Rajagiri Journal of Social Development
Vol. 16, Issue 1, January-June 2024: 1-13
DOI: 10.5958/2583-7087.2024.00001.5

Research Article

Adapting to Climate Variability: Challenges and Interventions in Majuli, Assam

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Floods in the Brahmaputra River, one of the world's largest rivers, pose significant threats to life, livelihoods and property annually in the riverine island, Majuli, Assam. The island community, especially the Mishings, has historically relied on traditional innovations to cope with these challenges. However, climate change has altered rainfall patterns, making floods more severe and unpredictable, and has disrupted their traditional coping mechanisms. Using qualitative research methodology, this study explores the challenges that the Majuli community faces in adapting to climate variability. It also identifies strengths, weaknesses and gaps in existing governmental and non-governmental interventions to enhance disaster management strategies. Furthermore, it explores public perceptions to shed light on community needs and encourage meaningful engagement. This descriptive study, encompassing Majuli's disaster resilience and sustainable development, contributes to evidence-based policies and programmes aimed at mitigating climate risks.

Keywords
Adaptation, climate change, disaster management, flood, mishings

INTRODUCTION

Among diverse regions worldwide, frequent occurrences of floods are the most common natural hazards worldwide. They result from a combination of climatic and non-climatic factors, with heavy rainfall and insufficient landforms being key drivers. Different types of floods, including riverine, flash, urban and coastal floods, have significant impacts on ecosystems. Many minor flood events have grown into major flood hazards over time. Recently, there has been a rise in catastrophic floods, often referred to as 'monster floods'. Floods are not only the most frequent natural disasters, but they also cause the greatest economic losses (UNISDR, 2017). Climate change is likely to worsen flood challenges in many areas (Kumar et al., 2013).

There is growing agreement that climate change will increase flood hazards and lead to an overall rise in flood risk worldwide by 2100 (Few & Matthies, 2006). Changes in storm patterns and rising sea levels could affect numerous coastal communities globally, including several megacities with populations over 8 million (Klein et al., 2003). Increased seasonal rainfall peaks and storm precipitation will impact various river basins, especially in already humid regions, though not exclusively. The exact locations, timing and extent of changes in flood hazards remain uncertain. However, it is likely that these changes will not only increase risks in existing flood-prone areas but also make some coastal and river basin regions newly vulnerable to severe flooding (Sharma et al., 2018).

India faces substantial flooding during the monsoon season from June to September, particularly in the Brahmaputra, Ganga and Meghna river basins in North and Northeast India. Among these regions, Assam, located in Northeast India, is highly susceptible to various natural disasters, including earthquakes, landslides, droughts, cyclones and severe floods. The annual floods in Assam cause significant damage to the lives and property of thousands of residents in the river basins and floodplains (Sharma et al., 2010).

Majuli, located within the Brahmaputra River in Assam, India, is recognised as the world's largest river island. The island faces a significant threat of extinction due to severe bank erosion and flooding, leading to a gradual loss of land. Changes in the volume and intensity of the Brahmaputra River's flow (IPCC, 2007) increase Majuli's vulnerability. Additionally, the floodplains of the Brahmaputra River are among the most hazard-prone areas in India, with over 40% of the land (approximately 3.2 million hectares) at risk of flood-related damage (Goswami, 2008). As one of the highly active seismic regions, this area

experienced two significant earthquakes, measuring 8.7 in magnitude, occurring in 1897 and 1950. These earthquakes rank among the most severe recorded in history. Their impact not only caused widespread devastation in the region but also altered its hydrological patterns (Goswami & Das, 2003). The island's diverse population relies heavily on the island for their livelihoods, and their knowledge systems are closely tied to the environmental risks posed by the Brahmaputra River.

The island is also an important cultural heritage site in Assam, renowned for housing the 'Vaisnavite' monasteries, known as 'Satras' (Sarma & Phukan, 2004). The Satras not only shape the religious and spiritual life of the community but also play a pivotal role in preserving diverse artistic traditions such as the celebrated Satriya dance, as well as crafts like mask and boat making, and pottery. Furthermore, these Satras serve as repositories for invaluable archaeological artefacts such as antiquities, manuscripts, and coins, which hold immense historical and cultural significance (Goswami, 2001). However, the island's rich cultural heritage and very existence are at risk due to ongoing flooding and erosion (Kotoky et al., 2003). Out of the original sixty-five Satras, only twenty-two remain today (Phukan et al., 2012). The others have either relocated or closed, marking a profound cultural loss for India. Residents of Majuli connected with these now-affected Satras face displacement and the loss of their spiritual centres.

Climate change exacerbates these threats, as it increases the risk of flooding and erosion on the island. Increased precipitation, as projected in several studies highlighted in the State Action Plan on Climate Change, is likely to intensify the frequency and severity of floods (TERI, 2018). Additionally, the river receives glacial runoff through its tributaries, and the accelerated melting of snow due to global warming will raise the volume of water in the river (Sarkar et al., 2012).

METHODOLOGY

Universe

All the communities/villages in Majuli which have been affected by recurring floods and erosion in the last five years comprised the universe of the study. Majuli island has 248 villages, with 210 cadastral villages supported by revenue maps and 33 non-cadastral villages without revenue maps, often representing areas affected by erosion-induced resettlements. According to the 2011 census, Majuli's population stands at 1.68 lakhs, with 70% belonging to tribal communities (Board, 2012). The time frame of the last five years has been set to ensure that the flood and erosion-impacted communities can provide a first-hand description of their experiences.

