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Research Report on

Understanding Climate Change Vulnerability in Two Coastal Villages in Bangladesh and Exploring Options for Resilience

Panii Jibon (Water is Life) - Phase II

Research Report on

Understanding Climate Change Vulnerability in Two Coastal Villages in Bangladesh and Exploring Options for Resilience

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Executive Summary

Bangladesh, due to its geographic location, is highly exposed to different climatic hazards and natural disasters. Environmental vulnerability coupled with poor infrastructural and socio-economic factors in the coastal belt of the country, further reduces the capacity of local communities to tackle the impacts of climatic shocks and stresses. The south-west coastal region has already been diagnosed with increasing effects of different slow onset stressors such as rising temperatures, salinity intrusion and sudden climatic shocks such as cyclones, floods, storm surge etc. The Intergovernmental Panel on Climate Change's (IPCC) Special Report on 1.5^{o} C predicts that, increase in heavy precipitation in coastal regions across the global along with tropical cyclones and increased sea levels may lead to increased flooding. Incidence of tropical cyclones, heavy precipitation, and degree of salinity in Bangladesh have been observed to have increased exponentially in the previous decades. These are expected to worsen as the effects of climate change become more and more prominent. The south-west coastal regions in Bangladesh tend to be the worst sufferer of these climate change induced changes, bearing adverse effects in their agricultural sector, water security, livelihood security, health status and overall wellbeing.

This action research has been conducted by the International Centre for Climate Change and Development (ICCCAD) under the HELVETAS Swiss Intercooperation led 'Panii Jibon' project, to better understand the agro-ecological, socioeconomic and political context of climate change in a coastal district in Bangladesh and the challenges associated with them. The study sites selected were two villages, namely Garuikhali and Kumkhali of Paikgacha upazila in Khulna district. Rapid vulnerability assessment of climate change has been undertaken particularly on livelihood and water security as well as on overall well-being of communities in the area. A set of participatory tools have been applied to derive local perception on different vulnerabilities, existing coping strategies and possible ways forward to address these vulnerabilities. Based on which, evidence-based solutions have been recommended to enhance the adaptive capacity and resilience of vulnerable communities to the impacts of climate change and also to improve their well-being

Both villages selected for the study demonstrate similar demographic and socio-economic conditions and were found to be subject to the climatic shocks and stresses at different extents. Cyclone/storm surge has been identified as one of the most frequent, severe and of high magnitude sudden climatic event affecting the area, attributing to the proximity of these villages to major rivers nearby. Cyclone Aila in 2009, was reported as the most devastating natural disaster to have occurred in recent history which not only caused serious damage to life and property but also led to significant intrusion of saline content both in water and soil. Even though some degree of salinity has always been present due to geographical location of the study sites, frequent occurrence of cyclones over the last 30-40 years has been cited as a key driving factor for the gradual increase in the levels of salinity experienced in the villages. Levels of salinity, both in water and soil, tend to rise during dry and summer months and gradually decrease at the advent of rainy season. High intensity short term rainfall has also been reported as another major climatic event by local communities in both the villages. Such irregular rainfall results in inundation and waterlogging, affecting nearly everyone. Excessive heat and changes in traditional seasonal patterns have also been observed by the communities. The traditional six-season climate pattern in Bangladesh has altered over the past decade or so and now warm and cool seasons are now prominent.

A culmination of all these recent changes in climatic events and patterns have severely impacted the livelihood security of the communities. Historically, livelihoods of both the communities were mostly dependent on natural resources and majority of local people practiced arable and pastoral farming, and

fishing. But over the years, the share of people engaged in agriculture has reduced due to salinity intrusion, irregular rainfall patterns, and excessive heat. One key difference noted between the two villages was the growing proliferation of shrimp farming in Garuikhali whereas nearly no one in Kumkhali was found to be engaged in the profession. As a result, Garuikhali has experienced a substantial deterioration of saline conditions, a situation further exacerbated by poor management of sluice gates in the village. Only 6% of the respondents in Garuikhali were found to be practicing agriculture in the form of vegetable production on elevated lands. In Kumkhali, on the other hand, people have restrained themselves from engaging in shrimp farming and as a result 66.0% respondents can still practice agriculture. However, crop yields in Kumkhali have also significantly reduced over the years due to different climatic changes which led 34% of the respondents to shift to non-farm activities.

Water security has also been impacted by different climatic events. Salinity intrusion in village ponds has largely affected the access to fresh drinking water in both the villages leaving only 5% of the respondents in Garuikhali with access to fresh drinking water. Mobility in accessing fresh drinking water is further restricted as a result of inundation due to high intensity short term rainfall. Consumption and household usage of saline and contaminated water give rise to water borne diseases like diarrhea, cholera, stomach bugs, and skin diseases. In both the villages, women and children have been found to be most afflicted by these diseases. Research has shown that saline water consumption in dry season contributes to hypertension during pregnancy which has several possible consequences including impaired liver function, low platelet count, intrauterine growth retardation, preterm birth and maternal and prenatal death.

Migration dynamics in the study areas have also shifted in the context of climate change. For about 53.5% surveyed households in Garuikhali and 21.4% households in Kumkhali, at least one family member or relative has migrated in the last 20-30 years to seek alternative income generating opportunities. Loss of income and livelihood opportunities have been found to be the most triggering factors of migration to nearby cities. In both the villages, mostly the male primary earning member were found to engage in migration, leaving their female counterpart alone to deal with other aspects of household life. All these impacts of climatic events on livelihood security, water security and health status affect the overall wellbeing of the community.

While the communities have adopted a myriad of coping strategies, some driven by traditional knowledge while others with support from both the Government as well as non-government agencies, these strategies can be deemed as largely unsustainable in the face of exacerbating climatic change impacts. To reduce the wellbeing loss and enhance livelihood security, equitable distribution of agriculture and shrimp farming, supply of saline tolerant rice seeds, better access to market and alternative livelihood training have been proposed by the study. Besides, rain water harvesting, desalination plant at community level, proper management of sluice gates were identified by local communities for ensuring their water security. Planned resettlement and migration of affected people have also been recognized as a means of enhancing their adaptive capacity. Furthermore, the study proposes setting up a financial mechanism for effective channeling of climate funds to the local level in order to support these practices and strategies, thereby promoting resilience of vulnerable communities in these two coastal villages.

