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Impacts of Natural Disaster on the People`s Livelihood and the Adaptation Strategies of Amrajuri, Pirojpur, Bangladesh

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ABSTRACT

Bangladesh has ranked first out of 170 countries for its susceptibility to the impacts of climate change, including its deltaic and low-lying regions, irregular rainfall patterns, rise in the frequency and intensity of floods, cyclones, and droughts, as well as its propensity for bad weather in the Bay. The current study aims to investigate the effects of natural disasters on people's livelihoods in the Amrajuri union at Kaukhali Upazila, within the Pirojpur district. Due to its geographic location and socioeconomic status, this area is much more vulnerable to natural disasters like cyclones, floods, river bank erosion, heavy rainfall, and storm surges. The 'Sustainable Livelihood Framework' created by Chambers and Conway (1991) can be obtained by adapting ecological, social, or economic systems to present or anticipated climatic stimuli and their consequences or implications. Accordingly, primary household questionnaire surveys, key informant interviews, and focus group discussions and secondary newspapers, journals, books, articles, websites, and union Parishad office data were gathered. About 36% people of the Amrajuri union are depended on agriculture as their primary or secondary livelihood. Natural disasters, such as cyclone and riverbank erosion have had a devastating impact on the study area's livelihoods in many sectors, including the lack of access to clean drinking water, malnutrition, extreme poverty, health issues, livelihood-related losses, and damage to crop cultivation, fisheries, poultry, and vegetable gardens, among other areas. People are utilizing alternative livelihood practices such as fish farming, livestock farming, tree planting, vegetable farming, joint common land cultivation, selling labor, poultry farming, migration, loans, and government assistance for livelihood security to combat the impacts on their way of life. They are also implementing significant adaptation strategies such as, diversification of livelihood, migration for labor, loans, and humanitarian relief. They also apply some sector-based coping strategies.

Keywords: Adaptation, Livelihood patterns, Adaptation strategies, Natural disaster, and Climate change.

INTRODUCTION:

According to the 2011 Climate Change Vulnerability Index, Bangladesh has ranked first out of the 170 nations that are most susceptible to the impacts of climate change such as deltaic & low land, cyclones, erratic rainfall, droughts, the intensified floods that

increased in number, and the existing rough weather in the Bay of Bengal (Maplecroft, 2011). The most vulnerable countries hit hard by natural disasters are Bangladesh, India, and Pakistan (Padli *et al.,* 2009).

In Bangladesh, the climatic change extremes are increasingly having a negative impact which is the significant, particularly in the southwest of the country, and the homeowners are eventually able to withstand these effects (Masud-All-Kamal, 2013). The Amrajuri union at the Kaukhali Upazila, under the Pirojpur district, is highly vulnerable to the natural disasters like heavy rainfall, floods, river bank erosion, cyclones, and storm surges because of its geographical location and socio-economic condition. The reasons for selecting Amrajuri union as the study area are the intensity of high disaster risk in the area, the relatively poor socio-economic condition of the local people, and the fact that no scientific research has been conducted to find out the causal driving factors of livelihood impacts and adaptation option in this area while this area is one of the least developed union of Pirojpur. Some 80 percent of the land of Bangladesh is a floodplain, and every year the 30-70% of total land of the country is flooded. It becomes really troublesome for Bangladesh and its people to cope with and adapt to the natural disasters as well as the effects of the climate change using its limited resources (Khan & Nahar, 2014). The coastal region's residents experience extreme the poverty, income marginalization, & inequality in comparison to the rest of Bangladesh (Islam, 2010). Moreover, the land distribution is relatively more skewed in these areas and the economically unfortunate poor people are more marginalized socially and politically than the people who live in other parts of the country (Datta *et al.,* 2003). The 'front lines' of the climate change are on the coastal areas in Bangladesh, which are directly affected by the sea-level rise, drainage congestion, and storm surges (IPCC, 2007). The effects on inhabitants of the coastal areas will be severe which include flooding, reduced sedimentation, saltwater intrusion, cyclones, tsunami, erosion by tidal waves, siltation of river estuaries, waterlogging, and coastal land subsistence (Rahman & Alam, 2003; Wisner *et al.,* 2004). Salinity intrusion from the Bay of Bengal will also affect the coastal areas, during the dry season which already penetrates 100 kilometers inland (Reid & Sims, 2007). Coastal cities that lies-low, the population from there are mostly vulnerable to the sea-level rise and storms (Kelkar & Bhadwal, 2007; Harasawa, 2006). According to the global distribution of the cyclones, on average only 1% of cyclones strike Bangladesh per year, but of the whole world's total, the fatalities they cause are 53% (Ali, 1996). The Bay of Bengal is prone to severe tropical storms known as Cyclones. Storms have harmful impacts on the life as well as livelihood of the coastal habitats. Bangladesh faced several deadly cyclones from 1990 to 2007, which caused death and displaced millions of the people (Climate Change Cell, 2007; MoEF, 2008). Super Cyclone Sidr, which struck on November 15, 2007, Cyclone Nargis, which struck on May 2, 2008, but had less destruction on the Bangladesh, Cyclone Rashmi, which struck on October 27, 2008, and Cyclone Aila, which struck on the May 26, 2009 (MoEF, 2008). Cyclones continue to put heavy burdens on the socioeconomic life of Bangladesh even though the death toll from cyclone events has decreased in the recent years with constructing of cyclone shelters & improving early warning systems. Extreme weather conditions in Bangladesh cause damage amounting to over U$ 2 billion a year and a Gross Domestic Product (GDP) loss of 1.81 percent between 1990 and 2008 according to the Global Climate Risk Index 2010, (Harmeling, 2009).

The definition of livelihood can be the bundle of various types of assets, including physical assets such as infrastructure and household goods, financial assets such as savings, pensions, stock of money, and natural assets such as activities that make a person or household able to survive, access to public resources, social assets and human assets (Stamolis & Zesza, 2003). Sayeed, (2007) expressed that infrastructure and livelihoods are still threatened and severely affected hampering further development of the coastal areas even though Bangladesh has early warning systems and cyclone shelters have been constructed along much of the coast. The study makes an effort to the investigate how Bangladeshi coastal residents responded to tropical cyclone Aila by coping with its effects and rebuilding their way of life (Agrawala *et al.,* 2003). Ongoing projects address food insecurity and food production shortfalls through crop diversification in Bangladesh and alternative employment generation opportunities which are aimed at the credit facilities, agricultural development, community development and infrastructure improvement. Fish and shrimp production for domestic consumption and exports are promoted

