

Policy and Institutions in Adaptation to Climate Change

Case study on flood mitigation
infrastructure in India and Nepal

Aaramyak

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Policy and Institutions in Adaptation to Climate Change

Case study on flood mitigation infrastructure in India and Nepal

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About this Study

From 2008 to 2010, ICIMOD, in partnership with partners in China, India, Nepal, and Pakistan, conducted a series of four case studies under the Sida-supported project Too Much and Too Little Water. The series looks at responses and field experiences to support the development of adaptation approaches, including policy and institutional support, to meet the challenges emerging from climate change and other drivers of change. This publication is based on one of these case studies. The other three case studies include:

- Policy and Institutions in Adaptation to Climate Change: Case study on tree crops in China, Nepal, and Pakistan (2013)
- Policy and Institutions in Adaptation to Climate Change: Case study on responding to water stress in Chitral, Pakistan (2013)
- Labour Migration as a Response Strategy to Water Hazards in the Hindu Kush-Himalayas (2011)

The synthesis of these four case studies, 'Role of Policy and Institutions in Local Adaptation to Climate Change', was published by ICIMOD in 2012.

Other related publications include:

- Local Responses to Too Much and Too Little Water in the Greater Himalayan Region (2009)
- Diversified Livelihoods in Changing Socio-ecological Systems of Yunnan Province, China (2009)
- Adjusting to Floods on the Brahmaputra Plains, Assam, India (2009)
- Life in the Shadow of Embankments - Turning Lost Lands into Assets in the Koshi Basin of Bihar, India (2009)
- Living with Water Stress in the Hills of the Koshi Basin, Nepal (2009)
- Traditional Knowledge and Local Institutions Support Adaptation to Water-Induced Hazards in Chitral, Pakistan (2009)

Introduction

Floods are the most common water-induced hazard in the Hindu Kush Himalayan region. The Brahmaputra River Valley in Assam, India, and the Koshi River basin covering parts of Nepal and India are two of the most severely flood-affected areas in this region. Riverbank erosion and land degradation from the deposition of sand on a large scale are other water-induced hazards associated with flooding. These three hazards together have seriously affected people's lives and livelihoods in many areas of these basins.

Government efforts to protect people living on riverbanks from flood waters and mitigate the impacts of floods have largely consisted of structural measures, primarily embankments. Attempts to control the erosion of natural riverbanks and embankments have been made using structural measures such as porcupines, bamboo screening, and revetments. These have met with mixed success, protecting people from floods and erosion effectively for a long time in some places, while failing to contain flood waters and even increasing flood hazards in others.

Embankments influence people's lives and their capacity to adapt in both positive and negative ways. When maintained properly, these structures can protect people from floods and enable communities to sustain agricultural activities, even attain agricultural growth, and pursue other social, economic, and cultural activities. Embankments have also helped preserve social stability, institutions, and traditions by providing respite from regularly reoccurring floods.

However, prolonged dependence on embankments has also weakened communities' traditional coping and adaptive capacities, rendering them more vulnerable to floods when embankments fail. Embankments can develop breaches and fail to contain flood waters, often because of poor maintenance, resulting in devastating floods. Poor performance of embankments is often due to technical faults in design, lack of quality control in construction and repairs, lack of sufficient funds, and financial mismanagement on the part of governing agencies.

The failure of an embankment and consequent devastating flood are essentially a governance problem. The status of flood mitigation structures such as embankments and the manner in which their upkeep is undertaken has significant influence on how people living in flood-prone areas near rivers and embankments respond to floods to reduce risk and cope with floods. Therefore, the governance system associated with flood management needs to be explored to examine how it influences people's vulnerability and resilience.

Unfortunately flood management in the countries sharing these basins generally suffers from several shortcomings and is marred by inefficiency, lack or absence of proper policy instruments, failure to properly implement policies and programmes, institutional dysfunction, and a lack of political will on the part of governments and their agencies. Institutions created for flood management are plagued by lack of flexibility, commitment, and transparency. Local communities, civil society, and experts outside the government regime rarely have an opportunity to participate in planning and decision making in formal flood governance.

In the absence of adequate support from the government, people have tried to deal with floods using traditional coping practices and contemporary learning. However, local coping and adaptation strategies have become less effective against the changing nature of floods and other water hazards attributed largely to climate change and its impact on the Himalayas. Both the Brahmaputra and the Koshi basins have been impacted by global warming and climate change (Gosain et al. 2010). Failure in the governance of flood mitigation structures has enhanced people's vulnerability and risk, which is different for different stakeholders at the individual, household, or community levels depending on the social, economic, cultural, and political characteristics of the stakeholder.

Poorly maintained embankments can develop breaches and fail to contain flood waters



This study attempts to explore the governance system associated with flood management in the Brahmaputra and Koshi basins, examine the bottlenecks in institutions, policies and practices, and recommend a strategy for improving the governance regime with specific reference to agencies and institutions, both formal and informal, as well as stakeholder communities that influence flood management practices at state and local levels.

Scope of the study

Although there is a general lack of good governance in flood management in the study region, the focus of this study remains mainly on embankments and the implications of their governance in people's capacity to cope with and adapt to flood hazards. Other structural and non-structural measures for flood management are not discussed in detail. The reason for choosing embankments as the representative flood management strategy is that they are the most common measure adopted to control floods in the study areas. The study sites chosen in these two basins have frequently experienced floods caused by the collapse of embankments that is attributable to inefficient governance. Moreover, embankments significantly influence people's ability to cope and adapt to floods in the study sites (Das et al. 2009) and have remained at the centre of a long-standing debate over their suitability.

The core study was carried out in Assam (Figure 1). Therefore, the bulk of the observations and analysis refers to the context of the study districts in the Brahmaputra basin in Assam. Inputs for a comparative analysis of flood governance were drawn from a study of the Koshi River basin covering Bihar in India and Sunsari and Saptari districts in Nepal (Figure 2). In the Koshi Basin, the flood management system was studied with reference to embankments spread over both Nepal and India, and maintained by Indian authorities, mainly the State Government of Bihar. The study in the Koshi Basin was mainly based on a literature review, analysis of secondary information and data, and limited field work carried out with support from local civil society organizations. Fieldwork consisted of visits to selected flood-affected areas, interactions with affected communities, and interviews with experts, activists, and government officials, carried out using participatory rural appraisal methods applied in a limited way and guided by the same set of research questions used for Assam contextualized for the Koshi River and its basin. The Koshi story is narrated separately towards the end of the report to highlight the uniqueness of the situation there.

Figure 1: Location of study area in Dhemaji and Lakhimpur Districts, Assam, India

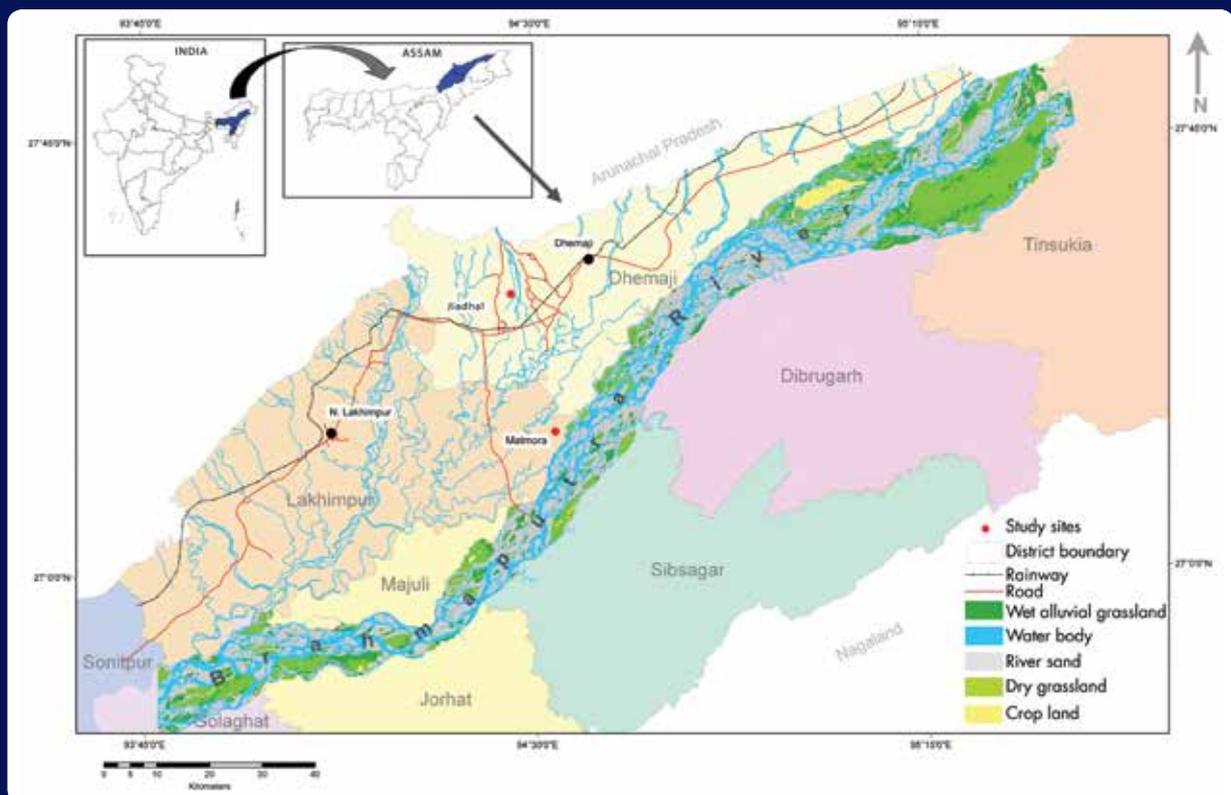
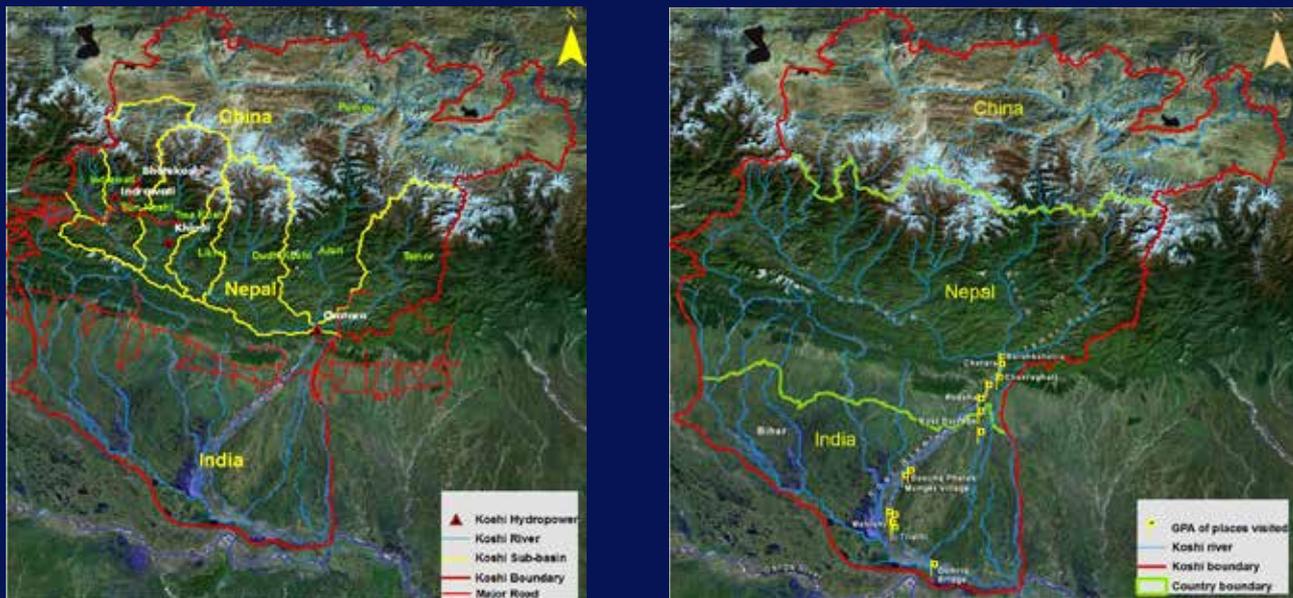


Figure 2: Map of the Koshi River system (left) and Koshi River basin with study sites (right)



Flooding and riverbank erosion are different but intertwined aspects of a similar set of hydrogeological characteristics of rivers. The erosive action of rivers is a principal cause of breaching of embankments. Therefore, erosion protection is an implicit part of flood management efforts and the flood mitigation infrastructure mentioned above is designed to control and reduce both floods and bank erosion.

Objectives

This study looks at governance issues pertaining to flood mitigation infrastructure in Assam in general, and three embankments in three study sites in particular, from the point of view of community adaptation to flood risk. The objectives of the study were to

1. evaluate the role and relevance of embankments as a flood mitigation structure in light of the prevailing debates and discourse;
2. understand how flood mitigation infrastructure, embankments in particular, and their governance influence people's risk reduction and adaptive capacities;
3. understand the existing formal governance of flood management with a focus on embankments with reference to institutions and policy at national and state levels;
4. examine the roles of local governance institutions, both formal and informal, in flood management;
5. document communities' responses to formal governance in flood mitigation;
6. understand what enables and disables people's participation in flood mitigation and communities' access to the equitable benefits of flood mitigation; and
7. recommend strategies for good governance in flood mitigation to make people more resilient.

Methodology

The study extensively used secondary research, mainly literature, to construct the history of the development of flood management discourses and practices and evaluate existing governance systems. Field research was carried out to obtain community perspectives on various issues. Participatory rural appraisal techniques were used, including informal chats, key informant interviews, transect walks, focus group discussions, and resource mapping. Other tools used were political power mapping, multi-stakeholder analysis, and institutional analysis. The data and the analysis were mainly of a qualitative nature.

Table 1: Objective-research question matrix

Research questions	Research objectives						
	1	2	3	4	5	6	7
What are the different discourses on embankments and other flood structures in India and how have these evolved historically?	X		X		X		
How has the formal flood management regime, in general, and flood mitigation structures, in particular, fared in achieving desired results?	x	X			X	x	
What is the policy regime and decision-making process for construction, quality control, and maintenance of flood management structures?	x		X	X			
To what extent do formal policy instruments and socioeconomic and political factors enable or constrain people’s participation in flood mitigation decisions?	x		X	X		X	
How do local communities and their institutions, both informal and traditional, respond to the formal flood management regime?		X	X	X	X		
To what extent are equity considerations addressed in the governance process with respect to institutions and stakeholders?	x	X	X	X	X	X	
How does flood mitigation infrastructure influence people’s coping and adaptive capacity?	x	X			X	x	
How can the capacity of local communities and local institutions, both informal and traditional, be strengthened to improve governance of flood mitigation and make it more adaptive?		X	x	x	X	X	X
What can be done to improve the formal governance mechanisms for flood management so as to enhance people’s adaptive capacity?		X			X	X	X

X = Highly relevant; x = Relevant

Research questions

A set of research questions was framed based on the objectives of the study. Information was then gathered and analysis conducted and complemented with observations made by the field team to search for answers to the research questions. The research questions address different research objectives (Table 1)

Study Areas

Brahmaputra basin in India (Assam)

Assam is one of the most flood-affected states in India, and floods occur annually during the pre-monsoon and the monsoon seasons from its numerous rivers, rivulets, and streams belonging mainly to the two major river systems, the Brahmaputra and the Barak (Meghna). The state’s flood-prone areas amount to 3.1 million hectares, which is some 40 per cent of the total geographical area. This includes over 90 per cent of the agricultural land and urban population centres, as well as its most valuable economic assets such as tea estates, oil fields, roads, and airports. On average, an estimated USD 47 million in annual crop production is lost because of floods, while damage to homesteads and livelihood affects some 3 million people (ADB 2006).

Riverbank erosion is also a chronic problem in Assam and is caused by the dynamic shifting of channels flowing through the unconsolidated heavy sand and silt of the floodplain. These shifting channels cause the failure of flood control structures such as embankments, triggering floods. Flooding also intensifies the erosion caused by rivers. Since 1954, Assam’s 17 riverine districts have lost 7 per cent of their land area to erosion. Some 8,000 ha of land (valued at USD 20 million) is lost annually as a result of floods and erosion and about 10,000 families are displaced (ADB 2006), many of whom become landless causing significant social and economic disruption.