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1. Introduction

1.1 Background

Panii Jibon (Water is Life) is a HELVETAS Swiss Intercooperation led initiative being implemented in collaboration with its local partners, that aims to address water related threats and vulnerabilities of an already impoverished population living in the disaster-prone coastal areas of Bangladesh. The overall objective of the Panii Jibon project is to **build resilience and reduce well-being loss of climate change affected disadvantaged communities, and particularly vulnerable women and youth, in the disaster-prone areas of South West Bangladesh.**

The project is guided by four sets of interrelated and mutually reinforcing result areas as specified below:

- **Outcome 1:** *Disadvantaged communities, and particularly the women, demand their basic rights for WASH services and benefit from improved WASH governance to increase year-round access to and use of safe drinking water, sanitation facilities and hygiene practices.*
- **Outcome 2:** *Women and youth enhance their food security and income through adaptation of their farming and water management systems and improved market linkages.*
- **Transversal Outcome 1:** *Women and youth enhance their transformative capacities and build and sustain their basic livelihood assets and income through long-term benefits from (seasonal) out-migration.*
- **Transversal Outcome 2:** *Disadvantaged communities, and particular women and youth, benefit from improved governance that leads to more participatory, transparent and accountable resource allocation mechanisms for the scaling-up of climate resilient strategies and actions.*

The project intervention zones are Koyra and Paikgacha Upazila of Khulna district and Morrelganj Upazila of Bagerhat district.

Phase II - Extended of the project commenced in 2018 with funding support from the Climate Justice Resilience Fund (CJRF). International Centre for Climate Change and Development (ICCCAD), a climate change research and training centre based in Dhaka, Bangladesh joined the consortium to implement Transversal Outcome 2 under the project, defined by Output 9 which states 'The needs of women and youth, and local public and civil society stakeholders for locally adapted climate resilient solutions and coping strategies are advocated for at local and national level.' The objective of ICCCAD's engagement under the project was to better understand the agro-ecological, socioeconomic and political context of climate change in the study area and the challenges associated with them. Based on which, evidence-based solutions would be developed to enhance the adaptive capacity and resilience of vulnerable communities to the impacts of climate and also to improve their well-being.

To accomplish the above, ICCCAD undertook an action research study in 2018, in selected project sites (Paikgachha Upazila). The study involved conducting a rapid vulnerability assessment to understand the impacts of climate change, particularly on livelihood and water security as well as on overall wellbeing in the area.

This report provides a synthesis of findings from the assessment and proposes possible ways forward for building resilience of targeted communities. The results of the study would serve to guide capacity building and policy advocacy interventions in the following years of the project (2018-2020).

1.2 Context & Relevance

Located on an active delta, Bangladesh is characterized by a high degree of environmental volatility which poses high exposure to climatic hazards and natural disasters. The country annually faces floods, riverbank and coastal erosion and is also susceptible to cyclones that form in the Bay of Bengal due to the country's funnel shaped coast (Mutahara et al., 2017). High incidence of poverty, particularly in the coastal belt, further perpetuates socioeconomic vulnerability of local communities and the country as a whole (Hossain et al., 2011).

Globally, there has been a significant increase in both the severity and frequency of disasters, and the link between climate change and extreme events is increasingly being recognised (IPCC, 2012). Sarker et al (2012) in their research mentions about the increasing temperature trend in Bangladesh for the last three decades, particularly during the monsoon season. The Intergovernmental Panel on Climate Change's Fourth Assessment Report (IPCC – AR4) states that the country is predicted to experience an increase in average day temperatures of 1.0 C by 2030 and of 1.4 C by 2050 (IPCC, 2007) indicating the effects of anthropogenic climate change have already begun to take shape in Bangladesh.

The coastal districts of Bangladesh are uniquely vulnerable to climate change due to their very low elevation with some of the terrain being at sea level, the topography of the deltaic region and the Bay of Bengal (which serves to funnel seawater upwards) and also socioeconomic and infrastructural factors that limit the low, albeit growing, capacity of the country to tackle the effects of climate related disasters (Agrawala et al 2003.) It is well-documented that the coastal regions of southwest Bangladesh are already being impacted by slow onset climatic stresses such as rising temperatures, salinity intrusion into agricultural soil and groundwater, as well as an increase in the occurrence and intensity of sudden shocks such as floods, cyclones, storm surges and riverbank erosion as a result of climate change (Rahman and Alam 2003; Shamsuddoha and Chowdhury 2007; Huq et al 2015).

Comprehensive Disaster Management Programme (CDMP II) in their study of 2013 has found increasing trends in mean annual temperatures using the data from all 34 stations of Bangladesh. He also suggests that the trend is 1.2°C. Shahid in his study of 2010, using the data from 17 stations for 1958-2007 has also showed similar results and observed an increase of mean temperature by 0.097°C per decade. He also observed the seasonal variation of temperature and come up with the result that, except for winter mean temperature is significantly increasing with an increase of 0.04°C per decade in Khulna station.

Salinity on the other hand has been a longstanding problem in the coastal zones of Bangladesh. In Bangladesh, about 30% of the cultivable land is in coastal areas where salinity is affected by tidal flooding during the wet season, direct inundation by storm surges, and movement of saline ground and surface water during the dry season (Haque 2006; Dasgupta et al. 2014a). Climate change is likely to increase river salinity leading to shortages of drinking water and irrigation, and significant changes in the aquatic

ecosystems in the Southwest coastal areas of Bangladesh during dry season by 2050. (World Bank Report, 2015).

Results from a study demonstrate that saline area in 10 selected coastal districts had increased on average by 27 per cent between 1973 and 2009 (Miah et al. 2010). Dasgupta et al. (2015) also found results in line with stating soil salinity to be gradually increasing. Studies have shown that salinity is moving further inland. In coastal rivers, increase in surface and river water salinity is well noted. For example, during 2004-2009 the greater Khulna District rivers experienced an increase of 20.5 per cent to 433.3 per cent in salinity (Miah et al. 2010).

Among others, rainfall variability is one of the climatic drivers of salinity. Accumulation of saline rain water is different in the western and eastern region of the country during dry season due to Gorai River that is the main upstream distributary from the Ganges and the main freshwater source in the western part of the region. Seasonal variation of salinity in south-western region decreases in monsoon. Figures below shows the clear relationship between monthly precipitation and soil salinity in coastal districts, with peak salinities at the end of the dry season.

