Research Paper

Re-imagining resilience, taking the case of *Majuli* – the disappearing island of India

Investigating the threatened hydro-geo-cultural heritage, and re-imagining resilience in the conflict between nature and built environment, taking the case of MAJULI

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Abstract

Majuli, the largest inhabited riverine island in the world, is a cultural heritage site of Assam, which is under serious threat due to the recurring floods and continued bank line erosion by the Brahmaputra and its tributaries. Constant erosion and flood have reduced the world's largest river island to less than half its original size.

This research aims to protect the vanishing geo-cultural heritage of Assam and look for plausible solutions to tackle the dual fury on the Island. The study also emphasizes the urgency of an effective spatial plan for the river island of Majuli to tackle the problems of flood and riverbank erosion and also to provide ideas for best practice solutions in terms of policy frameworks and their spatial manifestations in safeguarding the protecting the tangible and intangible heritage as well as local aspirations of the people and harmonizing a balance between Nature and People. The paper focuses on creating a resilient village community and re-imagining the spaces of conflicts between the forces of nature and the built environment, by delineating the master plan of the area and the spatial characteristics of the community considering the livable, workable spaces, and the third spaces. Strategies that would reinstate ecological resilience within the community through spatial configurations and flexible and adaptable architecture are another point of concern and to re-establish the community's image through architecture by incorporating local cultural aspirations and place-making within the communities to create vibrant public spaces. Before delving into the design directly, gradual study and research have been done regarding the design intervention area. Identification of the existing water bodies and water channels, through the intervention area and the low-lying areas, are also identified. Thus a blue-green network is created, which acts as an ecotone, an interface that will promote resilience. The study concludes with strategic planning decisions and providing a resilient master plan of the area. Detail architecture design considers the triad of living, work, and play and redefines those spaces, thus re-establishing the community's image through architecture by incorporating local cultural aspirations.

Keywords

Resilience, Flood Management, Geo-Cultural heritage, Policy framework

1. Introduction

1.1. Project Background

In India's far northeast, a region overlooked by many a tourist, sits a river island in Assam state: Majuli. Encircled by the rushing waters of the Brahmaputra river, **Majuli, the largest inhabited riverine island in the world, is a cultural heritage site of Assam, which is often inscribed as the 'Cultural Capital' of the state.** Majuli island once held a Guinness World Record for being the world's biggest river island, but it's slowly but surely being washed away by the fast-moving waters of the Brahmaputra river.

Erosion and flood rips at its banks every year, claiming lives, lands, and homes. The island is formed by the Brahmaputra River in the south and the Kherkutia Xuti, a branch of the Brahmaputra, joined by the Subansiri River in the north. However, the existence of this cultural heritage is under serious threat due to the recurring floods and incessant bank line erosion by the Brahmaputra and its tributaries. Constant erosion and flood have reduced the world's largest river island to less than half its original size. In the last hundred years, Majuli island shrank by more than 60%, from over 1,000 km² to barely 400 km². One of the haunting questions, as of now, is, 'Will the Brahmaputra eat away one of the world's largest river islands'?

1.2. Location

Majuli, the mid river island situates itself in the river Brahmaputra in North-East & South-West angle. It is located in the north of Jorhat district of Assam, India. The island is about 300–400 kilometres east from the state's largest city —Guwahati. The elevation of the area varies from 60 to 85 meters from the mean sea level and it is bounded by three major rivers Kherkutia Suti, Subansiri and Brahmaputra.

