to large bodies of water or the coast can also impact area flooding.

As past research show (Hallegatte et al., 2013; Jongman et al., 2012; Sundermann et al., 2014), factors such as rising sea levels, urbanization, especially along coastlines and large water bodies, deforestation, aging infrastructure, and rural-to-urban population shifts increase the occurrences of flood. In urban areas, causes of flooding also include improper design of drainage and wastewater systems (Dewan, 2013; Swan, 2010). There is increased concern especially due to changes in precipitation patterns and urbanization for pluvial (rainfall) flood risk. This is often associated with insufficient capacities of the sewer system or low drainage efficiency of urban areas. Pluvial flood risk is exacerbated in hilly areas with hillside runoff

adding to the risk of flooding (Simperler, Kretschmer & Ertl, 2019).

1.2. Impacts

Urban areas are more vulnerable to flood risks as a consequence of concentration of population, businesses, and infrastructure in small areas. By 2030, research (Schafer & Victor, 2000) shows that the urban population will increase by 175%. This would cause shortage of natural resources and stresses the urban ecosystems (Mentens et al, 2006). Urbanization results in cities and towns with paved streets and concrete buildings that increase impervious surfaces. Research shows a significant relationship between urbanization and flooding as a result of changes in land use and stream channels for the water to flow out (Haddad & Teixeira, 2015; Gu et al., 2011; Konrad & Booth, 2002). An increase in migration from rural to urban areas for better economic prospects is leading to a rapid growth of population in the urban areas of developing nations. This impacts the infrastructure through the loss of flood storage, drainage, and natural barriers when the new inhabitants make their homes by encroaching wetlands, floodplains, waterbodies and hills (Nithila Devi et al., 2019). Urban drainage systems are designed for surface water runoff and heavy showers can lead to excessive stormwater that exceeds the existing capacity of the drains thereby severely impact the lives and livelihoods of the residents (Qin et al., 2013; Zhang et al., 2017) through waterlogged streets, traffic interruptions, and damage to property, public works infrastructure, and natural resources.

The economic impact of flooding on individuals, families, communities, businesses, and the government include loss of income from the inability to work, property damage, disruption of transportation and telecommunication services, and deteriorating infrastructure (Linnekamp et al., 2011; Shuster et al., 2005). Resources have to be diverted from developmental work to recovery, which can stagnate the economy. The loss of homes and effects on housing prices significantly impacts communities (Tapsell et al., 2002). Additionally, lives are lost from flooding (Milojevic et al., 2012; Albrecht, 2017). Due to these losses, urban poverty runs rampant and people are displaced in large numbers (Buragohain & Bhuyan, 2015). Individuals lose precious personal belongings that can't be recovered through flood insurance policies (Tapsell et.al., 2002).

The political impacts determine voter decisions based on how quick governments can rally to provide disaster relief and recovery. This impacts trust in the government entities in charge of disaster relief (Albrecht, 2017). There is a need for governments to work together between federal, state, and municipalities to create policies and construct flood prevention and protection structures and standards. Individuals have blamed actors at the states level, rather than the federal level for slow responses to relief needs (Potluka & Slavikova, 2010). Furthermore. water pollution

occurs from flood impacting the drainage channels and creation of unsanitary conditions from deposition of waste materials in the drains (Gupta & Nair, 2011). Urban runoff affects the water quality as shown by Girija et al., (2007) in their study of the Bharalu catchment and stream. Waste disposal services are disrupted, potable water is polluted, waste water remains accumulated leading to sicknesses (Ganaie et al., 2013; Rafiq et al., 2016).

This review suggests that the intensity of urban flooding is increasing as a direct consequence of climate change, and rapid and uncontrolled urbanization and concretization of space. The resultant impact of flood on the lives and livelihoods of the inhabitants of the urban areas are well researched. So, the purpose of this study is to examine and understand the policies adopted by government to address urban flooding.