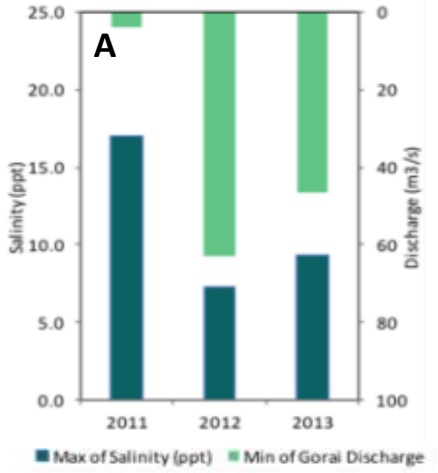

Figure 1: Salinity variation at Khulna on the Rupsha River with Upstream Gorai River Discharge

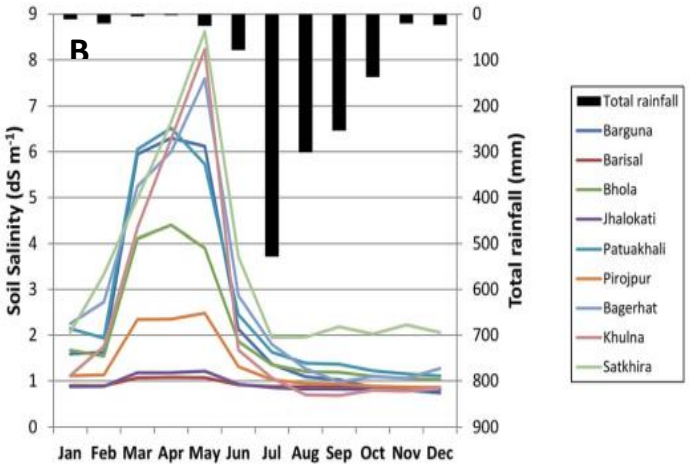

Figure 2: Seasonality of soil salinity (district average) and total rainfall in the coastal areas

Sea level rise further triggers salinity intrusion. Saltwater intrusion from the Bengal delta typically varies by season. During summer, more glacier is melted in the Himalayas causing more precipitation and more entrance of fresh water. But during winter, much of that glacial ice remains frozen resulting into less fresh water flow from upstream and more saltwater from the bay intrudes upstream into the delta.

Furthermore, incidence of tropical cyclones and storm surges also exacerbates salinity in the region. Figure below demonstrates the impact of storm surge on salinity levels using salinity levels in 2011 and showing what would be the impact on river salinity if a Sidr-like cyclone were to occur in 2011.

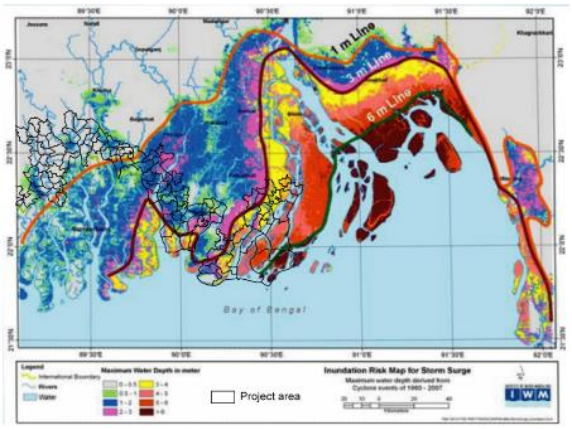

Figure 4: Inundation risk map for storm surge using cyclone data from 1960-2007

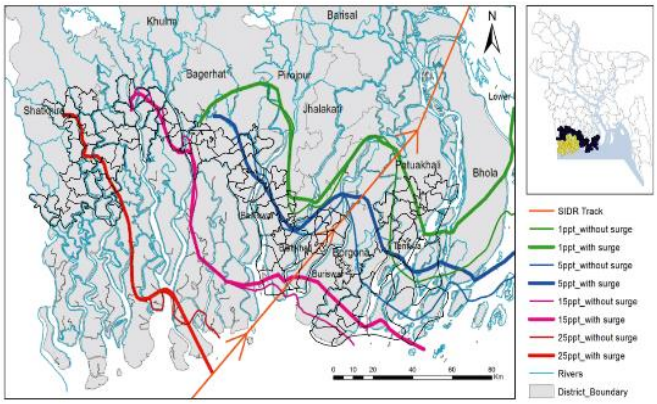

Figure 3: Impact on river salinity of Sidr-like cyclone in 2011.

Nearly 6 million people in Bangladesh are already exposed to high salinity (>5 ppt), but because of climate change the number is expected to increase to 13.6 million in 2050 and 14.8 million in 2080, with the population in Khulna, Satkhira, and Bagerhat most affected. The Sundarbans, the world's largest mangrove forest which has a considerable high biodiversity, is particularly under threat because of its coastal location. A study by the World Bank (2016) using different aquatic salinity scenarios in 2050 predicted that salinity increases will negatively affect 14 mangrove species (especially the most valuable Sundari tree).

There is also evidence that suggests that the patterns of incidence of tropical cyclones in Bangladesh and associated storm surges have also shifted over the last few decades. Total of 129 cyclones were formed in the Bay of Bengal in the period of 1978-2913 of which 32 hit Bangladesh (GoB 2008). JTWC Best Track tropical cyclone data showed that between 1961 and 2013, a total of 61 cyclones hit Bangladesh. Among them, 28 per cent and 16 per cent cyclones hit south-western and south-central coastal zones respectively (Quadir and Iqbal, 2008). Brammer in his study of 2014 has mentioned that, available literature for cyclones between 1960-2013 shows associated storm surge ranging from 1.5 to 10.0 m. Frequency of highest storm surges for the Bay of Bengal will increase significantly even though there is no substantial change in the frequency (Unnikrishnan et al. 2006). Pender et al. (2008) reports that increased wind speeds resulting from higher sea surface temperatures due to climate change means that storm surge heights will increase from 15 per cent to 25 per cent in the 2020s and 32 per cent in the 2050s. An analysis of cyclones occurring in the Bay of Bengal from 1960 to 2007 show there have been more cyclones of higher intensity between 1991-2007 than in the previous few decades (see diagram below).

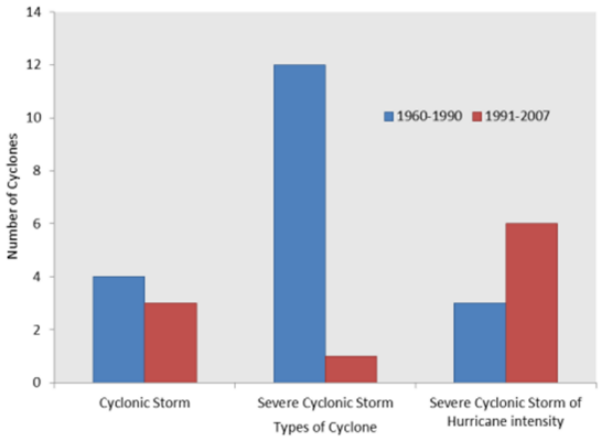

Figure 5: Different categories of cyclones and their patterns

Models predict that by 2050 an additional 15 per cent of the coastal area of Bangladesh will be inundated with storm surges during cyclones. Table below shows the additional area that will be impacted by inundation in 2050. Not only will areas in Khulna, Bagerhat and Satkhira Districts be newly exposed, but tidal surges at 3 meters height will also inundate 69 per cent more land area than they do at present.