The districts of Lakhimpur and Dhemaji are located on the north bank of the Brahmaputra River in the eastern part of Assam. These districts are also two of the most disaster-prone in India on account of multiple water-induced disasters such as flood, flash flood, riverbank erosion, and land degradation from intense siltation of riparian lands. Box 1 presents baseline information about the study areas relevant to this study. While Figure 1 shows the general study area in Assam, Figure 3 and Figure 4 show the location of the study sites in Assam. The study villages in these districts were selected based on location and proximity to embankments. All of these villages are severely affected by floods and erosion and are critically dependent on embankments for their survival. The Jiadhul River, a north-

bank tributary of the Brahmaputra originates in the lower Himalayan ranges in Arunachal Pradesh at an altitude of 1,247 m. It flows through Dhemaji District of Assam to meet the Kherkatia Suti, a distributary of the Brahmaputra. In the plains of Assam, the Jiadhhal River frequently migrates and changes its course with almost every flood (Brahmaputra Board 2000). It has a catchment area of 1,346 km² out of which 306 km² lie in the hills of Arunachal Pradesh and 1,040 km² lie in the plains of Assam. It lies between latitudes 27°08'N and 27°45'N and longitudes 94°15'E and 94°38'E. The Jiadhhal basin experiences severe floods every year inflicting enormous loss and damage to property, agriculture, land, and surface communication. Its middle and low reaches are particularly prone to flooding with a highly vulnerable area of 60 km². Flood management measures taken so far consist mainly of embankments together with pro-siltation and anti-erosion measures such as porcupines, boulder pitching, and boulder deflectors. Rainfall in the catchment varies from 2,965 mm to 4,386 mm.

Hydrological data available for the river are patchy and discontinuous. Based on old data from up to 1983, maximum and minimum discharge at Jiadhalmukh just below the debouching point are 2,243 m³ per second

Box 1: Study areas in the Brahmaputra basin, Assam, India

- **Jiadhhal embankment and adjoining areas, Dhemaji District**

Embankment studied: Jiadhhal dyke on left (26 km) bank and Kumatiya dyke on right bank (19 km)

Panchayats covered (7): Jiadhhal, Naruathan, Ghuguha, Bishnupur (left bank), Misamari, Bordoloni, Barbam (right bank)

Villages covered (20): Tekjuri Boro, Tekjuri Barman, Tekjuri Lagasuk, Bor Mothauri, Kekuri, Dihiri, Lalukijan Dharmapur, Dihiri Khalihamari, Holoudunga, Dihingia, Nepali Khuti, Bali, Rotuwa, Auniati, Na-pam Aadarsha, Gohain gaon, Pehioti, Gurorthali, Sapekhati

Population of study area: 22, 481

Number of households: 3,803

- **Dhokuakhona Circle, Lakhimpur District**

Embankment studied: Sissi-Tekeliphuta Flood Embankment on the Brahmaputra River

Length of stretch of embankment studied: 17 km

Panchayats covered (3): Pub Dhakuakhona, Matmora, Kherkata (north bank)

Villages covered (10): Lutasur, Bahir Kopchang, Bandena, Janji Dangdhora, Khamon Birina, Arkep, Mising Bali, Modarguri, Papung, Bahir Tekeliphuta

Population of study area: 32,413

Number of households: 5,403

Figure 3: Study sites in Dhemaji District, Assam, India

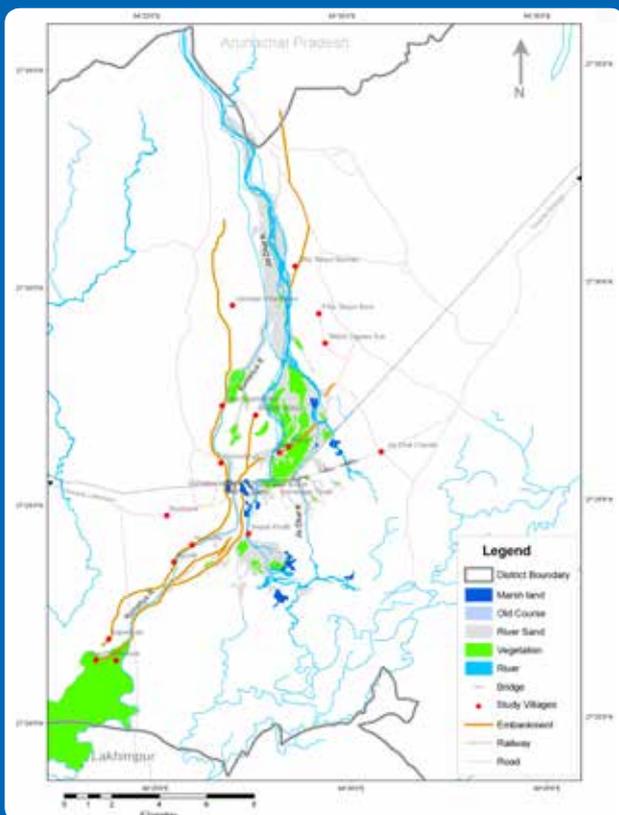
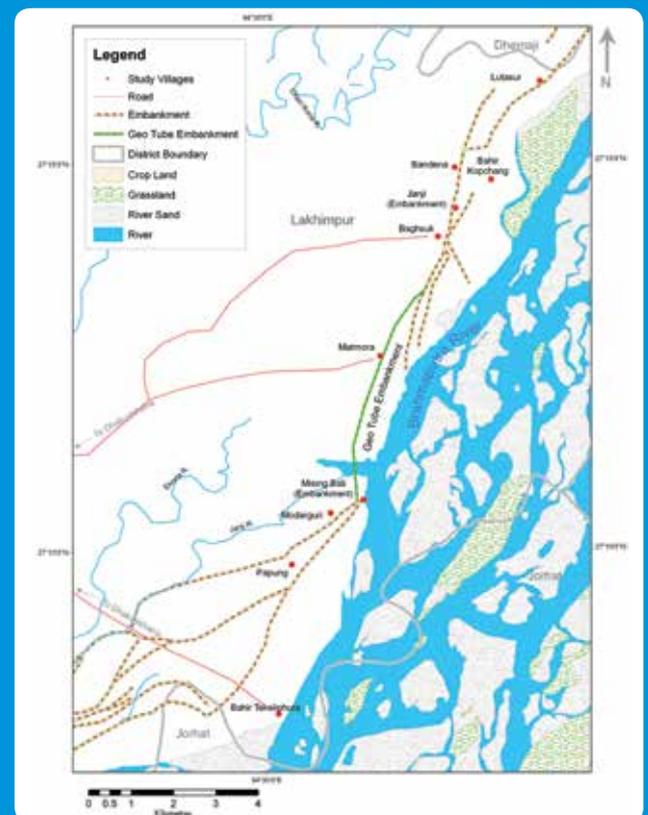


Figure 4: Study sites in Lakhimpur District, Assam, India



(in 1973) and just under 2 m³ per second (in 1976), respectively. Average annual discharge is about 86 m³ per second. Mean annual water yield at Jiadhalmukh is 2,718 million m³.

As the upstream hilly part of the catchment consists predominantly of argillaceous sandstone with thick soil cover, the river and its tributaries carry heavy silt load during monsoon. The silt yield of the river in the year 1984 was in the order of 0.171 hectare meter/year/square kilometre, which is more than five times the silt yield of the Subansiri River, which has a discharge nine times that of the Jiadhhal (Brahmaputra Board 2000). While the hilly part of the catchment soil is red loam, the middle part is old alluvium and the plains are new alluvium with sand, silt, and humus rich bog clay.

The study site in Dhemaji covers the entire length of the river in Assam over which embankments exist on both sides of the Jiadhhal River. Flooding from bank spillage and the breaching of embankments, acute erosion of the riverbank, and frequent shifting of the river channel and consequent floods are a chronic problem in the Jiadhhal River catchment. The flood in 2007 caused by failure of the right embankment devastated about 30 villages. The Samarajan area has experienced annual flood mayhem since the 1980s, the floods in 2009 and 2010 were let out by the left embankment adding to the prolonged misery of the people.

The Brahmaputra is one of the world's largest rivers, with a drainage area of 580,000 km². The gradient of the Brahmaputra River is as steep as 4.3 to 16.8 m per kilometre in the gorge section upstream of Pasighat, dropping to nearly flat near Guwahati at 0.1 m per kilometre (Goswami 1998). The dramatic reduction in slope of the Brahmaputra as it cascades through one of the world's deepest gorges in the Himalayas before debouching onto the Assam plain explains the sudden dissipation of immense energy locked in it and the resulting unloading of large amounts of sediment in the valley downstream. The Brahmaputra is one of the most heavily sediment-charged large rivers in the world carrying an average annual suspended load of 400 million tonnes at Pandu at an average daily rate of nearly 2 million tonnes in the rainy season (May to October) (Goswami and Das 2003).

The other study site is the Matmora area in Dhokuakhona circle in Lakhimpur District where the Sissikalghar-Tekeliphuta embankment is the object of study. This embankment, also known as the Matmora dyke, starts from Sissikalghar and ends at Tekeliphuta village bordering Majuli Island, thus extending 27.5 km. Part of the dyke near Sissikalghar lies in Dhemaji District, but the larger part is in Lakhimpur District. In this site, a stretch of the dyke of about 17 km lying between Lutasur village (bordering Dhemaji) and Tekeliphuta was selected for study. The reach of the dyke between Matmora and Baligaon is extremely erosion prone. Bank erosion is found to be acute near Matmora and upstream of Majuli Island below Tekeliphuta.

During the floods of 2007, the Matmora dyke was breached at two locations, one near the village Matmora in September and the other near Baligaon in October, flooding the countryside including part of Majuli Island. The Matmora breach was about 500 m in length. It breached again in 2008 widening the breach to a length of about 5 km. On both occasions, the flooding was large-scale and catastrophic. Widespread sandcasting turned the area into a virtual desert. The flood waters of the Brahmaputra through the breach at Matmora affected Majuli Island, aggravating its already worsening flood and erosion scenario. Mean annual discharge at Pasighat, the nearest upstream gauging station is 5,896 m³ per second (MDoNER 2009). The rates of erosion and accretion estimated in Matmora reach for the period 1967 to 2008 are 3,956 ha and 506 ha, respectively, constituting a net loss of around 3,450 ha of land. The history of flooding and the saga of devastation in both of the study sites are narrated further in Das et al. (2009). Table 2 presents the district and state level information on geography, demography and development status of study areas in Assam.

Koshi basin in India (Bihar) and Nepal

The Koshi River was also studied to supplement the main study to learn about the centuries-old experience of embankments erected for flood control. The Koshi River is the third largest tributary of the Ganges and originates in the Himalayan range in the Tibet Autonomous Region of China at an altitude of about 7,000 m. The river is called Sapta (Seven) Koshi in Nepal because it receives water from seven tributaries: the Indrawati, Sun Koshi, Tama Koshi, Likhu River, Dudh Koshi, Arun River and Tamur River. The Sun Koshi, the combination of the first five rivers,

Table 2: District and state level information on geography, demography, and development status of study areas in Assam

	District		Assam
	Lakhimpur	Dhemaji	
Location	26.48' N–27.53'N 93.42' E–94.20'E	27°05'27" N–27°57'16"N, 94°12'18"E–95°41'32"E	24°08'10"N–27°58'15"N 89°42'05" E–96°01'14"E
Average altitude (masl)	90	104	28–130
Geographical area (km ²)	2,277	3,237	78,438
Total population	889,010	571,944	26,655,528
Population density (per km ²)	390	177	340
Population below poverty line (%)	37.21	42.66	35.48
Literacy (%)	68.51	64.48	63.25
Human Index Value	0.337 (17)	0.277 (20)	0.407
Income Index Value	0.154 (13)	0.026 (23)	0.286
Education Index Value	0.657 (4)	0.622 (10)	0.595
Health Index Value	0.200 (20)	0.186 (21)	0.343
Gender Development Index, Value 2001	0.491 (8)	0.410 (13)	(0.537)
Human Poverty Index (1999)	20.23	19.60	23.24

Source: GoA 2003, 2006

Note: Population figures represent 2001 census estimates

joins with the Arun and the Tamur at Triveni in Dhankuta District of Nepal and assumes the name Sapta Koshi. The river meets the plains at Chatra, about 10 km from Triveni. After traversing a distance of about 50 km in Nepal, the river enters the Indian state of Bihar at Bhim Nagar, assuming a width of about 6 to 10 km (Figures 6 and 7).

The Koshi has a catchment area of 74,030 km², of which only 11,410 km² is in India and the remaining 62,620 km² lies in Nepal and Tibet. The Koshi is a complex river system, with acute riverbank erosion and a migrating channel, capable of causing huge flooding. The annual load of sediment carried by the river is very high, and because of the excessive silt deposited in the channel it frequently braids and shifts course. The annual sediment load of the Koshi at Barakhshetra is 92.5 million cubic meters (BSIC 1994a, cited in Mishra 2008b). It shifted course by a massive 160 km between 1723 and 1948 (Mishra 2008a). It has 15 abandoned channels through which its water used to flow before embanking.

Embankments as a Flood Mitigation Measure: A Critical Look at Debates and Discourses

Embankments are important structural measures for the management of floods the world over. Embankments laid on one or both sides of a river are designed to contain rising waters and protect settlements and infrastructure. Also referred to as 'artificial levees' or 'dykes,' embankments are usually made of piles of earthen material with a broad base tapered towards the top laid parallel to the course of a river. The alignment, spacing, and height of an embankment depends on the area to which protection is to be provided, the magnitude of the expected peak flood discharge, and the availability of resources (material, financial, and human) for construction (Dixit 2009). Embankments are designed and constructed to afford a degree of protection against floods of a certain frequency and intensity; the maximum recorded flood; or the maximum probable flood, depending on the availability of long-term hydrological data. While designing the embankment, the spacing of the embankment with respect to the natural riverbank is to be properly planned keeping in mind the way that the river meanders.

Embankments, in general, are effective in containing floods for a certain period of time (the lifetime of the structure), usually 20 to 30 years in India if properly constructed and maintained. However, there are instances where embankments, when nurtured properly, have served an area well beyond this average lifespan. For example, the 9.5 km long town protection dyke in Dibrugarh in Assam built in the mid-1950s, strengthened later with revetments and accompanied by a series of spurs (ADB 2009), has managed to protect the town from floods of

the Brahmaputra River for the last 50 years. Embankments serve as safe shelters (high land) for flood-affected communities. They are also commonly used as roads, facilitating transport and communication in rural areas. Embankments are generally a cheap, fast, and easy structural measure to implement for flood protection.

However embankments also have serious disadvantages. They are affected by natural weathering (rain and wind), human pressure, and lack of proper and timely maintenance. Embankments can fail because of seepage, leakage, piping, and sand boiling resulting in the slumping of soil; these factors become more prevalent as the embankment ages (Deka 2007). Embankments are also known to be weakened by denuding of grass cover, planting of roots, and digging by burrowing animals and rodents. As embankments are usually made from locally available earthen material, they are almost unfailingly susceptible to breaches, so much so that breaches are an inherent feature of any flood control embankment, no matter how well it is maintained (Dixit 2009).

Embankments confine the flow of a river within a narrow space and deprive the river of its natural space to meander and stabilize. As a result, the flow becomes faster and water levels rise within embankments during the flood season, sending high flood peaks to downstream areas. Further, embankments increase flood discharge intensity and the rate of siltation within the embanked reach of a river causing the river bed to rise and the channel capacity to be reduced. If an embankment breaches, water gushes out with very high momentum, causing large floods in the adjoining areas. Large amounts of silt and sand originating from the river water and the embankments are carried with the flood water and are deposited on the flooded land in a process called sand casting. These layers of sand can be several feet deep and have affected vast areas in settlements and farmlands along riverbanks in Assam and Bihar. Sand casting has badly affected agriculture in both these states driving farmers out of their livelihoods. The sandy landscapes in Matmora in Assam, Birpur in Bihar, and Kushaha in Nepal are the result of sand casting from embankment-induced flooding.

Embankments also cause the flow of water from tributaries and other water bodies to become blocked resulting in the choking or closing of outfalls (mouths) of tributaries, impeding natural drainage, and water logging and even flooding areas outside the embankment. This impact is everywhere outside the embankments along the Koshi River in Bihar, including in the Tilathi village in Saharsha district. This can result in the temporary or permanent degradation of land, making it unfit for agriculture or human habitation.