Sampling Framework of the Study

The sampling framework of the study in Majuli involved a systematic selection of villages, households, primary respondents, government officials and NGO functionaries. Sixteen villages were selected for the study, including Sarighoria, Mohorichuk, Birinabari, Bormukolo Gowalgaon, Tantibari, Mayongia, Susnoi Mari, Sarai Chapori, Dakhinpat, Besamora, Baghargaon, Pohardiya, Jengraimukh, Kamalabari, Dakhinpat Kumar Gaon and Sumoi Mari. These villages were chosen through purposive sampling to ensure representation from different parts of Majuli. Within these villages, a total of 160 households were randomly sampled, with 10 households selected from each village. The primary respondents included heads of households, women, youth and elderly members, reflecting the diversity of perspectives within the community.

A range of NGO functionaries from prominent organisations such as South Asian Forum for Environment (SAFE), Impact NE, Amar Majuli, Neads, MIPDAC, NEICORD, Oxfam, ACTED, Save the Children, PAD, Prachodhan and Rural Volunteers Centre were purposively sampled to provide insights into the role of NGOs in disaster response and mitigation efforts.

Government officials from different departments were also purposively sampled to understand the role of governmental agencies in disaster management and policy implementation. Overall, this comprehensive sampling framework facilitated a thorough examination of perspectives from various stakeholders involved in disaster management and climate adaptation efforts in Majuli.

The large sample size of 160 respondents in this qualitative study is justified by the need to capture the diverse and complex experiences of the community in Majuli. The island's high incidence of floods and erosion affects various segments of the population differently, necessitating a larger sample to ensure that all relevant perspectives are included. Additionally, the study aimed to cover multiple villages with varying degrees of vulnerability, further supporting the need for a substantial

sample size to achieve a comprehensive understanding of the responses to climate-induced disasters.

Inclusion Criteria for Selecting Households

To ensure a comprehensive representation of the diverse community in Majuli, households within the selected villages were chosen based on several inclusion criteria:

1. ***Demographic diversity:*** Households were selected to reflect a mix of demographic characteristics such as age, gender, and socio-economic status, ensuring varied perspectives within the community.
2. ***Geographical distribution:*** Households from different parts of each village were included to avoid geographical bias and capture the varied impacts of floods and erosion across different locations.
3. ***Vulnerability:*** Particular attention was given to households known to be especially vulnerable to floods and erosion, such as those near riverbanks or in low-lying areas prone to flooding.
4. ***Local recommendations:*** Recommendations from community leaders and NGO functionaries were considered, leveraging their local knowledge to identify the most affected families.

Problem Statement

The scope of the problem statement encompasses the challenges faced by Majuli, a vulnerable river island in Assam, India, due to climate-induced disasters, particularly floods and erosion caused by the Brahmaputra River. Despite historically relying on traditional methods to mitigate flood risks, recent changes in climate have rendered traditional coping mechanisms of the communities less effective. The study addresses the responses implemented by both governmental and non-governmental organisations to mitigate these impacts and support affected populations. Furthermore, it examines public perceptions regarding the effectiveness of these responses, highlighting areas of concern, gaps in intervention and opportunities for improvement. Overall, the scope of the study provides a comprehensive understanding of the complex issues surrounding climate-induced disasters in Majuli and sets the stage for proposing targeted solutions and interventions.

Rationale of the Study

The rationale of the study lies in the urgency to address the pressing challenges posed by climate-induced disasters in Majuli, an island highly susceptible to floods and erosion in Assam, India. These disasters have profound implications for the island's communities, threatening their lives, livelihoods and environment. Climate change has altered rainfall patterns and has heightened the severity and unpredictability of floods, thereby undermining the traditional coping mechanisms of the island's communities. Understanding the effectiveness of responses by governmental and non-governmental organisations is crucial for devising informed strategies to mitigate the impacts of such disasters and enhance community resilience.

By examining the responses of both governmental and non-governmental actors, the study seeks to identify strengths, weaknesses and gaps in current intervention efforts. This analysis is essential for refining existing strategies and developing more robust approaches to disaster management and climate adaptation in the region. Moreover, exploring public perceptions regarding these responses provides valuable insights into community needs, concerns and priorities. This understanding is pivotal for fostering community engagement, ensuring interventions are culturally sensitive and aligning with the aspirations of local populations.

Ultimately, the study lies in its potential to inform evidence-based policies, programmes and initiatives aimed at enhancing disaster resilience, promoting sustainable development and safeguarding the well-being of communities in Majuli and similar vulnerable regions worldwide.

Research Design

The study employs a qualitative research method and is descriptive in nature, to gain a deeper understanding of the challenges faced by the island's communities in adapting to disasters, and to evaluate the effectiveness of responses by both governmental and non-governmental organisations in mitigating these impacts and enhancing community resilience.

Methods and Tools of Data Collection

The study involved both primary and secondary data. Secondary data was collected at various levels (district, block and village) and included information about the physical, environmental, socioeconomic and vulnerability characteristics of the study site and surrounding areas. This

data was obtained from a variety of sources, such as published and unpublished articles, documents, reports and academic works, from both government and non-government entities.

On the other hand, primary data was collected directly from the respondents at different levels: community, group, household and individual. Various methods were used to collect this data, including Interviews (Interview Schedule and Interview Guide) and Non-Participant Observation (Observation Guide).