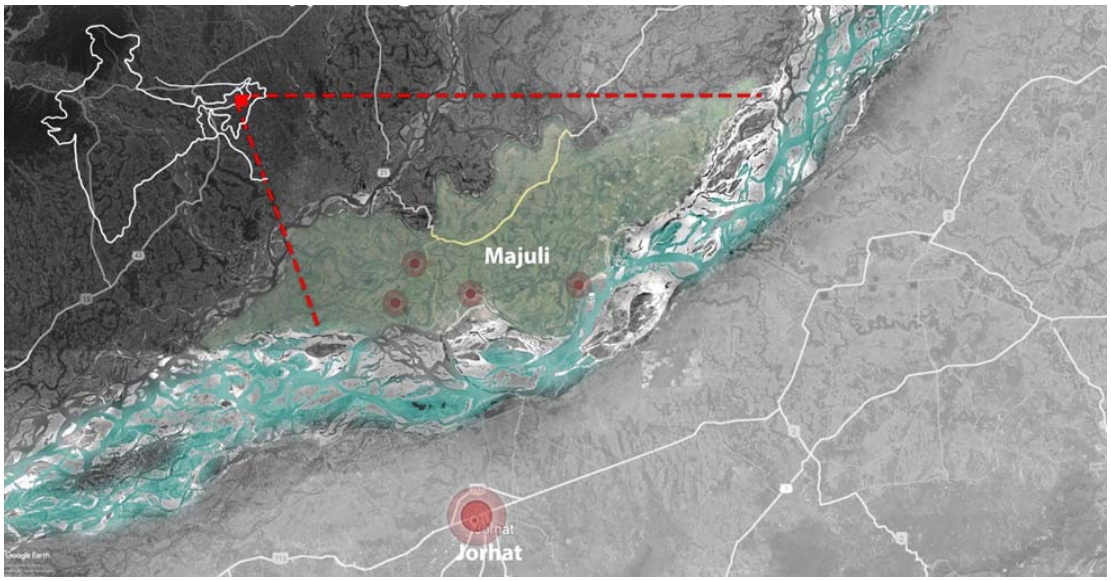

Figure 1. Location of Majuli

2. Study of Majuli

2.1. Map of major character areas of Majuli

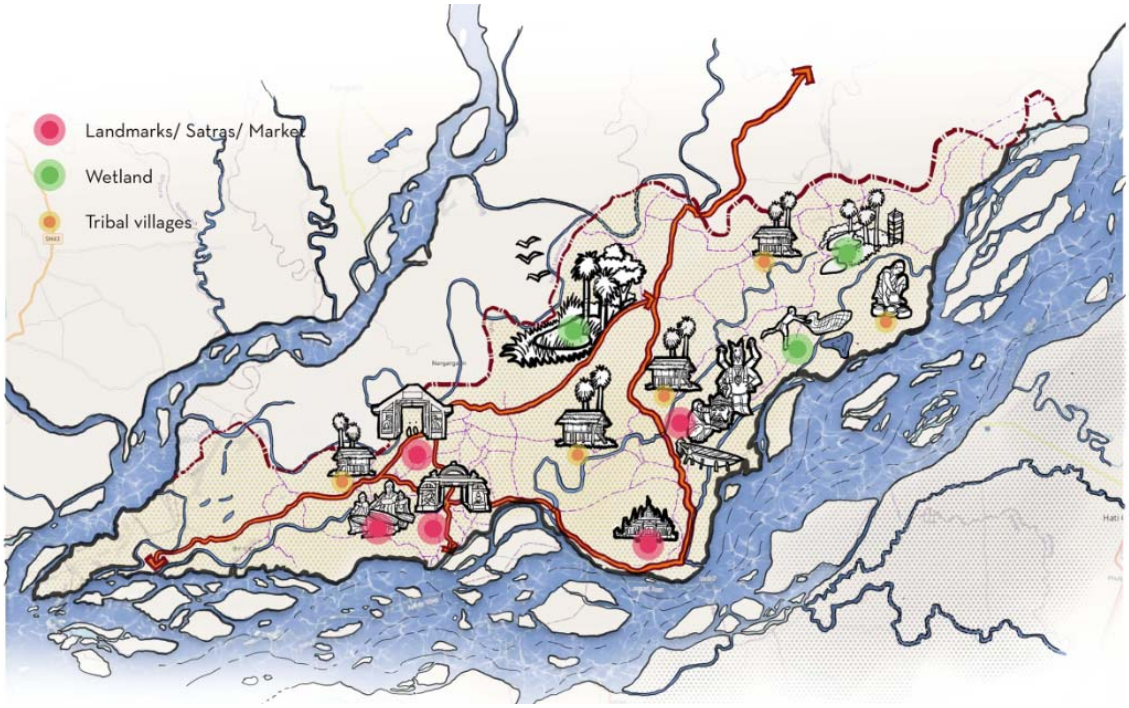

Figure 2.Illustrated map of major character areas of Majuli

Majuli is the birthplace of Vaishnava Satras. The cultural ambience of the Satras has percolated to the villages of the island, in its traditions, in its people's daily lives. The focal point of all villagers is the Namghar (prayer hall) where people gather to sing and pray. It will not be out of place to mention in this era of individualism that Majuli still preserves the notion of community. Among the majority Mising community, who migrated from the Arunachal hills many generations ago, traditions of ali-ay-ligang (the harvest festival) are still preserved, and different ethnicities have been living together peacefully for generations. The above mentioned diagram shows the different major character areas within the island and their spatial relationship within the context. Mapping of major Landmarks areas like satras, and work places, natural areas like wetlands and also tribal settlements for example Missing tribe settlements

2.2. Art, Culture and People of Majuli

Majuli a pilgrimage island of Assam is distinguished for its geography, culture and primarily a place where Vaisnavism has prospered since fifteenth century. Majuli is celebrated as the world's biggest river island nestles in the lap of the mighty Brahmaputra and also the place of numerous Satra Institutions (Vaisnavite monasteries), in which some of the Satra celebrated as the most legendary Satras of the Assam, caringthe heritage of socio-religious culture, and rich traditions of various art and literature, signifies it from the other places of Assam.

Majuli the celebrated land of Satras, socio-religious harmony and cultural genesis, has been always cherished the rich cultural life since the medieval period. Majuli has been the cultural capital and the cradle of Assamese civilization for the past 500 years.

Majuli boasts of a multiplicity of ethnic tribes, which have contributed immensely to its rich and colourful cultural heritage. It has a diverse population of tribal and non-tribal origin and comprises communities like the Mishing, Deori, Koch, Kalita, Keot, Ahom, Chutia, Kachari, Brahmin, Tanti, Sut, Kumar, Moran, Mottok, Brahma, Jodi and Kamar who have altogether given a new golden coating to the erstwhile colourful, composite culture of Majuli.