with special emphasis on rural poverty alleviation and employment generation. All such developmental programs are important in enhancing the resilience of the poor (Kelkar & Bhadwal, 2007). Chambers and Conway, (1991) developed 'Sustainable Livelihood Framework' and it is gained through adjusting ecological, economic or the social systems to the original or expected climatic stimuli and the effects or impacts (UNISDR, 2009). The use and access of people to resources determines individuals or household's ability to cope with and adapt to stress (Adger, 2000). The concept of access is highly depended on and related to the concept of adaptation and vulnerability (Wisner *et al.,* 2004). The process of livelihood diversification gives the rural families a scope to construct a diverse choice of activities and social support capabilities in their survival and helps in improve their living condition (Ellis, 1998). People try to diversify their income activities into both on-and off-farm activities considering a risk when primary livelihood activities can not satisfy their needs (Hussein & Nelson, 1999). It is expanded by Datta *et al.* (2003) that diversification of income sources is the primary strategy almost all groups in the marine environment using to cope with disasters. This study addressed the natural disasters impacts on the livelihood activities in the Amrajuri union of Kaukhali Upazila under the Pirojpur district. The factors like the presence of different rivers with high tide, poor infrastructure, poverty, poor communication system, poor socio-economic conditions, and high population density extremely increase the chance of occurrence of disaster in the study area. Coastal people perceive an increased number of cyclones over the past few years, even though there is no rigorous scientific evidence that tropical storms in the Bay of Bengal are increasing in frequency or intensity (Hossain and Islam, 2022).

Due to the location of their dwelling houses which are near the river bank, they are always vulnerable to hydrological disasters such as floods, heavy rainfall, water logging, and river bank erosion. This is why maximum people of this area have to change their livelihood options frequently because livelihood is the first option for poor people who are highly affected by natural disasters every year. Sometimes, to maintain or manage their livelihood options, they have to migrate to another location and try to cope with the devastating impact of natural disasters. The overarching goal is to the investigate how natural disasters affect people's livelihoods and their coping strategies.

1) To find out the frequently occurring natural disasters
2) To identify the livelihood pattern and natural disasters impacts on livelihood
3) To determine the adaptation strategies practiced by the affected community

MATERIALS AND METHODS:

Study Area Selection

The study area (**Fig. 1**) is Amrajuri union, which is under Kaukhali Upazila. Kaukhali Upazila being a part of the coastal region is susceptible to natural disasters. It has gone through the devastating impact of cyclone in 2007, 2009 and 2013. This area is mostly vulnerable to natural hazards because of the high population density with an extremely poor residential area, and the increase in occurrence of different climatic disasters. The Amrajuri union is under Kaukhali Upazila, which has 16208 households, population of 70130, and a population density of 881 per sq. km. The Upazila has a total area of 79.56 sq. km. The location of this area is between 22º31′ and 22º40′ north latitudes and between 90º01' and 90º07' east longitudes. The Nesarabad Upazila is at the north, Jhalokati Sadar and Rajapur Upazila, of Jhalokati Zila is on the east, Bhandari Upazila is on the south, and Pirojpur Sadar Upazila is on the west. The study area is surrounded by Kaliganga River in the west, Sayna Raghunathpur union in the south, Nesarabad Upazila in the north and the Katcha River in the east.

The total area of the union is 3211 acres. The total household number in the area is about 2054 (BBS, 2011). The main occupations of the people are the pottery, agriculture, fisheries, Boat driving, and day labor works in both agriculture and non-agricultural activities or at other households (BBS, 2011). The Kalinga and Katcha Rivers are flowing alongside the union that makes the area highly vulnerable to many natural disasters like cyclones, river bank erosion, storm surges, tidal floods, freshwater scarcity, tidal surges and so on (Kaukhali Upazila Parishad, 2018).

Data collection

This study was conducted based on primary and secondary data, to analyze the effects of different natural hazards and its effects on to understand about the status of natural disaster and its impact on liveli-

hood and the people's capacity to deal with these hazards negative impact. The data collection procedure has been conducted on inhabitants and local government. It was implemented to analyze the capacity of the local people to adapt to the upcoming hazardous events.

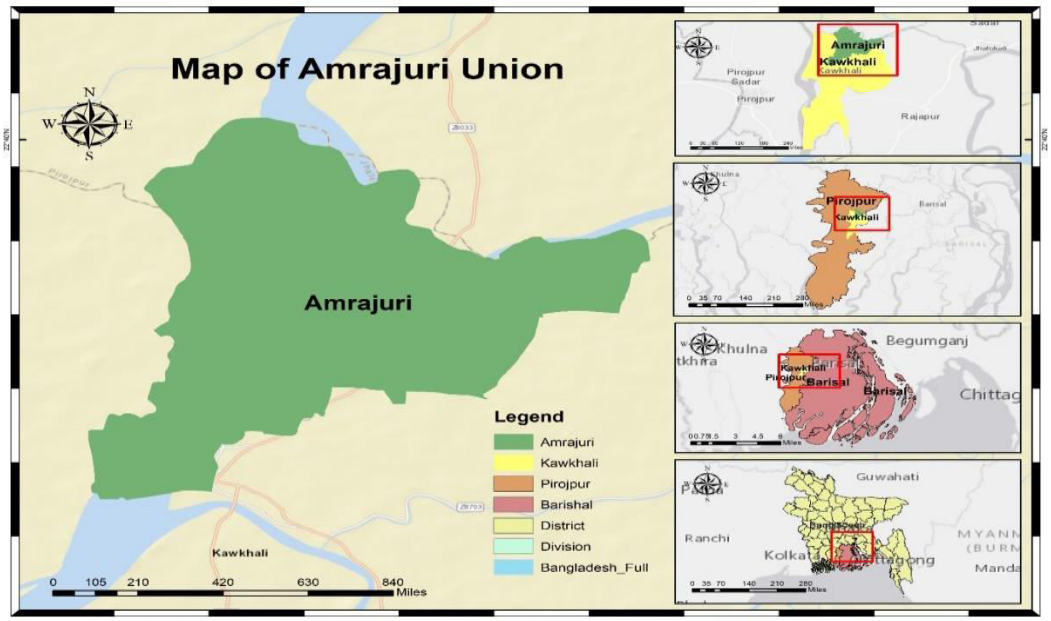

Fig. 1: Map of the Study Area.

The primary data was collected from the local people in the most vulnerable part of the study area and frequent field visit/ field survey was done to gather knowledge about study area. To collect the data 75 household sampling was taken. Besides, 5 focus group discussion and 6 key informants' interviews were conducted. The primary data was collected through household questionnaire survey, focus group discussion, key informants interview, field visit/field survey. For household questionnaire survey the questions were focused under the major three categories, they are: the hazard information, livelihood related information, and adaptation strategy. For conducting this research household survey, focus group discussion and key informants' interviews were conducted at three villages (Sonakur, Amrajuri, Harindhara) of Amrajuri union at Kaukhali upazila under Pirojpur district. Total 75 households have been interviewed among them from Amrajuri 40, Shonakur 24, Harindhara, 11. Household questionnaires were mainly conducted with local people who are vulner-able to natural disasters or who live in vulnerable conditions. Among the respondents who participated in the questionnaire survey, about 72% were male and 28% were female. Total 5 FGD were conducted with the most vulnerable groups under the study area. Among these vulnerable groups, farmers are the main victims of natural disaster. Moreover, boat-men, Fishermen, the Livestock farmers are also victims of natural disasters. Key informants interviews were the conducted with some notable stakeholders or leaders in the Communities, such as traditional leaders, teachers, and aged people as well. Several Field surveys were also conducted within this study area for understanding the scenario of the study area, to observe the condition of local people. The secondary information was collected from various sources related to the natural disaster, livelihood and disaster impacts on livelihood and adaptation practices particularly existing in the coastal region. Some sources of data collection are, Books, Literature reviews of journals, online articles, newspapers, websites, and the documents collected from different government offices.

