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# Changing climate and its impacts on Assam, Northeast India

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## Abstract

The paper explores climate change induced hydro hazards and its impact on tribal communities in Majuli (largest river island of Brahmaputra River Basin). The island has been experiencing recurrent floods, erosion, and siltation, which has distressed the socio-economic foundation and livelihood of the Mishing—a indigenous community on Northeast India, leading to out migration from the island. The indicators selected to capture the vulnerability of the island to climate change are dependency ratio; occurrence of natural hazards (floods) and coping methods; income of the household; and livelihood diversification. To gather the quantitative and qualitative data on these parameters the methods was designed to conduct both sample survey of households and focus group discussions. The findings reveal that in the selected villages, the dependency ratio is 4 (dependents): 1 (earning member); average income of the household is low i.e. \$ 40/month and is declining as compared to last few years because of frequent floods, erosion and siltation that has decreased farm productivity which is the main source of income. The impact of changing climate and heightened flood and erosion risk to farmlands has been forced migration to cities and neighboring urban centers like Jorhar for stable livelihood. Therefore, we propose that a possible way to enhance social resilience to changing climate and vagaries of monsoon (tropical disturbances) is to promote alternative occupation like eco-tourism as (Majuli is the center of *Vaisnavism* and *Satras* in Northeast India) and invest in adaptive strategies to mitigate flood by incorporating lay and place-based knowledge of the Mishing community in flood management. Also facilitate community's participation and awareness towards hydro hazards based on flood proof housing focusing on indigenous knowledge.

**Keywords:** Adaptation, Agriculture, Floods, Majuli Island, Mising tribes

## Background

Climate change is gaining importance as scientific and socio-economic studies have brought forth substantial evidences (American Meteorological Society 2012; Norris et al. 2008; Agrawal and Perrin 2008; Paavola 2008; IPCC 2014; UNFCCC 2007; Adger and Kelly 1999). The impact of climate change is more likely to have an adverse effect in the developing countries due to high dependency on climate sensitive livelihood like rain-fed agriculture, water, and forestry (Moorhead 2009). The human development report of 2014 also declared that climate change has limited the choice of an

individual and would further erode 'human freedoms' (UNDP 2007). According to IPCC (2007) climate change is real and already taking place. The report states that the impacts of climate change and their associated costs will fall disproportionately on developing countries threatening to undermine achievement of the Millennium Development Goals, reduce poverty, and safeguard food security. Climate Change will reduce access to drinking water, affects the health of the poor, will pose a threat to food security. Various researchers have established that larger burden of climate change disproportionately falls in the developing countries of the global south (Agrawal and Perrin 2008; Norris et al. 2008; Paavola 2008; UNFCCC 2007; Adger and Kelly 1999). Additionally, poor people in developing countries tend to be more vulnerable due to limited opportunities and choices, small land holdings and lack of access to market. Within countries the marginalized groups have limited resources and capacity to adapt and are the most vulnerable (IPCC 2001). Climate change policies are crucial for enhancing adaptive capacity of the community.

Institution plays an important role in community's adaptation to climate change (Berman et al. 2011). Various adaptation measures have been under taken across societies to fight the impacts of climate change. One of the most common methods of adaptation is migration. In areas where livelihood choices are limited, decreasing crops yield may lead to out migration. Climate change has been cited as one of the growing drivers of migration across the world (ADB 2012). IPCC in its first assessment report has mentioned that by 2050, estimated 150 million people could be displaced due to climate-induced factors like floods, drought on storms (IPCC 1990). However, migrations may not be the best methods to adapt to climate change. Various factors like education, health, sanitation, are likely to be affected by migration. Therefore, there is a need for proper adaptation strategies to fight the long-term impacts of climate change.

