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Fishing as a primary livelihood option in a village hamlet affected by sand-bar movements in River Brahmaputra, Assam, India

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ABSTRACT:
Sand bars and river islands are the most dynamic fluvio-geomorphic landforms, and are characteristics of a braided river and are delineated by many fluvio-geomorphic conditions. Most of the sandbars shift due to multi river channel flow of water that creates massive erosion along with high peak flood and deposition. Thus, creating limitations to most of the households that are living below poverty line due to lack of educational, health care, transport and communication. The present study mainly focuses on the fishing households in the bank of Brahmaputra in Tezpur. Although, there has been a gradual decline in the catch of fish from open water resources because of overfishing and environmental degradation, the present study saw an increase of the fish production and a shift from agriculture to fishing since past few years after the sandbar people shifted from the char to the river bank. Three categories of fisher are identified which are professional, seasonal, and subsistence.

KEYWORDS: Livelihood, Fishing, GIS, Income

I. INTRODUCTION

Dynamism of sandbars occurs widely through diverse geographical regions and lead to the formation of Riverine Island called 'Chars' or 'Chaporis' (Sandbars). Sand bars and river islands are the most dynamic fluvio-geomorphic landforms, and are characteristics of a braided river and are delineated by many fluvio-geomorphic conditions (Dutta, et.al, 2020). Due to braided characteristics, the main river consists of various number of different sized channels and sand bars that change their locations and sizes each year (Malak, et.al, 2016). Chars are subjected to erosion on their upstream part and deposition on downstream end. Thus, the Chars migrate downstream (Hoque & Hazarika, 2020). Reported by Sarker (2003), erosional accretional process of rivers create bars like structure. For instance, Medial bars emerge in braided rivers, point bars emerge as land connected to the riverbanks occurs in both braided and meandering rivers. And these emerging lands are termed as Chars/Chaporis/Sandbars (Sarker et al.2003). The most striking feature of the change in channel configuration of the Brahmaputra is the continuous shift of the 'thalweg' from one location to another within the bank lines of the river, the movement is high during May to June and drops during the peak flood season of July to August (Malak, et.al, 2016).Scott (2013) emphasizes on the erosional impact of the Indian summer monsoon to be the driving force for erosional processes, despite of more precipitation occurs during the winter season.

Shifting the focus towards the condition of people residing on the Chaporis, their livelihood is majorly affected by the river morphology. Most of the Chaporis in the state of Assam are inhabited by Bengali-speaking Muslims (Kumar & Das, 2019). The chars are poorly connected to the mainland and thus are very much prone to acute erosion and flooding which makes the people vulnerable but, in spite of the fact that they are vulnerable to the river and sandbar morphology most of them reside in the chars, enduring the uncertain and most difficult conditions (Sarker et al. 2003). More than 80% of the people are involved in agriculture (Hoque & Hazarika, 2020), but in the case of the particular study area, fishing and daily wage work are the two major source of income due to loss of Char areas being prone to severe flood and erosion that destroys the crops or cultivation. The importance of fisheries in Assam is next to agriculture (Department of fisheries 2024). Living with challenges like low economic and social conditions, shift of land overnight, movement for work and living, etc. The history of British rule in Assam led to the process of inhabitation in chars (Kumar & Das, 2019). Migration of people living in char is frequent due to massive flood and erosion (Malak, et.al, 2016) but in the case of the study being done, most of the people shifted during 2003 to the river bank and does not move out during

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floods. Both men and women live in uncertainty and gets overburdened with domestic chores and earning a livelihood, respectively.

Most of the sandbars shift due to multi river channel flow of water that creates massive erosion along with high peak flood and deposition (Malak, et.al, 2016). Thus, creating limitations to most of the households that are living below poverty line due to lack of educational, health care, transport and communication. Bicycle is the main means of transport of the Chars and during the flood season, 'Bhutbhuti' (Machine Boat) are used as a means of transport (Hoque and Hazarika, 2020). Boats and bicycles are the two most important means of transportation found in this study as well. Survey by the 'Assam State Char Areas Development Authority' conducted in 1992-1993 and 2002-2003 declares that Char dwellers comprised of 9.37 percent of the State populace but, accountable for only 4 percent of the State's cultivable land, having high rate of illiteracy and economic backwardness (Kumar & Das, 219). In the case of present study area, people living near the chars are not illiterate as interview responses shows that most of the household of fishermen send their children to schools and most of the fishermen did their schooling to a certain level.