Figure 3. People of Majuli

Majuli has fertile land and suitable climatic condition for agriculture. It is the most widespread occupation with both commercial and non-commercial. There are more than 60 large beels (water bodies) which are used for fish cultivation and production that provides livelihood to large number of Majuli inhabitants. Also, Majuli is famous for potteries in entire valley for design and quality of their products and artefacts. Being a flood prone, rain fed and water logged area where water transport is the only mode of transportation, the boat making is an age-old traditional business. Around 3000 families are dependent on this trade. Bamboo craft and cane works are main handicraft trades. Women of Majuli are expert weavers and weave their own cloths. Mising women weave a world famous fabric called 'Mirizim' that is known for striking designs and pleasant colour combination. The popular art work of mask making is also one of the craft works of the people during the time of religious festivals.

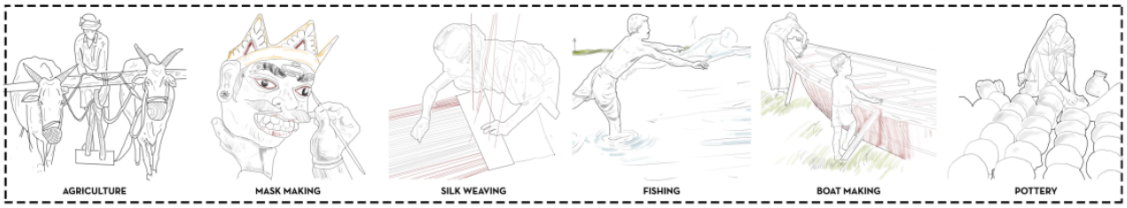

Figure 4. Major occupations of people of Majuli

2.3. Environmental setting of Majuli

Majuli island forms a part of hyporheic zone of the Brahmaputra river basin. The island is bounded by the Subansiri river on the northwest, the Kherkatia suti (a spill channel) on the northeast and the main Brahmaputra river on the south and southwest. The island extends for a length of about 80 km from east to west and for about 10 to 15 km width along the north to south direction with a total area of about 875 sq. km. Majuli is purely a region of fluvial geomorphology. It rises from the Brahmaputra basin and in course of time turned into a flat-level alluvial plain. The geomorphology of this region is directly related with its physiographie characteristics. The island is bounded by the river Subanisri and her tributaries Ranganadi, Dikrong, Dubla,Chici and Tuni etc. on the North west, the kherkatia Suli (a spill channel of the river Brahmaputra) in the northeast and the main Brahmaputra River on the South and the South west. These tributaries usually bring flashy floods with heavy load of fine silt and clayey sediments.

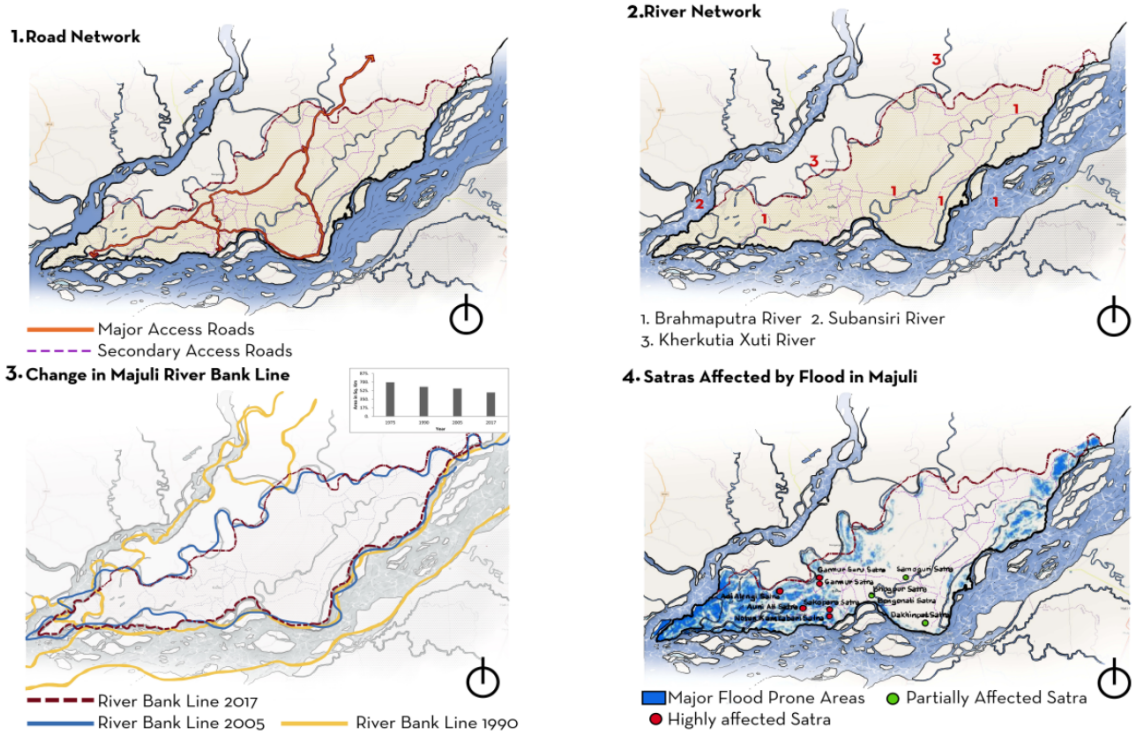

Figure 5. **1.Road network map 2. Major Rivers of Majuli 3. Change in Majuli river bankline 4. Map showing the important Satras of majuli**