Both India and Bangladesh face many common challenges. Even as their overlapping geographies allow them to share a climate, with its associated vulnerabilities, their use of common resources like water means that actions in one country can profoundly impact the other. As the impacts of climate change begin to set in, the commonalities in the former will lend greater urgency to the relationship in the latter. As both countries begin to face ever-increasing temperatures and ever more erratic rainfall patterns, they will be forced to find greater common cause in their shared water resources. Majuli River Island in Upper Assam located in the Ganga–Brahmaputra–Meghna (GBM) river basin is the geographic focus of the paper. We will look at a micro region Majuli island as a case study to understand the impact of climate change and glacial ice melt in the Himalayas and Tibet that triggers floods and bank erosion induced displacement of people in the local environment and how communities cope with it in Assam, India.

In Majuli like other parts of South Asia climate change is having disproportionate impact of marginal people particularly the Mishing communities who live and depend on the river island for their livelihood. Majority of the research on Majuli have focused on bank erosion, rainfall pattern, drainage discharge of the Brahmaputra river, geomorphic changes in the river basin and the impact of the 1950 earthquake on settlements and fluvial pattern of the river (Sarma 2014). There is hardly any discussion of local knowledge system and resilience of the community to manage natural disasters triggered by global weather change. This paper will make a small beginning in this direction by bringing to

the forefront communities adaptation to flood and bank erosion in Majuli River Island focusing on the Mishing community. This is important to understand the human dimension and plight of the local communities and how they evolve resilient strategies to live with floods. The findings of the paper will be of interest to policy makers and experts to design new strategies on how community knowledge can be integrated to policymaking on climate change and disaster risk reduction.

Taking this in perspective, a study was conducted in Majuli Island, located in the river Brahmaputra in India. The following objectives were considered for the study.

- i. What are the strategies adopted by the communities to match the impacts of climate change like flood, erosion and siltation?
- ii. Is migration undertaken as an alternative to enhance adaptation to climate change?
- iii. What are the plausible options available to the people to enhance the adaptive capacity?

### **Climate change and migration**

Climate change in the developing world is a hindrance in the path of development. Although the basic science of climate change is simple, the causes and likely impacts of climate change on human beings are highly complex (Hepburn and Nicholas, 2009). The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment report 2007 (AR4) has declared that “Warming of the climate system is unequivocal, as is now evident from observations of air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level” (IPCC 2007, p. 30). IPCC (2007) makes it clear that climate change is real and is already taking place. Climate change will have wide-ranging effects on the physical environment as well as on sectors like water resource, agriculture, food security and human health (UNFCCC 2007). The fear is that the impacts of climate change in the form of droughts, famines, floods, variability in rainfall, storms, coastal inundation, ecosystem degradation, heat waves, fires and epidemics will undermine the international efforts to combat poverty (HDR 2008). Although many areas could experience temperature increases in the region whereas some areas may actually cool under global warming conditions (Houghton et al. 1996). Patterns and amounts of precipitation are also likely to change, and it is projected that rainfall will increase in some areas and decrease in others (Houghton et al. 1996).

The social and physical impacts of climate change are not uniform or homogenous as the magnitude and direction of climate change across the globe vary and even within the same regions experiencing climate change are likely to vary because some ecosystem, sectors, or social groups are more vulnerable to climate change than others (O’Brien and Leichenko 2000). As evident from various literatures (Adger and Kelly 1999; UNFCCC 2007; Norris et al. 2008; Agrawal and Perrin 2008; Paavola 2008) the impact of climate change will fall disproportionately among the different sections of the population, which is more likely to strike economically developing countries or poor countries even harder. As a consequence natural resource-dependent rural households in developing countries are likely to share a disproportionate burden of the adverse impacts of climate change (Agarwal and Perrin 2008).