RESULTS AND DISCUSSION:

Hazard Information

The Amrajuri union of the Kaukhali upazila faces various natural disasters due to its geographical location and socioeconomic condition. They have to depend only on a few livelihood opportunities such as agriculture, Livestock farming, fisheries, day labor, small business, etc. which are significantly vulnerable to the many natural disasters. Different natural disasters like cyclones, river bank erosion, salinity intrusion, water stagnation, heavy rainfall etc. are the main causes of the perpetuating coastal poverty (BBS, 1999). According to the data (**Fig. 2**)

which was collected from the study area, most of the respondents (n=75) mentioned more than one disaster. About 70 responds mentioned about Cyclone, 64 respondents mentioned Flood, 62 respondents mentioned River-bank erosion, 62 people mentioned Storm Surge, 54 people mentioned Heavy rainfall, 42 respondents mentioned water Logging, 29 respondents mentioned Scarcity of rainfall, 24 respondents mentioned Thunder storm and about the 14 respondents mentioned about Extreme Temperature as most common disasters existing in that area. So, from the seasonal calendar it is clear that disasters like riverbank erosion, cyclone, flood, storm surge and heavy rainfall has a great impact on the people of the area as majority of the people mentioned about these.

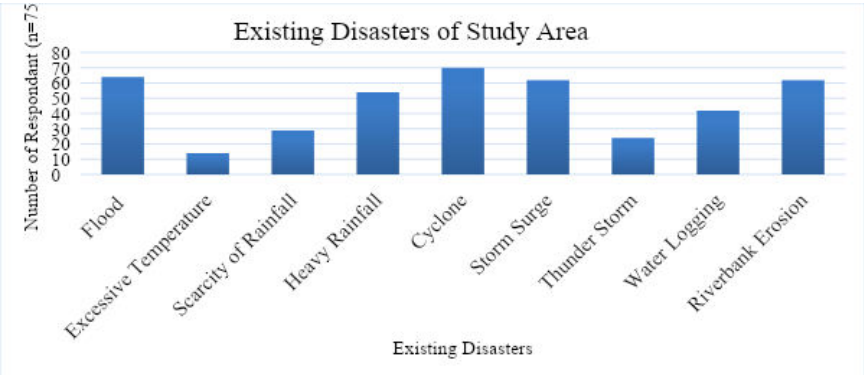

Fig. 2: Existing Disasters of the study area.

Table 1: Most frequently occurring natural disasters of the study area ranked according to their frequency of occurrence (last 12 months).

Ranking	Name of natural disaster	Responses (n=75)
1	Riverbank Erosion	65
2	Scarcity of Rainfall	59
3	Storm Surge	55
4	Heavy Rainfall	49
5	Flood	42
6	Extreme Temperature Rise	37
7	Thunder Storm	29
8	Water Logging	21
9	Cyclone	0

Seasonal Hazard/Disaster Calendar of the study area.

Table 2: Disaster Calendar of the study area.

Hazards/ Disaster	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Flood												
River-bank Erosion												
Cyclone												
Heavy Rainfall												
Storm Surge												
Water Logging												
Scarcity of Rainfall												

Analysis of the Hazard/Disaster Calendar

The most prominent and frequently occurring natural disasters in the study area are the riverbank erosion, flood, storm surges, cyclone, heavy rainfall, water logging and scarcity of rainfall. Riverbank erosion occurs throughout the whole year, but it occurs more severely from mid-April month to July month. Every year, many parts of the study area are affected by rain-fed floods or flash floods apparently from May to August which has now become a recurrent phenomenon. Water logging problems are seen to occur during the months of the July to September. Cyclone is another phenomenon that is low in frequency but devastating in the magnitude, which occurs mainly from the month of March to the month of May and from the month of October to the

month of the November. Heavy rainfall events are usually seen during the month from May to August each year. Scarcity of Rainfall is seen to be occurred during the month of March to the month of May and October to December. Storm surges are very common natural disasters which cause great damage to the resources and livelihood of the study area. Storm surge usually occurs from the month of April to the month of June and from the month of October to the month of November.

Livelihood Information

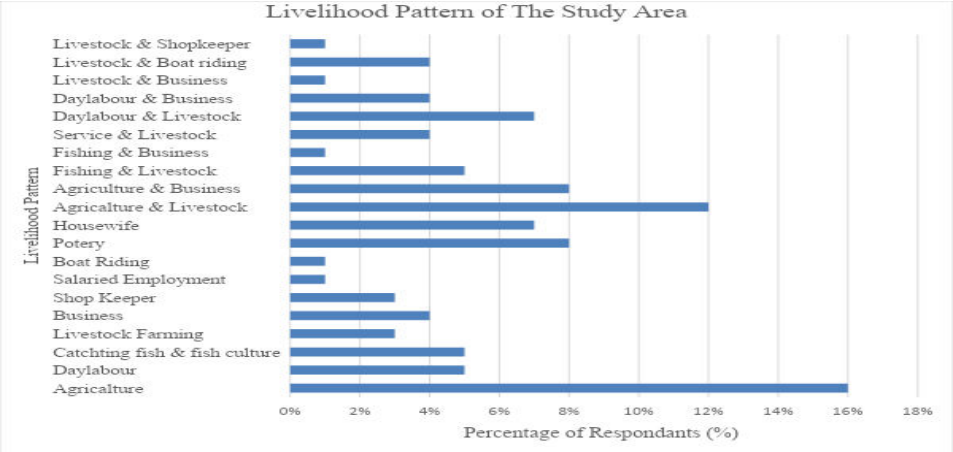

Fig. 3: Typical livelihood pattern of the study area.

It was found that the main livelihood source of the area is agriculture.

Table 3: Typical livelihood pattern and percentage of associated people (n=75).

Livelihood Pattern	Percentage (%)
Agriculture	16%
Day labor	5%
Catching fish and fish culture	5%
Livestock farming	3%
Business	4%
Shop Keeper	3%
Salaried Employment	1%
Boat Riding	1%
Pottery	8%
Housewife	7%
Agriculture and livestock farming	12%
Agriculture and business	8%
Fishing and livestock farming	5%
Fishing and business	1%
Service and livestock farming	4%
Day labor and livestock farming	7%
Day labor and business	4%
Livestock farming and business	1%
Livestock farming and boat riding	4%
Livestock farming and shop keeping	1%

From the Table above it is clear that more than half of the total population of the area are the somehow dependent on agriculture.