3. Major issues and threats of Majuli

Majuli island floods every year during the monsoon season and the natural floods help crops flourish and feed fish populations. But Majuli is accelerating. Much of the acceleration is caused by climate change. Rising water levels and increasingly severe weather patterns are never beneficial to a sandy island's waistline. Rain and monsoon patterns, once relatively predictable, have become erratic at best, leading to a loss of crops and property for Majuli's agricultural community. Most of these people belong to the Mishing clan and, as their land and villages have disappeared, they have been transformed from farmers into laborers. Majuli is well-known for having suffered from two natural hazards: severe bank erosion and flooding. Erosion has increased the pressure on the available land manifold and has made living on the island unsustainable for many displaced families forcing them to migrate out of Majuli. The island had 210 revenue villages and 33 non-cadastral villages, primarily resettled and rehabilitated due to flood and erosion.

The impact of these floods and erosions are –

- Displacement of people, loss of agricultural land and home
- Weakening the economy of the island,
- Lack of physical and social infrastructure such as improper road networks,
- Lack of proper medical facilities,
- Flood affected school buildings which hamper the education system of the place,
- Loss of culture and heritage and also severe psychological effects amongst the people.

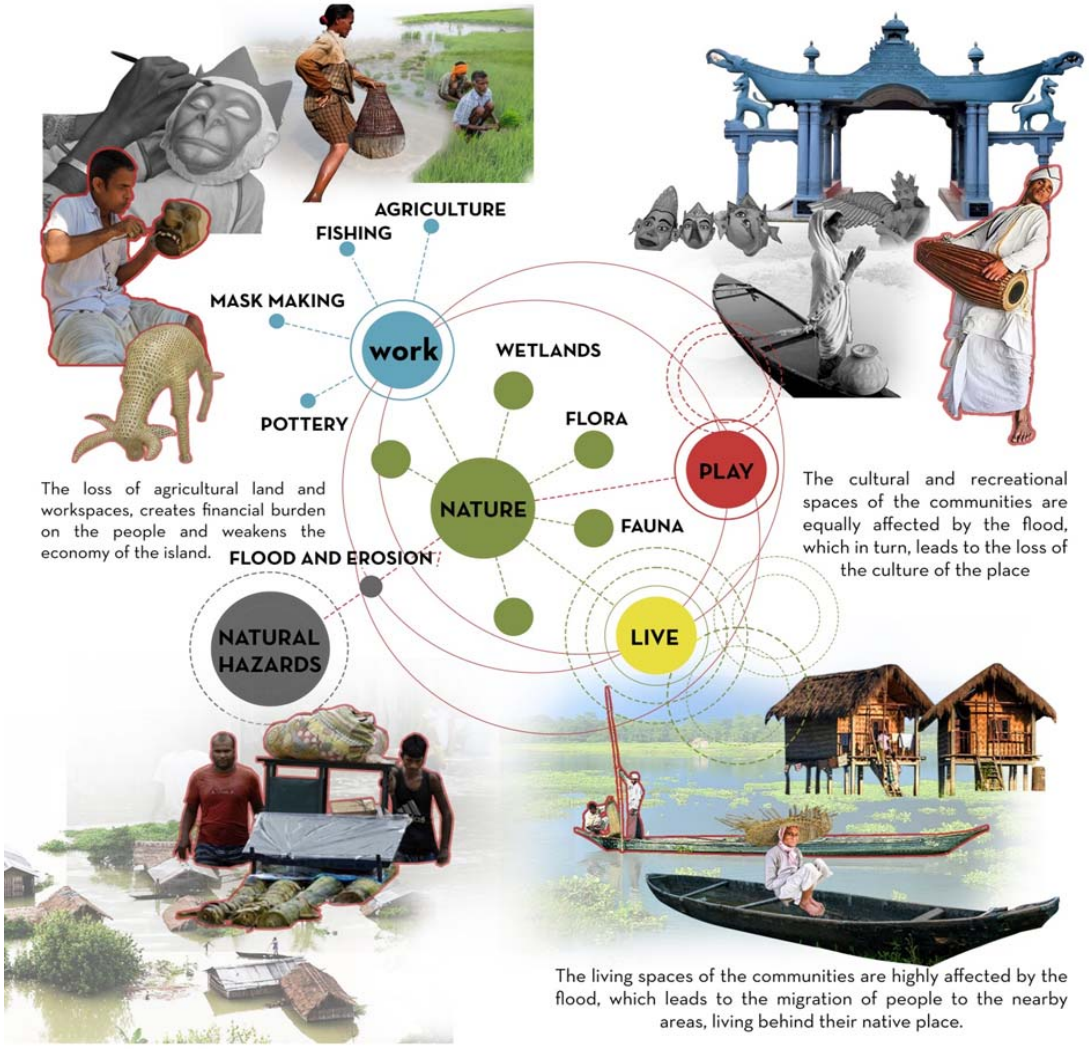

Figure 6. Major problems and issues of Majuli island

Geographical Problems

The Island, which is more than just a physical location, has faced numerous issues, mostly of a geological, economic, and cultural nature. The stream Brahmaputra has posed a serious threat to its physical survival due to ongoing flooding and erosion. There is hardly any chance of Majuli Island disappearing from this country's map due at least to erosion or the river Brahmaputra, which has now become the key to the cry for the protection program. However, based on historical experience and geological reset, it may be argued that in the distant future serious threats be possible for the Suvansiri rather than from the river Brahmaputra.

Economic Problems

Even though Majuli Island's economy depends on the growth of its agriculture, the island's agriculture is not yet established. The usage of HYV seeds, insecticides, fertilizers, and pesticides, as well as irrigation, are improperly used in the development of agriculture. The intended level of contemporary production techniques adoption has not been reached. Additionally, Majuli Island lacks sufficient marketing infrastructure for a variety of goods. In addition, the annual floods can do significant harm to the Kharif crops. Therefore, the focus should be placed on developing an appropriate agronomic program for the advancement of agriculture. Proper selection of crop rotation planning is not only helpful in minimizing the risk of flood damages, but also in increasing the income of the farmers.

Cultural Problems