Reservations about embankments are not at all a contemporary concern, as many would like to believe. In fact the opposition to embankments in India is as old as the history of colonial flood control regime in the country. The Orissa Flood Committee constituted by the British Government with four engineers in 1927 to investigate the nature of flood problem in Orissa and advise the government about solutions was quick to realize the folly of embankments even in those early days and expressed its views that were quite radical. The Committee recognized that the embankment and canal systems were at the root of the flood problem in Orissa because they resisted draining out of flows to the sea and observed that removal of obstructions to the working of nature, was the only cure for the flood problem of Orissa and the country as a whole. The committee recommended gradual removal of selected embankments while keeping others ensuring that they do not breach and do not obstruct rivers beyond a certain extent (Williams 1929).

Embankments can block outfalls of tributaries, impeding natural drainage and water logging areas outside the embankment



In 1937 Captain GF Hall, Chief Engineer of Bihar, commented during a debate on flood control in the Patna Flood Conference that flood prevention was undesirable and bundhs are primary causes of excessive flooding (PFC 1938). He wisely observed that there was a strong correlation between the available resources and practical engineering, but it did not mean that the cheapest solution was the best option, usually far from that. SC Mazumdar, when he was the Chief Engineer of Bengal in 1940, wrote "In fact having regard to our experience in Bengal,

construction of flood embankments as a flood controlling measure would be like mortgaging the future generations to derive some temporary benefits for the present generation" (Mazumdar 1942).

The opinion of decision and policy makers, experts, and the general public about the utility, desirability, and efficacy of embankments is varied and often polarized. Starting with the first National Flood Policy of 1953, most of the Government of India's policies and programmes promoted embankments as the main form of flood management, especially as an immediate control measure. State agencies (in Assam and Bihar) have constructed embankments almost with religious fervour, while neglecting their maintenance or the need to supplement embankments with non-structural options. However, it is argued that technocrats consider embankments not as a solution, but as one of the options for protecting people from floods (Pandit 2009) and adopt this option even though the detrimental impacts are known.

Despite the shortcomings of embankments, either inherent or as a result of bad governance, embankments have been adopted as the main form of flood management in India. It is important to understand the socioeconomic, technical, and political interest in promoting embankments to grasp the range of governance problems that plague flood management in India. The prominence of embankments for flood management is also partly attributable to the dominance of traditional reductionist engineering thinking, which views floods as a source of unmixed damage and loss ignoring the crucial ecosystem services rendered by monsoon flows (Bandyopadhyay and Ghosh 2009), such as the distribution of soil nutrients and replenishment of fisheries and wetlands.

Recent expert opinion generally supports a stop to embankments and a more comprehensive, innovative, and integrated approach to flood management. Some of them recommend a paradigm shift from conventional flood control regime to flood mitigation or flood risk reduction combining unhindered drainage, flood adapted structures, and building social resilience (Dixit et al. 2007; Dixit 2009). Some experts (Iyer 2008) and the general public believe that we should allow rivers to flow freely (Dixit 2009) and encourage vulnerable people to live with floods and governments to work with communities to strengthen adaptive capacity. Some experts even recommend the demolition of existing embankments. Others consider the network of embankments developed so far to be an asset and recommend strengthening them, while implementing a gradual paradigm shift in flood management involving new structural techniques together with non-structural measures and institutional reforms.

While the views are many and varied, the debate persists between the advocates of techno-centric flood management and civil society, represented mainly by environmentalists and water management experts. In this debate, civil society has been criticized by technocrats and government experts for spreading technically incorrect information about flood management (Pandit 2009).

Influence of Embankments and their Governance on Local Adaptation to Floods

Current flood management practices dominated by structural interventions have failed to provide assured and long-term protection to people. Embankments have collapsed frequently with the resulting floods disrupting community life and social order every year. In the absence of alternatives, people have depended on embankments and much of their coping and adaptation have centred on these structures. For example, people take shelter on embankments along with their movable property and livestock during floods. Many families that have lost their land or houses stay on the embankments even after floods are over. Those who are not resettled and rehabilitated can end up living on embankments for years.

Some people in villages such as Auniati and Na-Kalita in Dhemaji and Tinigharia in Matmora area prefer living close to the embankments in temporary houses rather in their original permanent houses, which are located in the low lying plains away from the embankment, so that they have immediate access to higher ground in case of a flood. This is common in cases where people believe the embankment is at risk of breach or collapse at places away from their village, but that the flood would affect the entire area. They have a sense of their vulnerability increasing in proportion to the distance of their settlement from the embankment. This practice enhances their coping to some extent, but at the same time makes them more vulnerable by weakening the embankment. One



Human settlements built close to embankments are a major cause of deterioration

major cause of deterioration and consequent failure of many embankments in Assam is the presence of human settlements on or close to the dykes. Similarly, use of embankments as roads help communities during floods and in remote areas greatly in accessing resources and support services, but the constant wear and tear ruins the embankment making them prone to erosion and floods.

Communities continuously devastated for several years by recurring floods, such as those in Matmora, are finding it harder to come back to normal life on their own resources. Annual floods have led to the

loss of livelihoods leading to further impoverishment and the breakdown of social cohesion in such communities. In the past (1968–1998) Matmora had prospered, when the embankment provided security against floods and when the communities were better able to cope with occasional floods on the strength of their own resources (Das et al. 2009).

Embankments have helped communities to make important decisions about livelihoods. For example, knowing that they are secure from floods has enabled people protected by embankments to make plans to invest in fisheries, plant certain crops, and send their children to schools in affected areas. It is when embankments and other measures fail to provide protection against floods and erosion that people are forced to migrate to other areas, and communities become socially and culturally uprooted and even more vulnerable in a situation where resettlement and rehabilitation are not guaranteed or adequate. Migration to other areas sometimes leads to conflict with the government and between communities over ownership and occupation of land, an important resource and one that can help people cope better in disaster-prone conditions.

On the other hand, people's growing dependence on embankments has reduced their willingness and ability to fight floods. As a result, in some instances communities are not sufficiently prepared when embankments breach and trigger large floods. Floods triggered by the breaching of embankments are often more devastating and cause more sand deposition than floods occurring in the absence of embankments. People in the study areas suffer more physically and incur more losses when embankments fail and flood-adjacent areas than those in areas prone to flooding but with no embankments. Examples include the breach-induced floods in the Jadhah River in 2007 and 2009; in the Brahmaputra near Matmora in 2007, 2008, and 2009; and in parts of Nepal and Bihar from the Koshi River in 2008.

Uncertainty surrounding weak embankments and the fear of floods has immobilized people and restricted them from making important decisions and actions that would have improved their condition and helped them adapt. For example, in Matmora, people are not eager to invest in repairing their stilt houses as a past breach in the dike has not been fully repaired; they know that a flood will most likely damage their houses again. Such an attitude makes many communities more vulnerable to floods in the next season. Development interventions, especially infrastructure development (such as the construction of educational institutions, hospitals, and industry) and housing subsidies, are sometimes decided based on whether an area is well protected from floods or not. Banks are reluctant to give loans to self-help groups in chronically flood-affected areas such as Matmora and Samarajan in Assam because they are not sure that the seed money will be used well in such a poverty-stricken area or the loan paid back.

As people are overwhelmingly dependent on embankments, they organize regular vigils along embankments during times of flood, monitor the status of vulnerable portions, and take steps on their own to plug breaches. They also volunteer with free labour during emergencies to help authorities repair the breaches. When flooding is accentuated by drainage congestion caused by embankments, the embankments are sometimes deliberately cut by the people to drain the flood water in another direction to save their own village or farmland.

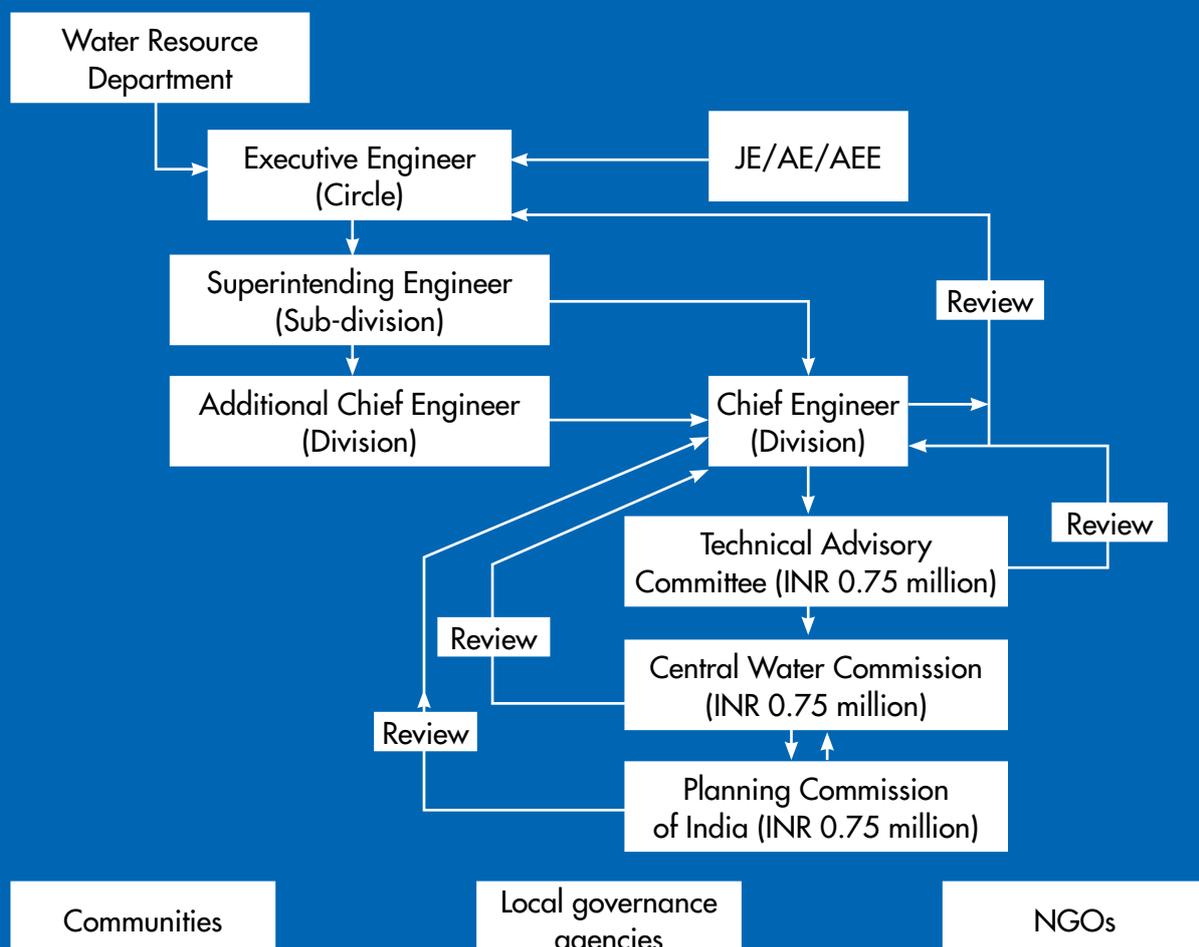
Despite their drawbacks, embankments are an integral part of riverine landscapes and people’s lives and adaptation processes in India. Embankments are not merely a techno-economic choice for temporarily containing floods, they are a critical determinant of development benefits and people’s resilience. This is why it is important to ensure that embankments are properly made and managed through a forward-looking, progressive, and accommodating governance mechanism. Good governance of flood mitigation structures, in general, and of embankments, in particular, will go a long way to providing the much-needed respite essential for developing adaptive measures and adaptive capacity among vulnerable communities.

Formal Institutions in Flood Governance: An Appraisal

Under the Indian Constitution, water is a state subject. Therefore, the major responsibility of utilizing and managing water resources and water bodies lies with the state governments in India. This includes the management of floods, for which the state Water Resources Department (WRD) is usually the concerned agency.

As shown in Figure 5, technical and financial estimates of schemes of maintenance work or new construction related to flood protection and anti-erosion measures are submitted by the office of the Executive Engineer from the subdivisions and divisions through the Superintending Engineer to the Additional Chief Engineers in respective zones from where these are directed to the Chief Engineer’s Office at Guwahati. These estimates are reviewed by the Technical Advisory Committee (TAC) at the Chief Engineer’s Office, where decisions about their modification and approval are taken. The Assam State Brahmaputra Valley Flood Control Board, a body within the WRD chaired

Figure 5: Institutional structure of development of flood protection and anti-erosion measures in India



by the Chief Minister of Assam, is responsible for the financial approval of projects. Projects requiring a budget of more than INR 75 million need the approval of the Central Water Commission and the Planning Commission. The work is then assigned to a contractor through a tendering process. The work of the contractors is monitored by the Executive Engineers' office and approval is made accordingly.

The TAC, the apex state body that gives technical approval to structural projects, is comprised only of experts and officials of various government departments, both state and central, chosen mostly from engineering disciplines. The TAC does not contain environmentalists, social scientists, or representatives of civil society and local communities. As a result, concerns about environmental and social impacts or the opinions of local people about flood control projects are never considered in the planning and approval of these projects. This has led to an official flood management regime dominated by structural interventions, without consideration of environmental and social impacts and risk management. There is neither provision for the consideration of, nor sensitivity towards, local knowledge in flood management strategies under the system.

Even local governance agencies (such as the Panchayati Raj Institutions and District Autonomous Councils) are not consulted by the WRD about flood protection projects, although many of the embankments built by the WRD, once dilapidated, become the responsibility of Panchayats or Autonomous Councils. In many places, embankments abandoned by the WRD have been repaired by local Panchayats or communities on their own. Although the WRD has asked villagers to form committees in some places in response to public pressure to mobilize public opinion about the department's schemes and to solicit suggestions for better schemes, villagers in Dihiri Mising Gaon, Jiadhah Panchayat claim that these committees were not consulted when the schemes were actually executed (as informed by villagers on 18 March 2010). The absence of an enabling environment to motivate people to participate in the planning and execution of flood management projects is a major institutional issue in Assam.

Lack of coordination between the WRD and the departments of Irrigation, Revenue and Disaster Management, and Public Works, and District Rural Development Agency (DRDA) or with Panchayats and Autonomous Councils is evident in many cases. Some amount of coordination is forced into play only in very urgent situations such as a big flood where the whole government machinery is compelled to act in unison to respond to the situational demands.

Floods in many places in Assam are the results of drainage congestion caused by the obstruction of river flow or bank spillage by railway lines and roads that are located on high ground and also act as embankments. The railway tracks and national highways in the Brahmaputra Valley run parallel to the course of the Brahmaputra River and, therefore, they offer resistance almost perpendicularly to the inflowing tributaries and many smaller streams that flow from surrounding hills on both banks. Many minor streams and other water bodies are obstructed by these structures because of the absence of sluices and culverts in proper positions and the closure of existing natural waterways. As a result, many areas are inundated artificially, resulting in water logging. This highlights the lack of coordination among the WRD, the Public Works Department, the National Highways Authority of India, and the Northeast Frontier Railways, the main agencies involved in the construction of flood protection structures, roads, and railways. This lack of coordination impacts directly on communities; for example, villagers of Kaupatani in Dhemaji want the railway line to be cut to drain floodwaters that accumulate annually from the Na-Nadi and cannot recede because of the railway line on the eastern side (as informed during a focus group discussion in Kaupatani village, Dhemaji on 22 November 2009).

Inefficiency and negligence in the construction, monitoring, and maintenance of embankments and other structures have characterized the flood governance system for over four decades, with high levels of substandard work. Breaches of embankments and consequent flooding have become profitable events as they create demand for more work in the next season. The vested interests in floods and embankments became so powerful that it is alleged that in many cases the schemes were prepared more to cater to the interests of the contractors than to address the needs of the people.

In addition, monitoring of the status of embankments and the quality of maintenance work is very poor in Assam. Local people are not welcome to help in the monitoring of such work, and even proactive feedback from them is not officially accepted. An example is the river training structure-cum-embankment being planned by the WRD on the Jiadhah River at Samarajan Panchayat in Dhemaji District. According to leaders of the Jiadhah Nadi Ban

Pratirodh Oikya Mancha during a focus group discussion in January 2010, the WRD is at loggerheads with local communities over the design of this structure being built for flood and erosion protection. Local people have lost faith in the engineers' capacity to train and manage the river and want their own recommendations to be implemented.

There are also examples of sheer negligence and insufficient work causing flooding and erosion to worsen at many places resulting in the escalation of the cost of structures raised to protect those areas at a later time. The Takam Mising Porin Kebang, the students' wing of the Mising community, warned the state government in 1987 that the Sissi Tekeliphuta embankment on the Brahmaputra had become highly vulnerable at certain stretches and it might breach at Pipalguri near Sissi-Tengani (Dhemaji District) and at Baligaon near Matmora (Lakhimpur District). They also submitted a memorandum to the then-chief minister of Assam demanding the proper repair of these sites. The embankment breached and flooding engulfed the area causing erosion as feared.