1.3. Context and Research Question

Flooding is one of the most frequent natural disasters affecting many states in India. Assam is one example that is affected by flooding annually. The flood prone area is 31,500 sq km (12162.23 sq miles), which is about 39.58 % of the total land area of Assam (National Remote Sensing Centre, 2016). Excessive runoff of the water from the surrounding hills, deforestation and urbanization, along with incessant rains during the monsoon months, clogs the vast network of rivers and streams affecting the carrying capacity and thereby resulting in flooding (ASDMA, 2014). Other regions of India such as Kerala in 2018, Chennai in 2015, Uttarakhand in 2013, and Mumbai in 2005 have experienced heavy flooding due to extreme weather (Mishra et al., 2018; Ali & Mishra, 2018). In 2019, the states of Assam, Bihar, Kerala, Maharashtra, Odisha and Karnataka among others bore the impact of heavy flooding with over 1600 people dead and millions displaced. The consequent necessity of relief, rescue, rehabilitation, and repair of infrastructure has diverted immense amounts of resources from developmental programs. This recurring problem raises challenges to environment, economic and community sustainability. For example, regular flooding causes erosion of fertile land making it unsuitable for crop production and thus affecting agricultural productivity (Goyari, 2005). Flooding affects the transportation and communication channels hampering development.

Annual monsoon rains cause major parts of Assam, especially Guwahati, the biggest city, to remain waterlogged for many days. Rapid population has led to rampant construction near wetlands without proper planning , encroachment of hills, wetlands and flood plains by migrants to the city, and large-scale deforestation in the city and nearby hills, which has resulted in aggravated flooding episodes annually (Sarmah & Das, 2018; ASDMA, 2014; Sharma et al., 2014; TERI, 2013). In addition, the flooding in Guwahati, like in many other big cities, is exacerbated by the lack of

proper drainage and by ineffective infrastructure planning, design and implementation. To address this gap, we ask the question, "What is the state of the flood management policies in India?" In order to answer this, we conduct a comparison of the national level flood management guidelines in six Indian states to examine if any differences in implementation exist. It is important to note that the policies, recommendations, and guidelines to mitigate flood risk are clearly defined at the national and to some extent at the state levels. However, the responsible parties during the time of emergency often fail to implement those policies.

2. Methodology

For this study, we applied a two-pronged approach to data collection: first, we collected the flood and storm water management policy guidelines from the National Disaster Management Plan (NDMP) and then collected the same policies from the state disaster management plans for six states: Assam, Bihar, Karnataka, Kerala, Maharashtra, and Odisha (Assam State Disaster Management Plan, 2013; Bihar State Disaster Management Plan, 2014; Karnataka State Disaster Management Plan, 2016-2017; Kerala State Disaster Management Plan, 2016; Maharashtra State Disaster Management Plan, 2016; Odisha State Disaster Management Plan, 2017; Ministry of Housing and Urban Affairs, Government of India, 2019; National Disaster Management Authority, Government of India, 2008). These states were selected because they experience recurring floods every monsoon season (that is, during the months of May to September) and have major cities located on or near waterbodies or flood plains. The major cities that experience flooding annually are Guwahati in Assam, Bangalore in Karnataka, Patna in Bihar, Kochi in Kerala, Mumbai in Maharashtra, and Cuttack in Odisha (Please refer Table 1 below).

The location and boundaries of these states are provided in Figure 1 below. Previous research (Bahadur, Lovell & Pichon, 2016) analyzed disaster management plans using a similar strategy but focused on states based on variation in climate, geography, and size. We selected our states based on the regular occurrences of flooding events and location of big cities that provide economic livelihood for millions and are near rivers that flood annually. The state level disaster management policy (SDMP) documents were obtained through online searches of the government websites. Once policy documents were obtained, we compared the policies in each of the six states and analyzed based on five categories: structural measures, inspection and rehabilitation, non-structural measures, capacity building, and flood response/warning systems. Based on other flood studies, a comparative approach to policy review can be an effective way to understand the policy approaches of multiple

locations (van Buuren *et al*., 2015).

We focused on the flood management policies in analyzing the national and state level disaster management guidelines. We reviewed these policies for the following: preparation, mitigation, response, recovery, and rehabilitation for flood related disasters, compare policies initiated and implemented at the state levels, and how the state level policies in Assam differ from the national level policies. We utilized content analysis to review the policy documents at the national and state levels using certain parameters that cover structural measures and non-structural measures. This technique generated data on the measures adopted in the policies at both the national and state levels. We were then able to conduct a comparison of the policies to check for similarities in policy guidelines. Based on the Assam State Disaster Management guidelines, we then interviewed key stakeholders, namely, government officials, administrators, researchers, and community advocates specifically for the state of Assam to understand the execution of the policies outlined in the SDMPs.