Majuli Island's village pottery industry is struggling with numerous issues. In the first case, it should be noted that the industry requires more labor and time. For the time of manufacture to sale, a lengthy period is always required. Regarding the goods purchased at the market, transportation is another issue. Due to the sensitivity of the products and a greater level of one of production expenses, a significant level of risk is always there. There is no need to discuss the natural disaster that must undermine market principles. The rising scarcity of mud soil and fuel forests is the biggest worry. Another flaw in the sector is its lack of organization. The state of the economy of the populace almost harms the sector. A group of people may occasionally condemn the trade for encouraging erosion on Majuli Island. However, Majuli Island's heritage is tied to the clay business. The past and present are connected by it.

The Brahmaputra and one of its major tributaries, the Dihing, once flowed parallel and close to each other. *An extreme flood, which occurred around 1750, appears to have diverted part of the flow of the Brahmaputra through the channel of the Dihing about 190 km upstream of its confluence. When the two rivers joined, the intervening land area formed Majuli Island.* Majuli was a component of a substantial region at the start of the seventh century. Majuli had a landform that was undulating physiologically. It was connected by the rivers Lohit and Dihing to a network of both large and small Chaporis, or islets, that were created through various waterways. Diverse forms of natural resources i.e. rivers on the southern and northern side, a network of tributaries, and the Chaporis (small Islands) together developed a mid-river delta system.

4. Flood Analysis

Presently Majuli is well known for having suffered from two natural hazards: severe bank erosion and flooding. Because of its peculiar location amidst the active floodplains of the Brahmaputra, Majuli gets inundated not only in severe floods but also in normal floods. The summer monsoon season is the main flooding season for Majuli. Government has constructed more than 100 km embankments surrounding the island in an effort to give relief from recurring floods. But breaches in the embankments due to high floods and erosion rendered the situation worse. The flood of Brahmaputra River has been creating havoc every year in the Island.

A considerable part of Majuli island is inundated by spill waters of Brahmaputra river and Subansiri during monsoon causing disastrous floods in its lowlands. The highest flood discharge recorded in the Brahmaputra at Bessamara (Southeast of Majuli) is 51,384 m3 /s in the year 1987, which is 23 times the minimum flow observed in that year. The 100-year return period flood has a magnitude of around 47,131 m3 /s with corresponding High Flood Level of 87.83 m at Bessamara gauge discharge site of the river.

The magnitude and frequency of bank-full discharge is considered to be of great geomorphic significance in the development of channel geometry and formation of flood. The bank-full discharge (corresponding to danger level, a level or stage at which the river just tops over the banks) has a magnitude of approximately 20,000 m3 /s. On the flood frequency curve, the recurrence interval of this discharge is 1.01 years.