Livelihood Seasonal Calendar

From the data collected through the field survey, a typical livelihood seasonal calendar of the study area is shown below:

According to the figure the traditional hazard seasonal calendar that helps the local people to understand the vulnerability of their livelihood sources for a particular season. As for agriculture, the farmers are busier during the sowing and harvesting period.

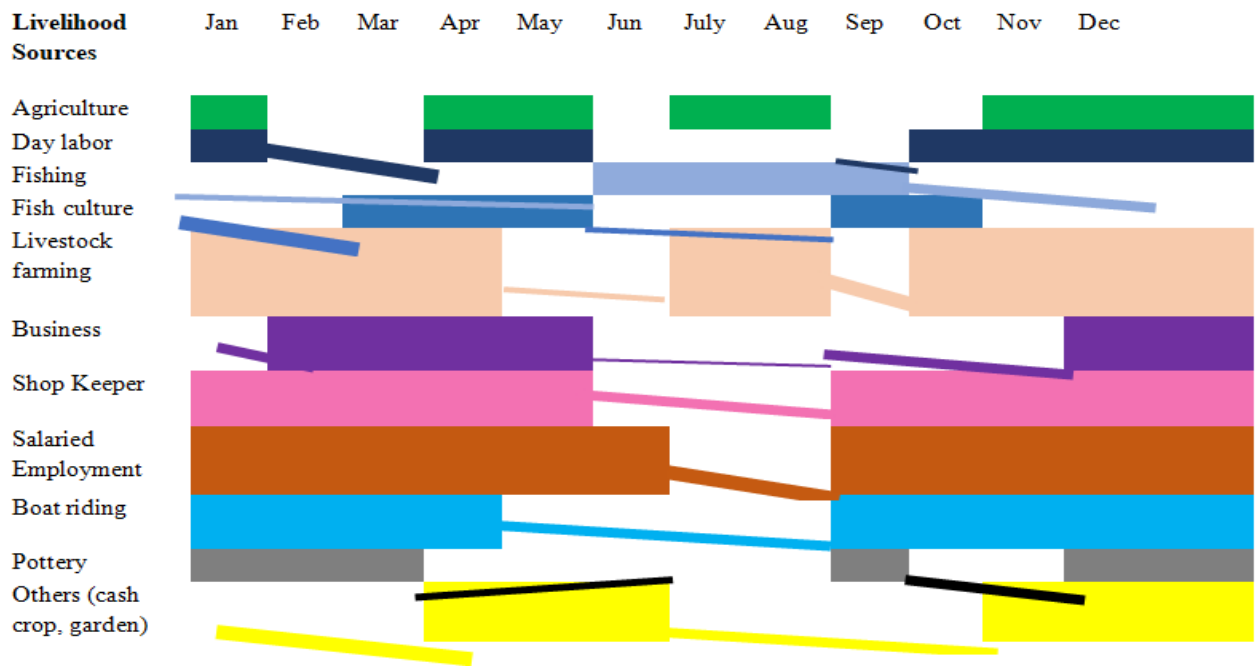

Fig. 4: Livelihood Seasonal Calendar (Author's field survey 2018).

December to January, which is the sowing period for *Boro* paddy and April to May is the harvesting period. The sowing period for *Aman* Paddy is between July to August and the harvesting period for *Aman* paddy is between November to December. Day laborers cannot go outside in search of livelihood due heavy rainfall during the months of June to August. As a result, they face major economic problems during these months. The main season for catching fish is from the month of July to October month as it is called the peak season for catching fish. The respondents associated with the fish culture, culture fishes during the months of January to May and September to October. During rainy season the work loads of livestock farmers increases so much because the livestock can't be taken out due to the rainfall and the farmer has to collect feed and fodder for their livestock, so most of the works for the livestock farmers fall between the months of the (May to July) and after the rainy season (July to September). Salaried employment requires services throughout the year, so salaried employees have to perform their duty no matter how unfavorable the weather condition is. Shopkeepers and people who run businesses suffer during the rainy season (Mid-June to Mid-August). From the months of September to April, the boatman can easily drive their boat but during the months of June to September, the number of the passengers on the water way decreases as people don't want to stay out of their houses when the weather condition is relatively unfavorable during these months. Potters and other people with very small livelihoods also suffer during the rainy season. The potters can't make their product due to heavy rainfall in the area.

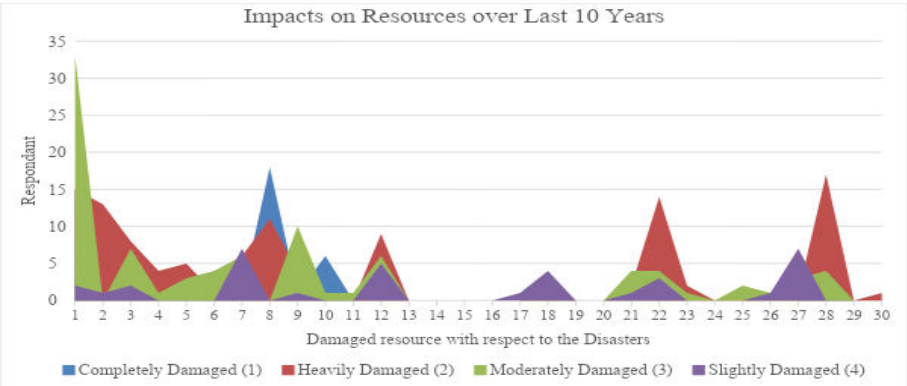

Fig. 5: Impact of flood, increases temperature and scarcity of rain on different resources with respect to the magnitude scale of damage.

Impacts of natural disasters on the resources of the study area

The impacts of natural disaster on different resources of the study area such as structure of house, live-stock, agricultural tools, handicraft, the fishing tools, transportation, trees & the plants, agriculture land/ paddy/ jute, communication tools & others are the describing in the charts below:

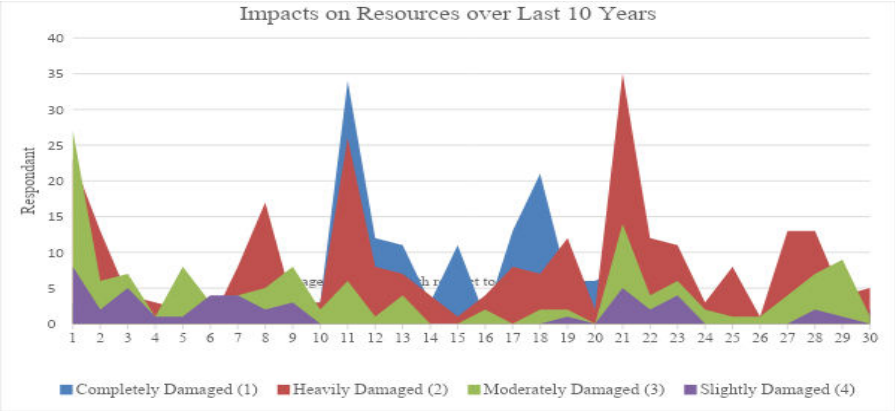

Fig. 6: Impact of heavy rainfall, cyclone and storm surges on different resources with respect to the magnitude scale of damage.