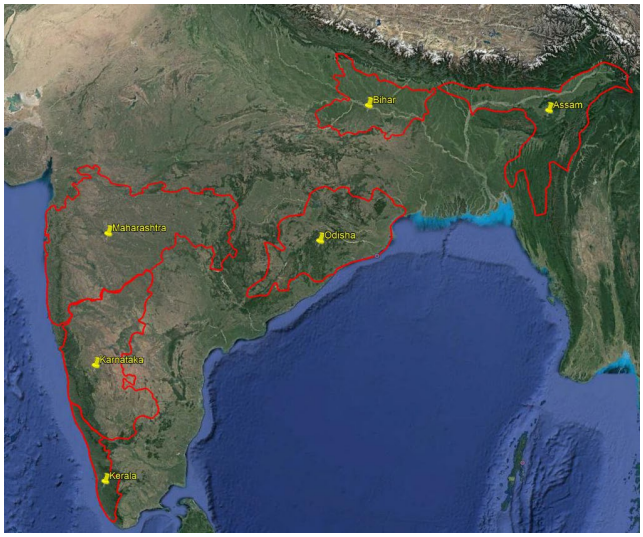

Figure 1. Locations and Boundaries of the Six States

Table 1: State Selection Criteria

Parameter	Indian Average	Highest Among Indian States (besides 6 selected)	Assam	Bihar	Karnataka	Kerala	Maharashtra	Odisha
Major cities that flood annually			Guwahati	Patna	Bangalore	Kochi	Mumbai	Cuttack
Avg. Annual Rainfall (mm)	1,362 (avg. from 2002 to 2011)	2,967 (Andaman and Nicobar Islands)	1,600 - 4,300 (avg. 2818)	750 - 2,000 (avg. 1,120)	731 – 3456 (avg. 1248)	3,104	882 -1034 (avg. 1007.3)	1,000 -1,500 (avg. 1489)
Total Population (in millions)	1,211	199 (Uttar Pradesh)	31.17	104.1	61.1	33.4	112.4	42
Geographical area (km^2)	3,287,240	342,239 (Rajasthan)	78,438	94,163	191,791	38,852	308,000	155,707
Population Density (per km^2)	382	11,320 (Delhi)	398	1,106	319	860	365	270
Flood disaster years since year 2000	N/A	N/A	2019 - 2014 2013, 2004, 2000	2019-2000	2015 – 13, 2011 - 05	2019, 2018	2019 - 2013	2015-2003, 2001
Number of flood disaster years	N/A	N/A	4	20	10	2	7	14

We conducted interviews with multiple administrators and research professionals in the following organizations: Assam State Disaster Management Authority (ASDMA), Brahmaputra Board, Water Resources Department; Town and Country Planning, Flood Control Department, Regional Meteorological Centre (RMC), Guwahati Municipal Corporation (GMC), and Guwahati Metropolitan Development Authority (GMDA). Besides, we also interviewed NGOs such as Action Aid, Disaster Mitigation Society, and Gyan Vigyan Samiti. In total, we interviewed 15 high ranked government officials from agencies tasked with implementing the policies from the Assam SDMP and 3 NGOs who assist with the implementation (Please refer to Table 2). The primary questions were around how state level flood management policies were designed and implemented. The secondary questions were related to the operations of the government agencies, collaborative practices to address the flooding, and flood management and enforcement of policies. Our findings are based on both primary and secondary data. Our research framework is shown in Figure 2, which outlines the process used to identify and collect the relevant data for conducting this study.

Table 2. Data Sources

	Data Sources	Count
Organizational Governing documents	Strategic National level Disaster Management Guidelines	1
	Governing State level Disaster Management Guidelines	6
Stakeholder Interviews	State level government and non-governmental administrators	18