Data Analysis

The qualitative data analysis followed a rigorous methodology to ensure the reliability and validity of the findings. All interviews were transcribed verbatim, providing a rich dataset for analysis. The transcribed data was imported into qualitative data analysis software, using NVivo, Atlas.ti, for coding. An initial set of codes was developed based on the research objectives and interview questions, including codes related to disaster response, community resilience, NGO and government interventions. As coding progressed, new codes were added to capture emerging themes, ensuring that the analysis remained flexible and responsive to the data.

Themes were developed through an iterative process of reviewing the coded data, identifying patterns, and grouping related codes into broader themes. Thematic analysis was conducted to identify key themes and sub-themes, looking for recurring ideas, notable quotes, and significant variations in responses.

RESULTS AND DISCUSSION

Challenges in Adapting to Climate Variability

The Brahmaputra River, one of the world's largest, brings significant annual loss of life, livestock, crops and property in India's northeast. Originating in the Tibetan Himalayas, it flows through India and Bangladesh before emptying into the Bay of Bengal. Due to its immense size, reaching up to 18 km wide at points, the Brahmaputra is often likened to a 'moving ocean'. It serves as a crucial lifeline for India's north-eastern region, deeply intertwined with its culture and identity.

The Mishing community, indigenous to India's northeast, are predominantly found in Assam and Arunachal Pradesh. Originating from the Eastern Himalayas in the 14th century, they settled along the banks of the Brahmaputra and its tributaries. Notably, they inhabit some of Assam's most flood-prone areas, including the Majuli river island. The community has endured floods for generations and has developed traditional innovations to adapt to recurrent flood threats and mitigate disaster risks. However, over recent decades, rainfall patterns in the northeast Indian region have become erratic, challenging the centuries-old coping mechanisms of the Mishing community.

The communities of the island have observed changes in rainfall patterns since 1980. Their traditional coping mechanisms have become less effective due to these changes. While they have historically passed down knowledge of rainfall patterns from generation to generation, the unpredictability caused by climate and anthropogenic factors has made adaptation more difficult. Flash floods, previously uncommon, now occur during moderate rainfall, leading to rapid damage. As a result, adaptation techniques such as constructing elevated homes (chang ghar) on bamboo stilts are less effective.

A respondent belonging to Mishing community highlighted the challenges faced during flash floods, noting instances where dykes are breached or small tributaries change course, resulting in entire houses being swept away. In such urgent situations, traditional adaptation methods become impractical as there is little time to prepare. Additionally, the respondent lamented the diminishing availability of wood due to logging bans and decreasing forest cover. This, coupled with the decline in passing down traditional skills, has made adaptation even more difficult. As a result, the Mishing people have turned to cheaper alternatives like banana boats, crafted from banana trunks, for transportation during floods. Another respondent expressed confidence in the resilience of their adaptation methods, emphasising that their approach is not to control nature but to coexist with it. He believes that by enhancing community preparedness, the community can effectively navigate the challenges posed by natural disasters like floods. A community organic farmer and entrepreneur based in Majuli highlights erosion as a significant threat alongside floods.

Despite these challenges, the Mishing community continues to seek innovative solutions. While some traditional methods like banana boats for transportation during floods remain in use, there is a recognition that new adaptations are necessary. Community members emphasise

the importance of living with nature rather than fighting it, suggesting a shift towards improving preparedness rather than solely relying on historical coping mechanisms.

Responses to Climate Change Disasters by Government

The Assam Government recognises the nation's vulnerability to climate change disasters and prioritises mitigating risks through collaborative efforts with its disaster management departments. One significant entity in this endeavour is the Brahmaputra Board, established under the Ministry of Water Resources in India through the Brahmaputra Board Act of 1980. Since its inception in 1982, the Board has been actively engaged in flood control and bank erosion mitigation efforts in the Brahmaputra Valley, with its central office located in Guwahati.

Responsibilities of the Brahmaputra Board include conducting surveys, investigations and formulating comprehensive Master Plans aimed at managing floods, mitigating bank erosion and improving drainage systems in the region. These plans encompass various strategies such as constructing storage dams, embankments, erosion prevention measures, urban safeguard initiatives and drainage optimisation schemes, tailored to address the Northeast's vulnerability to floods. In particular, the Brahmaputra Board has developed segmented Master Plans covering both the Brahmaputra and Barak Valleys. These plans also address specific concerns, such as those related to erosion on Majuli Island. However, some challenges have been observed in the effectiveness of certain flood control measures, particularly regarding newly constructed embankments. These embankments have altered natural sediment deposition patterns, leading to sediment accumulation and increased flood risks in certain areas. Additionally, issues with water outlet sluices have contributed to drainage congestion and waterlogging in surrounding regions. In response to these challenges, the Brahmaputra Board continues to assess and adapt its strategies to effectively manage floods and mitigate the impacts of climate change disasters in the region.

Construction of Stone Spurs: Wire-encased stone spurs are annually erected to mitigate the impact of the river's force on Majuli Island and redirect its flow. However, some spurs, particularly those at locations like Hatisal, Nimatighat and Kakilamukh on the southern mainland of Majuli, have inadvertently altered the Brahmaputra's flow trajectory, intensifying devastation in the Ahatguri Mouza area. These spurs, implemented as flood control and anti-erosion measures, have led to the formation of sandbars and new river channels within the Brahmaputra, diverting its current toward the lower parts of Majuli and contributing to erosion-induced disappearance of Ahatguri Mouza.