The study mainly focuses on the fishing households of the study site in the bank of Brahmaputra in Tezpur. Although, there has been a gradual decline in the catch of fish from open water resources because of overfishing and environmental degradation (Ahmed, et.al., 2013), the present study saw an increase of the fish production and a shift from agriculture to fishing since past few years after the chapori people shifted from the char to the river bank. Three categories of fisher are identified based on the level of professionalism, seasonal and subsistence as seen in the research paper of Ahmed (2013). Most of the households own a basic set of fishing net and have at least a rowing boat.

Therefore, the provided review of literature allows to connect the study with the socio-economic implications of the fluvio-geographic processes and how the people residing on the particular physical feature deals with day-today life to support their life and livelihood. Geomorphology influence the livelihood of people residing on a particular physical feature. Erosion and flood are the major challenges faced by the people residing on the 'Chars' (Sandbars), these force them to move away from the area and shift their shelter somewhere else. There is no certainty that they would continue working on the fields as farmers or practice fishing to earn a livelihood. To wonder upon the life of the char-chaporis people, we need to understand what are these geomorphological features and how does it impact the socio-economic condition of the people of Chars. The study prevails in the Sonitpur district of Assam, where the river 'Brahmaputra' flows through, which deposits huge volume of sand and silt on the river banks and river beds (Alluvial Deposits). The mighty river Brahmaputra known as an extremely braided river thus forming chars spread out all along the river, from east to the west corner of Assam. Studying the economic condition and livelihood that the people of the study site are engaged with and the stories of them shifting their shelter years after years showcase the uncertainty that the people of Char are abide by. Hence, more studies and government interventions should reach more such people living in the area that are not stable.

Geomorphology is simply the study of physical features such as landforms, their processes, sediments at the surface of the earth which are worked out by air, water, ice, etc. Fluvial Geomorphic processes are the natural processes that occur, produce, maintain and change the dynamics of fluvial landforms (kale,2002). Sandbars are the offshore bar that submerged or partly exposed ridge of coarse sediment or silt that is built by waves offshore from a river bed (Augustyn, 2008). Fluvial processes include – erosion, transport and deposition. All these processes together make the river a crucial agent to break down the landforms all over the world that forms the Fluvial morphology (IWM-network). Fluvial erosion occurs when the energy of the flow of river is more than the resistance of riverbed and material on the banks. The water flow depends on the stream velocity. On the other hand, fluvial deposition take place when the river losses its flow energy and cannot farther carry the sediments along with it, thus forming into sandbars or other depositional landforms. Therefore, changes of water release and silt load can cause different consequences for waterway system itself. That is Geomorphologic development of stream channels can be incredibly influenced by changes in water release and the connection between residue/sediment load and silt transport flow capacity.

This study is designed to bridge the gap between geography and livelihood of the people dependent on it and also involves application of Geographical Information System and remote sensing to understand dynamics of the chosen study

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area near the Brahmaputra river of 2003 and 2024. Remote sensing of rivers as stated by Scott (2013) is an emerging subdiscipline in the river sciences and it has grown rapidly in recent years because of the need of data to document and evolving technologies that enable low-cost data acquisition (Scott, 2013). To aware the readers about one among the various Sandbars prevails in a small area in Tezpur, Sonitpur district of Assam, the study has been conducted to understand the condition and impact on their lives by the dynamicity of the river morphology. The research question is how the channel deposits and erosion over time changes their position? And how the sandbar dynamism impacts the livelihood of the people dependent on it? To Observe what is the source of income and was there any shift of activity to earn a living of the people of chaporis and When did the people move out of the chapori and settled in the river bank of Brahmaputra? How did the pandemic affect them and their livelihood?