Recent studies shows that climate change has lead to migration of rural communities in search of better livelihood opportunities. Climate change will increase migration due to factors like warming and drying of some region which will lead to decrease in agriculture productions and high precipitation leading to floods in low lying areas (Shamsud-doha and Chowdhury 2009). Climate change will especially lead to forced migration of rural communities in developing countries whose livelihood mainly depends on agriculture (Brown 2008). Large numbers of people are displaced every year due to floods and drought in most of the developing countries in Asia and it is likely to increase in the coming years (ADB 2012). High rate of poverty, population growth, limited landholding size, limited livelihood opportunities and government policies combined with environmental factors have increased forced migration in the global south. According to a report published by International Organization for Migration (IOM), forced migration increases pressure on urban infrastructure and services, undermine economic growth, increases the risk of conflict thereby leading to low human development among the migrants (Brown 2008). Migration due to climate change is likely to evolve into a global crisis (Panda 2015). In countries like India and Bangladesh, there are many instances of migration leadings to ethnic tension and conflicts. For example, in Assam the presence of Hindustani people coming from central India and Bihar has caused ethnic tensions and violence in the past. Similarly the perceived threat that people from Bangladesh will immigrate to northeastern part of India due to its low population density once climate change intensifies cyclones, floods and sea level rise in the coastal belt of Bangladesh has raised threats of ethnic clashes and violence in the region. Nonetheless there are both positive as well negative impacts of migration. Positive impacts are in the form of remittances that are likely to boost the economy of the household whereas negative impacts are likely to increase the rate of unemployment, illiteracy and slums in the urban areas. Various human development indicators like education, health, sanitation, access to water, and assets might be missing from the migrant.

The link between migration and poverty is complex and dependent on the specific circumstances in which migration takes place. Migration can both cause and be caused by poverty. Poverty can be alleviated as well as exacerbated by migration. In Kerala, India, for example, migration to the Gulf States has caused wages to rise, reduced unemployment, and improved the economic situation of those left behind (Zacharia et al. 2002). In other situations, migration does not lead to economic or social improvement. Research on the impact of labour migration in tribal Western India found that for poorer migrants 'many years of migration have not led to any long-term increase in assets or any reduction in poverty'. However the study also noted that migration offered poor migrants 'a short-term means to service debt and avoid the more extreme forms of dependency and bondage' (Mosse et al. 2002).

Therefore, it is important to enhance employment opportunities among rural communities who are likely to face the heat of climate change. Our study will explore whether migration has been undertaken as an alternative ways of adapting to climate change.

### **Majuli River Island**

The study mainly focuses on how climate change may have an impact on the livelihood of the people inhabiting Majuli. It is a river Island located in the midst of the

Brahmaputra River in Assam, India and is recognised as one of the largest river Island in the world. The population of the Island is 1.68 lakh (Go 2011) with majority of the population belonging to tribal communities namely Mising, Deori, Sonowal Kacharis. The poverty rate of the Island is high with around 21.47 % (District Administration, Jorhat, India) of people living below poverty line i.e. less than \$2 per day. Due to the intrinsic link between poverty and vulnerability (Adger and Kelly 1999), poverty has been kept at the centre while assessing community's vulnerability to any type of changes. The Island has been constantly affected by flood and erosion. Due to continuous erosion the Island is gradually shrinking in the last century (Table 1).

The island is vulnerable to flood and bank erosion which has resulted in the shrinking of the land area. More than 90 % of the population is dependent on agriculture for their livelihood. Erosion has been a major problem in the region and every year hectares of agriculture land are eroded along with standing crops. Another problem faced by the people of Majuli is flash flood during the rainy season. Climate change is particularly thought to be adversely affecting the livelihoods in rural locations because of dependence on subsistence agriculture and the vagaries of monsoon rain and unpredictable floods. The impacts of climate change have been felt in the area with continuous shifts in rainfall pattern as well as changes in the temperature. These study mainly focuses on the community's vulnerability to any type of environmental change mainly climate change and building resilience among the rural communities by enlarging the capability of the people. Pomua, Kumarbari, and Jengrai Chapori are the three villages located in Majuli Island, Jorhat district which were selected as study sites based on the following criteria:

(A) Poor economic conditions: Majority of the population of Majuli are dependent on agriculture for their livelihood. As mentioned earlier, due to constant flooding of the region crops are destroyed leading to high-rise in poverty. (B) Vuloods and erosion: Erosion and flood has been a common problem in the Island. Every year during the time of monsoon due to heavy rainfall fall in the region the area is flooded as well as agriculture land are being eroded making the people vulnerable. (C) Small land holdings of households: Most of the farmers have a small land holding of agricultural land that acts as the prime source of household income.