That was the beginning of the chronic annual failure of the Brahmaputra embankment in the Matmora-Baligaon stretch, as told by Paramananda Chayengia, former Chief Executive Councilor, Mising Autonomous Council (MAC), Gogamukh, Dhemaji on April 2010. The Matmora dyke breached at many other places later because of insufficient protection, causing flooding almost every year as well as widespread sand casting, culminating in the collapse of a 5 km stretch of the dyke. Apart from costing a huge amount to repair the embankment, the geotextile tube technology employed to plug the breach during 2009-2010 has cost about INR 1,400 million.

A lack of financial resources is at the core of many of the failures of the department, despite sincere efforts and proper planning by its engineers and staff. While the frequency and intensity of floods has increased recently as a result of many factors resulting in (and also caused by) an increasing number of breaches in embankments, the money allocated for maintenance remains grossly inadequate when compared to estimates submitted for consideration by the field investigators from the districts. According to some officers, they receive less than half what they ask for in funds. The result is patchy work that is insufficient to make the embankments and other structures fit to protect against floods, sometimes even compromising the height of the embankments, a crucial parameter that determines the structure's flood containing capacity. The newly built section of the Jiadhah right-bank embankment adjacent to Auniati village is shorter in height than the older portion of the same embankment. The reason for this is insufficient funds. Although the height of the embankment is a technical parameter, it is no longer a function of the expected flood level, but has become an indicator of the financial condition of the WRD.

"The administrative and management system of the Water Resources Department cannot take urgent and immediate steps to safeguard the embankments; the Water Resources Department does not have contingency funds to be used in sudden and urgent situations," claims Paramananda Chayengiya, former Chief Executive Councilor of the MAC (interview, Gogamukh, Dhemaji, 20 April 2010). According to Chayengiya, during his tenure on the MAC from 2006 to 2009, the district WRD official approached the MAC for funds to repair breaches that had appeared unexpectedly on certain embankments in Dhemaji District in 2007.

The prevailing budgetary cycle also prevents the timely completion of the construction and maintenance of embankments. Funds for the schemes prepared after the flood season (after October) are released only from April in the next financial year. By that time the rainy season has set in, early floods start occurring, and the rivers become more erosive in many places. The work has to be done hurriedly in the rainy season making it difficult to complete because of rain and floods. As a result, the work becomes more expensive and the quality cannot be maintained within the given timeframe and with limited funds. Such a mismatch between the monsoon calendar and the budget cycle renders even the genuine efforts of well-meaning

In Auniati village, the newly built section of the embankment is lower than older portions because of insufficient funds

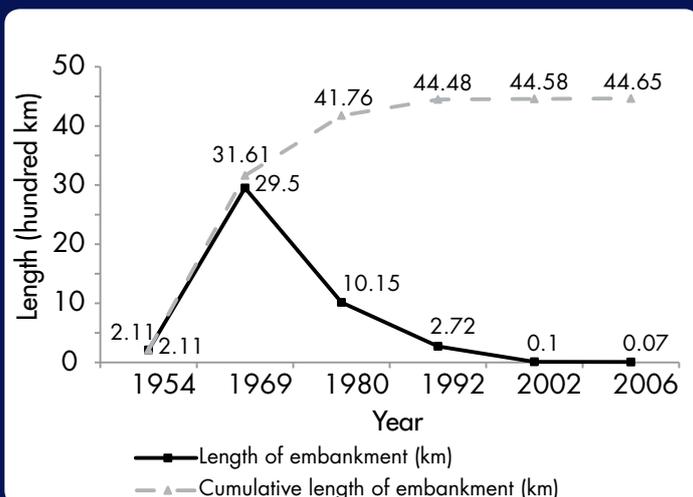


officials and contractors ineffective. some contractors their work as best as possible despite the constraints, even though the payment of their bills is not always adequate or timely. The process of releasing money to contractors is anomalous and biased in favour of powerful contractors close to politicians and officials.

Analysis of the rate of building of embankments and drainage networks in Assam over the last six decades reveals interesting results. The pace of building embankments in the state became sluggish in the 1980s. Out of the 4,465 km of embankment laid until 2006, 4,176 km (93 per cent) was completed by 1980 (Figure 6). This happened mainly because as the embankments grew in number and length, the cost of their maintenance also increased proportionately, which gradually became unaffordable for the state government. Most of the embankments built in the 1950s and 1960s completed their lifetime in the 1980s, thus making their maintenance of prime concern. Erosion being a major reason for the degradation and breaching of embankments, anti-erosion measures became the focus of the Water Resources Department's activities from the 1980s onwards. Building new embankments became a financially difficult proposition. At the same time, in the rush to build embankments, drainage development work, which is so essential to sustaining the benefits of the embankment, was grossly neglected. The construction of drainage channels almost stopped after 1970 (Figure 7).

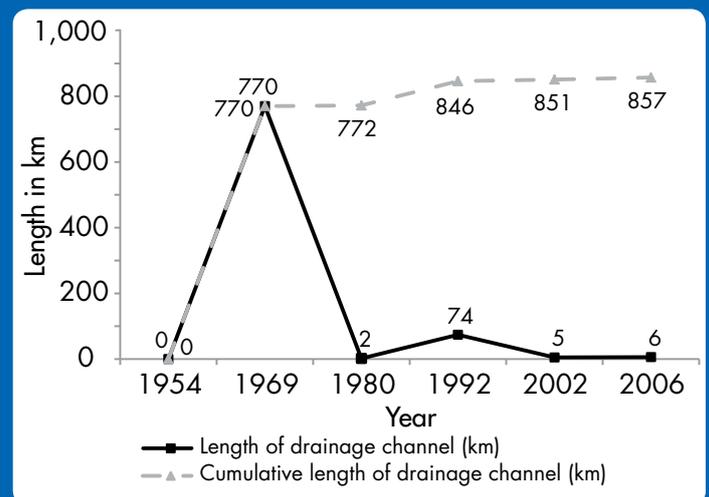
However, lack of funds was not the only reason for the fall in the rate of embankment building. By the beginning of 1980s the shortcomings of embankments were becoming evident. Most of the resources of the Water Resources Department were spent in constant 'fire fighting', including maintenance and plugging of embankments. The growing awareness among people and debates over the detrimental impacts of structural flood control measures such as embankments also influenced some decision makers. However, there was also a political dimension of the decision to slow the construction of new embankments. A technical norm to be observed in designing embankments is to space the embankment from the natural bank of the river a distance at least 1.5 times the width of the river at that stretch. With population increasing at an average rate above 40 per cent per decade in Assam and the Brahmaputra Valley being naturally narrow (about 600 m long on average, east-west, and 70–80 km wide, north to south) with numerous rivers criss-crossing, land became an increasingly scarce resource for settlement, agriculture, and forestry from the 1970s. Riverbanks that were already inhabited by indigenous communities became more populated along with chars (river islands), with significant immigration from neighbouring Bangladesh as well as many other parts of the state. Hence, building embankments with the required spacing became unviable on the Brahmaputra and its major tributaries as this would leave a large population and important infrastructure on the riverside exposed to floods. Acquiring land for more embankments increases pressure on community resources and livelihoods, which can have serious implications during elections. Thus, by the end of the 1980s, embankments had become a politically risky proposition. The number of embankments being built in new sites, therefore, dropped significantly from the 1990s.

Figure 6: Growth of embankment in Assam (1954-2006)



Source of data: Water Resources Department, Government of Assam

Figure 7: Growth of drainage channel in Assam (1954-2006)



Source of data: Water Resources Department, Government of Assam

Policy Framework for Formal Flood Governance: Evolution and Evaluation

At the national level, the first formal policy statement on flood control in India was enunciated on 3 September 1954 by the then-Union Minister for Planning and Irrigation of India, Gulzarilal Nanda, in the aftermath of the devastating floods of 1953 and 1954, which affected many parts of India. This policy statement envisaged three types of flood control measures: immediate, short-term, and long-term. Immediate measures (first phase) included revetments, spurs, and embankments at selected sites; short-term measures (second phase) included construction of embankments and channel improvement covering large parts of affected areas; and long-term measures (third phase) consisted of building of storage reservoirs on certain rivers and additional embankments if found necessary (Brahmaputra Board 1985; Mishra 2002).

In this policy statement the objective set before the nation was to rid the country from the menace of floods by containing and managing floods. This objective was afterwards modified to say that reasonable protection that was technically and economically justifiable would be provided, with greater emphasis on flood forecasting, flood warning, and flood management (Thakkar 2006). With this statement, the philosophy of the flood policy was set to change and become more realistic. On 27 July 1956, less than two years after announcing the National Flood Policy, the same minister declared that absolute immunity from flood damage was not possible, even in the distant future, because of the unpredictability of natural forces. The emphasis was rather on “learning to live with floods to an extent” (NFC 1980, pp 98). Thus, although structural measures and embankments were emphasized in the very first policy on floods in independent India, their limitations were also recognized from the beginning. It was also said in the same context that “no single measure can provide a complete answer to the problem of floods. Each case will have to be considered on its merits and a measure or a combination of measures adopted if a proper solution is to be found out” (Mishra 2002).

After this initiation, a number of committees, commissions, and task forces were formed to study flood problems, assess government programmes, and recommend strategies to deal with flood and erosion problems in various regions of India. Important milestones that defined the evolution of the flood management regime in India are presented in Box 2. Among these initiatives, the Report of the National Commission on Floods is considered groundbreaking. The National Flood Commission (NFC) was constituted in 1976 by the Government of India “to evolve a coordinated, integrated and scientific approach to the flood control problems in the country and to draw out a national plan fixing priorities for implementation in the future”. The report of the NFC, regarded as an important document reflecting the realities of the flood management regime in the country, evaluates the country’s approach to and programmes on flood control since 1954 and provides important policy guidelines for future flood management in the country. The NFC made 204 recommendations, but hardly any of these recommendations have been followed, as found in the reviews of the Central Water Commission in 1987 and the National Commission for Integrated Water Resources Development in 1999 (Thakkar 2006, pp 14). The Ministry of Water Resources itself admits that not much progress has been made in the implementation of its recommendations. As such, the Ministry of Water Resources set up an expert committee in October 2001 to review the implementation of the recommendations of NFC, identify the difficulties faced by the state governments in their implementation, and suggest measures for effective flood management in the country. The report of the committee is still under examination by the Ministry of Water Resources.

The report of the National Commission for Integrated Water Resources Development (NCIWRD) submitted in 1999 observes that there are no universal solutions that can provide complete protection against floods. It, therefore, recommends a shift in strategy from structural measures to a mix of structural and non-structural measures including the efficient management of flood plains, floodproofing, disaster preparedness and response planning, flood forecasting and warning, disaster relief, flood fighting including public health measures, and flood insurance (Thakkar 2006, pp 14). “The report further suggests that performance review of selected embankments may be carried out and based on the findings, planning, designs and management of embankments may be reviewed for obtaining better results. It also recognizes the importance of associating the beneficiaries in the upkeep and surveillance of embankments during the monsoon season for prevention of possible breaching” (Thakkar 2006, pp

Box 2: Evolution of flood management regime in India

- First Policy Statement: 1954
- High Level Committee on Floods, 1957
- Policy Statement on Floods, 1958
- Ministerial Committee on Flood Control, 1964
- Minister's Committee on Flood and Flood Relief, 1972
- Working Group on Flood Control for Five Year Plans, 1972
- Rashtriya Barh Ayog (National Flood Commission), 1980
- Establishment of Brahmaputra Board, 1980
- National Water Policy, 1987
- Committees for Flood Management in Ganga and Brahmaputra basins, 1987: Two committees were formed by the Water Resources Ministry, one for the States of Uttar Pradesh, Bihar, West Bengal and Orissa and the other for North eastern states.
- Committee for Flood Management in Northeastern States(Naresh Chandra Committee), 1988
- National Commission for Integrated Water Resource Development Plan(S.R. Hasim Commission), 1996
- Regional Task Forces, 1996: Five Task Forces were constituted by the Central Government on flood related issues for the eastern, north-eastern, northern, north-western and southern regions
- Expert Group on Flood Management in UP and Bihar, 1998: Set up by Central Government for suggesting effective flood control measures for Uttar Pradesh and Bihar
- National Commission for Integrated Water Resources Development (NCIWRD), 1999
- A Model Draft bill on Flood Plain Zoning, 2002: Prepared and sent to the State Governments by Union Water Resources Ministry in 2002; originally circulated in 1975, but not implemented in any state except Manipur that enacted legislation on the suggested lines.
- Multi Disciplinary Committee on Silting of Rivers, 2002: Formed by Government of India to study the problem of silting in rivers(Dr. B.K. Mittal Committee)
- National Water Policy, 2002
- Report of the Expert Committee to Review the Implementation of Recommendations of Rashtriya Barh Ayog(R. Rangachari Committee), 2003
- Report of the Technical Group on Flood and Erosion Problems of North Bengal(M.K. Sharma Report), 2004
- Prime Minister's Task Force for Flood Management / Erosion Control, 2004: Constituted by Indian PM to examine the problem of flood and erosion in Assam and neighbouring States, West Bengal, Bihar and Eastern Uttar Pradesh
- The Disaster Management Act, 2005
- National Disaster Management Guidelines for Management of Floods issued by the National Disaster Management Authority, 2008 January
- National Policy on Disaster Management, 2009

Source: Brahmaputra Board, 1985; Thakkar, 2006; MDONER, 2006

14). The Report of the Task Force on Flood Management and Erosion Control, constituted by the Government of India in the aftermath of the catastrophic floods in northeastern, eastern, and northern India in 2004, also provides guidelines for flood protection work (MWR 2004). The Task Force recommended several measures to ensure the flow of adequate financial resources to the states to implement flood management measures. It suggests that flood control schemes should be funded through the Centrally Sponsored Scheme in the ratio of 90 per cent from the central government and 10 per cent from the state government, instead of the present ratio of three to one. It asks the government to earmark funds in the state sector as additional central assistance for the maintenance

of embankments. The report introduced the idea of a 'flood cess' of 1 to 2 per cent that could be levied on new infrastructure such as roads, buildings, and power plants in flood-prone states to mobilize resources for a revolving fund to be used for flood protection in the states.

The report emphasizes the urgent need to plug breaches on embankments, raise and strengthen embankments, carry out bank protection work and anti-erosion work, construct high-rise platforms, provide sluices in embankments, provide weak sections of embankments with fuse plugs, and construct drainage development schemes as short-term measures. The Task Force report advocates for storage reservoir projects upstream in flood causing rivers in Assam to find a 'permanent solution to the problem of floods and erosion'. Further, it suggests non-structural measures such as the revival and maintenance of wetlands, watershed management, flood plain zoning, and the extension and modernization of flood forecasting and warning systems. It also advocates for community participation in the maintenance of embankments.

In essence the policies in flood management being pursued in India are the same as adopted in the 1950s with only the immediate and short-term measures such as embankments being promoted more vigorously than other measures. For example, since the launching of the National Programme on Flood Management in 1954, as much as 4,459 km of embankments and 851 km of drainage channels have been constructed in Assam. In addition, 681 village protection works (bank protection and anti erosion) have been completed, thus benefiting an area of 1.64 million hectares, while 2.18 million hectares of land still remained to be protected as at 2004 (MWR 2004). Almost 80 per cent of these embankments were built from the 1950s to the 1970s, and the remainder were built in the 1980s and 1990s (interview with AK Mitra, former Secretary Water Resources, Government of Assam, Guwahati, 19 July 2010). However, some non-structural measures also have been adopted, but not to the desired extent and without the desired results. Most of the forward-looking recommendations from subsequent experts and commissions that needed institutional reforms and better governance were ignored.

The flood control regime developed in Assam following the evolution of policies and programmes in the country as a whole. The first official attempts to tackle floods in the state can be traced back to the late 1940s especially in the wake of the unprecedented floods of 1946. Many experts and committees visited the northeast region and suggested measures for dealing with floods and harnessing the river Brahmaputra for beneficial purposes. In 1947 Sri Man Singh of the Central Water and Power Commission suggested construction of storage reservoirs on large rivers of the region like Dihang, Lohit, and Subansiri. On the other hand, SC Mazumdar, a member of the erstwhile Central Water Irrigation Navigation Commission held his view against use of embankments in the context of Assam, rather he wanted embankments to be removed and flood moderation to be achieved by means of reservoirs and detention basins (Brahmaputra Board 1985).