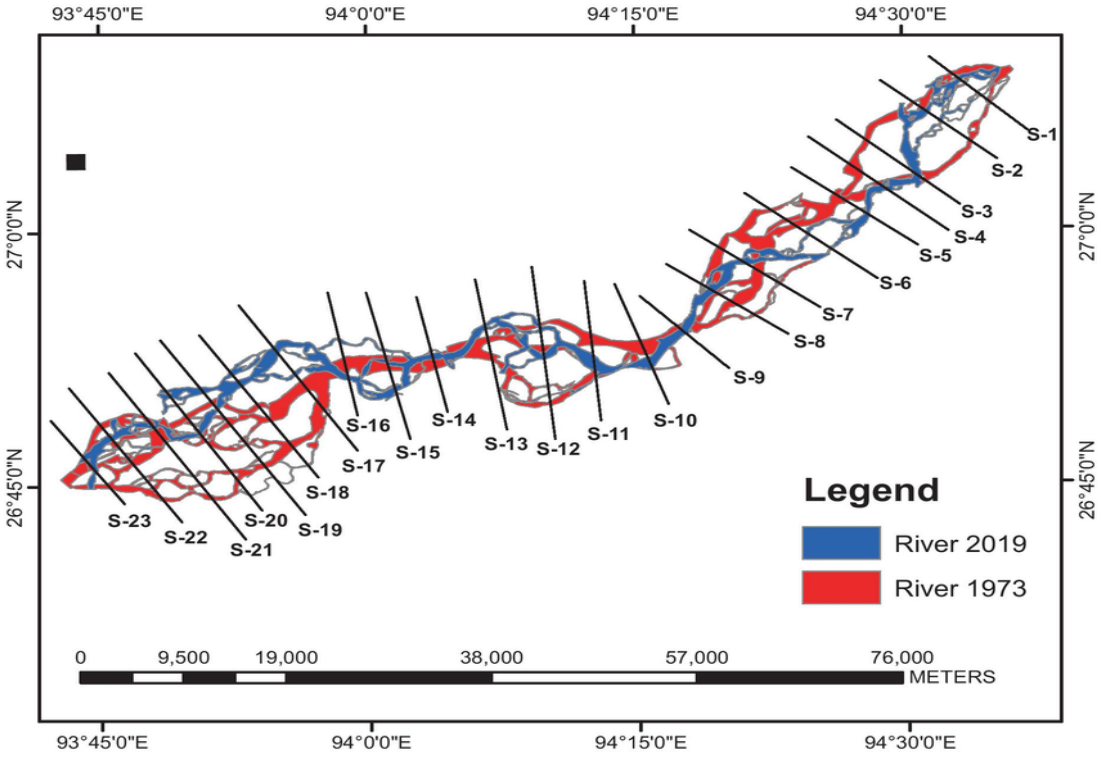

Figure 7. River Channel migration from the year 1973 to 2019
Image source - Google

5. Policy and Frameworks

5.1 Restoration Methods -

A. Brahmaputra Board

A positive aspect for Majuli is that a number of organizations are working for the protection and preservation of this unique island. Execution of Majuli protection work by the Brahmaputra Board has resulted in the river island regaining landmass at an average rate of 2 to 2.5 sq. km annually. In 1996, the Flood Control Department of the Assam Government requested the Brahmaputra Board to prepare a Master Plan and also carry out hydraulic studies to suggest suitable anti-erosion measures. In November 1999, Brahmaputra Board prepared a Scheme for Protection of Majuli Island from Floods and Erosion' at the estimated cost of Rs 86.56 crore, based on the recommendations of the Master Plan of Brahmaputra River. The scheme was proposed to be implemented in three phases – Phase one at Rs 41.28 crore, Phase two at Rs 18.28 crore and Phase three at Rs 27.00 crore. The scheme was submitted to the Central Water Commission by Brahmaputra Board during August 2000, which was cleared in August 2003 by Ministry of Water Resources, Government of India. Since January 2004, Brahmaputra Board has incurred expenditure for undertaking measures for the protection of Majuli Island from floods and erosion under various Phases is detailed in table below.

Broadly, protection works encompass raising and strengthening of embankment, plugging of breaches, casting and laying of permeable RCC porcupines' screens, spurs and dampeners, construction of boulder spurs, river bank revetment and construction of raised platforms.

Table : Expenditure Incurred by Brahmaputra Board for Protection of Majuli Island under Various Phases

Sl. No.	Description	Estimated cost (Rs in crore)	Actual Expenditure (Rs in crore)	Remarks
1	Immediate measures (Year 2004-2005)	6.22	5.92	Completed
2	Phase- I (Year 2004-2011)	56.07	53.40	Completed
3	Emergent Measures (Year 2008)	4.99	4.62	Completed
4	Phase-II & Phase-III (2011-December 2013)	115.99	84.12 (up-to December 2013)	71.57% of physical progress has been achieved. The scheme is targeted to be completed by March 2014.
Total		183.27	148.06	

Source - :http://brahmaputraboard.gov.in/NER/Archive/Brahmaputra_Board_at_a _Glance.pdf

Table : Land Mass Reclaimed by Majuli Island since the Implementation of Protective Measures by Brahmaputra Board

Year	Area of Majuli Island (in sq. km)	Net Area reclaimed (in sq. km)
2004	502.21	
2008	506.37	4.16
2011	520.26	13.89
2013	522.73	2.47
Total		20.52

Source -:http://brahmaputraboard.gov.in/NER/Archive/Brahmaputra_Board_at_a _Glance.pdf

B. Non-Governmental Organizations (NGOs) in Majuli

To save the physical and geographical structure of Majuli i.e. to cease the erosion of Majuli or to avoid flood devastation and to assist the natural calamity affected people, various social organizations and NGOs were setups in Majuli. Moreover, many organizations are working in Majuli involving themselves with various activities to maintain the ecological balance, to preserve the near-extinct species of birds and animals, to create health awareness or to attract tourists from foreign countries.