Table 1: Vulnerable Area Estimates (sq. km)

Inundation Depth	2050 Without Climate Change (sq. km)	2050 with Climate Change (sq. km)	% Change
More than 1m	20,876	23,764	+ 14%
More than 3m	10,163	17,193	+ 69%

Dasgupta et al. 2014

Because of its geographical location, historically Bangladesh has always received very high precipitation with highest concentration in monsoon. The monsoon season consists of the months June-September even though the onset of rainfall varies from time to time. Mondal et al. using the precipitation data of Bangladesh Water Development Board (BWDB) from 1961-2010 for 234 stations found that, no significant change has happened in the country wide annual normal rainfall for 30 years period (1989-2009). But significant changes in some regional annual rainfall has been found. He also showed that, the south-west (including Khulna) region undergoes increased annual rainfall at 90 percent confidence level. A similar study also validated the significant increase in precipitation in these two regions. Another study of Mondal et al. found that, the number of consecutive rainy days has increased and the trend is statistically significant for Khulna and Satkhira. IPCC special report on 1.5° C predicts that, increase in heavy precipitation in coastal regions along with tropical cyclones and increased sea levels may lead to increased flooding. While Rimi et al. in her study of 2018 showed that, Bangladesh is likely to experience significantly higher frequencies of occurrence for 1 and 5 day extreme rainfall events during pre-monsoon and monsoon seasons for a 1.5C change (for sub-region 1&2). Compared to preindustrial periods of

Bangladesh, the risk of a 1 in 100 year rainfall event has already increased significantly with additional increases likely for 1.5° C and 2.0° C warming.

Models of climate change suggest higher than average monsoon rainfall in the future (Islam and Neelim, 2010; Choudhury et al., 2003). Table below summarizes the modelling data that represents climate change scenarios for the country under three different timelines. Winter months, December, January, February, will become warmer and drier while monsoon months (June, July and August) will become warmer and wetter.

Table 2: Temperature and precipitation scenarios used in GoB documents

Timeline	Mean Temperature Change (°C)			Mean Precipitation Change (%)			Sea Level Rise (cm)
	Annual	DJF	JJA	Annual	DJF	JJA	
2030	1.0	1.1	0.8	5	-2	6	14
2050	1.4	1.6	1.1	6	-5	8	32
2100	2.4	2.7	1.9	10	-10	12	88

***Note**: DJF indicates dry season, comprising of December, January and February, while JJA indicates peak monsoon, comprising of June, July and August months (Agrawala et al. (2003); MOEF-UNDP, 2005)*

The monthly distribution of rainfall and the number of rainy days for the Khulna Divisions (which contains the target project areas) projected by the four GCMs are presented in the figures below. These predicted changes in seasonal temperature and rainfall pattern will have will have implications on lives and livelihoods of people. Increased monsoon rainfall may lead to frequent occurrence of high-intensity floods over the floodplains (Ahmed et al. 2015). Monsoon flood duration will be prolonged by a significant number of days and inundation area, and inundation depth will be increased (Climate Change Cell, 2009). The reduction of rainfall during the drier months (November to March) coupled with increased surface desiccation, will heighten moisture stress and phonological drought in Bangladesh, particularly the western parts of the country (Ahmed 2016; BCAS-RA-Approtech, 1994; Huq et al., 1996).

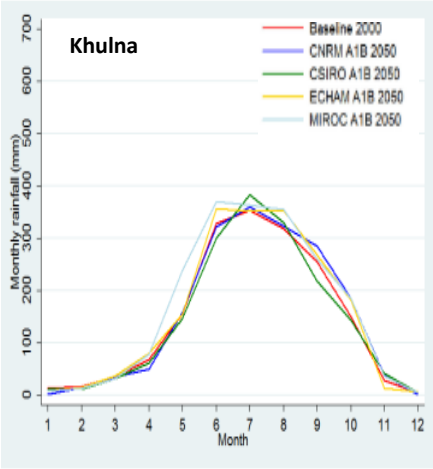

Figure 6: Monthly precipitation in 2050 in Khulna division as predicted by four GCMs (Thomas et al. 2013)

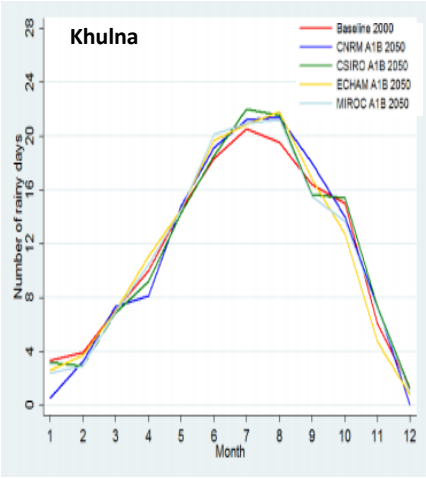

Figure 7: Number of rainy days in 2050 in Khulna division as predicted by four GCMs (Ibid)

There is a general consensus that the above presented climate change induced shocks and stresses pose the greatest risk to the agricultural sector in Bangladesh and the coastal districts specifically. Agriculture is both critical to many livelihoods and remains the sector most threatened by climate change (Yu et al. 2010, Hossain et al., 2011, Huq et al., 2015). The short-term effects of climate change-induced changes in the environment to agricultural sector include damage to housing and agricultural land, food and water insecurity. In the longer term, agricultural practices have been and will continue to be disrupted further as fisheries and arable land are encroached by saline water from rising sea levels; and drinking water shortages will occur for the same reason (Dasgupta et al. 2014). The uneven distribution of rainfall has noticeable impact on crop production (Sarker et al., 2012). Soil salinity, irregular rainfall patterns and a temperature rise in particular will directly lower agricultural yields (Harun-ur-Rashid and Islam, 2007), creating devastating consequences for livelihoods built around agriculture, as the vast majority in rural Bangladesh are. Salinization has led to unplanned cultivation of shrimp as an adaptation strategy in many of the coastal districts, as many fish species have become unviable, leading to further salinization as more farmers switch to shrimp farming (Khanom 2011). Shrimp farming has intensified over the past two decades, negatively affecting surface and groundwater resources, and the large-scale shrimp farming is greatly changing the local landscape, (Datta et al. 2010). Short-term impacts have become long term due to the continual intensification of climate change impact - namely the shift from temporary to permanent salinity in coastal areas as both the sea level and frequency of coastal flooding and storms increase (Huq et al 2015.) When it comes to the project region, Khulna and Bagerhat are among the districts that are projected to face the most severe salinity problems. Farmers are already unable to grow multiple crops during the year (Shamsuddoha and Chowdhury 2007). Crop models and global climate models project that potential production losses will be greatest in the more vulnerable southern sub-regions (Yu et al., 2010, Gornall et al., 2010).