RCC Porcupines: Rain-forced cement concrete (RCC) Porcupines, triangular-shaped structures made of reinforced concrete, serve as cost-effective dampers along the Brahmaputra. Positioned transversely or parallel to the flow direction, they obstruct 15 to 20% of the river's flow, effectively training its course, reducing impact intensity and protecting banks by decreasing flow velocity. These structures have successfully mitigated erosion on Majuli Island, being affordable, easy to construct, environmentally friendly and minimally impacting surrounding areas. Use of Geo Bags: The government has employed geo bags, large geotextile bags filled with sand and soil, strategically placed along vulnerable riverbanks and areas prone to erosion. These bags stabilise riverbanks, reduce erosion and prevent land and property loss caused by floods and strong river currents. They offer greater flexibility, adaptability, and potential environmental benefits compared to traditional embankment methods. The design of geo bags enables them to conform to natural contours of riverbanks, enhancing their effectiveness in preventing erosion and maintaining the area's natural ecosystem. Despite government efforts, the efficacy of flood protection measures in Majuli is not universally successful, as evidenced by breaches at various locations, including embankments, spurs, and roads. For instance, breaches at the Tekeliphuta embankment near Haladhibari during significant flood events in June and September 2012 resulted in damage to agricultural land, houses and properties in Majuli villages.

Disaster Mitigation and Action Plan

The Assam Relief Manual delineates the responsibilities of different departments in disaster management. Furthermore, the Majuli Sub-Division adheres to the District Disaster Management Plan, which establishes Emergency Support Functions (ESFs). These ESFs consist of specialised teams in Majuli, each assigned specific duties.

The Sub-Divisional Officer oversees relief operations in the sub-division as outlined in the Assam Relief Manual. A standing Sub-Divisional Relief Committee for natural

calamities is formed, chaired by the Sub-Divisional Officer. It comprises sub-divisional officers from pertinent departments, a local legislator and the Secretary of the Sub-Divisional Red Cross Society.

The committee's responsibilities include organising relief efforts in accordance with the relief manual and official directives. It coordinates with government departments and non-governmental organisations for relief operations, suggests improvements to relief measures and provides guidance on necessary actions.

Annually, before February 15th, the Sub-Divisional Relief Committee convenes to plan for the forthcoming flood season. Pre-flood activities entail assessing relief camp requirements, identifying shelter locations, defining roles for individuals and volunteer organisations, collaborating with Gaon Panchayats (local self-governance bodies), finalising infrastructure repair projects, estimating required relief supplies and updating the vehicle list for relief operations. Population data from Gaon Panchayats is collected.

After floods, the committee evaluates damages across various sectors, collects agricultural statistics, reports losses to relevant departments and submits this data to the Revenue Department through the Deputy Commissioner. Assessments cover housing, fisheries, handloom industries, animal husbandry, among others. Plans are made for the distribution of seeds and seedlings, provision of aid for agricultural rehabilitation, allocation of alternative homestead lands for erosion-displaced individuals and pursuit of land revenue suspension/remission if necessary. The committee reports to the government at the commencement and conclusion of relief efforts.

Initiatives by Government Organisations to Disseminate Public Health Information and Facilitate Health-related Activities

In particular, public health department officials prioritise educating the Mishing community on maintaining cleanliness and hygiene during floods. They utilise posters and leaflets to convey these messages, especially as the Mishing community often resides near rivers. Additionally, officials distribute chlorine tablets, bleach, chemical packets and clean drinking water to ensure safe drinking water during floods.

For effective disaster mitigation, various teams collaborate closely, including the early warning team, search and rescue team, relief and coordination team, carcass disposal team, first aid and trauma counselling team, and sanitation and drinking water team. Their collective efforts contribute to efficient disaster management and response.

First Aid and Trauma Counselling Team

Prior to floods, the first aid and trauma counselling team compile a list of vulnerable individuals and ensure stocked first aid kits with up-to-date supplies. They distribute basic medicines, ready stretchers and bamboo alternatives for transporting the injured. Upon flood warnings, they verify kit contents and shelter conditions. After floods, the team treats injuries, provides trauma counselling, assists medical personnel, manages infectious cases, administers preventive medication and reports supply needs.

Sanitation and Drinking Water Team

Similarly, the sanitation and drinking water team undertake pre-flood tasks such as ensuring disinfectant stocks, proper water storage and conducting awareness campaigns. They establish water treatment standards, manage hand tube wells and maintain mobile water treatment facilities. During floods, they assess water sources, arrange power supply and maintain sanitation facilities. Post-flood, the team disinfects water sources, maintains water treatment facilities, coordinates with health officials, manages waste disposal and prevents waterborne diseases. Numerous free medical camps have been organised to provide healthcare and medicines to flood-affected individuals. Various relief camps across Majuli have also been established, accompanied by medical teams to address flood-related diseases.

Boat Clinic

Operating in flood-prone areas adjacent to the Brahmaputra River, boat clinics offer mobile healthcare services to impoverished and marginalised communities. Their primary objective is to ensure healthcare inclusivity and accessibility for millions, particularly those residing in remote regions. Recognised by the World Bank for bridging rural healthcare gaps, there are currently 15 operational boats stationed on the Brahmaputra River. Each boat is staffed with two medical officers (MOs), three nurses, a slab technician and a pharmacist.