In Majuli, at present, there are more than 34 registered NGOs under Farm and Societies Registration Act 1860. However, only a few NGOs are actively working for the socio-economic development of Majuli among which —Majuli Island Protection and Development Council (MIPADC) is an NGO who is concerned about the conservation and development of the island. The objective of the organization is to build up mass awareness about the perilous future of this unique Island and its shrinking shoreline due to rapid erosion. The MIPADC initiated a movement for wresting the United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage Site status to Majuli for the first time in 1998. It submitted a nomination on its own to the UNESCO, through the Governments of Assam and India, the same year. The UNESCO, after examining this dossier, had declared Majuli's case as a fit one for the purpose and granted US $ 20,000 for preparation of a detailed nomination dossier.

'Sadbhavan' is a voluntary organization to provide services for socio-economic development of downtrodden people of flood affected areas of Majuli with a special emphasis on women empowerment of people of schedule caste and schedule tribe community of the Majuli. Abakash Majuli is another NGO organizing various activities including career counselling camp, medical camp, flood relief camp, awareness camp on agriculture, awareness camp on Japanese encephalitis, workshop on women empowerment, workshop on Sattriya dance, etc.

C. Majuli Cultural Landscape Management Authority (MCLMA)

The MCLMA was set up as a statutory body under the Majuli Cultural Landscape Region (MCLR) Act, 2006. The Act came into effect through Government Notification dated 27/07/2006. The act has mandated the MCLMA to integrate development and heritage for the protection of heritage resources of MCLR through education, awareness, understanding of the cultural significance and ensuring a sustainable and positive development trend. MCLMA aims to protect the island from floods and erosion and development as well as preserve its unique. In keeping with the Government of India's initiative to wrest WHS status for the river island, the MCLMA has undertaken initiatives to make the people aware of the cultural treasures preserved by the islanders and the need to uplift the island's status to that of a WHS. The executive body group of the MCLMA consists of 30 members with the chief secretary of Assam as its chairman, cultural affairs principal secretary its vice-chairman and commissioner (Upper Assam division) its chief executive officer. Besides, Government of India has been advocating for Majuli to be declared a UNESCO world Heritage Site in an effort to preserve this socio-culturally rich island.

5.2 Policy Implications

i) Retirement embankments in the island should be reconstructed immediately using latest technology.
ii) Brahmaputra Board should bring reclaimed land (20.52 sq. km) under social forestry.
iii) People of Majuli, individually as well as through NGOs, are actively engaged in protection and conservation of cultural and natural resources of this island. Government agencies should come forward for financial support to them.

iv) Sattras of Majuli also possesses antique materials, items and resources. All antiquities, manuscript, heritage buildings should be documented and preserved.
v) A wetland, Majuli is a hotspot for flora and fauna, harbouring many rare and endangered fauna species including migratory birds that arrive in the winter season. Measures should be taken to develop Majuli as one of the bird viewing sites of India.
vi) There is a huge potential to developed river island Majuli as one of the religious and cultural tourism destinations as it is enriched with rich cultural heritage. Besides these, Majuli has also immense opportunities to develop tourism activities like adventure tourism, rural tourism, cruise tourism, wildlife tourism, eco-tourism, tribal tourism. But there is a lack of promotion about Majuli, as a tourist destination, in the International arena. The author here suggests that the Ministry of Tourism, Assam and India, should take necessary steps in this regard.
vii) All the stakeholders should come forward to prepare and submit nomination dossier for Majuli's World Heritage Site (WHS) status as per latest World Heritage Committee (WHC) Operational Guidelines.

5.3 Government Policies –

Press Information Bureau
Government of India
Ministry of Water Resources
Protection of Majuli Island – Endeavour of Brahmaputra Board

The Union Minister of Water Resources, River Development and Ganga Rejuvenation Shri Nitin Gadkari will lay the foundation stone for a new scheme for protection of Majuli Island in Assam from flood and erosion of river Brahmaputra, at an estimated cost of Rs. 233.57 crore tomorrow. The scheme has been framed by Brahmaputra Board based on the recommendations of the high level Expert Committee of the Government of India that visits the island at least twice a year to monitor and recommend anti-erosion measures. The major components of the scheme include (a) Bank revetment with geo bags filled with earth / sand for a reach length of 27 km in 14 locations (b) RCC porcupine works in 41 locations (c) Construction of a sluice and (d) Construction of a Pilot channel for a length of 3.50 km. The scheme was sanctioned by Government of India in March, 2017. The funding for the project would be from Ministry of DoNER.

Brahmaputra Board was initially requested by Government of Assam in 1999 to take up necessary measures for protection of the Island. Formal 'No Objection' of Government of Assam for execution of flood and erosion protection works in Majuli Island was communicated in August 2003. Work was started by Brahmaputra Board in January 2004 in 4 phases.