In addition to reduction of the productivity of agricultural land, Shamsuddoha and Chowdhury (2007) recognise drinking water scarcity as another significant long-term consequence of salinity ingress. Saltwater intrudes not only upstream into freshwater rivers, but into groundwater stores such as aquifers as well (Toufique and Yunus 2013.) Benneyworth et al. (2016) identify salinity as one of the main problems affecting water quality in Bangladesh (the others being pathogens and groundwater arsenic), with a high majority (86%) of respondents in their social survey of water quality in the Dacope upazila of Khulna saying their fields had been covered in saltwater. Most of these locals thought that salinity was linked to cyclone events. More generally, 42% considered water quality from tube-wells and ponds to have decreased in the last 20 years, whereas 39% felt it had improved and the rest discerned no change (Benneyworth et al, 2016.) Declining access to water due to climate change is expected to have major implications on health conditions. The impact of salinisation of water sources has been correlated with skin diseases, increased hypertension (Vinies et al 2011), and numerous pregnancy complications (Khan et al 2011; Khan et al 2014b). Khanom (2011) found that villagers also associated gastric problems and fever with saline water consumption, and its domestic use in washing and cooking leads to skin lesions, unclean clothes, and food prone to rotting early, all of which can have health consequences over time.

Livelihood vulnerability to climate change is experienced disproportionately by women for a variety of socioeconomic and cultural reasons. These include a more direct dependence on natural resources; limited access to resources, particularly land tenure; limited access to education and information; limited roles in decision-making; limited mobility and more (Asaduzzaman, 2015.) Climate related disasters, such as flood poses a great hardship for women and undermines their well-being because of their dependence on economic activities linked to the home (Goh, 2012). Particularly, rural women's crucial role of collecting water is made more difficult in salinity-affected regions, which has impacts on their other domestic duties, relationships and education (Pettengell 2010). With these limitations, recovery from and resilience to environmental disaster is more difficult, demonstrated in the fact that women are less likely to migrate than men despite being worse affected (Penning-Roswell et al., 2013.) Rashid et al. (2014) note however that perception of climate change and participation in local level adaptation processes was similar between male and female farmers in their study of southern Khulna.

Migration or population displacement has been identified as an inevitable result of climate change in Bangladesh projected to increase with its environmental impacts (Akter 2009), but Saroar et al. (2015) claim that the relationship between vulnerability and (forced) displacement is not well understood. Though climate-related stressors are themselves well documented as impacts of climate change, there is less literature on migration as a response to these stressors on livelihood and water access specifically. The factors influencing migration are many and thus the type, conditions and incidence of migration vary between groups (Kartiki 2011). Generally, however, population movement in response to climate hazards and disasters tends to be a response as a last resort (Penning-Roswell et al 2013; Saroar et al 2015). Moreover, poverty presents a barrier to secure voluntary displacement, reflected in the lack of correlation between wealth and migration despite poor people's greater vulnerability; in other words, reason to migrate (Gray and Mueller, 2012).

Currently, there is little permanent movement in hazard prone areas except where the land is physically eroded or otherwise unable to support an income; rather, migration is a temporary retreat for safety and income recovery following hazard events, especially for the landless (Penning-Roswell et al 2013.) Only long-term impacts of climate change such as salinity ingress and riverbank erosion typically encourage long-term migration (Penning-Roswell et al. 2013). Such chronic or recurrent hazard exposure is experienced particularly in the southwest of Bangladesh, but as coastal land is very fertile, people are unlikely to migrate permanently if other adaptation options remain (Saroar et al. 2013). From a longitudinal survey of at-risk Bangladeshi households, Gray and Mueller (2012) similarly find that disaster exposure is not highly correlated with movement. In fact, post-disaster the means or resources that enable migration may naturally be negatively impacted, so mobility is reduced. This could raise the idea of migration being better suited rather as a precautionary adaptation, under material conditions in which it is more feasible. Kartiki (2011) states the need for migration to be facilitated and managed as an adaptation strategy, to ensure this phenomenon occurs with minimal disruption and its potential as a sustainable adaptation strategy is realised. Warner and Geest (2013) thus mention in their research that, lack of knowledge, skills and means or resources are the reasons that village people are not taking the coping or adaptation strategies. Facing adaptation constraints, the communities or individual household accept loss and damage and undertake more significant transformation, which wither effect their wellbeing or out migrate their locality leading to the change in livelihood or social systems. Hassani-

Mahmooei and Parris (2012) in their research note that climate change would be affecting migration within Bangladesh, and will increase movements of people towards the east or north east districts, or in the urban areas which are less prone to disasters. Migration flows will also impact the adaptation funding choices that need to be made in future between either local-level climate adaptation initiatives, or providing affordable housing, land and services, and fostering employment for migrants moving from vulnerable areas.

Rachel Dodge et al (2012) in their article summarize a new definition of wellbeing where the people have the psychological, social and physical resources so that they can meet a psychological, social and/or physical challenge. There is wellbeing loss when the challenges are more than available resources to cope, relocate or evacuate, or to respond to the increases in the necessary commodities, for example: food, water etc. (Environmental Protection Agency, 2012). Hence, it is necessary to explore how people cope with change and how their levels of well-being are affected (Rachel Dodge et al 2012). The impacts on livelihoods will be more significant when there is limited access to finance among larger group of population. More focus should be given on strengthening ongoing process and current adaptive strategies. Importance of improved adaptive capacity for reducing vulnerability to climate risks has made way for climate change issues into the policy agenda of many countries (Smit and Pilifosova 2003, Smit and Wandel 2006).

To address both current and future vulnerabilities of coastal communities due to climate change, promoting strategies to enhance their adaptive capacity is critical (Awal et al., 2016). A systematic, participatory and sustainable approach to building resilience and improving well-being of affected communities offers the potential for transformative adaptation. For instance, several financing mechanisms have been set up, both at the international and local level, to help vulnerable communities' tackle the impacts of climate change. However, effective mobilization and use of these funds at the local level is hindered by institutional and governance barriers (Christensen et al., 2012).

Local communities in the coastal belt have also begun to perceive changes in their climate. Haque et al. (2012) show using that villagers have clear perceptions of the changes in heat and rainfall over the last 10 years. Using household surveys and focus group discussions, they demonstrate that locals perceived increased heat, warmer winters and reduced and erratic rainfall. The management and adaptive techniques in these situations are also well studied. Haque et al. (2014) find, using household interviews, that although there are many short-term coping mechanisms offered by governments and NGOs for physical vulnerabilities, there is a lack of long-term infrastructural support for those whose livelihoods are damaged by climate change. For instance, social protection programs for food security do not consider livelihood vulnerability at large, even though they provide relief during short term food shortages, ignoring the underlying problems faced by agricultural livelihoods that may lead to such shortages in the first place (Haque and Marschke, 2015.) Rashid et al. (2014) similarly use focus groups and participatory assessment techniques to assess how communities employ the adaptation strategies at their disposal; in particular, noting how less vulnerable communities look to more vulnerable ones for learning adaptation strategies and using new crops, agricultural practices and species of fish that are suited to the changing climate.