The Government of Assam's National Rural Health Mission recognised the potential of this approach and established a unique Private Public Partnership with NRHM in January 2008. The boat clinics aim to provide sustained healthcare to underserved populations, particularly focusing on the health and nutrition of expectant and recent mothers, as well as ensuring timely completion of full immunisation cycles for children. Additionally, family planning services, basic laboratory tests and other essential healthcare services are provided.

A Jorhat Boat Clinic Medical Officer shared the following incident: A senior resident from Majuli arrived at one of the camps and quietly observed the team's activities. When asked if he needed medical attention, he responded with a smile, assuring them he was in good health. When asked why he came, he explained, 'I came here to see a doctor. I've never actually seen what a doctor looks like.'

Other initiatives by Government Organisations

Governmental organisations have initiated significant efforts to support communities during floods, playing a crucial role in providing assistance. Officials utilise various communication methods, such as posters, hoardings and advertisements, to educate people about flood safety measures. Schools and colleges also contribute to raising awareness about floods, rescue operations, emergency evacuation procedures and personal hygiene maintenance during floods. This collaborative effort helps reduce the overall impact of floods. Additionally, authorities provide food aid, temporary shelter and healthcare services to affected communities.

Government officials have introduced the use of ham radio sets to issue early warnings to the populace. Civil officials from the Sub-Divisional Officer (SDO) department explain that flood-related information is widely disseminated through television, print media and social platforms. These platforms enable individuals to access real-time updates and make informed decisions during floods.

Furthermore, government officials emphasise their active involvement in rescue operations during flood events. They establish relief camps to accommodate those displaced by floods. Among the six priority areas outlined in the Assam State Disaster Management Plan is the creation of climate-resilient habitats, aligned with India's National Action Plan on Climate Change. In cases where homes are damaged by flooding, officials engage in reconstruction efforts. To further support affected communities, economic relief is provided through national programmes such as Pradhan Mantri Gramin Aawas Yojana (PMGAY), facilitating house construction and ensuring comprehensive efforts to safeguard food security and housing stability. SDO officials highlight that financial aid is allocated based on damage assessments.

Government representatives express concern for the traditional livelihoods of the population, acknowledging the significant threat posed by floods. A noticeable shift from agrarian pursuits to wage labour is observed, affecting livelihoods such as pottery, livestock rearing and handicrafts. While some individuals receive compensation from the government for livestock and livelihood losses, most respondents report limited economic support. Additionally, some villagers relocate to distant urban areas in search of semi-skilled and unskilled labour opportunities.

Circle revenue officials outline the government's role in rehabilitating affected communities following floods. The recurring floods in Majuli have resulted in the erosion and disappearance of numerous villages, necessitating the relocation of a significant population. The circle revenue officer highlights the case of seven villages in Ahatguri Mauza lost due to erosion in 1972, leading to their resettlement in Darang district. Government records indicate that between 1971 and 2001, approximately 7,361 families were displaced due to floods and river erosion.

Responses to Climate Change Disasters by Non-Governmental Organisations (NGOs)

In addition to governmental organisations involved in disaster management, several non-governmental organisations (NGOs) play a vital role during disasters in Majuli. Presently, there are over 34 registered NGOs operating under the Farm and Societies Registration Act of 1860 in Majuli, but only a few actively participate in disaster-related efforts. Prominent NGOs engaged in disaster management in Majuli include Abakash Majuli, Impact NE, Amar Majuli, Neads, MIPDAC, NEICORD, Oxfam, ACTED, Save the Children, PAD and Prachodhan.

Hummingbird School

The NGO Ayang Trus is committed to empowering marginalised communities by providing access to quality

education and dignified livelihood opportunities. The education system in Majuli faces significant challenges due to geographical isolation, annual floods and systemic issues. At the heart of Ayang's mission lies The Hummingbird School, an exemplary educational institution located in Kulamua, Majuli. Serving approximately 110 students, the Hummingbird School was established on 16 January 2017, in response to the pleas of villagers residing in underprivileged areas.

Principal Bipin Dhane spearheaded the initiative to establish the Hummingbird School, relinquishing his prosperous position in cosmopolitan Singapore to create a school in a remote village, addressing the educational needs of the Mishing tribe's children. This marked the beginning of a transformative journey as Dhane collaborated with local Mishing community leaders to enhance the quality of education amidst blessings and challenges. Thirteen villages in the vicinity joined forces, offering extensive support in various forms. The school's land was generously donated by a local villager and the construction of desks, benches, tables and the school building itself relied on wood donated by the community. Even the soil used to elevate the building's foundation was graciously provided by the villagers. The construction process was a collective effort undertaken solely by the local community, illustrating the unity and determination that brought the Hummingbird School to fruition.

Floating Agriculture

To address the challenges posed by floods and erratic rainfall, the residents of Majuli have embraced a distinctive approach to agricultural cultivation known as floating agriculture. Introduced by the South Asian Forum for Environment (SAFE), an NGO committed to promoting sustainable development, floating agriculture offers a solution for adapting to increasingly unpredictable climate conditions on the island. This innovative technique involves cultivating vegetables on specially designed rafts that can float on water bodies like rivers or floodplains.