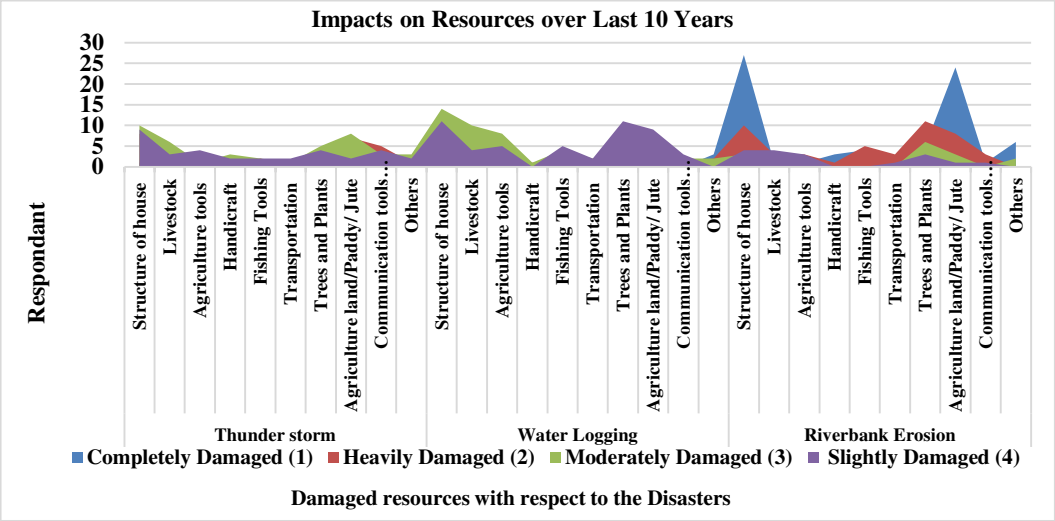

Fig. 7: The Impacts of thunder storm, water logging and riverbank erosion on different resources with respect to the magnitude scale of damage.

The data which were collected from the respondents (n = 75), by the asking them to rank the disasters according to their damaging effect. The respondents ranked the impact in the scale of (1 - 4), where 1 represent complete the damage, 2 represent Heavy damage, 3 represents moderate damage and 4 repre-sents slightly damage of the resources. The data collected from the field survey (n = 75) which is represented in the bar chart, it is clear that Cyclone had the most severe impact on the resources. The Flood had also the caused serious damage to the resources of the area, the Heavy rainfall, Scarcity of the rainfall had moderate damage rate and the increased temperature caused the least damage to the resources in the area. The seasonal calendar shows that Storm surge and Riverbank erosion had the most severe impacts on the resources after Cyclone and Flood. The thunder storm and water Logging had minor impacts on the resources, Heavy rainfall, Scarcity of the rainfall and the increased temperature caused the least damage to the resources in the study area. The extent of damage to crops and cultivable land was the highest over the last 10 years. The extent of damage to livestock, household items were also very high.

Adverse impacts of natural disasters on livelihood

From the analysis of the data collected through the household questionnaire survey, the impact of different disasters according to their magnitude is shown on the charts below:

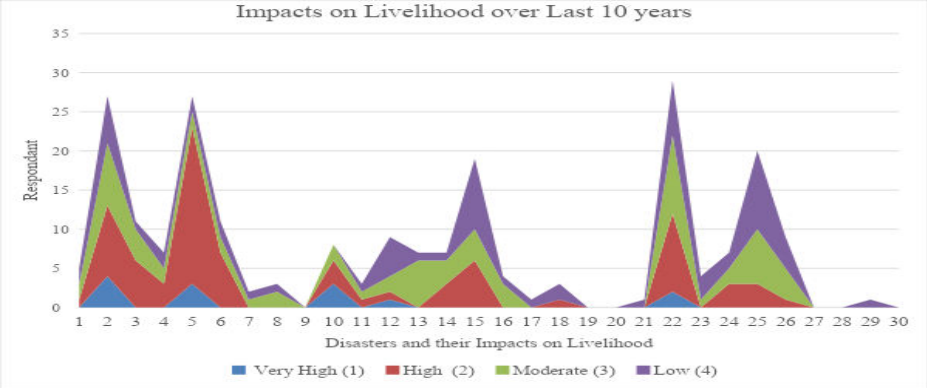

Fig. 8: The impacts of flood, increased temperature, scarcity of rainfall on livelihood options with respect to the scale of disaster magnitude scale.

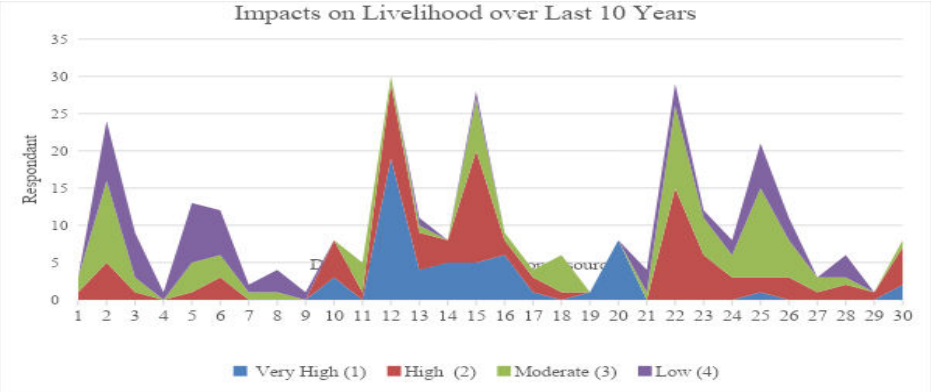

Fig. 9: Impacts of heavy rainfall, cyclone, and storm surge on livelihood options with respect to the scale of disaster magnitude scale.

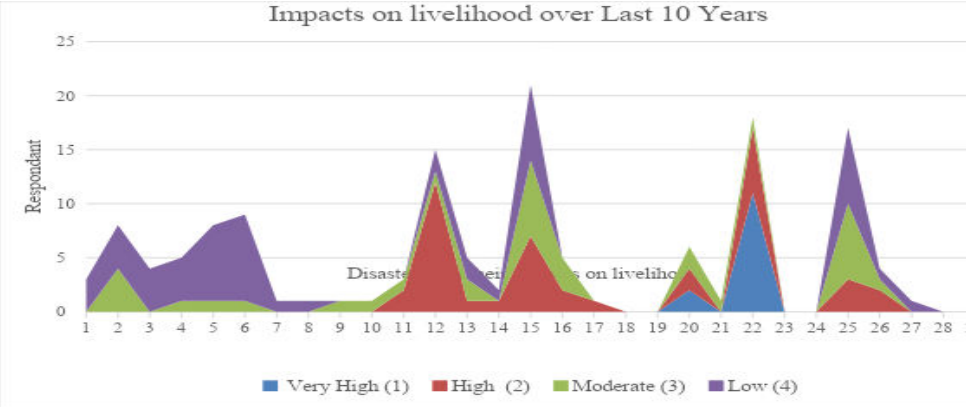

Fig. 10: The Impacts of thunder storm, water logging and riverbank erosion on the livelihood options with respect to the scale of disaster magnitude scale.