II. MATERIALS AND METHOD

The study was conducted based mainly on Primary Data sources for a period of 7 days in the river bank of Brahmaputra that flows through Tezpur, Sonitpur district of Assam (Figure 1). A considerable number of people were known to be associated with fishing and the method used for interview and questionnaire in the river bank along with that stretch of land was Snowball Sampling. The dynamicity of the chars was compared from 2003 to 2024 with the help of Geographical Information system. Qualitative and Quantitative methods were used for results and findings. A boat was hired to observe the char that they use for fishing. Fishermen were distinguished on the bases of professional, seasonal and subsistence along with full-time, seasonal and part-time). Group discussion with the fishermen and members of the households of fishers were conducted twice during the field visit to understand their part of story related to loss of land, fear of displacement, government initiatives that are very few and topics related to their life and livelihood. Research papers, Articles related to the keywords of the topic was selected to form literature review and to write the report based on the view of the literatures. Websites to find out the scientific names of the fishes (indiabiodiversity.org) and to generate thematic map of the river Brahmaputra flowing through the particular study location (bhuvan.nrsc.gov.in). QGIS, Area measurement location app, Google earth pro are the software used in collecting coordinates, images and making maps. Survey data were entered into excel sheets, pie charts and bar graphs are generated to show the source of income they are mostly dependent on, the sex ratio, water supply mode, family size, amount of fish they catch per day and the cost per kg of the types of fish. Tables related to socio-economic data and notes on the impact of covid-19 pandemic in their lives are made to clearly showcase the objectives of the study. Maps of 2003, 2020, 2024 was made using QGIS software to interpret the geomorphological dynamicity of the study area.

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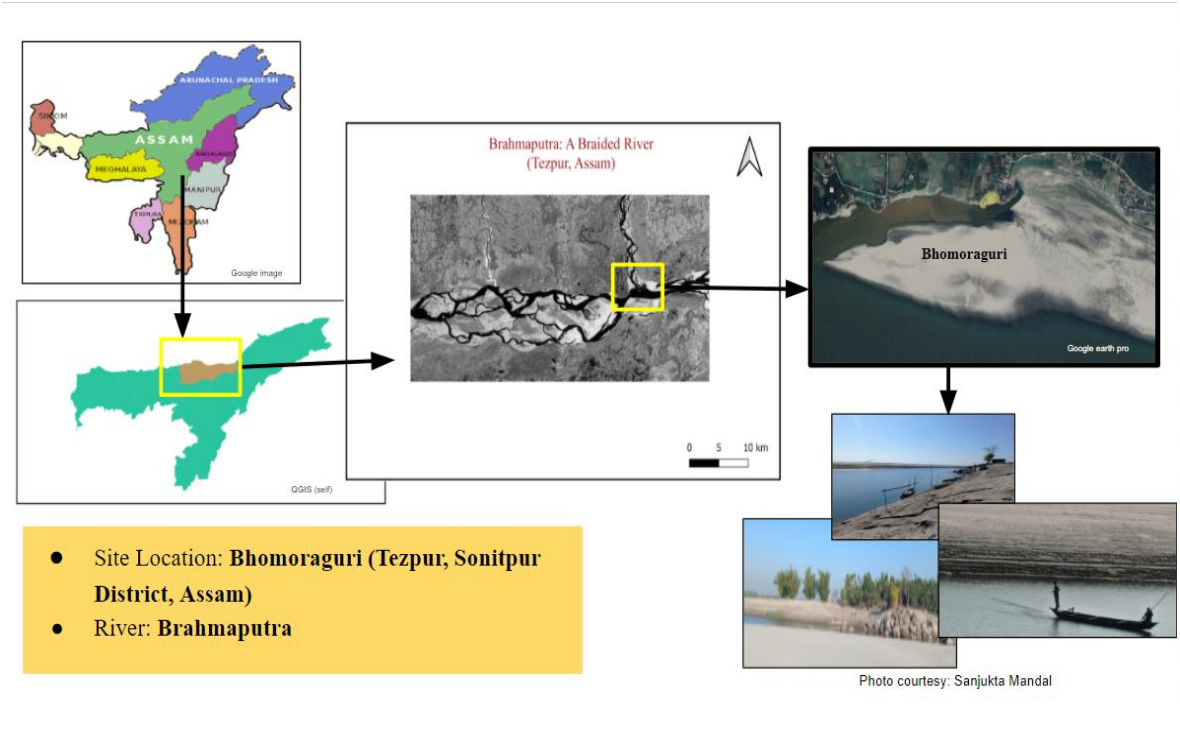