## Methods

The research was initiated with identification of research problems followed by a literature review and secondary data collection, based on which villages were selected and schedules were prepared to gather the quantitative and qualitative data. Sample populations were identified to conduct the survey and discussions and data were analyzed and interpreted after aggregation.

The following figure depicts the framework followed (Table 2).

### Selection of villages for the research study

Kumarbari and Jengrai Chapori are the two villages located in Majuli Islands, Jorhat district which were selected as study sites based on the following criteria:

1. Poor economic conditions (income).
2. Vulnerability of the villages to flood and erosion.

**Table 1** Area eroded in Majuli River Island. Source: Suryanarayana Murthy 2012

Loss of landmass (in sq km) in Majuli island by erosion	Land area	Area eroded	Average area annually lost	Data source
1914	733.79	–	–	Survey of India
1949	588.79	24.88	0.71	Survey of India
1963	513.89	120.12	8.58	Survey of India
1988	510.79	74.90	3.00	IRS LISS 3
2004	502.21	8.58	1.3	IRS LISS 3
2008	506.37	–4–06	–1.04	IRS P6 LISS IV
2013	522.73	–16.36	–3.27	IRS P6 LISS IV

3. Land holdings of households.
4. Agriculture as the prime source of income.

#### Preparation of schedules

Schedules were prepared to collect quantitative and qualitative data. Quantitative data was collected from households through a questionnaire, whereas qualitative data was collected through Focus Group Discussions (FGDs). The questionnaire and the focus group discussion checklist were designed after discussion with a few stakeholders in the village (a NGO called Impact NE, students and community elders who are well informed about the villages.) and secondary data was gathered through literature review.

#### Questionnaire

The questions in the questionnaire were divided into four categories as follows.

The first section of the questionnaire was intended to gather basic information about the household. It consists of questions on respondent's name, the social group to which the household belongs their occupation, literacy level, and dependency ratio in the family and agricultural land holdings.

The second section of questionnaire was based on qualitative semi structured questions to gather information on climate change and its impact felt by the respondents. The questions asked were on types of crops cultivated season-wise, changes in rainfall and temperature agricultural pattern and output, incidents and destruction caused by floods, erosion, siltation, adaptation process and migration. The third section of the questionnaire deals with information relating to policies, which includes questions relating to government policies, scheme implementation in the villages etc. This section was prepared based on information gathered from Assam.

**Agriculture policy:** The last section of the questionnaire was to see the economic status, access to market to sell the agricultural output, the amount of agricultural output sold in the market, and storage for agricultural output of the household.

**Sample population:** The sample consisted of randomly selected households. Random sample selection is a method, which allows each possible sample to have an equal probability of being picked, and each item in the entire population to have an equal chance of being included in the sample. The household survey was conducted among 30 households in each village.

**Table 2 Process of gathering information. Source: Suryanarayana Murthy 2012**

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1. Identification of research problem/framing of objectives
  2. Literature review and secondary data collection
  3. Selection of villages for the research study
  4. Preparation of schedule
  5. Selection of sample
  6. Field visit to the selected village collection of data
  7. Data analysis
  8. Interpretation
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***FGD to collect qualitative data***