Initially, plants were grown in nutrient-rich water instead of soil, using bamboo rafts covered with water-soaked sponge material. Despite initial success, the use of bamboo rafts presented durability issues due to rotting. A new method was implemented in 2021, utilising drums to maintain the buoyancy of bamboo rafts, with vegetables now grown in grow bags placed on the rafts. Solar-powered pumps draw water from nearby ponds to irrigate the crops, enhancing moisture retention and reducing water loss. Protective nets and punctured grow bags allow excess water to drain back into the pond and prevent bird damage.

One significant advantage of this system is its resilience to flooding, as the platforms rise with the water level, ensuring the crops remain unaffected. Over fifty newly designed rafts are currently in use by farmers, each accommodating approximately 25 grow bags. Integrated fish farming within the same water body further enhances the system's economic viability, reducing labour requirements and expenses compared to conventional agriculture practices.

Farmers have expressed satisfaction with the new floating farm beds, highlighting their ability to cultivate preferred vegetables reliably and sustainably. With modest profits achieved by selling surplus crops, the community's primary goal remains ensuring improved and nutritious food security. As the project expands, there is optimism for greater profitability, especially with the potential for local production of farming materials like compost.

Other Initiatives Undertaken by NGOs to Support Disaster-Affected Communities

Numerous non-governmental organisations, including the Rural Volunteers Centre, are actively involved in enhancing community resilience, highlighting the efficacy of community infrastructures in disaster management. A significant portion of the NGOs operating in Majuli focus on restoring the livelihoods of the most severely flood-affected families.

For instance, the NGO Amar Majuli assists in the rehabilitation of the worst flood-affected families by supporting farmers' groups through the distribution of seeds, tools, tillage, irrigation facilities and providing training to women to reinstate non-farm livelihoods. This includes activities such as artisans, handloom weavers, pottery making, eco-tourism, etc. Amar Majuli also promotes micro-credit activities and cycle banks among women to encourage their participation in income-generating activities.

Ayang Trust is dedicated to empowering Self-Help Groups (SHGs) and youth with the skills necessary for prosperous lives and establishing diverse livelihood sources with lower risk of significant loss during disasters. Additionally, Ayang Trust is actively involved in essential

community welfare projects, including initiatives related to Mental Illness Treatment and Awareness, flood relief and activities aimed at enhancing community resilience.

Abakash Majuli organises various activities including career counselling camps, medical camps, flood relief camps and awareness camps on agriculture.

NEADS (North-East Affected Area Development Society), an NGO, focuses on enhancing the resilience of communities in North-East India affected by disasters. Through collaboration with TDH (Terre Des Hommes) Germany, NEADS empowers communities through skill development, healthcare services and education. NEADS has extended assistance to ten flood-affected villages by distributing vital first aid kits and search and rescue materials.

To establish a community-based early warning and prevention system, NEADS equips affected individuals with necessary skills, organises vulnerable communities, establishes village-level disaster management institutions and emergency task forces, conducts Participatory Assessment of Climate & Disaster Risks (PACDR) and facilitates disaster simulation exercises and mock drills within communities. Additionally, NEADS has provided five boats to specific villages and is actively involved in distributing boats, which are crucial for residents in flood-prone areas.

NEADS also focuses on improving food security and vulnerable livelihoods by promoting sustainable income-generating activities such as early harvesting crops, traditional weaving, effective livestock rearing, capacity-building training on organic farming and livestock management, and integrating sustainable farming practices and flood-resistant agricultural crops. With financial support from the Sustainable Environment and Ecological Development Society (SEEDS), NEADS has undertaken the construction of a hybrid form of chang ghar to enhance durability.

People's Action for Development (PAD) has distributed medium-sized country boats and installed high-rise hand pumps in villages to address clean water access issues. PAD also distributes resilient rice seed varieties to farmers, erects elevated clay platforms for shelter during floods, plants saplings for environmental preservation and facilitates the establishment of Village Disaster Management Committees (VDMCs) and task forces. Prachodhan offers boat services during floods to mitigate healthcare crises and has contributed to the construction of bamboo bridges and operates schools in Majuli. Prachodhan is actively involved in educational initiatives, environmental conservation efforts and health awareness activities.

These NGOs coordinate with the district health administration, mobilise mobile health units, organise health check-up camps, provide training on rescue operations and emergency evacuation methods, educate people on personal hygiene during floods and conduct awareness activities on health and sanitation.

As part of water, sanitation and hygiene promotion, NGOs establish a water distribution system and train volunteers in hygiene promotion. One of their initial responses is to raise tube wells to prevent contamination because many wells become submerged in contaminated water during floods. After floods recede, NGOs provide bleaching powder and instruct people to clean and rehabilitate wells.

Hygiene promotion activities are conducted at camps, communities and schools, focusing on personal hygiene, handwashing, clean and safe drinking water, waterborne diseases and sanitation. NGOs provide buckets or jerry cans for household-level storage of safe drinking water, construct rapid latrines to prevent open defecation, monitor latrine use, household-level water treatment, and storage, and mobilise the installation of water treatment units. They also distribute chlorine tablets to meet the need for safe drinking water in many communities due to the impracticality of deploying water purification units on a large scale.

The Red Cross installed a water purification unit capable of purifying approximately 5,000 litres per hour, providing safe drinking water to 1,500 flood-affected people for nearly a month. Prompted by floods in 1998, the NEICORD project provided the sanitation system in Majuli for the first time. Full sewerage installation was considered unfeasible due to insufficient water for a flush system to operate. Instead, public latrines were constructed initially, followed by offering credit for self-help groups to build domestic models.