Figure 1. The study area

The Geospatial image-based study is primarily concerned with the place of riverine chars' formation in Assam. The area is located on the north bank of the mighty Brahmaputra river in the foothills of Eastern Himalayas, its coordinates are 26.6176°N, 92.8290°E and the area is 443.06 m. The ownership of the land that they are residing in is brought from government and locally given the term to be 'Medi Patta'. Extremely braided river Brahmaputra and known for its inland waterways, carries heavy silt load while entering the region of Assam which is because of the high velocity of the flow of water in the northern tributaries that flow down from the rain- soaked Himalayan slopes (Ahmed, 2019). The River Brahmaputra has a high tendency to flood, the river valley in the region of Assam is enclosed by the hill ranges on the north, to the east and to the south that receives an annual rainfall of more than 100 inches (2,540 mm). the cause of the extensive flooding of the Brahmaputra river valley occurs annually in the state of Assam during the summer monsoon. The climate near the river Brahmaputra varies from region-to-region being harsh to cold and to dry. In Assam the climate is found to be hot and humid conditions. The Indian parts of the river is dominated by monsoon climate (wet and dry). The average temperature of the Tezpur region in summer is around 36 °C (97 °F) and average winter temperature is 13 °C (55 °F). The climatic data of Sonitpur district is given in Figure 2.

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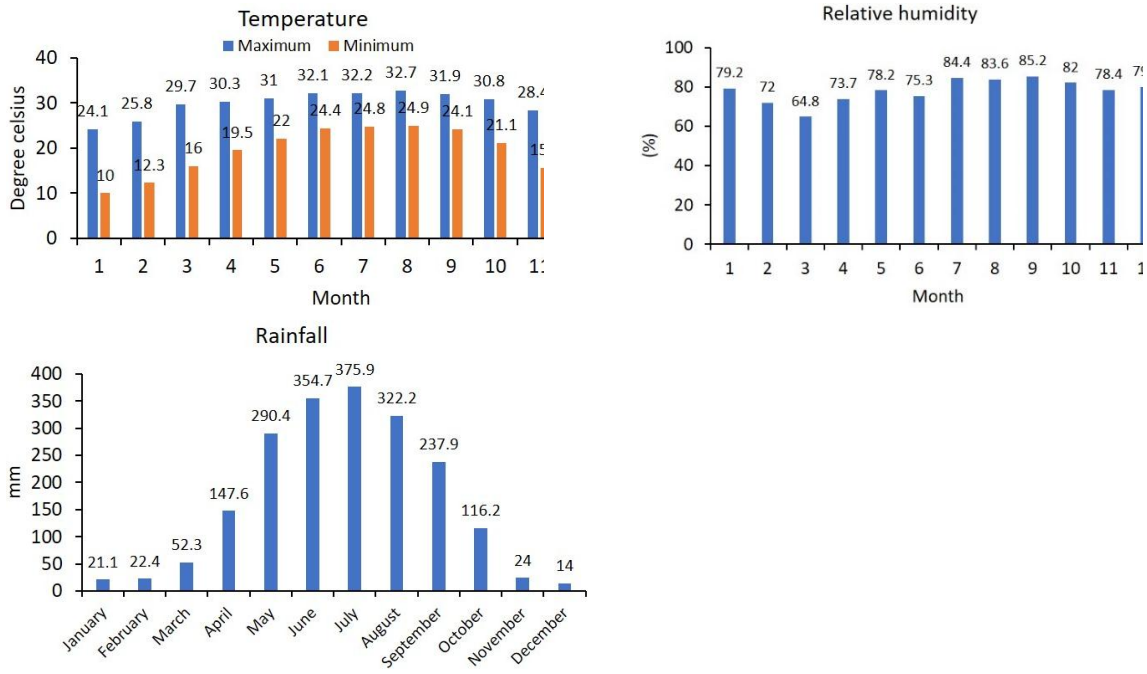