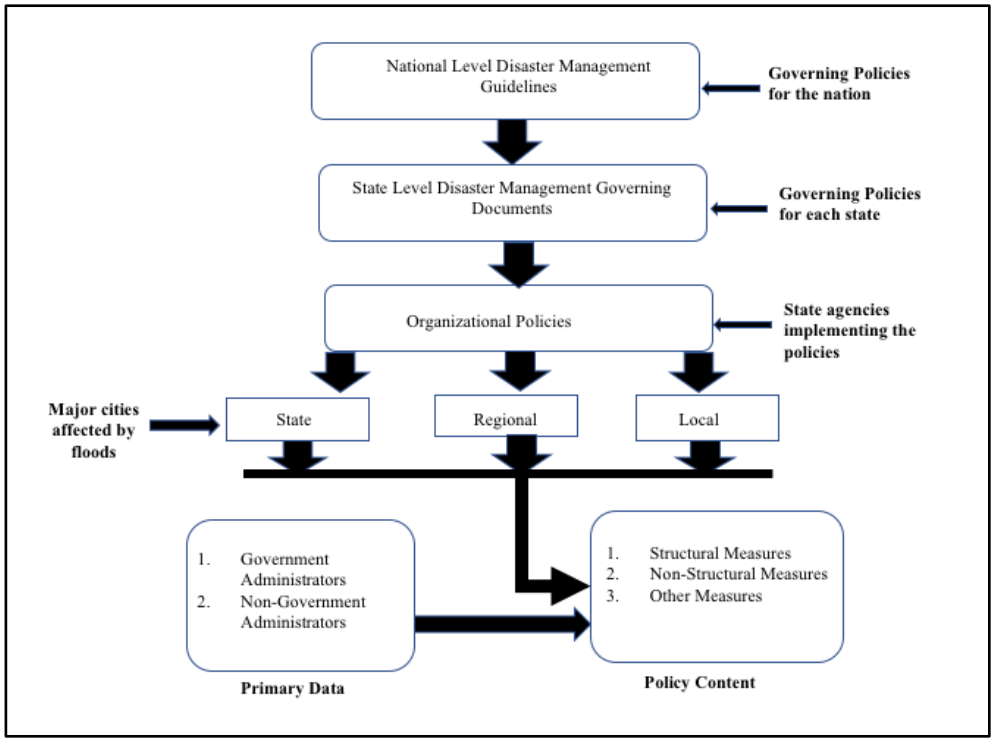

Figure 2. Research Framework

3. Findings

As shown above, professional asset management is mainly focused on efficiency and risk control while operating assets. Our analysis shows the flood management guidelines for the states selected were derived from the National Disaster Management Plan (NDMP). These guidelines are categorized as structural measures, inspection, rehabilitation and maintenance, non-structural measures, floodplain zoning/regulations, and capacity building. We used the following criteria (see Table 3) for analyzing the context and content of the policies stated within the NDMP and the six State Disaster Management Plans (SDMPs). These criteria are tools (Alexander, 2013) to assess organizational level policy analysis.

Table 3. Flood Management Policy Analysis Criteria

Criteria for Flood Management Policy Analysis	National Disaster Management Plan (NDMP)	State Disaster Management Plan (SDMP)
Policy Document Production and Location	Prepared as national guidelines for disaster management. Flood management is part of the document. Document is accessible online.	States adapted sections of the NDMP for various disaster management. Policy documents are not readily accessible for all states.
Authorship and Audience	Prepared by a taskforce at the national level as policy guidelines for all states.	State disaster management agencies adapt various items from the national guidelines
Policy Context	Provides strategic governance guidelines to prepare, manage, execute, and mitigate flood related disasters.	States adapt the policies to their context with appropriate governing responsibilities to local authorities.
Policy Text (Content)	Focuses on structural measures; inspection, rehabilitation & maintenance; non-structural measures; floodplain zoning, and capacity development.	Inconsistent adaptation of the policies within the state guidelines.

Policy Consequences	National government provides policy action guidelines and funds for policy implementation. Impactful as a national guide for disaster management and governance.	States adapt the guidelines and implement policies by delegating to various departments. Monitoring and evaluation are not thorough. Impact challenging to assess without regular evaluation and a designated governing mechanism.