In response to the health-related impacts of floods, ACTED provides training to community members on shelter, water, health and sanitation in emergencies. These trainees become leaders and advocates in their communities, increasing community awareness.

An employee of Save the Children assisted a pregnant woman in delivering a child in the absence of medical aid.

The employee narrated the incident, stating that while returning from relief distribution, the team encountered a woman in labour pain on her way to the hospital. The team improvised a stretcher and transported her to the hospital, where the employee assisted in the successful delivery with guidance from their doctor's brother.

Numerous NGOs actively participate in relief distribution efforts, providing essential assistance to flood-affected individuals by distributing food and basic non-food items such as tarpaulins, mosquito nets, bed sheets, kitchen sets, sarees, dhotis, buckets with lids and towels. They also distribute Ham radios to locals before floods to facilitate communication.

To safeguard food supplies during floods, NGOs aid community members in constructing granaries on sturdy foundations. Steel sheets are used to shield the base of granary pillars from damage by rodents and small animals. NGOs often sponsor these projects, with islanders contributing as per their capacity. Additionally, NGOs assist community members in repairing houses damaged by floods.

Community Perspectives on Government's Responses to Climate Change-induced Disasters

The response of Majuli's residents to government assistance regarding the construction of embankments has been varied. While some individuals appreciate the government's efforts to build embankments as a means of flood protection, others express reservations and concerns about their effectiveness and environmental impact.

A portion of the population views the construction of embankments as essential to safeguard their homes and livelihoods from recurrent floods. They see these structures as a tangible solution to prevent flooding, erosion and property damage. These individuals recognise the government's commitment to providing flood protection and believe that embankments offer a sense of security during flooding. However, dissenting voices exist among residents. Some are sceptical about the long-term efficacy of embankments, citing instances where these structures have failed to prevent flooding or exacerbated erosion. Concerns are raised about the alteration of natural river flows and the resulting impact on the ecosystem, including silt accumulation, reduced sediment deposition on floodplains and changes in drainage patterns.

Furthermore, some residents believe that embankments alone are not a comprehensive solution to the flooding issue. They stress the importance of a holistic approach that considers various aspects of flood management, such as sustainable land use planning, community-based adaptation strategies and the preservation of wetlands and natural drainage systems.

In Majuli, residents express a variety of concerns regarding the government's efforts, particularly regarding the installation of bamboo-porcupine fences. Despite protests against these measures, residents feel their objections were suppressed, leading to a sense of frustration. They believe that rather than investing in ineffective measures like these fences, allocating compensation of Rs. 1 lakh per family would allow them to acquire new plots of land in safer areas. The perceived misappropriation of public funds adds to their disillusionment.

Another source of discontent stems from the inconsistency in replacing geo bags, essential structures designed to combat flooding and erosion. Residents worry about the risk posed by the lack of maintenance, which undermines their trust in these flood management measures. There is a call for increased transparency and community involvement in maintenance efforts to ensure effectiveness. Additionally, concerns are raised about the poor quality and lack of replacement of rain-forced cement concrete (RCC) porcupines, demonstrating a lack of responsiveness to community needs.

Residents also expressed dissatisfaction with the government's response during floods, including the provision of inadequate and poorly managed food supplies. These supplies cover only a few days, leaving residents to cope with flood damages on their own.

Displaced residents share stories of insufficient aid, emphasising the need for consistent government support throughout the year, not just during major flood events. They criticise the government's failure to provide adequate assistance and express frustration at the lack of communication with district authorities.

There is a prevailing sense of vulnerability among residents, compounded by the perceived ineffectiveness and neglect of government interventions. The sentiment is one of cynicism and frustration, with residents feeling let down by broken promises and ineffective policies.

Furthermore, awareness and training programmes are criticised for their limited reach, leaving many residents uninformed about flood preparedness. Indigenous

knowledge becomes crucial in mitigating the impact of floods. Moreover, obstacles are highlighted regarding the availability of chang ghars provided under government schemes, adding to residents' dissatisfaction.

The lack of awareness regarding government health programmes and delayed public health information further contribute to residents' frustrations. Conflicting health advice and inadequate shelter availability during floods exacerbate their challenges.

Overall, residents express deep dissatisfaction with government interventions, calling for more effective and responsive measures to address their needs and concerns.

According to a respondent, the government's decision to dispatch teams of medical experts to flood-affected areas on regular visits was commendable. These experts have been actively educating residents about the importance of maintaining health and hygiene in challenging circumstances, particularly focusing on preventing water-borne diseases.

Farmers on the island appreciated the government's provision of flood-resilient paddy and mustard seeds, which they considered vital for their survival. However, they emphasised the need for a more robust solution to address floods and soil erosion before reaching a critical stage. Farmers shared their experiences of enduring these challenges for many years and losing everything to the relentless forces of the river.

Respondents from at-risk communities consistently expressed a sense that government intervention remained largely abstract, characterised by incompetence and a focus on ambitious yet often unfinished projects. This sentiment was succinctly articulated by a farmer from Sapori, stating,

> The government seems to prioritise paperwork over tangible actions. Their efforts appear temporary and lack long-term solutions. The engineering expertise appears inadequate. While Majuli is a remarkable place, the government's measures to safeguard it are insufficient. With proper planning and investment, erosion and flooding might be mitigated. However, it seems that the government lacks a comprehensive plan, and Majuli's fate is at risk of being consumed by the Brahmaputra.