Figure 2. Temperature, relative humidity, and rainfall in Sonitpur district – 2015-2016, Assam (Adapted from KVKS 2016)

The soil type of sandbars near the Brahmaputra River bed is mainly of sandy coated with silt which is good for cultivation of winter crops such as, corn, mustard, potato, watermelon, etc. The region is enriched with numerous plant and animal species nearby the area it has a tropical semi evergreen forest. Kaziranga Tiger Reserve is enclosed with the study region through which the river Brahmaputra flows. Sal (valuable timber), tall reed jungles that grow in the swaps and waterfilled area (jheels) in the floodplains, Bamboo thickets, deer, wild-buffalo, elephant, one-horn Rhino, etc, are found near the region. The area is surrounded by various beautiful destination to attract tourists from all over the world, it is known for its religion significance as well as cultural significance. National Park, hills, museums, pilgrimage and wildlife sanctuaries are some of the tourist attractions. Even the char lands are used for picnics or as a tourist spot.

III. RESULTS

Based upon the first research question of How the channel deposits and erosion over time changes their position? The study was conducted to understand the Sandbar (chars) dynamics that occurred in the Bhomoraguri village of Tezpur, Sonitpur district of Assam. The maps show two different time frames to subject it with change of River course that displaced the people living in the char land to the mainland. The Char livelihood are certainly different from the main land (Malak et al. 2020). Floods are the common annual condition of the River Brahmaputra, during the south-west monsoon the main stream and the tributaries spill over their banks that causes devastating floods in the Assam Plains that creates huge loss to the human lives (Singh, 2008). Thus, the study area observed drastic changes over the years as the river changes its direction.

Figure. 3 (below), explains the dynamicity of the river where in picture no.1 the location (red point) of the char dwellers is pointed on the sandbar ‘1’ on 2003. This is due to the area that is occupied by the people residing on the char that provides them to sustain their life by carrying out agricultural activity as the sandbar provides them with fertile sandy soil that is good for cultivating various crops like groundnut, corn, mustard, rice, watermelon and many more. Eventually, this sandbar shows a shift of morphology due to erosional processes and floods over the period since 2003 which led to the shift of the char as well as the people living and dependent on it.

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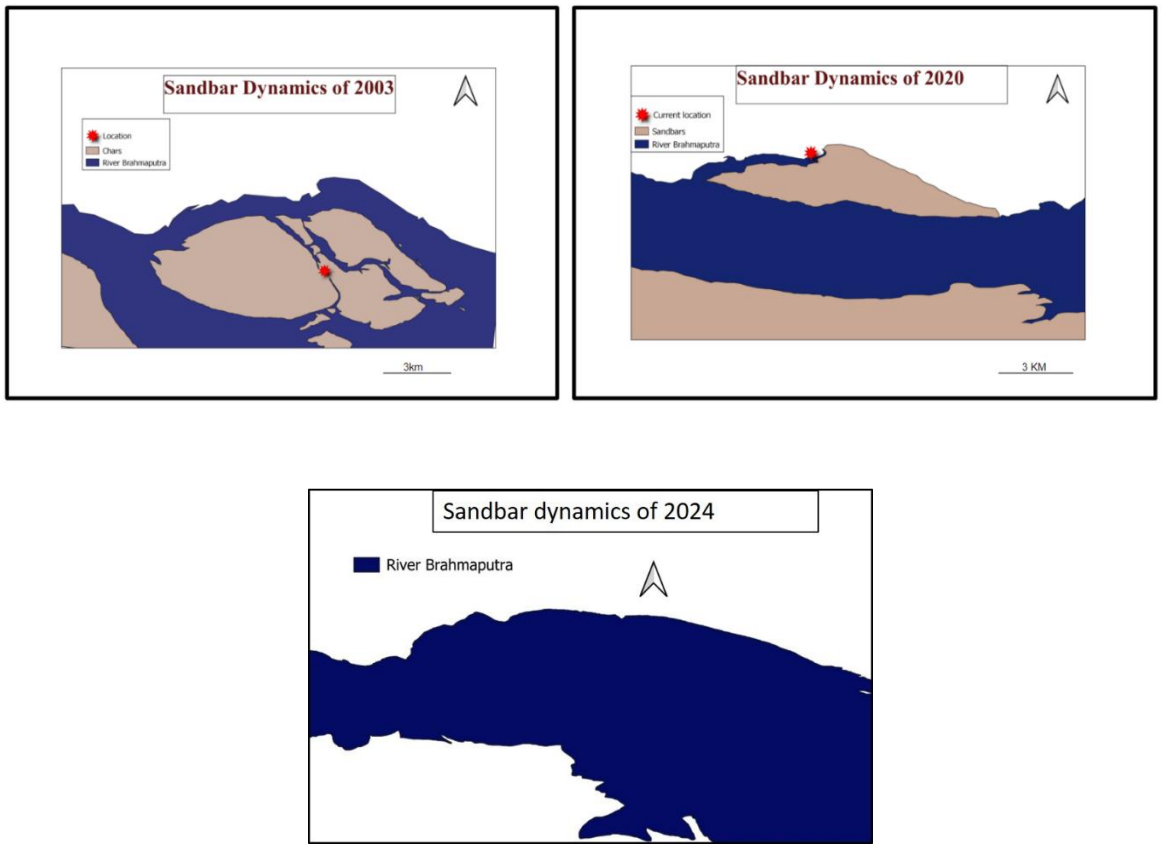