A FGD checklist was prepared and a facilitator was contacted who informed the people in the village about the discussion to be held. Interaction with the concerned group was held at a convenient time and place, in order to not interfere with the time of their livelihood and daily activities. The discussion was recorded to facilitate recall of important issues and informed consent was taken before organizing the interviews. A survey of the village was done which helped immensely to observe the area with the help of villagers and supervisors to know the surroundings of the villages like fields, farming practices, irrigation facilities, and existing education and health infrastructure. It was very helpful to locate and pinpoint various physical aspects of the villages. The concerns and issues discussed in the FGDs revolved around ownership of cultivable land, agriculture pattern and practices, perception on variation in rainfall and temperature, adaptation mechanism to cope with natural calamities like floods and droughts, migration of youth, participation of women in agriculture and decision-making. In each of the three villages, two FGDs were held, one with the males, and females group, except in Pomua village where one FGD was held with males, and mixed group (males and females). The FGDs were held after a gap of 5–10 days of the survey. The FGD were held with both male and female participants to record their gendered experiences of the vagaries of flood and loss of agricultural land.

Sample population: The affected Mishing community was selected for the FGD, the group comprised of both men and women engaged in agriculture and belonging to lower income group.

Data analysis and drawing interpretation:

- i. Data analysis: The data were analyzed according the land holding of the respondent.
- ii. The qualitative information collected through focus group discussion (FGD) are collated and documented as case studies.

**Results and interpretations**

Tribal communities primarily inhabit the three villages and the random sample selected revealed that all the respondents belonged to Mishing tribe. The results of the household survey are analyzed below. Agriculture is the main occupation of the people represented by 90 % in Kumarbari and 93 % in both Pomua and Jengrai Chapori. A few of them work as government employees. Paddy is the main crop cultivated—Kharif (*Boro Dhaan*) in Monsoon, Rabi (*Sali Dhaan*) in winter, and cash crops like mustard oil, black daal,



during autumn etc. During the last few years there has been slight change in agricultural pattern and practices; recently, tractors, and chemical fertilizers (urea) have been introduced in the agriculture fields. But traditional methods of cultivation are still predominant among the villagers. Due to constant occurrences of flood, erosion and siltation in Majuli agriculture production has gone down excessively and agriculture production has no longer been profitable thereby impacting the income of the household from agriculture. Along with destruction of crops, property like houses, cattle, etc. are also washed away due to flood. Most of the farmers in Pomua (43.3 %) Jengrai Chapori (30 %) own 1.0–2.0 ha, and in Kumarbari (40 %) own relatively smaller landholding, i.e. 0.5–1.0 ha. Crops are cultivated in three seasons, summer, winter and autumn by the entire sample population. Paddy is the main crop cultivated during summer (*boro dhaan*) and winter (*Sali dhaan*) season; and cash crops like mustard and pulses (black daal) are grown in autumn season.

Rainwater is the major source of irrigation in all the three villages and a very small number of households depend on water pump (summer season: Pomua and Jengrai Chapori—3 ha each, and Kumarbari—7 ha out of which 3 ha own above 2 ha of land). Rainwater is the only source of irrigation for crops grown in winter (*Sali dhaan*) and season (cash crops). Water demand is relatively higher in summers; therefore, there are a few households, which depend on water pump. The overall perception on the impact of the change in rainfall on the agriculture output is that the produce has decreased with the variation in the rainfall, hence leading to a decrease in their income from agriculture.

All the respondents witnessed the loss of property and crops as a result of floods in the villages; they confirmed the occurrence of major floods in 1998, 2007, 2008 and 2013. In addition, they have experienced erosion and siltation of their agriculture land to a large extent; least impact was in Jengrai Chapori (41 %) and most was in Kumarbari (63 %), in Pomua, on an average 54 % of the respondents are affected by erosion and siltation. Flooding, erosion and siltation hampers the growth in agriculture output in turn impacting the income of the household from agriculture.

Therefore, employment opportunity diversification is central to raise their economic status and enhance their adaptive capacity. Although the literacy rate of Majuli is 73.92 % but the number of people attaining higher education is very low. As a result of these the chances of getting employment is very low thereby forcing people to go for unskilled jobs. As education plays an important role in building the capability of the people, therefore education of the people in the Island is crucial. Highest number of literate respondents was in Pomua (93.3 %) village followed by Kumarbari (83.3 %) and Jengrai Chapori (80 %), respectively.