The data collected from the respondents (n=75) from the study area that are represented in **Fig. 7**, **Fig. 8** and **Fig. 9**, shows that flood, cyclone, storm surge and riverbank erosion have the most severe adverse impact on the livelihood of the people of the study area. Agricultural and fisheries sectors are seriously affected by the adverse impact of different natural disasters such as flood, scarcity of rainfall, heavy rainfall, cyclone, storm surges, water logging and river bank erosion. Shop keepers, day laborers and potters are also severely affected by these natural disasters. Livestock farming and Business sectors are seriously affected by the cyclone, flood, riverbank erosion, heavy rainfall & water logging. The thunder storm and extreme temperature rise has relatively minor impacts.

Analysis the Impact of Cyclone on the livelihood

Small shops, housing structures for small businesses were also damaged by both of the Cyclones. The other livelihood options were also affected due to the

destruction of the means of livelihood such as boats, nets, livestock, agricultural tools, farmland structure and loss of capitals. Farmers can reduce the impact if they use resistant crop varieties. Risk mitigation measures & development measures should be implemented to increase the resilience of the community to cyclones. More cyclone shelters should be built. Government should take steps to provide agricultural insurance for the farmers.

Impacts of Riverbank Erosion:

River bank erosion is a very common phenomenon of the union of Amrajuri and people of this area facing the devastating impact of river bank erosion throughout the year. The erosion causes the severe damage to the residential houses, *kancha* roads, educational institutions, crops and cultivable lands, grazing lands, domestic animals and to all sorts of other livelihood sources of the area. The erosion rate is the highest at Shonakur and Amrajuri village as these villages are located near the rivers. Still the local people should continue using their traditional tree plantation along the riverside methods while trying to reduce the erosion rate.

Impacts of flash flood

Flash floods frequently occur in different parts of the union every year and cause great damage to ripen paddy fields. Crop production and livestock rearing is decreasing, fish production loss. Day laborers also face great problems as it becomes difficult to find any work during floods. Farmers should cultivate flood resistant crop varieties. Planting water resistant crops reduces the stress of floods from agriculture. Building embankment along the vulnerable parts of the river and the proper drainage system can be developed to the remove excess water. Government should take necessary step to reduce the impact and rehabilitate the livelihood source of affected people.

Fig. 11: Ripen paddy field of the study area damaged by flash flood.

Fig. 12: Damaged grazing land due to the scarcity of rainfall.

Heavy Rainfall and Scarcity of rainfall

According to the survey, respondents mentioned that their *Boro* paddy got fully rotten due to excessive rainfall last year. Excessive rainfall and untimely rainfall cause the serious damage to the crop and production loss. Many farmers from Harindhara village claimed that their *Aush* paddy seedlings that they cultivated were fully damaged due to the scarcity of rainfall. Some women also claimed that they cannot feed their livestock properly due to excessive rainfall and damage to the grazing land due to scarcity of rainfall. Heavy rainfall effects on shopkeepers and farmers could not sow the seedlings of the *Aush* paddy. Day laborers of the area cannot go to work because of heavy rainfall, the life of a boatman becomes difficult for the heavy rainfall. Government should facilitate the provision of loan for farmers with easy conditions.

Storm Surges

During the months of the April and May, the local people are face storm surges the most. Storm surge during this month are considered as a common seasonal event which is known as *"Kal Boisakhi"*.

Storm surges damages the straw that are stored as feeds for livestock. Storm surges also causes serious damage to the cultivate vegetables and paddy field. Household structures, poorly constructed embankments are heavily damaged. Fishing boat, trawlers are also affected by the storm surges. People with salaried job can't go to work. Day laborers becomes jobless. Cash crops get damaged by the storm surge**.** Fishermen should keep their boats in a safe place until the storm passes. Fodder for the livestock should be stored in a dry place (Nur *et al*., 2021).

Impact of Water logging

In the study area, the water logging problem creates troubles for the livestock farmers, as they can't let their livestock out for grazing. Increases maintenance cost for the business, small farms, livestock farms, fish culture. Causes production loss of vegetables. Planting water resistant crop varieties can reduce the vulnerability. Properly built embankment and drainage system can reduce the impact of water.

Extreme Temperature and Thunder storm

Many livestock farmers mentioned that disease outbreaks are likely to happen when it is too hot and livestock tend to suffer from heat stroke.

Major livelihood adaptation practices and strategies suggested by the community

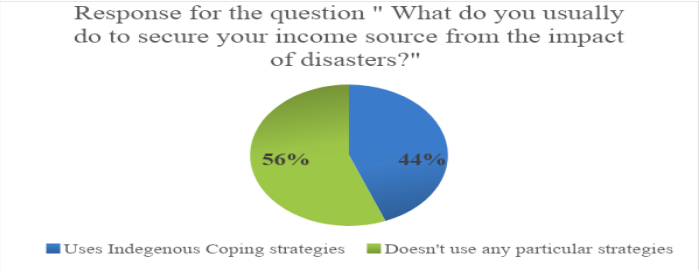

Fig. 13: Percentages of respondent that uses and doesn't use adaptation strategies.

Using the Knowledge that they developed by the following many generations of experience, people of the study village have learned to cope with disasters in their own ways. Some of the major strategies suggested by the community were:

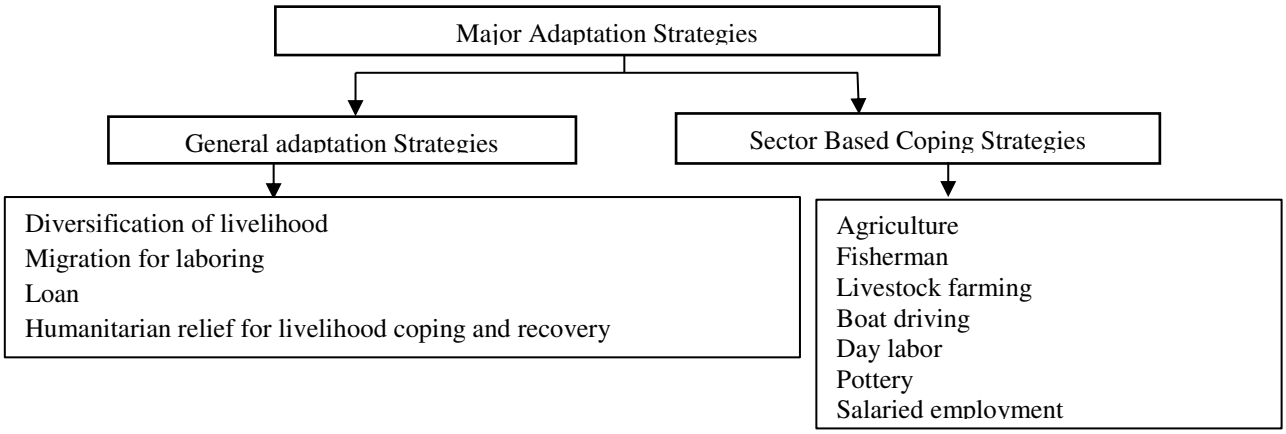

Fig. 14: Adaptation strategies suggested by the community.