Figure 3. Morphological changes that lead to Sandbar Dynamics (2003, 2020, 2024)

Figure shows the displacement of the people (red point, 2020) to another area that is attached to the mainland. Sand bar '2' is at the close proximity to the people who once lived on the char in the river (2003) and now moved away to live in the riverbed (2020). Formation of another sandbar can be seen due to depositional activity near the river bank. In the year 2024, the sandbar is completely wiped out. Sandbars are highly dynamic in Assam rivers. More than sixty percent of the river bed of Brahmaputra is covered by sandbars and islands (Saikia et al. 2019). Large sandbars are more stable than the smaller sandbars (Goswami et al. 2024). There seem to be a shift of income sources, where fishing turned into their primary source of living in 2020, partly because of the loss they faced during the lockdown where they had to throw away crops under 4-5 bigah of land and also mainly due to the shift of the chars that they decided upon carrying out fishing as their primary source of income. Some images related to char area is shown in figure 4.

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Figure 4. Some images from study sites. (*Picture courtesy: Sanjukta Mandal)*

"Fear of losing our current land made us somehow buy a land near the town area which does not feel like home"- Anwar Husain (Fisherman and a single farmer among the fishermen group).

The graph below (figure 5) shows the fishes that are found on daily basis and its cost per kilo, that are sold by the fishermen. Weight of the fishes caught are 10 kg per day Bahu (*Labeocatla*), 5 kg per day Bolihara(*Aspidopariamorar),*Bhorali *(Wallago attu*), 3 kg per day Nara *(Labeo bata),* Kuhri(*Labeogonius*) and 2 kg per day Aari (*Aorichthysseenghala),* Hilsa(*Tenualosailisha*).

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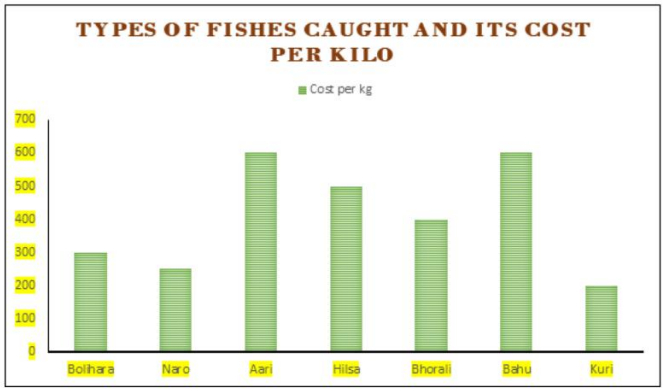