Table 4: Comparison of Flood Management Guidelines Between National and Selected States

National Flood Management Policy Guidelines	**Assam**	**Bihar**	**Karnataka**	**Kerala**	**Maharashtra**	**Odisha**
	Structural Measures					
Build Embankments, Floodwalls, flood levees	●	●	●			●
Dams and Reservoirs	●	●	●			●
Natural Detention Basin	●		●			●
Channel and Drainage Improvement	●	●	●		●	●
Diversion of Flood Water		●				●
Catchment Treatment Area	●	●	●		●	●
Anti-Erosion Works						●

Flooding can be addressed through the creation and implementation of policies that will aid in flood prevention and protection. There are both structural and non-structural policies that can reduce flooding risks (van Duivendijk, 2006; Shivaprasad *et al*., 2018; NCSL, 2019). India uses several structural approaches, which include the building of embankments to protect communities, flood levees in flood prone areas, catchment area treatment, dams and reservoirs, detention basins, anti-erosion works, sea-wall protection in coastal areas, culverts to divert water flow, and highway bridges over bodies of water (National Disaster Management Authority, Government of India, 2008; Mohapatra and Singh, 2003). Based on our analysis, there is some variability in the state flood management measures. This is shown in Table 4 which provides one-by-one comparison of the six states' flood management policies with national policy.

A detailed explanation of the findings from the document analysis discussed in Table 4:

(1) *Structural Measures:* Structural measures are physical structures to reduce the flood risk hazard. The national guideline includes building embankments, floodwalls, flood levees, catchment area treatment, dams and reservoirs, detention basins, anti-erosion works, sea wall protection, provision of waterways via culverts, and bridges on highways. It should be noted that the states of Assam, Bihar and Karnataka have included most of the structural measures in their guidelines, whereas Kerala's guidelines do not discuss any of these structural measures. Our analysis of the SDMPs shows that Assam, Karntaka, Bihar, and Odisha have developed policies and plans that are aligned with the structural measures laid out in the national guidelines. Odisha is the only state out of the six to have a provision for the diversion of flood water and anti-erosion works. Maharashtra has only a couple of structural measures as outlined in their policy. Kerala mentions a flood mitigation project called Operation Anantha, which began in one city and was later extended to another district (Kerala State Disaster Management Plan, 2016). Based on their disaster management plan, the project will expand to other districts if funding permits. Kerala mentions that protection and preservation of the paddy lands and wetlands to mitigate flood damage, however, no specific structural measures are listed (Kerala State Disaster Management Plan, 2016).

(2) *Non-structural Measures:* These are measures that have no physical impact on the community. However, they have the ability to prevent flooding and reduce the impact of flooding on the community. An advantage of non-structural measures is their ability to be sustainable over the long term with minimal costs for operation, maintenance, repair, rehabilitation and replacement (US Environmental Protection Agency, 2014). These non-structural measures can reduce the number of lives lost and property damage by alerting communities before flooding occurs (Andjekovic, 2001). Many structures potentially are subject to reduced risk and damages or no risk/damages due to implementation of non-structural measures. The national guideline has non-

structural measures that include floodplain zoning, flood proofing in flood prone areas, flood forecasting and warning systems, regulation of reservoirs, and the purchase of flood insurance by families and business in high flood areas (National Disaster Management Authority, Government of India, 2008; Mohapatra and Singh, 2003). Assam and Odisha included all of the provisions for non-structural measures from the national guidelines. Kerala did not include this category in their guidelines. Karnataka included flood proofing and elevation while Maharashtra addressed floodplain zoning in the category of "Flood plain zoning/Regulations." Bihar included hazardous mapping for flood, satellite or radio-based communication for flood management, and adequate cushion for reservoirs.

(3) *Other Measures:*

i. Inspection, rehabilitation, and maintenance: These are critical for structures that reduce flood risk. At the national level, it is recommended to inspect structural measures twice a year, before and after the monsoon, to ensure restoration of vulnerable locations and structures every year. Only Assam, Bihar and Karnataka have included policies for inspections, while the other three states did not. The most detailed of these policy guidelines are in Assam and Karnataka.

ii. Floodplain zoning/regulations: Floodplain zoning reduces the risk and cost of damages due to flooding. This regulation limits building and development in flood zones to reduce the risk associated with flooding. National level guidelines are comprehensive and address the following 12 items:

(a) Pre-requisites for the enforcement of flood plain zoning;
(b) Regulation of land use in flood prone areas;
(c) Categorization and prioritization of structures in flood plains zoning;
(d) Flood plain zoning regulations;
(e) Incentives and disincentives to states for enactment and enforcement of flood plain zoning regulations;
(f) Encroachment into the waterways and natural drainage lines;
(g) By-laws for buildings in flood prone areas;
(h) Legal framework for making infrastructure flood resilient;
(i) Survey of flood prone areas;
(j) Wetlands conservation and restoration;
(k) Watershed management including catchment area treatment and afforestation; and (l) Coordination and enforcement.