Diversification of livelihood

The main disaster-adaptation strategy of almost all resilient respondents was the diversification of their income sources for lesser impact on their monthly income.

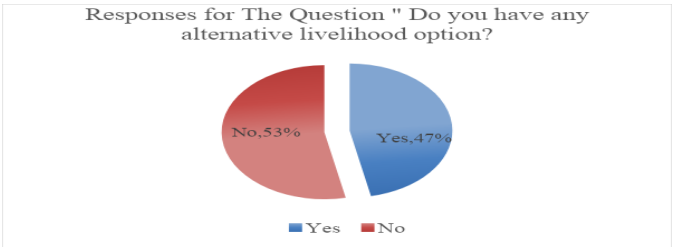

Fig. 15: Percentage of respondents' alternative livelihood status.

Fig. 14 represents that, about 47% people have alternative livelihood options while about 53% people don't. The following alternative livelihood sources as minor income source as shown on the table below:

Table 4: Alternative Livelihood Sources.

SI No.	Alternative livelihood Sources
01.	Sharecropping
02.	Tree Plantation
03.	Fish culture in mini pond
04.	Mini Poultry farming
05.	Livestock rearing
06.	Boiling paddy and processing
07.	Craft manufacturing
08.	Day Labor
09.	Homestead gardening
10.	Selling goods

Besides the practicing one of the major livelihood options like the agriculture, fisheries sectors as their main occupation, local people also the choose other options as their alternative livelihood sources as a full-time income source or for a limited period of the year.

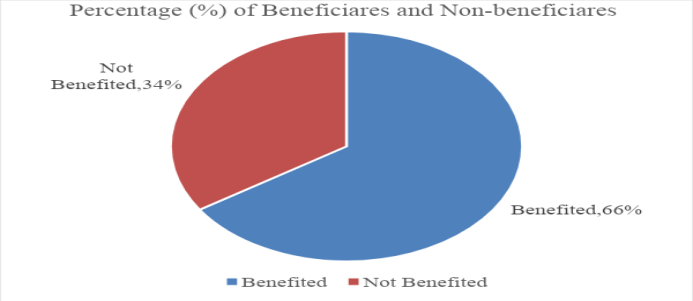

Fig. 16: The average number of beneficiaries and non-beneficiaries from alternative livelihood sources.

Migration for laboring

Many households of Shonakur village of Amrajuri Union moved into urban areas in order to the finding employment. Some common cause's migration for laboring is: loss of livelihood due to major disasters, loss of agricultural land due to river erosion, loss of fisheries resources, lack of working opportunities.

Loan for Livelihood Opportunity Generation

Through the household questionnaire survey, KII, FGD conducted on the study area it was found that; Loans or the money borrowed from the relatives, *Mahajans* (Money Brokers), and the credits from different NGO helped them a lot in coping process. Wealthy neighbors also help the poor households of Amrajuri during the disaster. Many respondents mentioned that loans from relatives were also helpful in the coping strategy.

Humanitarian relief and Government projects for livelihood coping and recovery

Many of the respondents said that they had received test relief from the Union Parishad. The relief was very helpful in maintaining their livelihoods. But this played a minor role in reviving previous livelihoods. So, many households were not satisfied with such assistance. They had doubts about the sustainability of their livelihoods. They wanted permanent employment opportunities. The government of Bangladesh also launched many projects for creating livelihood resources like, Food for Work, the Safety Net System for the Poorest, EGPP project etc.

Coping Strategies

Coping Strategies on Agricultural sector

The farmers of the study area practice various coping strategies which help them in reducing the vulnerability and impacts natural disasters. Such as –

1) Adjustment in crop practices for Early sowing/ Early Harvesting
2) Changes in Cropping Pattern
3) Planting cash crops
4) Joint cultivation of common land
5) Water management
6) Irrigation

7) Drainage system
8) Raising high bunds/embankments
9) Raising land for cultivation
10) Preservation of seed
11) Mulching system

Coping Strategies on Catching fish and Fish Culture

1) Raising pond bank
2) Re-excavation of traditional ponds & Cultivate fish in mini pond
3) Indigenous Fish Variety Cultivation

Coping Strategies on Livestock Farming

1) Storing crop residue
2) Using fallow land for grazing purpose
3) Raising the floor of the Cowshed

Coping Strategies on Boat driving

1) Using engine driven boat, sailed boat and dual boat riding system for driving

Coping Strategies on Household adaptation

1) Raising the house plinth
2) Storage of dry food & fuel wood
3) Making fertilizer out of manure
4) Household level income generating livelihood activities
5) Structural measures

Benefits and Limitations of Adaptation Practices

Table 5: Advantages and Limitations of the adaptation practices performed in the study area.

Advantages	Limitations
Agriculture Increase crop production Reduced hazard vulnerability Improve soil fertility Fulfilling local nutritional demands Facilitate seed availability Sustainable livelihood Livelihood Security Better Lifestyle	Poor farmers and seasonal farmers don't have the ability to provide cultivation cost Low energy use efficiency and requires the use of diesel for engines for irrigation. High initial investment for purchase of engine for irrigation. Subsidies or restrictions on crops inhibit farmers from changing practices or crops Poor access and availability of loan High cultivation cost Land failure due to natural phenomena Poor knowledge about modern farming technologies
Catching Fish & Fish culture Self-employment opportunities ground water recharge and tree planting in embankment Reduce livelihood vulnerability Increase fish production Mixed farming practices (fish and poultry at the same time) Low maintenance cost & Increase income	Various types of disease High feed prices in market Lack of initiatives to protect the indigenous fish breeds. Less breeding due to unfavorable water condition
Livestock farming Alternative economic sources in off season Improve nutritional status Provide confidence in self-employment Increased calf production	Shortage or high price of cattle and poultry feed Shortages of grazing land Different contagious disease and water borne diseases Highly difference between input and output income

CONCLUSION:

The study is intended to know about the frequently occurring disasters, the different livelihood patterns, impacts of frequently occurring disasters on different livelihood options, and the adaptation strategies practiced in the study area. Riverbank erosion, scarcity of the rainfall, storm surge, heavy rainfall, flood, extreme, temperature rise, thunderstorm, water logging, the cyclone, etc. are the most frequently occurring natural disasters in the study area. The major livelihood patterns of this area are mainly based on agriculture 36%, day labor 13%, Fisherman 11%, livestock farmer 7%, business 5%, shopkeeper 3%, salaried employed 4%, boatman 5%, potter 8 %, Housewife 7% and others 1%. They often chose one of these major livelihood options as their alternative livelihood sources while they already have another main income source. The impacts of natural disasters vary based on socio-economic conditions amongst the vulnerable people. The households of the Amra-juri union had low resource bases to cope with the occurrence of frequent disasters. Through the study, it is found that, for the last 10 years, the resources of the study area were severely damaged by Cyclone,