Fishes Caught (in a Day)	Weight (in kg)
Bolihara	5kg
Naro	3kg
Aari	2kg
Hilsa	2kg
Bhorali	5kg
Bahu	10kg
Kuri	3kg

Figure 5 Primary Data on cost per kg and weight of Fishes

Figure 6 explains the main source of income that they are involved in after shifting from the char of 2003 to the current location. The graph shows out of the 8 households, all of them are involved in fishing which becomes their primary activity to earn a living, then 6 among the 8 households are also involved in wage labour which is also important for their survival. The shift from agriculture is prominent as it shows only one person is carrying out agriculture near his land. Livestock are used in the urgent need for earning, which is after flood or to buy anything important and fuelwood are used as sustenance or are sold off to earn some penny. Thus, the source of income becomes a crucial aspect in determining their socio-economic condition. Sixty percent of the population are male and forty percent are female, when interviewed based upon the sex ratio, it seemed to be totally biological factor of more having a greater number of male that female. It is also observed that females use the river to avail water supply which they directly bring filling in a bucket which says sixty nine percent of the household uses it. It becomes difficult for the members to access to water supply which is the essential part of one's livelihood. Handpumps are available to those who can afford it and it accounts for thirty one percent of the total household being surveyed.

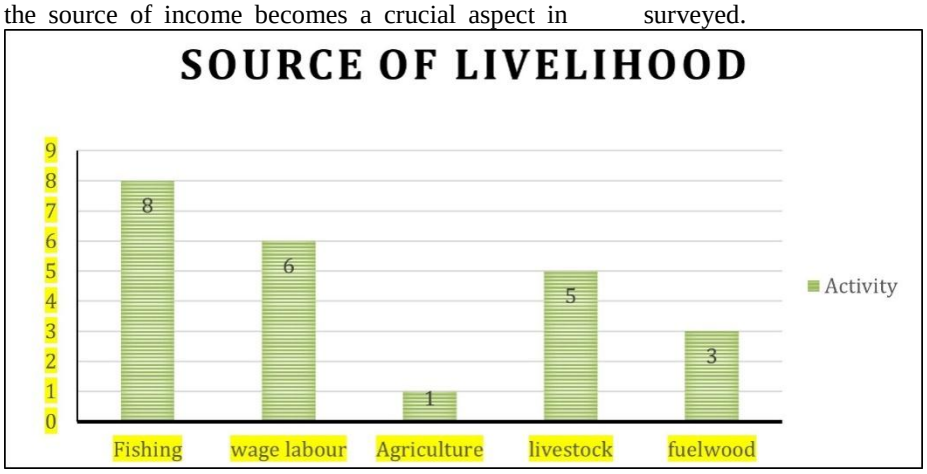

Figure 6. Source of income (livelihood)

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Thus, sandbar dynamics clearly shows the influence on people who are dependent on the geomorphological landscape formation that are not stable in itself (Figure 7). Tezpur town, Gotlong etc. *Some says (interview responses): "we sell high valued fish in lower rates just in the name of earn some living*", for instance, Hilsa fish which is of 800 per kilo is given at a price of 500 outside the market. 5 household among the 8 lives in comparatively better condition. The pandemic affected their livelihood along with the flood of 2020. Interview of the fishermen (responses): "We somehow manage to survive and earn during the flood but, the pandemic had showed us the real sufferings".

Figure 7. Socioeconomic activities in the study site, *Picture courtesy: Sanjukta Mandal*

Figure 8 explains the annual income of the 8 interviewed fishermen households. The data is cross checked with the available information provided by the fishermen and the family members on fishes caught, per day catch and also information regarding their expenses which is on fishing net and boat.