Kerala did not address the above items except conserving paddy and wetlands, and rainwater harvesting in slopes less than 20% to minimize magnitude of flood. Bihar addressed in general for strict regulation of settlement and economic activities in the

flood plains without additional details; develop master plan for flood management; watershed management including catchment area treatment and afforestation. The other four states have included guidelines for flood prone zones, prohibition of development in wetlands, remote sensing and GIS based flood mapping, development of flood hazard map, removal of encroachments in water ways, etc. with some degree of variabilities by states.

iii. Capacity Development: National level guidelines recommend that the state governments strengthen flood management education by facilitating the incorporation of the best available technical and non-technical inputs on flood management in the educational curricula. At the national level, it includes flood education (public awareness of dos and don'ts before, during, and after floods); target groups such as elected representatives and government officials at national and state levels for capacity development (conducting training via mock drills); research and development of scenario analysis and simulation modelling; detailed information on rainfall, river flow, catchment characteristics, etc. Of the six selected states, Bihar and Maharashtra included detailed guidelines on capacity development similar to national one. For example, the government of Maharashtra has mandated the local governments and departments (Revenue, Irrigation, and Urban Development) to conduct study of past floods to assess loss and damage occurred, prepare departmental contingency plans, train for rescue and recovery, and organize mock drills and trainings for stakeholders (Kolvanker, 2019; MSDMA, 2016). Maharashtra's capacity building initiatives were shared with other states as examples. Bihar state government also implemented initiatives for quicker response and recovery by establishing Emergency Operation Centers (EOC) in all districts, procuring satellite and GPS communication devices, and awareness generating programs for the people to mitigate flood risks (Agarwal, 2012; Vahanvati & Mulligan, 2017). Most of these capacity development programs were implemented in coordination with local NGOs and has helped with awareness generation and preparedness. Assam included information on increasing public awareness, provide flood hazard zoning information to stakeholders and establish monsoon forum at the state and district levels. Assam also specifies the need to increase public awareness regarding flooding. However, the other states lack any information regarding capacity building or training in their disaster management plans.

iv. Flood response/Warning systems: A flood warning system is a method of forecasting extreme storm events in advance. Management and control of the adverse consequences of floods require coordinated and effective response systems at multiple levels. The response system includes emergency search and rescue operation, emergency relief, incident command system, community-based disaster preparedness and response coordination among various organizations, involvement of the corporate sector, specialized team response, improving flood response, emergency logistics, emergency

medical response, and action plan for strengthening flood response. Assam, Bihar, and Odisha list guidelines in their state plans for flood response and warning systems. Assam addressed on-going initiatives of flood early warning system (FLEWS), encouraged use of flood warning in high-risk prone areas, and established communication protocol to relay information on flood to communities at risk. In 2012, Assam had FLEWS installed in 14 out of 33 districts, of which 8 systems were operational and 6 were in pilot phases and are working to make them operational (ASDMA, 2012). After the initial success of the FLEWS in Assam, other states such as Bihar requested support of the NDMA to implement FLEWS. Bihar provided general Standard Operating Procedures (SOPs) for general evacuation plan, not specific to flood, and included training of search and rescue team members; addressed emergency relief; support services from corporate bodies and other sectors; involvement of corporate sector; formation of trouble shooting team; and emergency medical response. Bihar is the only state which covered major categories under flood response/warning systems. Odisha also addressed improving the flood forecasting and warning system using remote sensing and GIS data. Kerala lists the warning alerts being made through the Meteorology Department, rather than a warning system directly utilized for flooding (Kerala Disaster Management Plan, 2016). Remaining two states did not address anything related to this category.

Findings from the stakeholder interviews in Assam suggest that various departments within the state government are assigned parts of the plan to implement. The departments and agencies interviewed, as noted previously, are important actors in the governance of the SDMA. The district administrations at the local levels are also involved in the planning, administration, and implementation of flood management policies within their areas of governance. Funding, from both national and state budgets, is allocated for the implementation of specific projects associated with the policies and are given to departments and nodal agencies assigned with execution of the projects. However, there exists a lack of coordination between the governmental agencies in implementing their tasks resulting in haphazard implementation and sometimes duplication of efforts. Additionally, there is a lack of follow-up or monitoring or inspection of the projects implemented for flood mitigation such as construction of embankments or bridges or silt traps resulting in deterioration of such structures that could reduce the prevalence and impact of flood.