From the literature reviews, it can be concluded that the impacts of climate change in the coastal belt of Bangladesh are already evident and is expected to become worse over time, threatening livelihood opportunities, freshwater access and overall well-being of local communities. This action research intended to identify specific vulnerabilities experienced by different groups in terms in these two coastal villages which share similar geographic and socioeconomic characteristics of the larger portion of the coastal region. The study particularly explored the inter linkage between livelihood insecurity and water insecurity as a result of increasingly prominent climate change impacts and how these affect migration decisions as well as general wellbeing of local communities. Also, the limitations of existing coping strategies and interventions in the villages, and why communities perceive them to be unsustainable have been studied, so that appropriate and effective interventions can designed for promoting their adaptive capacity. Based on the findings, the study also proposes recommendations to be made both to decisionmakers at the national level for development of policies and plans to enhance the resilience of coastal communities and also to international communities for increased disbursement of financial resources.

2. Methodology and Approach

This chapter presents an overview of the methodology and approach employed to undertake the study.

2.1 Research Questions

The study was guided by the following key research question and supporting questions.

- **How to enhance community resilience of vulnerable people in the coastal belt of Bangladesh in the face of a changing climate?**
  - What are the different short-term and long-term impacts of sudden and slow onset climate stressors on local livelihoods and water use? (Chapter 3.2, Chapter 3.3, Chapter 3.4)
  - How the community life and wellbeing is being affected as a result of these impact and what could be the future risk on this regard? (Chapter 3.6)
  - How would climate induced loss and damage be perceived at the local level? (Chapter 3.3, Chapter 3.4, Chapter 3.5, Chapter 3.6)
  - What is the current scenario of migration dynamics at the study site in relation to climate change? (Chapter 3.5)
  - What coping practices exist at the community-level at the study sites? And what is the local capacity to respond to impacts? (Chapter 3.7)
  - What combination of practical actions and policies can create more resilient livelihood systems in the face of severe environmental threats? (Chapter 4.1, Chapter 4.2, Chapter 4.3)
  - What sort of mechanisms need to be in place to ensure the access to public resources for improving well-being? (Chapter 4.4)
  - What sort of mechanisms and procedures need to be in place to mobilize financial resources for addressing climate change impacts? (Chapter 4.4)

2.2 Geographic Scope

The study was undertaken in two villages situated within the project's intervention area - Garuikhali village and Kumkhali village of Garuikhali Union in Paikgacha Upazila, Khulna. **See village profile in Appendix 2.** The sites chosen demonstrate similar geographic and socioeconomic characteristics as the ones in Bagerhat district as well as other districts situated in the coastal belt. Literature review suggests that prevalent livelihood practices as well as water security issues present in these study sites are similar to the majority of the south-western coastal belt, affected by the same climatic shocks and stresses. Furthermore, coastal districts are characterized by similar poverty levels and issues of social inequity as observed in the two study sites. Findings of the study therefore provide an approximate snapshot of climate change vulnerability experienced by majority of the coastal belt and solutions recommended can be replicated across the coastal region. However, unique socioeconomic and environmental characteristics would need to be accounted for when prescribing ways forward for the other areas in the region.

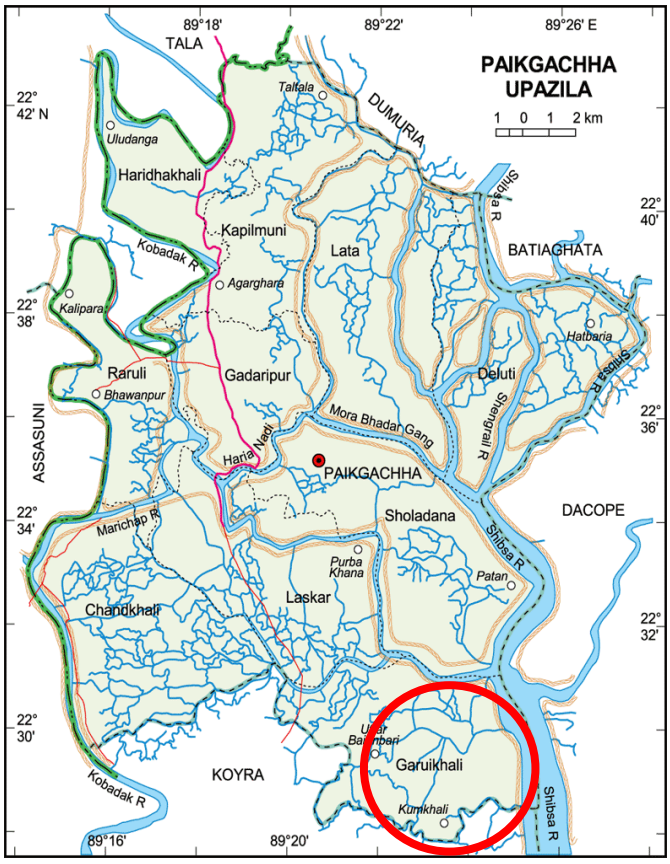

Figure 8: Location of the study area

A combination of quantitative and qualitative approaches was employed to guide research and data analysis, and the methodology can be replicated for undertaking similar kind of detailed assessment for other locations and settings.

2.3 Data Collection Tools

To address the research questions set by the study, a combination of top-down and bottom-up data collection approaches has been applied. Top-down approaches aimed to provide a scientific analysis of climate change and its impacts on the system of interest and included review of relevant literature as well as GIS modelling. Literature review helped understand the current status of vulnerability to climate change in the coastal region and prevalent gaps that exist. A snapshot of change projection for the region as well as future vulnerability were also drawn from the review. GIS modelling was applied to assess topographical changes in the region and how these changes relate to current and future exposure to climate change impacts.

Also, bottom-up approaches were employed to draw out necessary information from affected communities and to help analyse what causes people to be vulnerable to different hazards in the study area. An array of Participatory Rural Appraisal (PRA) tool were applied to understand key vulnerabilities of local communities how they perceive risks to their livelihood and water security and to identify strategies for mitigating these risks. A household survey was undertaken to acquire quantitative information on the overall socio-economic situation of the sites, and a general view of exposure, sensitivity and adaptive capacity of the community to climate change. In addition, key informant interviews with relevant local stakeholders were held during the brainstorming phase of the project.

Detailed information on the data collection tools and their objectives, approaches and respective outputs are provided in **Appendix 1.**

2.4 Sampling Procedure

Community discussion sessions for applying the different PRA tools, were held in selected parts of the villages, where other implementing partners have been active during the previous phase of the project. In selecting the respondents, several factors were considered such as diversity in live, different economic status etc. Separate group sessions for male and female respondents for each PRA tool. The individual interview respondents were selected for group discussions. The Key Informant Interview (KII) respondents were mostly relevant local government and non-government stakeholders as well as community people with significant role in decision making in the village. See table below for a summary.