Community Response to Non-Governmental Assistance

A significant number of respondents highlighted the increasing importance of NGOs in addressing community needs. These organisations engage in various activities, including raising awareness and providing training on health, sanitation and hygiene practices. NGOs also play a crucial role in flood response and mitigation on the island, although their geographical coverage may be limited.

NEADS NGO's involvement was cited as instrumental in addressing flooding challenges. Villages collaborated with NEADS to construct elevated hand pumps and raised toilets, effectively addressing drinking water and sanitation issues during floods. NGOs also assisted in building granaries to safeguard agricultural produce.

Residents adopting the hybrid form of chang ghar constructed by NEADS witnessed its effectiveness, surviving multiple flood seasons. However, they noted ongoing hygiene and sanitation issues during the monsoon season. There is a call for integrating traditional Mishing techniques into sanitation and education sectors. Floods often lead to school closures, prompting suggestions to construct schools using traditional models.

While NGOs contribute to disseminating health-related information, respondents noted limitations in their reach, particularly affecting individuals from multiple villages. Food and non-food relief items provided by NGOs were sometimes insufficient, with some respondents reporting never receiving relief items. Respondents expressed that both government and NGO assistance primarily focus on preventing casualties and ensuring access to essentials. However, emotional distress is often overlooked. Specific groups like the elderly, persons with disabilities, victims of sexual assault and domestic violence lack adequate support. Educational setbacks of children during disasters are also unaddressed.

Some respondents expressed doubts about coping independently without external aid, especially considering future floods. Longer residency periods were associated with increased confidence in self-reliance. Relief agencies prioritise emergency provisions over long-term initiatives due to funding constraints. Concerns were raised about government-sponsored food-for-work programmes fostering dependency, with voluntary community tasks exchanged for food.

The findings underscore the importance of NGOs in meeting community needs but highlight limitations in their reach and the adequacy of relief items. Both government and NGOs primarily address immediate necessities, overlooking emotional distress and the specific needs of vulnerable groups. Government efforts to address soil erosion face criticism for maintenance issues and inferior

structure quality, prompting community reliance on self-help measures and calls for stronger interventions. Dependency on government food-for-work programmes is also a concern.

CONCLUSION

The responses to climate-induced disasters in Majuli, undertaken by both governmental and non-governmental organisations, reflect a multifaceted approach aimed at mitigating the impacts of floods and erosion on the island's vulnerable communities. Governmental efforts, while demonstrating commitment through infrastructure projects and relief assistance, have faced challenges such as inadequate maintenance and inconsistent support. Conversely, NGOs have played a vital role in addressing immediate needs, promoting sustainable practices and empowering local communities to adapt to changing environmental conditions. Public perceptions underscore the critical importance of effective disaster management strategies that prioritise long-term resilience-building measures, community engagement and transparent governance. Despite facing recurrent challenges posed by climate-induced disasters, there is a prevailing sense of resilience and determination among the people of Majuli to overcome adversity and build a sustainable future for generations to come.

As climate change continues to pose increasing threats to vulnerable regions like Majuli, it is imperative for governmental and non-governmental stakeholders to collaborate closely, listen to community voices and implement holistic strategies that address the root causes of vulnerability while fostering local ownership and empowerment. By working together and integrating traditional knowledge with innovative solutions, Majuli can navigate the challenges of climate-induced disasters while building a more resilient and sustainable future for all. In addition to the multifaceted approach taken by governmental and non-governmental organisations, it is essential to recognise the significance of community-driven initiatives and indigenous knowledge in addressing climate-induced disasters in Majuli. Local communities often possess valuable insights and traditional practices that can complement formal intervention efforts.

Furthermore, the importance of incorporating gender-sensitive approaches into disaster management strategies cannot be overstated. Women and girls often face unique vulnerabilities during disasters, including increased risk of gender-based violence, limited access to resources and disruptions to their livelihoods. Efforts to empower women, involve them in decision-making processes and address their specific needs are crucial for building resilience in Majuli.

Moreover, there is a need for enhanced coordination and collaboration among various stakeholders, including government agencies, NGOs, community-based organisations and international partners. By fostering partnerships and leveraging collective expertise and resources, stakeholders can maximise the effectiveness of interventions and ensure a more comprehensive response to climate-induced disasters.

Education and awareness-raising initiatives also play a vital role in building resilience and fostering adaptive capacity in Majuli. By educating communities about the risks associated with climate change, promoting sustainable practices and providing training on disaster preparedness and response, stakeholders can empower individuals to take proactive measures to protect themselves and their communities.

Finally, it is crucial to adopt a holistic approach to disaster management that addresses not only the immediate impacts of disasters but also the underlying vulnerabilities that exacerbate their effects. This includes efforts to address poverty, inequality, land degradation and inadequate infrastructure, which can contribute to communities' resilience to climate-induced disasters in the long term. By integrating these additional points into disaster management strategies in Majuli, stakeholders can enhance the island's resilience to climate-induced disasters and build a more sustainable future for its inhabitants.

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How to cite this article: Nongmaithem, J. (2024). Adapting to Climate Variability: Challenges and Interventions in Majuli, Assam. *Rajagiri Journal of Social Development, 16*(1), 1-13.