Riverbank Erosion, Storm Surges, Heavy rainfall, and Flood. Loss of resources has serious impacts on livelihood stability. Flood, cyclone, storm surge, and riverbank erosion have the most severe adverse impacts on the livelihood options. The Thunderstorms and extreme temperature rise have relatively minor impacts. It is also found that agricultural and fisheries sectors are mostly affected by different natural disasters such as Flood, Scarcity of rainfall, Heavy rainfall, Cyclone, Storm surges, the water logging, and river bank erosion. Though most of the farmers were unaware of the concept of adaptation strategies, they practiced many traditional strategies to adapt to the adverse impacts of natural disasters. Such practices include alter-native livelihood options such as fish culture, live-stock farming, planting trees, cultivating vegetables, joint cultivation of the common land, selling labor, the poultry farming, migration, loans, government assistance for livelihood security, etc. and different sector-based coping strategies.

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CONFLICTS OF INTEREST:

We the authors declare that the above manuscript has no conflict of interest to publish in your journal.

REFERENCES:

1) Adger, W. N. (2000). Social and ecological resilience: are they related? *Progress in human geography*, **24**(3), 347-364.
2) Agrawala, S., Ota, T., and Van Aalst, M. (2003). Development and climate change in Bangladesh: focus on coastal flooding and the Sundarbans (pp. 1-49). *Paris: OECD*.
3) Ali, A. (1996). Vulnerability of Bangladesh to climate change and sea level rise through tropical cyclones and storm surges (pp. 171-179). *Springer Netherlands*.
4) BBS, (1999). Population & Housing Census: Preliminary Results. *Bangladesh Bureau of Statistics,* Dhaka.
5) BBS, (2011). Population & Housing Census: Preliminary Results. *Bangladesh Bureau of Statistics,* Dhaka.
6) BBS, (2011). Population and Housing Census, Community Report, Pirojpur Zila, June 2012. *Statistics and Informatics Division*, Ministry of Planning.
7) Chambers, R., & Conway, G. (1991). Sustainable Rural Livelihoods: Practical Concepts for the 21st Century. IDS Discussion Paper 296*, IDS, Brighton*.
8) Climate Change Cell, Government of Bangladesh. (2007). Retrieved from - http://www.climatechangecell-bd.org
9) Datta, A., Frans, D., and Soussan, J. (2003). Coastal Zone Policies & Livelihoods in Bangladesh, in Water and Poverty-A Collection of Case Studies: Experiences from the field.
10) Ellis, F. (1998). Household strategies and rural livelihood diversification. *The j. of development studies*, **35**(1), 1-38.
11) Harasawa, H. (2006). Key vulnerabilities and critical levels of impacts on east and southeast Asia. *Avoiding Dangerous Climate Change*, 243.
12) Harmeling, S. (2009). Global Climate Risk Index 2010: Who is the Most Vulnerable? Weather-Related Loss Events 1990 and how Copenhagen Needs to Respond. *Germanwatch, Berlin*.
13) Hossain MU., and Islam MJ. (2022). Livelihood pattern and health seeking behavior of working children in Khulna city, *Br. J. Arts Humanit*., **4**(2), 32-39. https://doi.org/10.34104/bjah.022032039
14) Hussein, K., and Nelson, J. (1998). Sustainable livelihoods and livelihood diversification. https://www.scirp.org/(S(351jmbntvnsjt1aadkozje))/reference/referencespapers.aspx?referenceid=1325894
15) IPCC, (2007). Climate change 2007: Synthesis report. Geneva.
16) IPCC, (2007). Summary for Policymakers. In M. L. Parry *et al*. (Eds.), Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (p. 1000). *Cambridge University Press: Cambridge*.
17) Islam, N. (2010). A study of the principal marketed value chains derived from the Sundar-

bans Reserve Forest (Vol. 1, Main Report). International Resources Group, Washington.

18) Kelkar, U., & Bhadwal, S. (2007). South Asian regional study on climate change impacts and adaptation: implications for human development. *Human development report*, **2008**, 47.
19) Khan, M. M. H., and Nahar, N. (2014). Natural disasters: socio-economic impacts in Bangladesh. *Banglavision*, **13**(1), 58-67. https://doi.org/10.1007/978-3-030-77259-8_21
20) Masud-All-Kamal M. (2013). Livelihood coping and recovery from disaster: the case of coastal Bangladesh. *Curr Res J Soc Sci*, **5**(1), 35-44.
21) Maplecroft, (2011). World's fastest growing populations increasingly vulnerable to impacts of climate change - 4th Global Atlas Reports. Retrieved December 1, 2012, from - http://maplecroft.com/about/news/ccvi_2012.html
22) MOEF, (2008). Bangladesh Climate Change Strategy and Action Plan. Government of the People's Republic of the Bangladesh, Dhaka, Bangladesh.
23) Nur MNB, Rahim MA, and Rasheduzzaman M. (2021). Identifying cyclone shelter facilities and limitations for enhancing community resiliency in coastal areas of Bangladesh, *Asian J. Soc. Sci. Leg. Stud.*, **3**(4), 107-118. https://doi.org/10.34104/ajssls.021.01070118
24) Padli, J., & Habibullah, M. S. (2009). Natural Disaster Death and Socio-Economic Factors in Selected Asian Countries: A panel data analysis. *Selangor, Malaysia*.
25) Rahman, A., and Alam, M. (2003). Mainstreaming adaptation to climate change in Least Developed Countries (LDC). *Bangladesh Country Case Study*.
26) Reid, H., Simms, A., & Johnson, V. (2007). Up in smoke? Asia and the Pacific. Fifth report of the Working Group on Climate Change and Development. *London: New Economics Foundation*. https://catalogue.nla.gov.au/catalog/4359972
27) Sayeed, S. K. (2007). Climate change and Bangladesh: A perspective on where we are. *The Daily Star*, **14**.
28) Stamoulis, K., & Zezza, A. (2003). A conceptual framework for national agricultural, rural development, and food security strategies and policies.
29) UNISDR, (2009). Terminology on Disaster Risk Reduction. The United Nations Office for Disaster Reduction, *United Nations, Geneva*. https://reliefweb.int/report/world/2009-unisdr-terminology-disaster-ris
30) UNISDR, (2009). Terminology on Disaster Risk Reduction. United Nation Office for Disaster Risk Reduction.
31) Wisner, B., Blakie, P., & Davies, I. (2004). *At Risk* (Working Paper 69). Institute of Development Studies. *Routledge: London and New York*.

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