In the case of Assam, the Assam Embankment and Drainage Act, 1953, came into force in 1954. This Act provided specific guidelines for building embankments and drainage structures governing operational aspects as well as execution processes such as the notification of schemes, requisition of land, objections, and coordinating with privately-owned land and existing structures for construction or removal (AEDA 1953). The Act vested considerable decision-making power regarding embankment construction and removal in district-level authorities, although final decisions regarding finance and administration were vested in the concerned state ministries or departments. This Act was repealed and replaced by the Assam Irrigation Act, 1983, which came into force in 1989. Surprisingly, the new Act deals mainly with irrigation and says little about the operational aspects of embankments construction. Instead it places irrigation as the sole aim of all water structures. It is difficult to understand how an act dealing solely with embankments and drainage systems can be replaced wholly by another act that deals only with irrigation (AIA 1983). Moreover, the institutional structure for both these activities was well demarcated between the Flood Control Department (now the Water Resources Department) and the Irrigation Department by the time the new Act was formulated. This was certainly a regressive step in the development of a progressive and adaptive governance mechanism for flood mitigation.

The assumption that all water structures were for irrigation was the result of narrow and reductionist engineering thinking on the part of decision makers. However, one can also see the coercive clout of vested interest groups behind such a move; interested parties who wanted norms and standards for structural interventions to become

diluted under a soft policy so that their business interest could flourish. As a result, there is no set of definite and legally-valid guidelines at present to govern the building of embankments. Their construction is based on a normative set of standard practices that have been followed so far. Surprisingly, it was found during this research that many officials of the Water Resources Department and other relevant departments were not aware of the contents of the Embankment and Drainage Act, nor did they know that it was no longer in operation.

Although there is no specific flood control policy in India, there are suggestive guidelines available in several documents that can be followed in flood mitigation. Both the National Water Policy of India, 2002, Section 17.3 (NWP 2002), and the Draft Water Policy of Assam, 2007, provide guidance to the state agencies in the matter of flood protection. According to the common vision of these two policies 'while physical flood protection works such as embankments and dykes will continue to be necessary, increased emphasis should be laid on non-structural measures such as flood forecasting and warning, floodplain zoning, and floodproofing for the minimization of losses and to reduce the recurring expenditure on flood relief'. The draft Water Policy of Assam goes further to say that 'structural interventions such as embankments, dykes, spurs, revetments, dampeners, porcupines, etc. should be considered only after careful detailed studies and investigations as a part of a package' (SWPA 2007). It also emphasizes on 'regular and adequate maintenance of such structures to be ensured with the involvement of the stakeholders'. Further it recommends provision of sluices at appropriate locations of existing embankments to arrange for adequate drainage to get rid of water logging. The state policy also advocates for structural erosion control measures such as revetments by boulders and geotextiles and downstream transport of sediments to reduce the intensity of erosion. On the other hand the National Policy on Disaster Management, 2009 insists that 'infrastructure like embankments should be constantly monitored for safety standards in consonance with worldwide safety benchmarks and strengthened where deficient' (NPDM 2009).

Other important sources where decision makers have found guidance for flood and riverbank erosion management are the report of National Flood Commission, 1980; the Master Plan of Brahmaputra Basin, 1985 that was modified in 1996; the report of the LC Jain Committee, 1990 appointed by the Planning Commission of India; and the report of Task Force for Flood Management and Erosion Control, 2004. The Master Plans for the Brahmaputra and Barak rivers that were updated by the Brahmaputra Board in 1996 provide a broad planning framework for flood and river erosion management through better data and knowledge gathering; and short- to long-term measures, comprising flood forecasting and warning, floodplain zoning, floodproofing, and watershed management (Brahmaputra Board 1985). Recently the National Disaster Management Authority (NDMA) has prepared a set of guidelines for flood risk management to assist the ministries and departments of the national government, the state governments and local governance agencies (like Panchayat Raj Institutions and urban local bodies) in preparing flood management plans (NDMA 2008).

Acquisition of land for flood control and anti-erosion measures is a necessity in Assam. The principal act that guides acquiring of land for public purposes in India was the Land Acquisition Act, 1894 until 2011 when it was replaced by the Land Acquisition, Rehabilitation and Resettlement Bill, 2011. The bill is expected to become an Act after incorporation of amendments and endorsement in the Indian Parliament in 2013. Additionally special laws have been formulated in Assam to acquire land for various important purposes, including the Assam Land (Requisition and Acquisition Act), 1948 and the Assam Acquisition of Land for Flood Control and Prevention of Erosion Act, 1955. These two laws were replaced by the most recent one called the Assam Land (Requisition and Acquisition) Act, 1964. This law was especially passed to facilitate speedy acquisition of land for urgent purposes such as flood control and anti-erosion measure such as embankments and drainage and providing land to landless flood-affected people. The procedures prescribed in the old state acts as well as in the All India Act of 1894 for acquisition of land were lengthy and complex. The new law simplified and accelerated the pace of implementing land acquisition for embankments.

Many of the villages on riverbanks in the study areas are non-revenue villages where people displaced by flood and erosion from nearby places and not rehabilitated have settled recently. Many people in these newly settled villages do not have legally valid documents of landownership and do not pay land revenues. Under this act and the main Land Acquisition Act, 1894, people occupying land but not possessing legal documents of ownership and not paying revenue are not considered as legal landholders and so they are not entitled to compensation when their land is acquired. They are considered as illegal occupants of government land. They don't get compensation even

for the houses and standing crops that are destroyed or damaged in the process of land acquisition (Gogoi and Agrawal 2008). Even in the case of revenue villages, compensations are not paid in time and in some cases paid after years of waiting. Ignorance of people about legal procedures of land acquisition and about how to appeal against acquisition to seek justice from administration and courts makes matters worse for them.

On the other hand, policy instruments such as the Mahatma Gandhi National Rural Employment Guarantee Act, 2005 (MGNREGA) have proved to be beneficial to flood-affected people in the study areas providing them cash income and helping them survive in dire situations where agriculture has become unviable in many places. Enacted in India on 7 September 2005 as an Act, this programme aims to provide for the enhancement of livelihood security of the households in rural areas of the country by providing at least 100 days of guaranteed wage employment in every financial year to every household whose adult members volunteer to do unskilled manual work (NREGA 2005). It is essentially a job guarantee programme with an aim of improving the purchasing power of rural people, primarily semi or un-skilled workers in rural India, whether or not they are below the poverty line. Around one-third of the stipulated work force is women. The Act and the ensuing schemes and programmes, appreciated as a progressive and the largest job guarantee initiative in the world are implemented through the Panchayati Raj Institutions. The MGNREGA aims to achieve the twin objectives of rural development and employment. Strengthening rural governance through decentralization and processes of transparency and accountability is one of its major objectives.

The activities that can be taken up under these schemes include specific rural development activities such as water conservation and harvesting, afforestation, rural connectivity, flood control and protection such as construction and repair of embankments. Digging of new tanks, ponds, and percolation tanks and the construction of small check dams are also given importance. In Assam the bulk of the work done under this scheme involves earth cutting for construction of rural roads. Using the funds and the labour power of this programme in activities related to construction and maintenance of embankments and development of drainage facilities has not received importance. Moreover, there are numerous allegations of misappropriation of funds and political abuse of the schemes under this Act in the country as well as in Assam. In spite of this dismal scenario which has reduced the benefits accruing from this well-meaning policy, some amount of important work is being done in the flood-prone study areas that has helped affected people cope better with the impact of floods and other water hazards. In both the study areas of Assam, some embankments have been constructed and maintained under this scheme (Jiadhal catchment in Dhemaji). Highlands or flood platforms where people take shelter during floods along with their livestock are also made by the villagers under this programme (Matmora area in Lakhimpur).

New Initiatives in Formal Flood Governance

The ADB intervention

While the central and state governments have continued to manage floods in a conventional way, a fresh initiative has taken shape in the flood management front that is likely to bring in significant changes to the governance scenario in the future. As a result of an initiative of the Asian Development Bank (ADB) that started in the year 2004, financial and technical assistance has been provided to the Government of Assam through the Government of India to implement the North Eastern Integrated Flood and Riverbank Erosion Management Project (Assam) (NEIFREM). The project aims to implement and improve both structural and non-structural measures of managing flood and riverbank erosion in the state and strengthen the state's policy, planning, and institutional framework to address the problems with a long-term strategy.

According to Kenichi Yokoyama, Principal Water Resources Management Specialist with ADB's South Asia Department, the project has a larger aim to 'help reduce poverty in flood and erosion-prone areas, boost production in agriculture, industry and urban services, and reduce damage from flooding and riverbank erosion while strengthening the essential institutional foundations to comprehensively address the problems'. The project is envisaged to enhance the livelihoods of the people within the project areas, benefiting some 1.3 million vulnerable people in Assam. Key structural works under the project will include rehabilitation and upgrading of existing embankment systems and associated riverbank protection works. Non-structural measures will include improving

flood forecasting and warning measures, floodplain zoning, and community preparedness with intensive stakeholder participation. In particular, the project aims to provide protection to the most vital areas of economic and national interests from river erosion and floods, with an adaptive approach that will protect critical reaches first, and then replicate suitable measures in other areas later. Work will start initially on three critically important stretches on the Brahmaputra: the Dibrugarh, Kaziranga and Palasbari.

Apart from integrating poverty alleviation and livelihood enhancement with flood and erosion management, the project will necessitate institutional reforms and changes in administration, policies, and practices within the state of Assam for achieving its goals. The relevant policies, laws, and institutional framework of the Assam government will be strengthened through the development of state flood and river erosion management strategy and action plan, and capacity strengthening of the relevant organizations. The Government of Assam and the Brahmaputra Board are mandated to improve public awareness of the integrated flood control and erosion mitigation strategy during project implementation and disseminate the project achievement through a public awareness programme. The Government of Assam established a special agency Assam Integrated Flood and Riverbank Erosion Risk Management Agency (AIFRERMA) in January 2010 for implementing the project. At present this agency is known as the Flood and River Erosion Management Agency of Assam (FREMAA). Anchored to the Water Resource Department of Assam, FREMAA has a mandate to implement the AIFRERMA in association with the Revenue and Disaster Management Department of the State. It will ensure that policies and institutions are ready to provide a comprehensive and coordinated flood and riverbank erosion risk management system for the state. The ADB project is the largest and most comprehensive attempt to improve structural flood protection work in the state to date.

Although it is too early to assess the impact of the project on the overall flood management scenario, it will surely bring in some much needed changes in policy and a governance mechanism that will make the system flexible and participatory. Moreover it will ensure an adequate amount of financing, the most important factor that has plagued the WRD of late, to protect critically important areas vulnerable to flood and erosion that would otherwise have not been possible, at least on financial grounds. However, the anticipated upliftment of the governance and management system will depend on the cooperation and good will of the existing hydro-technocracy and the government as a whole. Based on the technical literature (pre-feasibility report, feasibility report, detailed project report, etc.) and financial estimates, one can expect to see a total change in approach and practices in the work envisaged. The prevailing style of functioning of the WRD and other line departments are expected to internalize these changes and reforms to move towards a new paradigm of hydro-governance in the near future. The project has completed the first phase of feasibility studies; it is in its second phase where detailed project reports are being prepared for the three selected sites. Although some people are skeptical about the extent of changes it will bring to the conventional system of flood governance, it has so far been welcomed by experts and the public in general.

The geotube dyke at Matmora

After the Sissi Tekeliphuta flood embankment breached at Baligaon in 1998, it was not properly repaired and, as a result, a 5 km stretch of the embankment was washed out between 1998 and 2008 in the Matmora area in Lakhimpur District. Hundreds of acres of fertile land became a virtual desert under thick deposits of sand, and the environmental and economic conditions of the area and its people were damaged almost beyond repair. Life of tribal communities such as the Misings was thrown out of gear, shattering the social fabric and the cultural milieu (Das et al. 2009). Put under tremendous political pressure and constant public demand the Assam Government changed the Water Resources Minister and initiated work on a retirement embankment joining the breached portions of the earlier dyke using a new technology of geotubes and engaging a Malaysian company called Emaskiara. The company was given the target to complete the work in 100 days after it was inaugurated on 16 February 2009; the company began work on 25 March 2009. However, the laying of the geotubes was completed on only 3.5 km of a total length of 5 km, leaving a wide gap of 1.5 km till the first week of July 2009. As a result, nearly 100,000 people in 90 villages of the Dhokuakhona Subdivision of Lakhimpur District were seriously affected when gushing waters easily breached the incomplete embankment between 29 June and 2 July.

The Assam Chief Minister ordered a high-level inquiry by a high-powered inquiry committee to find out the reason the geofabric embankment was not completed and to detect any malpractice or corruption in the INR 1,000 million

contract awarded to the company. The total budget of the Matmora protection project was INR 1.4 billion. It was found later that the Assam Government had defaulted in paying it a mobilization fund of INR 300 million, and had released only INR 150 million. Low tide in the Kolkata harbour, delays in customs clearance at Kolkata, and holding up of vehicles at the Srirampur interstate check gates by the Assam Government Sales Tax Department also contributed to delays in the completion of the project.

The geotube dyke has assumed all the more importance because the protection of the northern part of the Majuli Island also depends on it. Majuli is a fresh water island in the Brahmaputra located in the Jorhat district, famous for its cultural heritage and biodiversity and World Heritage Site. This is the first geotube-based embankment in India and the second in the world. The work was completed in July 2010. So far there has been no report of erosion or floods in that stretch. Community opinion has been divided on the new dyke. While many are optimistic about it, hoping they will be protected well by the geotube-based structure, others are sceptical and want to wait at least for a full season whether it can withstand the water pressure of the Brahmaputra. Some local people have alleged that the construction work is not satisfactory, especially the inadequate height of the dyke; the side bundhs of the upper and lower parts are poorly constructed, which may result in a breach at any time.

The ADB intervention and the geotube dyke at Matmora have heralded a change in the age-old convention of flood protection practice. Geofabric bags of a different kind are being by WRD used in several other places to arrest erosion on the Jiadhhal River, including Holoudonga, Dihiri Khalihamari and Bhakatgaon.

Local Governance Agencies and their Role in Flood Management

Local governance agencies play important roles in flood management at the local scale. The performance of local governance agencies is also an indicator of the health of the overall governance machinery spanning state and national regimes. It also shows how well-coordinated decentralized governance networks are. Local formal governance is studied here with respect to two prototype agencies, namely, the Panchayati Raj Institutions (PRI) and the Autonomous Councils (AC) of the study areas of Assam.

Role of the Panchayats in local flood management

The Panchayati Raj Institutions formed under the dictates of the Constitution of India represent the lowest strata of democratic local self-governance in rural areas in India. Although the Panchayat system existed in many states of the country in various forms, a country-wide uniform system was introduced by the Constitution Act (73rd Amendment), 1992 which came into force with effect from 24 April 1993. It introduced a three-tier system consisting of Panchayats at the village, intermediate, and district levels requiring direct election of members from the territorial constituencies in the Panchayat area. It ensured reservation of socioeconomically weaker sections as well as one-third of the seats for women in both general and reserved categories and similar reservations for for chairpersonship of the Panchayat bodies. The Assam Panchayat Act, 1994, which incorporated the provisions of the 73rd Amendment Act, 1992 of the Constitution of India, introduced a three-tier Panchayati Raj system consisting of the Gaon Panchayat (GP, equivalent to the Gram Panchayat in other states of India) at the village level, the Anchalik Panchayat (AP) at the intermediate or development block level, and the Zilla Parishad (ZP) at the district level (Ghosh 2008).

Although there is no direct reference to any activity for flood mitigation or construction of structures for flood protection, these agencies have been given power to take up some other activities wherein such flood-related tasks can be included within their respective jurisdictions. For example the Gaon Panchayat can include construction of structures such as canals, sluices, embankments and maintenance

Use of geofabric bags to prevent erosion of the embankment on the Jiadhhal River



of the same in the annual development plan that they are required to prepare for their area of jurisdiction. It has to mobilize relief in case of flood calamities and construct and maintain village roads that can qualify for small road-cum-embankments. The same is the case for the Anchalik Panchayats with the added advantage that the state government can assign any work related to rural development to it under an existing scheme. This can include flood protection work. In addition, the APs can implement irrigation work and construction and maintenance of rural roads, public ferries, and water ways thus providing them a scope for inclusion of flood protection work. Similarly the Zilla Parishad can construct and maintain roads; reclaim and develop land; and construct, renovate, and maintain minor irrigation work all of which provide opportunities for including flood protection work.