4. Discussion

This study compares the state disaster management plans of Assam, Bihar, Karnataka, Kerala, Maharashtra, and Odisha to examine existing flood management policies. Based on the analysis of the state level disaster management plans, Assam, Bihar, Karnataka, and Odisha adopted most of the national level guidelines compared to

Kerala and Maharashtra. However, only Odisha's policies addressed improving their flood forecasting and warning systems using remote sensing and GIS data., and Bihar developed a comprehensive set of policies related to flood response/warning systems. We also find that of the six states, Assam is most advanced in terms of establishing guidelines. Additionally, in 2020, the Energy and Resources Institute (TERI) in New Delhi, along with the National Disaster Management Authority (NDMA), launched an experimental automated web-based flood warning system (FEWS) for the city Guwahati for emergency preparedness by alerting local authorities via text and email about flash floods, heavy rainfall and waterlogging. FEWS is designed to predict and proactively address urban flooding, and if successful in Guwahati, will be replicated in other big cities. Guwahati is the third major city to install the FEWS system after Mumbai in Maharashtra and Chennai in Tamil Nadu. According to TERI (2020), the FEWS launch was in response to a meeting of India's Prime Minister with the chief ministers of six states Assam, Bihar, Uttar Pradesh, Maharashtra, Karnataka and Kerala, where he highlighted the need for development of local-level flood warning system.

Structural measures can give a false sense of security to communities (Andjekovic, 2001). This stresses the need for structural measures to not only be in place but to be in good order. Overall, the states provide for the structural measures that match the guidelines at the national level. However, not all of the states provide for the inspection and remediation of the structural measures in order to ensure their sustainability. Whether structural or non-structural, it is important that flood prevention measures be put in place at all levels of government. This ensures that during an emergency event, there is a chain of command regarding flood response. Arlikatti et al. (2018) found an overwhelming majority of the flood survivors in the State of Uttarakhand to favor emergency planning at the household and village levels. While some of the state policies reviewed mention non-structural measures, the state of Assam has several initiatives for capacity building and emergency management projects that include workshops on planning for disasters. However, such trainings do not often result in actual emergency planning and decision-making.

In terms of practice, we find that the implementation of these measures is haphazard, suffers from governmental apathy, lacks agency coordination, disjointed from local communities, and ineffective functioning. This is consistent with findings in previous studies (ASDMA, 2014; Coelho, 2012). Others (TERI, 2013) also echo the lack of coordination in implementation, suggesting that the presence of multiple agencies with their distinct areas of governance and management make it challenging to address the issue of urban flooding in an integrated manner. Previous research found that there was a need for clarity for the division of responsibilities at both the state and national levels (Bahadur et al., 2016). While responsibilities for implementation are delegated to various agencies, enforcement is delegated to another district level entity

not involved in execution of policies. Thus, the enforcement capability is missing leading to policy implementation with little to no follow-up. Capacity building, which is considered to be a primary tool for disaster risk management and emergency response is conducted regularly by the Assam State Disaster Management Authority (ASDMA), which serves as the regional hub for exchange of information and knowledge for the north-eastern region. This requires buy-in as well as support from agencies across the state as well as the region. By serving as a key point for information exchange, this agency commissions research and disseminates the findings, and conducts trainings and awareness campaigns for disaster preparedness and mitigation.

This is also important from a governance perspective for one nodal agency to coordinate decision-making related to disasters especially flooding. These decisions could be assessment and navigation in advance of an emergency event, and addressing the many social, economic and ecological consequences brought about by flooding. Flood governance including risk assessments and mitigation is an area that could be developed to address the annual flooding events. While having plans are good, these plans must be implemented, monitored, and evaluated on a regular basis for the benefit of all residents.