Before the protection work was taken up by the Board, cultivation could not be done in many areas of the island such as Malowal-Malapindha during kharif season due to large numbers of breaches in the embankment. People suffered from flooding year after year and land of the island was lost at about 2.5 sq km in a year. Due to raising and strengthening of 96.25 km of existing embankment, the entire area of Majuli Island within the embankment is now secured from floods unless there is breach in embankment. Communication from remote areas has improved as people use these embankments as roads. Due to implementation of the anti-erosion and pro-siltation measures such as RCC porcupine, bank revetment and spurs, the situation of Majuli Island has now reversed in most areas.

Erosion in most of the vulnerable locations except for a length of about 10km along Brahmaputra could be contained due to these measures. Judicious laying of porcupine screens encouraged heavy siltation and have brought about favourable changes in the river morphology and regime.

Reclamation of land started and area of Majuli Island increased from 502.21 sq km in 2004 to 524.29 sq km in 2016 with net gain of 22.08 sq km as per study on satellite imageries. Thus, not only overall erosion of the Island is arrested, but the trend has been reversed favourably. It is noteworthy that Brahmaputra is one of the most difficult rivers to tackle as it is very dynamic with morphology changing continuously. Measures adopted elsewhere may not be applicable in this river which is 3rd largest in the world and carries highest silt amongst the rivers of its size.

6. Conclusion

In order to maintain the presence of the age-old cultural tradition of the island, the physical processes operating in the region need to be taken cognizance of and tackled if need be, to protect the island and its heritage. Necessary steps need to be taken in order to secure the future of the land, its people and the golden heritage it bears. The fresh water river island Majuli have suffered a significant rate of erosion since historical time. Observation on the bank line migration spanning the period from 1966-1975 to 2008 an extensive rate of migration was observed. The bank line of the Brahmaputra Rivers has migrated for a distance of about 6 km towards north at Khorapargaon and 5.1 kms near Ujani Gejeragaon. The bank line of the Subansiri River has shown its migration up to a distance of more than 3km towards south specifically around Bohumari and Nunibari areas.

Remedial Steps to Protect Majuli

Steps Taken:

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The major components of the scheme include-

(a) Bank revetment with geo bags filled with earth / sand for a reach length of 27 km in 14 locations

(b) RCC porcupine works in 41 locations

(c) Construction of a sluice and

(d) Construction of a Pilot channel for a length of 3.50 km.

The scheme was sanctioned by Government of India in March, 2017. The funding for the project was from Ministry of Development of North Eastern Region (DONER)

Further Steps

The vulnerability of the population to climate change is high as the adaptation capacity of the village is declining in light of uncertain flooding that disturbs their crop cycle and annual crop calendar. This is reflected in the flood damage data produced by the Brahamapura Board, a nodal agency established by the government of India in the 1980's to manage flood and erosion in the Brahmaputra river basin.

To live with floods the Mishing families lives in chang ghars (stilt house) that are made of locally available bamboo; when the damage induced by the floods is greater they move to higher lands. This has been passed down from generation and does not prevent them from flood damages to their cropland and livestock. Therefore their vulnerability to floods will persist.

While seasonal migration acts a safety valve to the imminent hydro hazards induced livelihood crisis, the real solution lies in finding solution through the use of community's indigenous ecological knowledge that would enhance their per capita income through participation in other activities that are not dependent on land alone.

The **promotion of cultural tourism** can be one of them. Majuli has been nominated twice as a **Cultural Landscape** for the **UNESCO'S World Heritage Site** (2012). Its unique Vaisnavait satra culture (namghars) attracts tourist from all over the world. The rich cultural tradition of drama, folk music and monasteries own Assamese literary and philosophical texts (locally known as burunjis) are of unique interest to promote cultural tourism. The need of the hour is to **promote tourism sensibly**—by highlighting the ***tangible and intangible heritage*** of the island—so that the local communities can economically support themselves by engaged in eco-tourism work such as working as tour guides, restaurant owners, boat owners, lodgers and story tellers. They can earn additional income and compensate the loss caused by flood and bank erosion.

Similarly institutions like the **Brahmaputra Board** and policy makers working on natural disaster management as well as the epistemic community should encourage the incorporation of ***place based knowledge of the community*** to be intergrade to mainstream flood management planning. The place-based knowledge of the community has historically developed to cope with growing uncertainty with floods. However, due to the erratic nature of floods and cloud burst induced flash floods during the pre-monsoon season farmers crop calendar has been readjusted.

The state agriculture department can help the community by incorporating their local understanding of farming in their ***agriculture improvement programmes***. Therefore the approach to climate change mitigation and disaster risk reduction should be visualised around local knowledge through the ***engagement of the communities and civil society groups*** that could work as facilitators in promoting sustainable livelihood.

Climate Change can be combatted by developing ***alternative livelihood opportunities*** for the community through ***community driven development programmes*** and by incorporating local knowledge in disaster management.

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