Although Panchayats have been given substantial power, responsibilities, and resources to ensure good rural governance, the PRIs have not performed to their potential mainly because of lack of awareness about the responsibility and power of the system among the villagers and even among the Panchayat members while political interference by state governments also significantly affects their functioning. Even then the system has done well in some cases in respect of flood management. The Dhemaji Zilla Parishad took the initiative to strengthen the embankment on the left bank of Kumatiya River in 2009. This dyke was originally built by the WRD but it was not properly maintained. The same agency carried out reinforcement of the embankment on Jiadhhal near Dihiri village in Jiadhhal Panchayat and the dyke on Na-nadi at Bhebeli Panchayat. It also implemented a project on channel cutting on the Singijan River to stop flooding from this small but powerful stream in the Bordoloni Panchayat areas. According to D Gogoi, member of the Demaji Zilla Parishad, all of these activities are carried out under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA).

Further the Dhemaji Zilla Parishad also provided funds for repairing the rain cuts in the right bank embankment of the Jiadhhal for a stretch of 3.5 km under MGNREGA according to SK Bora, Junior Engineer in an interview in May 2009. The Bishnupur Panchayat helped in building six boulder-spurs under MGNREGA in the year 2009 in the left bank of Jiadhhal. According to villagers in Kekuri during a focus group discussion, the flood-affected families of Kekuri village received financial aid in 2009 for rehabilitation from the Revenue and Disaster Management Department at the initiative of the Jiadhhal Panchayat.

On the other hand PRIs have performed poorly in representing people's concerns to state authorities due to dominance of vested interests and poor coordination with relevant state agencies. PRI agencies are seldom consulted by WRD and other agencies in matters related to embankments except in situations where disputes over land or other issues are involved. Villagers from Kekuri feel that ward members of Gaon Panchayats are discouraged to raise questions and complaints about embankments or land acquisition since Gaon Panchayats are not mandated to execute technical projects such as embankments. Similarly representatives of the Gaon Panchayat to the Anchalik Panchayat are also discouraged to argue against decisions of the state government imposing embankments. The lobby of government officials and contractors is strong enough to influence village representatives not to raise complaints over quality of construction or maintenance of embankments in Panchayat meetings.

According to the Assam Panchayat Act, 1994, the main functions of the PRIs are chosen from bureaucrats (appointed or deputed) serving the state government at high positions. The block development officer is often appointed as the executive officer (who is also the ex-officio secretary) of the Anchalik Panchayat. The chief executive officer of the Zilla Parishad (who is also the ex-officio secretary) is a bureaucrat not below the rank of an additional deputy commissioner appointed by the state government. Moreover the chief accounts officer and the chief planning officer, the other two key posts of the Zilla Parishad are also held by appointees of the governments. Although such arrangements are made in principle to ensure coordination of the Panchayats with the state government through the district administration, it also paves the way for the bureaucrats and the government to exert political influence on the PRIs. More important, the Panchayats depend overwhelmingly on funds from the state government to carry out their activities. With its annual budget 'becoming effective only if approved by the state government, the Zilla Parishad's functions are likely to be controlled at every step by the authorities in the state capital and the arrangement is far from the ideal of democratic decentralization', observes Bhattacharjee and Nayak (2001). The presence of the local member of parliament and the local member of legislative assembly as

members of both the Anchalik Panchayat and the Zilla Parishad also creates space for incursive political interest to creep into the system.

Political considerations play a major role in influencing the distribution of funds and schemes to different areas. The interests of the party having majority in the three levels of Panchayats or the ruling party of the state are given more importance than others while allocating development funds and projects. According to Deba Gogoi, a member of the Dhemaji Zilla Parishad, it can be difficult for representatives to get enough money and schemes approved for their respective areas because of an affiliation to the opposition party.

Role of Autonomous Councils in local flood management

Autonomous Councils (AC) have been created by the state government in Assam to ensure welfare and development of some tribal communities under self rule in areas that do not qualify under the Sixth Schedule of the Indian Constitution. In this study we examine the role of the ACs in flood management taking the Mising Autonomous Council (MAC) since the Misings are the largest tribal community in Lakhimpur and Dhemaji districts and most of our study areas come under the jurisdiction of the MAC. The MAC was established in 1995 under the Mising Autonomous Council Act, 1995 passed in the Assam State Assembly with the objective of social, economic, educational, ethnic, and cultural advancement of the people residing within its area of jurisdiction consisting of core areas (compact and contiguous areas inhabited by the Mising population) and satellite areas (areas of a non-contiguous clusters of villages inhabited by the Mising population) spreading over eight districts of Assam (MAC 1995).

Unlike the PRIs, the MAC has been given specific responsibility to implement 'flood control schemes for protection of villages (not of highly technical nature)' (MAC 1995; Chapter III, Section 18) along with minor irrigation, land, and land development and roads. However, this local council has not been able to fulfil its mandate in general and ensure people's security from floods and other water hazards in particular. While lack of efficiency and financial irregularity on the part of the council are considered a main cause for its failure to perform, there are administrative bottlenecks on the part of the state government that are also responsible for the failure of the council. Elections have never been held for this council since its inception reducing it to the status of an ad-hoc body run by interim committees appointed by the state government. The last ad-hoc body that was appointed in 2006 to run the council had the support of leading social and political organizations of the Mising community; however, it was suspended by the government on charges of financial misrule in 2009. Presently it is being run by the state government through its official appointees. But the council continues to be perpetrating malpractices, turning itself into a system that has stopped delivering goods to the people. The MAC did not get audited nor was it given any administrative and financial guidelines for implementing its activities until 2006, ten years after its inception. Not surprisingly, people belonging to both Mising and other communities have strong resentment over the credentials of the administrators of the council and their failure to deliver good governance whether it is for socioeconomic development or for flood protection. They have demanded reconstitutions of the MAC with democratically elected people's representatives.

Although lack of performance and corruption are surely the main reason of the non-performance of these autonomous councils, the existing administrative mechanism of these councils are also responsible for making these local governance agencies ineffective. According to P Chayengiya, former Chief Executive Councillor of the MAC during 2006-2009, the MAC has failed to meet the aspirations of the local communities because the council has never been given adequate autonomy, power, and financial resources. The interim committees have to work under tight bureaucratic control of the Welfare of Plains Tribe and Backward Classes Department and officials make it difficult for the committee to get financial resources in time, compelling them to resort to unfair means such as bribing higher officials in the state government to get funds.

While the entire MAC area is critically flood-affected with flood protection works like embankments in bad shape, the MAC has not been given power to execute schemes of the right size and nature that will be effective in protecting people from flood and erosion. Under the present Act, it can take up only small schemes of non-technical nature for flood protection. Many people in these areas think that once they have people's representatives in the MAC, responsibilities of flood management at the local level, including the functions of the WRD, should

be entrusted to the MAC. They believe that when the people who themselves are flood-affected run the MAC, they will be in a position to understand the problem and do better to reduce people's flood risk than WRD engineers. For example, the MAC, in one of its few effective interventions, successfully resisted river erosion in the Bahir Jonai Panchayat of Dhemaji District by using bamboo based on traditional knowledge and spending a small amount of money whereas the WRD failed to control erosion there for years even after spending much larger amount of money using RCC porcupines. P Chayengia, former Chief Executive Councilor, MAC, 2006-2009, argues that government agencies often work in isolation from the local communities and do not recognize the indigenous wisdom about rivers and water, but councils, if run by local representatives, might fare better in flood management if adequate powers and resources are provided to them.

The WRD, the nodal department of flood governance, the Revenue and Disaster Management Department, and other local agencies such as PRIs are not properly linked and coordinated with autonomous councils or among one another. The demarcation of responsibilities and geographical areas of jurisdiction are also not clear. While creating the MAC, it was not sorted out how it will coordinate and interact with other agencies or line departments engaged in similar work of rural development or flood protection. As a result, one sees several agencies such as the PRIs, the District Rural Development Agency, and the Integrated Tribal Development Project, doing the same kind of work under different schemes resulting in wastage of scarce funds. Lack of coordination is a result of lack of transparency and trust among these agencies.

In the present arrangement the Welfare of Plains Tribe and Backward Classes Department receives the funds from the central government and distributes the same to the councils according to the size population under each council. With control of funds, the state government has the ability to exert control over and interfere in the business of the councils. There are allegations that funds are released in proportion to kick-backs received. Funds are released to the MAC towards the end of the financial year (April–March), and that too in instalments compelling the council to spend the amount hurriedly and even resorting to false utilization certificates to get the next instalment within the same financial year. The result is that the flood protection projects are completed in a hurry, compromising the quality and standard of construction and maintenance. Construction and repairing of embankments or roads that should be complete before the advent of the rainy season (April to October) are often spoilt by rains and floods since commencement of work coincides with the advent of the rainy season. This inconvenient funding cycle is partly to blame for the failure of the flood mitigation infrastructure whether executed by the MAC and other councils.

Lack of Influence of Traditional Institutions in Flood Governance

There used to be an influential traditional institution of the Misings called 'kebang' or village council that worked as an administrative as well as social decision-making platform for the villagers in all matters of collective concern for the village. This included decisions related to shifting of households in a village or the village itself to new locations in the aftermath of flood or because of changing courses of the rivers, or about how to do agriculture in a better way so as to make up for the loss from floods. However, there is no information about any instance of village kebangs coming to conflicts with the government's flood protection projects. The benefits accruing from the flood protection structures in the initial years in 1960s and 70s after embankments started getting built on a large scale earned people's faith and support to a large extent. According to local opinion, the kebang system became weak after the 1970s owing to a number of reasons such as penetration of modern education in the villages, growing familiarity about judicial systems and gradual weakening of traditions and customs.

Degeneration of the kebang as a traditional institution became accelerated in the 1980s as the self-sustained village economy and livelihoods became fallible because of increasing flood hazards in many riparian areas where the Mising community live. The kebang has lost its vibrancy and relevance and almost become a defunct institution. It is no longer an effective traditional institution governing social affairs of the community. They exist only for the namesake symbolized in some villages by the 'Murong Ghar', the community house where villagers customarily gather to discuss about various issues of importance to the village under the leadership of the 'Gam' or village headman. In the villages of Khamon Birina and Opar Khamon in the Matmora area, the Murong Ghar is

a derelict identity bearing the brunt of annual flood devastation, symbolizing a vanishing institution. In many cases the activity of the erstwhile kebang is being replaced by village development councils formed to work for all-around development of the villages at the initiative of the Takam Mising Porin kebang and the MAC. Local traditional institutions are on the wane, losing ground and influence on the community. They have very little role to play in this process of interacting with state-level decision making regarding flood governance.

Community Response to Formal Flood Governance

There is widespread discontent, dissatisfaction and disillusionment among the people about the government's failure to provide them with effective protection from flood. They are disgruntled because the state agencies don't take into account their opinion in building flood mitigation structures. Community's grievances and demands are being expressed as organized campaigns protesting against the faulty flood management regime, often leading to conflict situations. This has particularly been prominent in the Jiadhah catchment in Dhemaji District since the early 1980s. Misuse of money in embankment construction is also an issue that the community is unhappy about. A group of people went to register its protest in the office of the circle officer of Dhemaji against corrupt practices and demanding implementation of what the people wanted in the month of June 1989; according to a memorandum submitted by a group of 76 signatories to the Sub Divisional Officer of Dhemaji on 10 June 1989, they were mercilessly beaten up by the police at the instigation of the contractor lobby who were benefitting from the work being done for the embankment.

Popular protests became organized under the United Platform for Resisting Floods of Jiadhah River, which is leading a local movement demanding a permanent solution to the flood and erosion problem of the Jiadhah area through properly implemented structural measures. This umbrella organization is a platform of villagers from eight different Panchayats affected by floods and erosion from the Jiadhah River. It has resorted to non-violent and peaceful programmes such as submission of memorandums, awareness meetings, and rallies. It is demanding durable structures (embankments and anti-erosion measures) from the foothills to about 30 km downstream of the river's Kumatiya channel as a long-term solution. As a short-term measure it recommends renovation of the Jiadhah extension embankment with boulder pitching. In 2010, the organization submitted a memorandum to WRD officials of Dhemaji Division local MLA, and Chief Minister of Assam requesting the lengthening and heightening of the railway and road bridges on the Kumatiya channel so that the volume of the river increases and water can easily pass through the channel without exerting much pressure on the guide bundh and the right bank embankment.

Led by this organization people are still resisting the WRD's plan to realign an old embankment by shifting the embankment by a kilometre into the countryside. They are of the opinion that a number of villages will be left outside the structure exposed to floods and the scheme will not be of any consequence for dealing with the flood problem. An intervention of the local member of the legislative assembly (belonging to the ruling party) favouring the government's decision was recently thwarted by the people leading to a stalemate in the resolution of the problem. Apart from pointing out the shortcomings of the official plan of the projects, the people have prepared alternative plans of structural measures indicating suitable locations and proper designs. Despite their plans being submitted to the authorities several times, the community demands have not been given official credence. In 2007 the local officials didn't pay attention to suggestions from the community about the site of construction of a flood wall and a coffer dam in 2007. The structures, located in unsuitable places, failed during the very next flood.

Although it is important to recognize community's knowledge in official flood protection work flood mitigation plans must be careful about implementing technical schemes wholly based on community recommendations, especially in the case of an unstable and dynamic river such as the Jiadhah. According to DK Deka, former Secretary of Water Resources, 'technical interventions should be enriched with indigenous wisdom, but their implementation should be left only to water resource engineers'. The dominant opinion in the Jiadhah area is that the river can and should be constrained to flow in a single channel by proper river training and this should be the approach to manage the river. This is not different from the engineers' view of river management. But such a notion cannot be endorsed and promoted without careful study of the geomorphology and hydrology of the river and its catchment. Conflicting interests of communities living on either side must also be considered, as these differences may lead to

serious conflicts in the future. In focus group discussions villagers from the left bank expressed the desire to push the embankment towards the right bank so that the river flows in a narrow channel of the Kumatiya, the right bank people want the left bank embankment to go further away from the bank (as the WRD wants) upstream so that the river can flow in a wider channel and their bank (on the left) remains safe.

Community action is not limited to movement and resistance only. There are numerous occasions in which the villagers repaired degraded parts of embankments and plugged breaches on their own without waiting for the government to act. Villagers helping the government workforce in plugging breaches or strengthening riverbanks during floods are a common sight in Jiadhal, Matmora, and Majuli. In 1994–95 the people of Samarajan Panchayat began a decade-long effort to cut out channels on the riverbed in a bid to divert the flow of water to the old course of Jiadhal River. According to results of a focus group discussion in Tekjuri Boro Gaon in Samarajan Panchayat in April 2010, this action delivered results, although temporarily, pushing water towards the Kumatiya channel and helping to reduce flood havoc on the left bank until 1997. During the rainy season when the possibility of floods increase because of heavy and continuous rains, the people in villages located on the on the right bank of Jiadhal like Holoudonga, Bokulbari, Maisa, Chaporigaon, Nagaon, Mongaloti, Podumoni, Kakoihal, and Dihiri Khalihamari organize vigils on the embankment around the clock. Groups are formed to keep watch on vulnerable parts of the embankment so that the eroded sections can be plugged instantaneously and the villagers can be warned when the water level rises alarmingly or flood water starts entering the countryside. Mobile phones play a very important role in informing people about the state of the river and embankment. This is also true in case of Matmora and Majuli.

People have also been protesting against the land acquisition practice of the government. Most of the villages lying on both the banks of Jiadhal are non-revenue villages, since new villages have been created by people displaced by flood and erosion from various parts of the district and outside. Taking advantage of this fact, the WRD considers the land of the village as government and hence does not pay any compensation. Even in revenue villages, residents most often do not get adequate compensation for the land they have lost to the embankments. Many of them have not received any compensation at all.