Our analysis suggests that the state level policy documents does not portray the actual state of the policies. As evident from the stakeholder interviews, the documents are adapted from the national guideline and implemented in an inconsistent manner. Some local district authorities were more proactive in the governance and mitigation of flood while others wait for assistance from the state government as noted in the administrator interviews. Most stakeholders were not involved in the decision-making process of adapting the guidelines. Thus, many stakeholders were not even aware of guidelines in the document. Additionally, the administrators tasked with governing the policies are transferred to other departments and positions, and because of this temporary responsibility, strategic decision-making involving inter-departmental and inter-governmental coordination is often incomplete.

Despite these limitations, we find instances regional and local flood policy governance and management advancing beyond what is stated in the guidelines. The strategic guidelines at the national level are very generic to allow states to customize the policies to their context. Within each state, there are variations in geography depending on the location of the villages, towns or cities. With the establishment of the web-based flood warning systems in Mumbai and Guwahati, and plans to implement them in other big cities point to the fact that the government and local administrators are taking risk management and flood preparedness seriously. This suggests that while states, in general, may not have designed policies beyond what is in the national guidelines, regions especially large urban areas within the states have adopted systems and processes to prepare for and mitigate flooding. These advances are very localized and can only be found through field research and news media. One significant finding

is that the research began as a search for policies with the assumption that there might be hardly any governing policy document. However, our research revealed that not only there are governing documents and committees tasked with oversight of the polices, many states are implementing the policies albeit in a unsystematic manner which is reflective of the large variations in demography and geography within states. The presence of governing bodies at the local levels also point to the fact that administration of the flood management is decentralized for greater effectiveness.

5. Conclusions and Recommendations

Flooding problems range from short-term water logging to major areas remaining inundated for weeks, impacting the lives of thousands. The consequences of severe flooding are many – food shortages, housing issues, shortages of drinking water and sanitation, health risks from water-borne diseases, economic productivity, and severe impacts on the livelihoods of the residents. In an attempt to understand how states are addressing the problem of annual floods in India, we start with understanding the flood management policies. We analyze and compare the national level disaster management policy with the state level policies of six Indian states through secondary data collection.

This methodology is unique because it explores the policies related to flood governance, management, and mitigation at the national and state levels. We focus on primary data related to governance and policy execution from key stakeholder organizations in the state of Assam. Although the research team had limited time to conduct more data collection and analysis, we were able to generate enough data to arrive at the following recommendations. First, the state level disaster management plans are based on the national guidelines but customized to the needs of each state. There exists state level agencies that designs the plans but the policy execution is delegated to the various agencies. Despite the fact that Assam has policies for most of the structural and non-structural measures with regard to flood management, there is lack of monitoring and enforcement post-implementation. It is imperative to have a nodal agency to enforce and regularly monitor the policies implemented due to the haphazard implementation of current policies.

This nodal agency could be tasked with flood management policy decisions that includes planning, implementation, and enforcement. Second, there needs to be regular coordination and communication between agencies implementing the policies to reduce waste and duplication and to enhance accountability. A nodal agency, as recommended earlier, could be tasked with spearheading the coordination efforts. Third, inclusion of diverse stakeholders such as citizens, environmental activists, researchers, academics, think tanks, NGOs, neighborhood groups, self-help groups, and private companies and firms in policy planning would help in garnering diverse perspectives as well as create

ownership of the policies resulting in more effective implementation. Fourth, emergency management, including early warning systems, evacuations, relief centers and recovery mechanisms should be planned well and ahead of time. Early warning systems have been implemented in some urban areas and this could be extended to other areas of the states. Fifth, enforcing flood insurance could reduce encroachment and illegal construction in low-lying flood plains. Finally, flooding is not confined to a state or city but affects the places in its vicinity. Thus, policy planning and execution must also include stakeholders and representatives from neighboring states and regions.

This study highlights the challenges of addressing an issue as complex as flooding, the multiplicity of the causes, the need for involvement of multiple stakeholders, and an integrated approach to addressing this global problem. While India has advanced flood management policy guidelines, and states have adopted most of the guidelines proposed, variability in execution of the policies is a challenge that must be addressed to effectively plan for and respond to the flooding crises that occurs annually. This calls for effective governance and decision-making by delegating an agency with oversight responsibilities that could coordinate the flood management activities at the state and local district levels.

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Dr. Bezboruah conceived the research, collected primary data, and conducted the policy analysis. Dr. Sattler assisted with the research conception and analysis. Dr. Bhatia collected the secondary data and conducted the document analysis.

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