The damages caused by floods and bank erosion is some times irreversible for example the loss of cropland to the river and salt deposition over farmland when the flood water enters the farmers field through embankment breaches and leaves a heavy silt deposit. Over the past 10 years nearly 30 % of the household income is lost due to erratic rainfall and floods. Most of the respondents particularly male observed that silt deposition is a major threat to their farmland besides loss of cultivable land to the river. These hazards compel households to migrate for alternative livelihood opportunities in the cities. Female members are less mobile unlike man and have to stay in the village to look after their



children's and elderly people in the family. They depend on the money send by their husbands and male family members working outside the village.

### **Result of focus group discussion**

Communities living in Majuli cultivate a variety of crops. The annual crop cycle follows the monsoon—*Kharif (Boro Dhaan)* in summer, *Rabi (Sali Dhaan)* in winter, and cash crops like mustard oil, black gram is grown during autumn. During the last few years there has been a slight change in agricultural practices—tractors and chemical fertilizers like urea have been introduced to the farmers field to improve yield per hectare and to make agriculture more productive and linked to market. But traditional methods of cultivation are still predominant among the villagers. Tractors are rented from larger landowners at the rate of Rs. 150 per *bigha*.

Rainfall has decreased as compared to a few years back. It is also observed that the rainfall generally does not occur timely as it used to be earlier. As a result of this agricultural production has decreased compared to last few years. The focus group discussions also revealed that lots of dust occurs due to less rainfall during winter seasons. Another problem faced by the people of this village is the frequent floods during monsoon months. Major flood occurred in this village during 1998, 2006, 2007, and 2008. There has been huge amount of loss and destruction caused by these floods (Please see Table 3). During floods people face problems of sanitation, health etc. The Mishing tribes live in *chang ghars* (stilt house), which are made of locally available bamboo to live with rising flood water as there households are located close to the swamps and ponds locally known as (*beel*). This method of adaptation has been integrated in the design of the houses built in Mishing villages.

The interviewed groups expressed that the summers are getting warmer and winters are becoming cooler, compared to the previous years. Vector borne diseases like diarrhea, dysentery and jaundice are widespread in the village during summer. Migration has been another major concern faced by the people. People migrate to different states like Kerala, Andhra Pradesh, Maharashtra and other parts of Assam to seek employment opportunities as semiskilled laborers in factories and as security guards. The main reasons for migration are lack of adequate employment opportunities in the village as agriculture is the main source of income. Decline in agriculture output and the vulnerability of livelihood to frequent flood and bank erosion is pushing inhabitants to seek seasonal employment outside the island. The government schemes implemented in this village include tractors, agricultural inputs like seed, fertilizers and pesticides, power tiller, 5 hp diesel pump set, 10 hp diesel power thresher for paddy, hand held sprayers are distributed to households having Kisan Credit Card (KCC). The interviewed group expressed that majority of the people don't receive government schemes. Households with high income and political patronage benefit from these schemes and not the intended relatively poorer families.

Women shares equal rights as that of men. Women are active counterparts of men in agriculture related activities. They help the male counterparts in the field and in processing of agriculture output like thrashing paddy, besides doing the household chores. They also share equal responsibility as men in decision-making process. Overall, the impact of climate change (change in rainfall and temperature) has been significant on the lives

of the people. Number of people living below poverty line has risen, migration has taken place and more incidences of water related diseases have been reported by two interviews representing Impact NE (a local NGO) present in the group discussion and there has been a overall decrease in agricultural output in the village.