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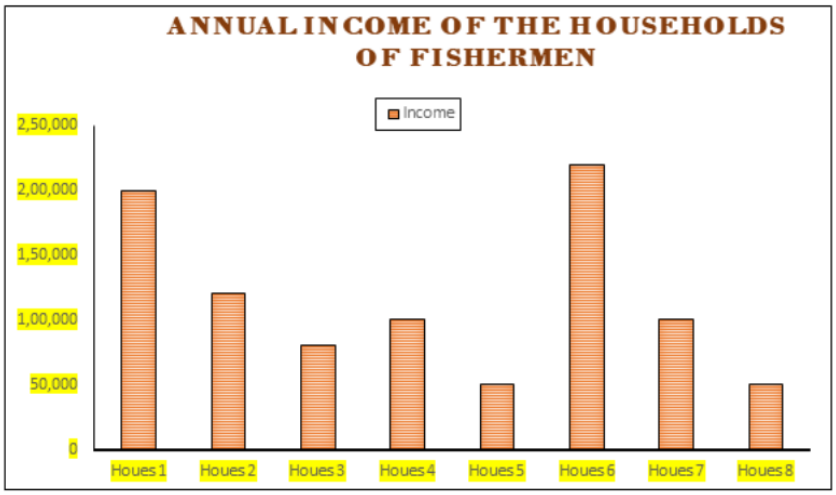

Figure 8 Annual income based on primary data (interview)

The figure 9 shows the division between three main groups of fishing according to Ahmed (2013)- Professional fishers, Seasonal Fishers and Subsistent Fisher. The findings show that there are a greater number of Subsistent fishermen (5 fishermen) and seasonal fishermen (5 fishermen). Communication and mode of transport shows that every household accept one owns bicycle and in case of boat 5 out of 8 households owns boat to fish and other 3 borrows from other fishermen to fish.

Households	Professional fisher	Seasonal fisher	Subsistent fisher	Boat owned	Mode of transport (Bicycle)	Fishing Nets	Livestock
House 1							
House 2							
House 3							
House 4							
House 5							
House 6							
House 7							
House 8							

Figure 9 Division of Fishing groups

Therefore, compiling all the data together gives a sense of the influence of livelihood that the char dwellers that moved out the char and started living near the riverbank faces and the earning to sustain their lives.

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IV. DISCUSSION AND CONCLUSION

Geomorphology does shape the livelihood of people residing on a particular physical feature. The present study saw a shift from agriculture to fishing since past few years after the chapori people shifted from the char to the river bank. Additionally, the household sell their livestock in times of need. Thus, the result of the study showed that the Char dwellers are involved in more than one livelihood option (Alam et al.2018). The fishermen prefer to fish near the edge of the Sandbars. Ahmed (2013) states that Subsistence fishing is carried out by almost all households in rural areas that are near to a water body which in this study is the river Brahmaputra. There are more of seasonal (April to July) and subsistence farming (throughout the year). Very poor communication system made the lives of fishermen dependent on the chars more vulnerable as rightly said by Malak et al. (2016). More than 80% of the people are involved in agriculture as stated by Hoque & Hazarika (2020), but in the case of particular study area, fishing and daily wage work are the two major source of income due to loss of Char areas being prone to severe flood and erosion that destroys the crops. An interesting observation shows that the fishermen use the edge of the new char land as place to catch their fish and keeps their lift net all day long.

Another important factor to look at in case of vulnerability is to get aware of the government interventions that is carried out and provided to the char dwellers of Assam. According to the Economic Survey 2012-2013 shows a growth in fishery sector by 7.14 percent. Fish production in Assam has reached to 3.31 lakh metric ton during 2018-2019 (RGVN 2020). River fisheries is one of the important fishery resources with two main rivers, fifty-three tributaries, and with over eleven thousand km of water spread area in the state (Dept. of fisheries 2024). The whole state is somewhat progressing but, there needs to be more awareness and knowledge regarding pisciculture in the study area of Bhomoraguri, Tezpur, Sonitpur district of Assam. Fisheries is a commercial activity, to be developed properly, in Sonitpur district (KVKS 2016). Rations, housing are some incentives given to the fishermen household, but availing the housing intervention is not very easy by the lower rank fishermen as they cannot afford to pay to the 'middleman' under who's permission they can avail the benefit.

Further study on the flood mitigation and government intervention needs to be focused on and the Revenue collection system that the fishermen have to renew yearly. Awareness programme and disaster management monitoring should prevail in these places who are the most vulnerable especially because of the Dynamicity of the river and the sandbar.

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