Civil Society Intervention

Flood and erosion are important issues having important social, political, and environmental dimensions. Therefore, in addition to communities many other social and students organizations have engaged themselves pursuing different paths but with the common goal of securing protection and justice for affected people. The Asom Jatiyatabadi Yuba Chatra Parishad, a student and youth organization, is strongly raising its voice demanding urgent and fruitful steps to control flood and loss of land from bank erosion in the district of Dhemaji through organizing meetings, street protests with slogans, mass gatherings, obstructing NH-52 (a major highway), and sit-in strikes. They have asked the state government to ensure completion of flood protection work between November and March and rebuilding of all those embankments that have completed their lifetime (older than 30 years) preceded by inspection and scientific assessment of the structures. Apart from engaging with the government, they also approached the leader of the opposition of the Assam Assembly requesting him to raise these issues in the House, but have not been met with an encouraging response. They, accompanied by local press inspected the embankments of the Jiadhal, Gai, and Siang rivers in different parts of Dhemaji District on their own, identified the most vulnerable ones and asked district authorities to take appropriate action. They persuaded the local administration to extend an embankment on the Gai River for a kilometre under an NREGA scheme, but since the work could not be completed before floods, the new portions were washed away in the floods of 2009 wasting all the money invested according to Ratul Borgohain, General Secretary of Dhemaji District Unit of the Asom Jatiyatabadi Yuba Chatra Parishad in an interview on 5 May 2010. Similarly the All Assam Students' Union is taking a proactive role in monitoring anti-erosion work in Majuli by taking steps to video record of the execution of the work by contractors. The local communities have frequently voiced their concerns over the problems of floods, riverbank erosion, and rehabilitation of flood-affected people and have demanded appropriate flood protection measures. According to BR Pamegam, former president of Bane kebang, the Bane kebang in a meeting in

Silapathar (Dhemaji) on 30 August 2009 made a public appeal to the government that the responsibility of making embankments should be immediately handed over from the WRD to the railway authorities because the railway tracks and the levees are far more durable than the flood embankments in the state and people believed that the railway engineers will do a far better job than WRD engineers. The Takam Mising Porin kebang keeps close watch on the construction work of the geofabric dyke in the Matmora area. Other organizations that have organized people on the flood issue are the Sonowal Kachari Students' Union, the Krishak Mukti Sangram Samiti, and the All Assam Water Resource Contractors' Association.

Flood Governance in the Koshi Basin

Taming the Koshi: History of the flood control debate

The debate whether the Koshi and other rivers should be embanked or not is more than century old. It started as early as in the 1870s when the first official plan to put embankments on the river was mooted after the devastating floods of 1869 and 1870 (Hunter 1877). The debate went with contrasting observations and comments of a host of experts, administrators, engineers and planners both during the British era and in independent India. The British tried to build embankments on the Koshi right after it had signed the Sugauli Pact with Nepal in 1891, a plan that could not be implemented. WA English, Chief Engineer of Bengal Province, opined that the river should be left to its own devices; Shillingford (1895) emphasized the swinging nature of the river's course while Charles Elliot (1895) favoured embankments because advantages resulting from embankments are immediate and obvious.

The Calcutta Flood Conference convened in 1897 to discuss the Koshi flood problem and its solution concluded that 'no steps are feasible for controlling the course of this tremendous river with its numerous channels and their wide and elevated beds' and that 'only short lengths of embankments could be built to protect isolated tracts exposed to floods'. As a result many embankments, built by local authorities and indigo planters sprang up in the area which, however, could not contain the river. The Orissa Flood Committee 1927 report encouraged the government to remove embankments from the Orissa delta. The debate on flood control was discussed in detail in the Patna Flood Conference 1937 where the majority of the participants argued against adopting embankments as a policy for flood control. It was in the same occasion that a storage dam was proposed on the Koshi in Nepal for flood moderation. During 1937 to 1938, the newly elected state Government of Bihar conducted a study to ascertain whether different channels of the Koshi could be trained with the obvious motive of building embankments. The study recommended that river training of the Koshi should be attempted.

The report of PC Ghosh who studied the rivers of Bihar extensively being engaged by the government opposed embankments and favoured the principle of distributing floods over as large an area as possible (Ghosh 1942, cited in Mishra 2008b). In 1945 the plan to tame Koshi got a boost when the possibility of freedom of the country came into sight. A plan by the state government to embank Koshi by confining it to a definite channel was rejected by the central government; instead he plan to build the flood control dam at Barahkshetra was approved. A detailed plan of this dam project was discussed and promoted as a better scheme than embankments in a conference of Koshi sufferers held in Nirmali in 1947. In 1951 a five member committee was formed under the chairmanship of SC Mazumdar, Advisor Engineer of Government of West Bengal, to give its opinion on the Barahkshetra dam project. The committee recommended dropping the project on the logic that a huge amount of power would remain unutilized and large capital will be invested unproductively with flood control benefits coming quite late in the project plan.

However the Mazumdar Committee introduced an alternative multipurpose proposal of an earthen dam in the Belka hills consisting of water and silt storage, hydropower generation, irrigation, and a 56 km long embankment. It was opposed by the people on the grounds that if flood and silt are controlled there is no need for the embankments. The government finally declared the Koshi Plan (also known as the Koshi Project), 1953 with three components: a barrage on the river, flood embankment on both sides of the river, and an eastern main canal system. Many people opposed the Koshi Project both on the technical questions of the efficacy of embankments in containing the Koshi, questions that have remained relevant. The people of more than 300 villages which

were going to be entrapped between the embankments were also opposed to the project. Politicians and state leaders made every attempt to convince the people and promised them many things to solve their problems. The embankments were almost complete 1959 and the barrage was made in 1963.

The Koshi Project resulted in the construction of a 125 km long embankments along the eastern bank of the Koshi from Birpur to Kopadia and a 126 km long embankment on the western bank from Bhardah in Nepal to Ghongerpur in Saharsa in Bihar with a design to withstand a discharge of 950,000 cusecs to protect 214,000 ha of land from floods. Additionally a 34 km embankment was built on the eastern side in Nepal part together with a 12 km long afflux on the west bank. Later a barrage was constructed in 1963 near Birpur on the river to regulate the river and provide irrigation to 712,000 ha of land through the eastern Koshi canal. The western Koshi canal was supposed to serve another 325,000 ha of cropped land on the western side of the river.

Floods and their impact in the Koshi Basin

The mayhem of floods and the associated death and destruction by the Koshi River for many years ultimately compelled the Bihar Government to approve the Koshi Project in 1953 and complete it in 1959. But the Koshi Project has failed to deliver the benefits it promised. It has irrigated far less an area than it was planned for. It has produced hydropower from the canals much below its designed capacity because of the high sediment content. In spite of the flood control measure Bihar's flood-prone area has increased from 2.5 million hectares in 1952 to 6.9 million hectares in 1994 (BSIC 1994b, cited in Mishra 2008b). The Koshi embankments have breached eight times since they were built: three times in Nepal and five times in India. Among these, the breaches in 1984 and 2008 caused the greatest havoc. In the floods of 1987, embankments were breached at 104 places in Bihar. The breach in the Navhatta block of Saharsa District in 1984 caused a catastrophic flood that uprooted half a million people and engulfed 96 villages in Saharsa and Supaul districts. The biggest flood in recent history occurred in 2008 when the eastern afflux embankment breached at Kusaha on August 18. It affected 16 districts, 98 blocks, 1,704 villages and 3.5 million people in Bihar and 50,000 people in Nepal (Dixit 2009). Fifty-six persons died, 10,9000 hectares of crop were damaged, and 283,797 houses were damaged.

Impact of embankment

Besides flooding there are other serious problems that are caused by embankments in the Koshi basin in Bihar such as water logging, sand casting, scarcity of drinking water, social conflicts, and water and vector borne diseases. The Koshi basin has remained historically prone to health hazards. Even prior to embanking of the river nearly 783,000 deaths occurred from diseases such as malaria, black fever, cholera, and small pox. Vast areas of land have become unusable as a result of deposition of sand and drainage congestion with water round the year. Since agriculture is the main livelihood, a large number of families is impoverished. Embankments have divided people into two worlds inside and outside. Those living inside embankments are exposed to floods every year and the inside areas are the most isolated and underdeveloped with people living a very hard life fighting every moment with floods, erosion, health hazards, and poverty. Life within the embankments is highly challenging, full of struggle for survival and subsistence and is socially unstable. About 380 villages are trapped between the two embankments of the Koshi where around a million people are subject to its onslaughts every year (Mishra 2008b).

Areas outside the dykes are relatively more developed, have better civic amenities and options of livelihoods because they are protected from floods. But this sense of security is temporary. They live in panic day and night fearing beaches and floods. Further, they suffer from water logging caused by obstruction of inflows to the river as well as water seeping out of the embankments from the river (seepage flow). Year-round water logging makes soil unfit for agriculture thus seriously affecting livelihoods. Water logging turns land into a stagnating pool and a landlord into a water lord; turns a farmer into a labourer and a labourer to a destitute, and edges him out to look for employment elsewhere, says DK Mishra (2002) pointing at the root cause of large scale migration of youth as well as children from Bihar to states such as Punjab, Uttar Pradesh, and Mumbai, in search of employment. Further embankments have created conflicts between people living in both sides. Often people staying inside are seen cutting embankments to save themselves from rising water whereas people belonging to the outer side of the embankments patrol embankments to stop such incidents.

Governance of flood management: Institutional mechanism and performance

Flood management in Bihar is run by a powerful hierarchy of technocrats and bureaucrats. The state governance mechanism is more or less similar to other states with a Water Resources Department calling the shots in matters related to flood management such as construction and maintenance of embankments and other structural measures. The Disaster Management Department's job is to help people prepare for floods and provide them relief and rehabilitation once they are affected by floods. The Koshi Project has a full-fledged set-up for operating the barrage and monitoring and maintaining the embankments and the canals. Flood management in the Koshi basin is run through coordination and cooperation of several agencies such as the Koshi Project Authority (stationed at Birpur at the barrage), the WRD at Patna and the Nepal Government. Bottleneck in communication at any node of this hierarchical structure may affect decision making and implementation, especially regarding maintenance work which may ultimately create situations where disasters cannot be avoided. Shrestha et al. (2010) have done an institutional analysis of the Koshi Project and the intergovernmental communication system and have found the channels and process of communication to be lengthy, indirect, complex, slow and ineffective. They found bureaucratic hierarchy and transboundary sensitivities to be the two main factors affecting communication within the institutional network.

An important dimension of flood management in the Koshi basin is the mechanism of Indo-Nepal cooperation under the Koshi Treaty signed between India and Nepal in 1954 and revised in 1966. According to the Koshi Treaty the responsibility of maintaining the project and its appurtenance rests with India. In other words, it is the Government of Bihar who is liable for all maintenance of embankments up to 32 km upstream of the barrage. The Nepal Government has no direct role in managing the Koshi Project and related infrastructure, except to facilitate the project's activities through administrative channels whenever needed. The Treaty has not ensured a regular maintenance framework for the Koshi Project authority. A shortcoming in the treaty is that it does not involve the Nepal Government in the operation and management of the Koshi project. There is a Koshi Coordination Committee which is a forum of six members three from each country created by the Koshi Agreement to discuss problems of common interest. The committee is mandated to meet as and when necessary either at Kathmandu or at Birpur at the barrage site or at any other place. But according to informed people, the committee does not meet regularly leading to a lack of communication and understanding, and often these meetings are not effective in raising important issues where collaboration is needed. Therefore, the communication gap between the two governments and their institutions has increased with time

Although the Koshi Treaty is signed between the governments of India and Nepal, full authority of running the Koshi Project lies with WRD of the state Government of Bihar. The Bihar government has an upper hand in the flood and irrigation management of the Koshi since water is a state matter according to the Indian Constitution. There is no direct channel of communication between WRD or the state Government of Bihar with the Nepal government and vice versa. Even in urgent situations, the first communications take place between the national government level (Kathmandu and New Delhi) before being referred to the state of Bihar. This is an obstacle on the way to making quick decisions in case of flood emergencies.

In the system, the local governance agencies such as the district administration have no place in the institutional set-up although the local administration represented by the Chief District Officer plays a key role in managing local law and order situations and could have been of great help in the Koshi Project area had there been a provision. Similarly there is no opportunity for the participation of local people in the flood management process. The common public does not have access to information about the subjects of discussion or decisions taken in the meetings of the Coordination Committee of the Koshi Project under the Koshi Treaty of 1954. This committee is responsible for resolving all important issues between the two countries that may affect the running of the project. However information is not always communicated to the civil society either by the barrage authority or Nepal government in this regard. Neither the Koshi management nor the Nepalese government interacts with the local communities on the Nepal side seeking opinion about flood management practices, nor are there any opportunity for the communities to take action on matters related to maintenance of embankments.

The Koshi authority and the other government agencies were already known for their negligence of monitoring and maintenance of the embankments as is evident from the fact that the Koshi has produced devastating floods because of breaching of embankments. The prevailing engineering and technical practices do not mandate regular maintenance, nor are relevant procedures and guidelines drawn (Dixit 2009) for such maintenance work. Similarly the desiltation of the beds of the canals is also not done properly thus blocking water flow that hampers irrigation. All maintenance work on the Koshi should be completed by April before snowmelt raises the discharge and water level downstream in the plains. Mending of the structures, on the contrary, is started in the rainy season. Moreover, villagers in Joginia, Saptari District, Nepal claim that corruption is also a reason of low quality of maintenance work.

We can have a good understanding of how the governance system works or does not work in the context of the Kusaha breach of 2008. Most experts attribute the Kusaha failure largely to dysfunction of institutions, lack of good governance, and absence of accountability (Dixit 2009; Shrestha et al. 2010). The same holds true for all Koshi disasters since the Koshi Project started. The collapse of a part of the eastern afflux bundh at Kusaha has been blamed on several factors. In principle the responsibility for this fiasco should be entirely borne by the Koshi Project Authority and the WRD of Government of Bihar. But agencies traded charges against one another. They also blamed external factors such as local people near the eastern afflux embankment who were on strike seeking employment in the project work and therefore did not allow engineers and contractors to work; the bad law and order situation under strikes called by political extremist groups; and the Nepal Army who stopped work on the embankment (Mishra 2008a, Shrestha et al. 2010). Rajeshwar Dayal, Chief Engineer of the Koshi Project, said that because of attacks by certain groups, repairs had to be stopped. The fact remains that the weakening of the Kusaha spot became evident at least two weeks before the breach when the two spurs installed to protect the embankments were slowly giving in to the current (Mishra 2008a). At least two full days were available for repair after the local disturbances were over. The breach was clearly a result of negligence. The catastrophe caught the governments and its disaster management agencies in both countries completely unaware and unprepared.

Monitoring the work carried out by the Koshi Project Authority is to be done by the Koshi High Level Committee (KHLC) under the chairmanship of the Ganga Flood Control Commission (GFCC), which has two members from Nepal. However there was no communication between the Indian members of the KHLC and their Nepali counterparts after the monsoon season of 2007. The KHLC remained inactive until the monsoon of 2008. As a result no joint monitoring was undertaken. Moreover, a group of Indian officers inspected the embankment without informing the Nepali partners. The Indians did not detect any problem on the embankment and the Nepalis also did not care to ascertain whether monitoring was done on their part or not (Shrestha et al. 2010). The WRD of Bihar didn't respond to the GFCC's repeated query about the status of protection work taken on the embankments. This is a glaring example of communication bottlenecks between the two countries that prevented established institutions from performing their assigned jobs.

Flood management in the context of climate change in the Brahmaputra and the Koshi basins

Both the Brahmaputra and the Koshi basins are considered extremely prone to the impacts of climate change. Gosain et al. (2010) has observed a significant increase in water yield and surface runoff in both the basins, much higher in the wet season than in the dry months, as a result of climate change in the eastern Himalayas. Increases as high as 20 to 40 per cent from the baseline may be attributed to both increases in precipitation as well as in snowmelt and may lead to increased flood frequency and magnitude. Under the same climate change scenario, the Brahmaputra basin is likely to produce 25 to 40 per cent more sediment.

In case of the Brahmaputra, melting of glaciers could lead to increased dry season runoff in the short term, while in the long term there could be a decline of dry season river runoff from glaciers (Cruz et al. 2007). According to Immerzeel et al (2010), there will be an initial increase in flow in the Brahmaputra basin due to accelerated glacial melt till about the fourth decade of this century and an increase in the mean rainfall over the upstream of Brahmaputra basin of about 25 per cent. A very strong increase in peak flows is projected during 1961-2100 (Gain et al. 2011).

Design and construction of the embankments carried out several decades ago didn't factor in the climate change impacts to which these rivers are now exposed. Extreme rainfall events in the upstream hilly areas may lead to overtopping and breach of embankments resulting in flash floods since the embankments may not be able to contain sudden rises in flood water level. Moreover, accelerated soil erosion resulting from increased landslides in the hills (a result of extreme rainfall) and recession of glaciers are likely to enhance the sediment load in these rivers. Deposition of excessive sediment on the riverbed will raise the riverbed, decreasing carrying capacity and resulting in overtopping of banks during the rainy season producing flooding more frequently. Thus the present observations on climate change have indicated more flooding and possible failure of embankments in the short-term period unless the embankments are strongly built and properly maintained. As a result traditional coping and adaptation practices may become less effective because of people's inability to deal with the uncertainties in rains and floods.