Table 3: Summary of Data Collection Tools

	Name of the Tools	Approach	Number of Participants
Participatory Rural Appraisal (PRA)	Problem tree	Participatory group exercises with the problems called “low access to water for daily use” and “effect of different stressors on people’s livelihood”	4 sessions - 2 in each village - 1 male group, 1 female group 15-20 participants in each group discussion

	Name of the Tools	Approach	Number of Participants
	Transect walk	Mapping of the village with the spatial dimensions of people's realities, local perceptions of risks and resources	2 sessions - 1 in each village - 2/3 local people and volunteers
	Seasonal calendar	Focus group discussion on the regular cyclical periods and significant events that occur during a year and influence the life of a community.	4 sessions - 2 in each village - 1 male group, 1 female group 15-20 participants in each group discussion
	Village timeline	Focus group discussion on mapping out the events include- weather/climatic events, disease outbreaks, conflicts, political events, and development related incidents those could be described as "Things that have happened in a single year which do not usually happen in other years".	4 sessions - 2 in each village - 1 male group, 1 female group 15-20 participants in each group discussion
	Community mapping	Participatory group activity to identify peoples' perception regarding their community, natural and social resources, basic infrastructure etc which also helps to identify the geographical vulnerability of the community.	4 sessions - 2 in each village - 1 male group, 1 female group 15-20 participants in each group discussion
	Livelihood Shock Analysis	Participatory group discussion to understand how people in the community perceive threats of different types of livelihood shocks, how often such shocks occur, and the extent to which such shocks have already affected households in the communities.	4 sessions - 2 in each village - 1 male group, 1 female group 15-20 participants in each group discussion
	Participatory scenario analysis	Focus group discussion with the community to perceive the future scenario of identified current environmental/ climatic/ social-political stressors	4 sessions - 2 in each village - 1 male group, 1 female group 15-20 participants in each group discussion
	Role-play	Participatory group activity to understand the community actions in the changing climate scenarios	4 sessions - 2 in each village - 1 male group, 1 female group 15-20 participants in each group discussion
	Institutional landscaping	Participatory group discussion to identify different projects undertaken by various institutions in the	4 sessions - 2 in each village - 1 male group, 1 female group

	Name of the Tools	Approach	Number of Participants
		communities and identify community's opinion on that projects	15-20 participants in each group discussion
	Solution tree	Participatory group exercise with the community to explore what solutions the villagers want to explore to solve the problem tree	4 sessions - 2 in each village - 1 male group, 1 female group 15-20 participants in each group discussion
	Resettlement choice exercise	Participatory group exercise to identify different factors that the community would prefer during strategic migration	4 sessions - 2 in each village - 1 male group, 1 female group 15-20 participants in each group discussion
Interviews	Key Informant Interviews	Interviews with the local government institutions, actors, NGOs and community leaders to explore the components and the current environmental and socio-political situation of the community.	8 individuals in 2 villages
	Livelihood histories	Interview with community person to understand the generation wise changes in people's livelihoods and the role of environmental and other shocks.	12 persons - 6 in each village- 3 males, 3 females

The household survey respondents were selected on the basis of systematic sampling technique where the surveyors started from one part of the village and maintained an interval of 10 houses between the next respondent. A single survey questionnaire was administered for each household. See **Appendix 1.**

The sample sizes for the household survey are provided in the table below:

Table 4: Number of households surveyed from both villages

	Total number of households	Male respondents surveyed	Female respondents surveyed
Garuikhali village	1584	51	51
Kumkhali village	1156[1]	50	50

Proposed sample size considered 95% confidence interval and 9.4% error margin. Because of the resource constraints, the team had to keep the sampling size relatively smaller and thus the margin of error is slightly higher than the standard.

[1] Population & Housing Census 2011 – Community Report: Khulna, Bangladesh Bureau of Statistics

3. Assessment of Climate Change Vulnerability

This chapter introduces the geographic and socio-economic characteristics of the study area, and presents findings from the ground regarding the present scenario of climatic shocks and stresses in the area. Community perception on the current as well as expected impacts of climate change are also delineated upon.

3.1 Site profiles

Garuikhali village is located about three and a half hours drive, 150 kilometers south-west from the Khulna City. It comprises ward no 1 under Garuikhali union (union number 10) of Paikgacha Upazila I Khulna District. Part of Shibsa river flows along the north-east side of Garuikhali village which is locally known as Minaj River. This river is freely accessible by everyone and used to be one of the main livelihood generating sources before the government prohibited the use of ghillie nets (include definition).

The first earthen embankment in this village built in 1974 was destroyed during cyclone Aila. Despite being repaired, the embankment is currently in a dire condition. Most of the homesteads in the village have a pond alongside. People have been using the pond water for all household chores and drinking purpose for years. But due to salinity intrusion over the years and shrimp farming, water in most of the ponds has become saline. However, due to unavailability of nearby freshwater sources villagers are compelled to use this water for washing dishes, clothes, cattle etc. The world's largest mangrove forest Sundarbans is at close quarter. People used to collect honey, wood from Sundarbans but after the prohibition on resource collection from Sundarbans from 2013, people's livelihood activities related to forest resource extraction have become limited.

The village has an average population of around seven thousand and among them 97% are Muslim and 3 % are Hindu. Literacy rate in this village is reportedly around 80%. However, from the household survey it has been identified that 55% of the respondents have obtained only primary education and 15% have never been to school. Eighty nine percent (89%) of the respondents in the village own some amount of land but majority are poor. In case of agricultural land, only 40% have agricultural land and among them 39% households own less than 30 decimals of agricultural land. 62% have semi-pucca type structure. 47% of the respondent's annual household income is between fifty thousand to one lakh Taka. Only 12% have annual household income above one lakh fifty thousand taka. Households those have large areas of land and practice large scale shrimp farming, fall under this category. Some consequences associated with poverty i.e. malnutrition, poor access to education, indebtedness are also prominent here.

Agricultural farming and fishing used to be the two-major income generating activities for the male members of this village. But due to salinity, irregular rainfall pattern, excessive heat and other socio-economic reasons most of the people have stopped practicing agricultural farming and fishing. Rather using the saline water, 61% male population are involved in shrimp farming. Only few of them practice shop keeping, vegetable farming, and day laboring in the brick field as main occupation. Most of the male population from village either work as day labor in the shrimp ghers or practice shrimp farming in a small

piece of land which is not profitable. In case of secondary occupation, 59% respondents have no secondary occupation. Only 16% male respondents practice vegetable farming and seasonal agricultural farming as secondary occupation. So, dependence on only one occupation which is not profitable makes the people even more vulnerable. Until 2012, large number of male members used to be wood loggers, but access to Sundarbans and collect resources has been prohibited in 2013. Now this source of livelihood no longer prevails. Women used to do vegetable production in their backyards and farmlands. At present in Garuikali, only 8% women are engaged in vegetable farming whereas 31% in shrimp farming.