### Adaptation strategies

The adaptation processes includes people moving to high areas during flood and generally live in stilt houses (*chang ghars*), which is a process of adaptation they have learned to live with floods. They also grow water resistant paddy in areas that are perennially inundated. The choice of crop cultivation and identification of worst areas affected by flood is based on their place based tacit knowledge. However, these responses are at risk due to the increase in the vagaries of monsoon and flash flood triggered by ice melt in the Himalayas during the pre monsoon season due to rising temperature over the past few years in northern India. All the respondents also mentioned that there is provision of government aid when natural calamities like drought and floods occur in the villages. Migrations have been considered as an alternative way of adaptation to increased floods. To adapt to flood and erosion people mostly youths are migrating to other places within and outside the state in search of employment. They mostly work as security guards, rickshaw pullers etc. in the urban areas. Migration has been a major problem for the people of Majuli as the workforce has been gradually decreasing in the Island. Most of the youth migrate to states like Kerala, Andhra Pradesh and Maharashtra to find employment opportunities as semi-skilled laborers in factories and as security guards.

**Table 3 Annual flood damage in Majuli 1988–1999. Source: Suryanarayana Murthy 2012**

Year	Affected area in hectares	Number of villages affected	Population affected in thousands	Cropped area affected in hectares	Number of cattle head lost	Total loss due to flood Rs in Lakhs	Period of flooding
1988	1,00,000	255	1,20,000	3657	4500	351.675	NA
1989	650	11	3081	37	NIL	0.924	NA
1990	8000	50	20,000	672	NIL	37.899	NA
1991	80,000	200	1,00,000	4590	987	510.150	NA
1992	33,000	65	30,000	40	Nil	391.150	June/92 to Aug/92
1993	17,000	60	60,000	10,500	Nil	200.75	4 Aug. 93 to 31 Aug. 93
1994	4380	3	736	NA	Nil	100.20	24 April 94 to 12 July 94
1995	30,000	110	80,000	9368	Nil	200.00	May/95 to Sept/95
1996	60,000	180	1,00,000	18,860	261	2755.98	28 June 96 to 26 July 96
1997	75,000	150	130,000	14,360	20	2259.639	5 July 97 to 16 July 97
1998	1,50,000	210	1,30,000	70,060	10,000	2912.121	July/98 to Sept/98
1999	16,000	50	3,00,000	8094	Nil	1561.125	23 June 99 to 28 Aug 99

Source: Majuli Master Plan-1998, Brahmaputra Board, Vasista, Government of Assam

All the respondents revealed that migration is prevalent in the village because of the lack of job opportunities, better employment elsewhere, poverty and vulnerability of agriculture to frequent flood and bank erosion.

### Findings

Our research in Majuli has come out with the following revelation. Firstly, the average number of dependents in the family is four and the number of earning member is one, which is relatively high and requires more resources for subsistence. Secondly, the employment diversification in the village is low as majority of the population is dependent on agriculture (90–93 % of population whose primary occupation is agriculture). Thirdly, Lack of employment opportunities in the region has resulted in a very high rate of migration (100 %) to other states. Most of the sample population (83 % in Jengrai Chapori and 80 % in Kumarbari) earn below Rs 2500/-per month as the income, which is primarily from agriculture and there is an overall response that the income is declining as a result of the changes in rainfall (80 % in Pomua, 60 % in Jengrai Chapori, and 100 % in Kumarbari).

Furthermore, the government schemes implemented in these villages are benefiting a very small section, and the beneficiaries are not the poorest households, the perception revealed in the FGD is that benefits are accrued by the households, which have association with the concerned authority. A combined impact of these changes is increasing poverty in the villages, which would weaken the adaptation capacity, and further result in more vulnerability to climate change. Therefore, the concern raised was that employment opportunity diversification is central to raise their economic status and enhance their adaptive capacity.

### Conclusion

Majuli river island is vulnerable to climate change as it experiences frequent floods, which induce erosion and siltation. In addition, climate change is taking a toll on the health and well being of the inhabitants as there is a serious problem of water related vector borne diseases. 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 Brahmapura Board, a nodal agency established by the government of India in the 1980's to manage flood and erosion in the Brahmaputra river basin (see Table 2).

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.

#### Competing interests

The author declares that he has no competing interest.

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