The flood management discourse and debate: Contemporary perspectives

The debate over the government's approach to flood control based on embankments is still going on among the civil society, decision makers, environmentalists, technical experts, and even the masses. The debate and discourse over embankments is highly developed in Bihar compared to many other parts of India. The majority of people including experts, activists and the public hold the notion that controlling rivers by structures such as barrages and embankments is largely responsible for the annual floods and associated disasters. Referring to the breach of 2008, Ajaya Dixit says that attempts to contain Koshi's floods are an inappropriate technological choice (Dixit 2009). As a result of the false sense of security promoted by hierarchically organized state agencies through structures such as embankments has helped in externalising the local resilience practices, rendering people highly vulnerable to floods when they occur, says Dixit. The notion of controlling the Koshi river with the help of structural measures has been challenged by many others. DK Mishra is a leading figure who has vehemently criticized the current flood control practices in Koshi basin.

While the flood control debate in the Koshi basin is about two centuries old, its legacy has continued in India. In Bihar, the level of awareness is very high and the people in flood-affected areas are also conscious about the pros and cons of this issue. In Nepal civil society actions in this line are limited to a circle of intellectuals that have criticized the governments for continuing with faulty flood control practices. The level of sensitization of the people is relatively low. It became a priority issue for NGOs only recently. People's activism such as organized protests and campaigns has remained low. It is not difficult to understand why this important issue, has taken so long to become the main agenda of a public movement. Nepal's internal political instability that prevailed for about two decades created a situation where it was difficult to organize democratic movements.

With little progress in improving the institutional coordination between the two countries, the suffering populace can only look to the role of civil society for ensuring security on both sides of the border. There are a number of community organizations and NGOs that have been relentlessly campaigning, demanding change in approach to flood control and for securing the rights of the flood victims. Notable among them in Bihar are the Barh Mukti Abhiyan (Freedom from floods campaign), Gramyasheel, Koshi Sewa Sadan, Megh Paine Abhiyan (Bihar, India) and the Koshi Victim Society (Nepal). H Singh, a lawyer and activist of Raj Biraj, Nepal emphasises the need for cooperation and coordination between civil society groups in both countries to find out and advocate for a mutually agreeable flood management paradigm for the common good of the two countries (Interview with Himmat Singh, Lawyer, at Raj Biraj, Nepal on 5 July 2010).

Conclusions and Discussion

Flood and erosion emerged as a big problem for the people as well as the Government in Assam in the aftermath of the 1950 earthquake just after India gained independence in 1947 from British rule. Structural measures, especially embankment popped up as a natural choice for the planners because people needed, and the government was also eager to provide, immediate protection and safety to the people with means that provide immediate and demonstrable results. Lack of financial resources in those initial years of nation building was also

a reason why embankments were preferred over other measures. But embankments were not supposed to be the only solution prescribed to cure the problem of floods as seems to be case today. Short and medium-term measures were to be mixed with long-term protection such as storage reservoirs and other non-structural measures. But other options were not given due prominence in northeast India. The flood management regime consisting mainly of the technocracy and the bureaucracy proved to be monolithic, rigid, and insensitive in subsequent decades. It didn't change much with time. Even six decades after the first flood control policy was adopted in 1954, the same strategies are being perpetuated. Embankments have become the symbolic icon of flood management although its limitations and negative consequences are well known.

Corruption has become a part of the governance regime in almost all sectors. The structural flood control system slowly transformed into a self-propagating cycle of mismanagement and corruption. Indigenous knowledge and opinions of local communities were isolated from the flood management process in a planned manner. Non-structural measures were neither given any importance nor encouraged for a long time. Embankments were promoted as something inevitable and unavoidable in flood-prone areas. Consequently people became so dependent on embankments that the traditional coping practices lost their importance and grew weaker. The inherent weakness of the embankments was fully exposed after massive floods triggered by breaching of embankments devastated many areas in the country as well as in Assam. Yet the official regime has not thoroughly explored solutions other than embankments.

Community opinion about embankments is not as varied or fractured as in the case of the experts. People in flood prone areas are overwhelmingly in favour of embankments that are built and maintained properly. They consider embankments an absolute necessity for their safety and survival. Life without embankment is unthinkable for them. Such a popular view may give an impression that embankments have served them well. That is not the case. They have suffered because of floods caused by embankments failures. They are aware of the limitations of embankments. But ingrained in them is the notion that the regime and governance are responsible for the operational failure of embankments, not the structures. Most hold officials and the contractors responsible for the collapse of embankments. To them embankments, if made and maintained in the right manner, will adequately protect them from floods. But there is a small population who thinks otherwise and holds that life without embankments is not impossible though difficult. They are mostly the elderly persons of the community, usually above 60 years of age, and a few others who are more informative and analytical. The seniors point to the fact that floods were rather beneficial than harmful before the embankments had come in the 1950s and 60s. Floods used to bring fine silt with nutrients and make their land more fertile and after every flood they reaped a greater harvest. People were knowledgeable about nature of rivers and floods. They had developed their own practices to cope with rivers and floods. After the advent of embankments, floods became more furious when they broke out from breaches in embankments. Floods now bring only sand and the land is deposited with piles of sand making agriculture impossible for years to come. After living with embankments so long, people have become too dependent on these structures. They have lost the habits and instincts necessary to cope with floods. The indigenous knowledge is fast vanishing.

Age often determines whether a person is in favour of or is critical of embankments. Younger people think embankments are absolutely necessary whereas the elderly people think life would have been better without these jackets on the river. There is no doubt that people want embankments because they have seen the dykes working effectively against floods, at least on some occasions. But they have not seen any other alternatives when it comes to flood protection. The younger generation has grown up seeing and experiencing only embankments. Affinity to embankments is a result of familiarity. Embankments are a symbol of safety when well built, but a big concern if in bad condition. People would rather cope with embankments than be exposed to rivers.

So great is the influence of the river controlling structures on people's mind that traditional knowledge has slowly given way to utilitarian choices. An alluvial river needs certain space for meandering and braiding. If entrapped by a pair of embankments within a narrow space, it starts silting across the channel and hits the banks, making embankments collapse and letting out destructive floods. People tow the engineers' line and contradict their own traditional knowledge when they want the Jadhah River to be contained in a single narrow channel. Inter-bank conflicts among the communities are slowly beginning to surface. Acting beneath such considerations is the concern

for land. Land has become scarce and precious because much of the land owned by the community has already been either eroded or silted by the river or acquired by the government for making embankments.

Aligning the embankment is more a political issue than technical as mentioned earlier in this report. Those who are relatively more resourceful or politically powerful with a better social network (e.g. supported by powerful Panchayat members or local politicians) and the ability to mould public opinion and influence government's decisions succeed in locating the embankments to ensure they are protected. Those who are marginalized and have no organized voice, suffer by getting alienated into the river side. The villagers of Khamon Birina and Bahir Tekeliphuta in Dhokuakhona resigned to their fate after giving in to the state's will to persist with embankments laid in a certain direction leaving them outside the line of protection. On the other hand the villagers of Jiadhah Panchayat have been successfully fighting all attempts to build an embankment that would expose some villages to flooding and erosion.

Communities play a multidimensional role in the flood governance realm. They monitor embankments for probable breaches during floods, keep a watch of the contractors' work, assess the appropriateness of engineer's designs, keep track of misuse of funds, and voice their protests from an organizational platform. Community activism is not equally distributed all over, but rather a function of how long and how many people are suffering, heterogeneity of demographic composition, education, social stability, economic condition, and exposure to outside world. People in Jiadhah are better organized, proactive, and politically conscious; those in Matmora are more reactive, disorganized and politically expedient, less aware about rights, and socioeconomically more marginalized.

The ADB intervention in improving flood mitigation infrastructure in Assam has found general acceptance because embankments are considered as indispensable and betterment of embankments is a must flood protection everywhere. The resource crunch on the part of the state government has also given credence to external aid from international agencies. Capacity building and much-needed reforms in the institutional mechanism of flood management will hopefully start soon with the effort of the Government of Assam under this initiative. However, the future consequences for the state of the terms of reference and preconditions, if there are any, need to be examined. The geotube-based embankment as a demonstration of application of new technology is a welcome experiment, but its efficacy remains to be seen, and until it is tested, the replication of this highly expensive technology cannot be recommended for other areas.

On its part the WRD needs to change its old ways of functioning. The TAC should open up itself to give space to experts from social sciences and environmental disciplines as well as representatives of stakeholder communities so that project proposals (mostly structural) can incorporate the crucial issues of social and environmental impacts and views of the community at the planning phase. Major projects having a long-term impact on river morphology and hydrology such as river diversion and geotube-based embankments should be subjected to environmental and social impact assessments before approval is given. To make the technical and financial estimates of the schemes selected by the Executive Engineer's office more feasible and technically sound, they could be sent to a research and development cell to be created in the department. The existing planning wing working under a Director of Planning (an officer of the level of a Superintending Engineer) can be reactivated to become such a research and development cell. Schemes that pass through rigorous scrutiny and review may be taken up for approval by the TAC with adequate provision of funds.

It is true that paucity of funds is a major factor that leads to substandard work. At the same time it is also used to justify and camouflage corruption. Making funds available to the department in time is a key to ensure good work from its officers. But at the same time monitoring and evaluation of the work done must be made very strict. Engaging community organizations as monitors can pay good dividends. Approval of projects and release of money should also be linked to the projects being technically sound and community friendly. More transparency and coordination needs to be assured among the PRIs, ACs, WRD and line departments so that projects with multi stakeholder involvements are completed smoothly. In the other side of this bleak picture, there are some committed people both among officials and contractors who perform a commendable job. Some contractors spend money in advance in the interest of the work and wait indefinitely to get paid by the department. Recently an organization of contractors of the WRD appealed to the government to release their bills urgently so that they can do better job of maintenance of flood protection in the coming season.

The process of creating the ACs should be reformed by providing a constitutional base to their formation and making them free of bureaucratic hassle and political interference. Elections should be held for the MAC immediately so that it can be run by democratically elected representatives of the people. A new financing policy should be followed by the central government in which release of funds should be ensured directly to the MAC much early in the financial year so that all important work related to flood protection and development can be planned and executed before the advent of the rainy season. Selected tasks of the WRD, the District Rural Development Agency and the Revenue and Disaster Management departments related to flood management should be delegated to the MAC to give it an opportunity to encourage participation of local communities. To bring in the changes necessary, the MAC Act, 1995 should be further amended to give it more functional powers in flood mitigation and more funds.

Adequate resources and powers should be given to them to take care of flood management locally using all means and methods, technical or non-technical. This should also include measures of disaster risk reduction such as flood preparedness, a judicious mixture of structural and non-structural measures of flood management, and mainstreaming of adaptation practices to development programmes and socioeconomic empowerment to promote traditional coping strategies. Guidelines should be provided to all relevant departments and agencies to ensure coordination and transparency so that the MAC can work independently as well as in coordination with other agencies for flood protection work. The District Development Committee should incorporate the MAC and its views while preparing development plans for the rural areas of the district to be implemented by the PRIs. It is also important to appoint an officer not lower than the rank of a Deputy Commissioner at the post of the Principal Secretary of the MAC so that this important official can deal effectively with Deputy Commissioners of the districts under the jurisdiction of the MAC in coordinating and implementing activities.

At the same time it has to be made more accountable to the people and the state so that corruption can be prevented. The MAC should make sure its services in the field of flood management, relief, rehabilitation, and irrigation are not confined to a particular community. Rivers are a common pool resource and flood and erosion are problems that cut across community and political considerations. Many people have a highly conscious ethnic sense of separation from the MAC. Non Mising people point to the discriminatory role of the council in dealing with flood protection and flood relief in Dhemaji on ethnic grounds. Even the Mising community for whom the council was created is rather aloof from the council having little knowledge about how it functions or what it does.

On a comparative note people are more familiar with Panchayats and have better opinion about PRIs. However even awareness about the Panchayats' powers and functions is not up to the mark. Functioning of the PRIs is plagued with political biases, political affiliation to the ruling party or loyalty to the government being the deciding factor of schemes and funds approved. People's representatives cannot perform at their full potential unless they are aware of the real power they have been given and gather the honest courage to exert that power beyond political and party considerations. The WRD and other related line departments should be decentralized to transfer more responsibility, power, and resources to PRIs to take care of construction and maintenance of flood mitigation infrastructure with participation of local communities in decision making as well as in engagement of workforce. The PRIs will have to embark on such activities in consultation with the concerned departments for technical guidance if needed.

The experience of people and the flood management agencies in the in the Koshi basin offer a lot of learning for people, researchers, and flood managers in Assam. Failure to manage floods effectively remains one of the main factors responsible for poverty and the overall lack human wellbeing and development in both states. The detrimental impacts of embankments are overtly visible in Bihar while similar scenarios are not uncommon in smaller scales in Assam. The embankment debate is not as mature and developed in Assam as it is in Bihar and in some other parts of India. Riparian communities have also different view-points about embankments. But the common thread in the two basins is that the local coping and adaptation strategies that the communities are adopting based on their traditional knowledge and contemporary learning deal with the changing characteristics of rivers and floods. In the absence of any sensitive government programme to support such autonomous adaptation on the part of the people, the success of such local efforts to sustain housing, livelihoods, and society in disaster-prone conditions is limited.

As a result of prolonged debate and varied discourse over flood management practices, new ideas and concepts have found some acceptance in the governance system but it will still take a long time for significant changes to take place in institutions and for policies and practices to shift from the prevailing paradigm of controlling rivers to mitigating flood impacts with adaptive and participatory paradigm. Such a change will require the application of sensible and flexible river engineering along with activities to empower people to cope with floods. Mainstreaming of adaptation in to the development process will be the hallmark of such a regime. Meanwhile we have to live with both embankments and floods. There is no better way than to strengthen the existing network of structures so that they perform better and the investment already made in them remains useful. Utmost care must be taken before implementing further embankments both on technical and socioenvironmental grounds. Governments must be bold enough to admit the limitations of the flood management strategies it is adopting at present and encourage and empower people to enhance adaptation to floods and rivers.

The Indian government has developed a policy framework for integrated flood management but major gaps continue to exist between the national framework and actual implementation at the state level. The state also needs to build the capacity of institutions for flood risk management and integrate their operations with the disaster management systems. The Government of Assam must adopt a flood management policy and a set of technical guidelines, if needed in the form of an Act, without any further delay. The land acquisition policy and related acts need to be much more sensitive in recognizing people's right of dissent to dispense with land. It must be remembered that with a growing population and degradation of farm land because of sand casting, land has become the most crucial asset people strive to possess and protect. If acquired with due consent for common good, compensations must be given to the people expeditiously and adequately so that they can create additional resources and assets for their future survival and adaptation.

The observed and anticipated effects of climate change on flooding and sedimentation as well as overall hydrology and geomorphology of the rivers must be accounted for in the flood management plans, including construction of structures such as embankments. Facilitating the enhancement of the adaptive capacity and resilience of local communities has to be the goal of disaster management and development projects along with efforts to mitigate floods.

The Report of the Task Force on Flood Management and Erosion Control by the Indian Government recommended establishment of a single authority for water management of the Brahmaputra River basin in northeast India and called it the North East Water Resources Authority. It was supposed to integrate all aspects of use and management of water so that water governance for the entire basin becomes unified and interrelated. It has not become a reality so far because of non-cooperation of some stakeholders. Along with this proposed new institution, other ideas of erosion and flood mitigation such as confinement of the rivers in critical reaches by channel improvement and silt management and bank stabilization are also gaining currency. Assam is now at a crossroads and it is the right time to take the right course of action. Lessons have been learnt from mistakes made in the past, new concepts are getting recognition, and support to implement new ideas is rising. It is time to change flood mitigation measures, and change them for the better.

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Acronyms and Abbreviations

AP	Anchalik Panchayat
FGD	Focus Group Discussion
GFCC	Ganga Flood Control Commission
GP	Gaon Panchayat
GoA	Government of Assam
GoB	Government of Bihar
Gol	Government of India
INR	Indian Rupee
ITDP	Integrated Tribal Development Project
KHLC	Koshi High Level Committee
MAC	Mising Autonomous Council
NFC	National Flood Commission
PRI	Panchayati Raj Institutions
TAC	Technical Advisory Committee
TMPK	Takam Mising Porin Kebang
WPT & BC	Welfare of Plains Tribe and Backward Classes Department
WRD	Water Resources Department
ZP	Zilla Parishad



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