Family position of women in this village is just like any other part of Bangladesh where they mostly engage in household chores, raise children and take care of family. 82% women are housewives. Managing water for family is a big responsibility of women. In 55% cases of household survey, it has been found out that, women are in charge of fetching water from the water sources. In 42% cases the main source of drinking water has been found to be 0.5-1 km away. Travelling this far for fetching water not only is time consuming it also causes physical stress to the women. Due to their social position, they also have limited decision-making power. All these lead to mental stress and domestic conflict.

For the entire population of Garuikhali village, there is only one school for primary and secondary studies in Garuikhali village. The school is located in a large compound with a big play field. The only fresh water pond in this village is also located beside the school which is far from many households in the village. There are three pond sand filters (PSF) in Garuikhali village which were set up by different NGO's in different times for providing safe drinking water to village people. But unfortunately, all three of them are not functional currently. Most of the people here have problem of storing fresh water/rain water as they don't have a reservoir/ water tank to store water. Only some of the effluent people who are politically affiliated with UP chairman, members have water tanks at their home. The union parisad complex is located close to the primary school. This village court and Madhumati banking service is also located in the same complex. As Garuikhali village is dominated by Muslim community**,** six mosques and one madrassa are situated there. The madrassa works as an orphanage as well. There are two markets called 'Garuikhali Bazar' and 'Shantar Bazar' located within the village. There is also a bank located inside the bazar.

Kumkhali village is located about three and a half hours drive south-west of the Khulna City. It is the 4 no ward under Garuikhali union (union no 10) of Paikgacha Upazila. Ghoshkhali River passes along the North-East side of the Kumkhali River which provides fresh water that helps Kumkhali to continue agricultural production. Most of the ponds inside this village provide fresh water. People use pond water for various purposes like washing, bathing, cooking etc. This has made the pond water polluted. The village has larger green landscape which is used both as play fields and cattle grazing grounds. World's largest mangrove forest Sundarbans is also at close quarters. Some villagers are dependent on mangrove plants like Golpata for their livelihood.

The village has an average population of around four thousand five hundred and among them 85% is Hindu and 16% are Muslim. In the village, Hindus and Muslims live in harmony. The ratio of male and female population is 1: 1.05 (Khumla Community Series, 2011). There are 17% households where there is no young member and in 34% households there is only one young member. In Kumkhali village as well, highest percentage of respondents has been found to have only obtained primary education. But in this village, 10% respondents have never been to school which is lower than Garuikhali village. Also, the percentage of respondents studied up to graduation is higher in this village. The scenario of female

education is same as Garuikhali village.94% respondents of this village own some amount of land but the size of land varies among people. In case of homestead land, 95% respondents' land size is not more than 50 decimals where as in case of agricultural land, 63.4% respondents have agricultural land. Among them, 33% respondents have more than 70 decimal lands. Unlike Garuikhali village, highest percentage (45%) of the respondents has kutcha structures. Most of the homesteads are made of mud and the roof of (chon). A front yard has been noticed in most of the homesteads. 55% of the respondents' annual household income is between fifty thousand to one lakh Taka. Only 8% have annual household income above one lakh fifty thousand taka. Even though agricultural farming still prevails in this village, the financial condition is not that good. With this limited income, they can hardly fulfill all their needs. As a result, they have to take loans from different NGOs.

Agricultural farming has always been the main income generating activity in Kumkhali. 66% respondents are engaged in agriculture either in their own land or on others land. Even though salinity intrusion, changed rainfall pattern, excessive heat, pest infestation, scarcity of water etc. have reduced their agricultural crop yield over the years, but they continue to do their agricultural practices. 52% respondents' have no secondary occupation. 21% respondents' do vegetable farming on their front yards as secondary occupation. Vegetable farming in front yard is mainly done by women. Besides, some women do handcraft (14%) for earning money and some (8%) help their husbands in the field especially during sowing seeds and harvesting.

The village doesn't have any big market where people can sell their products. Some middle men locally known as "bepari" come at their door step to buy their crop. They usually don't give them fair price rather sell their products at high price in the local market. There are two primary schools in the same compound one for boys and the other for girls. These schools are located just beside the temple. There is one high school in this village as well. Kumkhali village is a Hindu dominated neighbourhood where 85% people are Hindu. There are five or six temples and a mosque in the village. In the same premises of the high school, there is a three-stored cyclone shelter which during normal times is used as school. Very few (not more than 3) tube-wells have been set up in this village in different times. But only one of them which is located close to the school is function. There are some mini bazars inside the village from where people can get daily necessary items. There is one Post-E-Centre in Kumkhali village from where people can have access to internet, computer training, agriculture related information etc.

Detailed information on the villages has been provided in **Appendix 2.**

3.2 Current Scenario of Climatic Shocks and Stresses

Livelihood shock analysis exercise was conducted in both the villages with male and female groups separately, to assess the present scenario of different environmental as well as socio-political shocks and stressors that affect the life, livelihood and well-being of local communities. The shocks and stressors selected were identified via a review of relevant literature as well as consultations with key local stakeholders during the inception phase of the study. The stressors were ranked by the respondents in terms of frequency (how frequently an event occurs), magnitude (how many people are affected by the event) and severity (how much time it requires to recover from the shock). The following table shows the scales employed for frequency, magnitude and severity (the lower the score, the more substantial its impacts).

Table 5: Scales for Livelihood Shock Analysis

Score	Frequency *how frequently an event occurs*	Magnitude *how many people are affected by the event*	Severity *how much time it requires to recover from the shock*
1	More than 1 time per year	All	Very severe, can never recover
2	Once per year	Almost all	Moderately severe, takes 5 years to recover
3	Once every two years	More than 1/2	Bad, but can recover in less than 5 years
4	Once every 5 years	About half	Can recover in less than 1 year
5	Once every 10 years	Less than 1/2	-
6	-	Very few	-
7	-	None	-

The outputs of the exercise are presented in the spider diagrams below for each village separately. The major climatic shocks and stresses persistent in the villages have been highlighted in red in the diagrams. According to respondents, these shocks and stresses are also directly and indirectly responsible for driving associated socio-political stressors.[2]

[2] **Baishakh** = Apr-May; **Jaishtha** = May-Jun; **Ashar** = Jun-Jul; **Srabon** = Jul-Aug; **Bhadro** = Aug-Sep; **Ashwin** = Sep-Oct; **Kartik** = Oct-Nov; **Agrohayon** = Nov-Dec; **Poush** = Dec-Jan; **Magh** = Jan-Feb; **Falgun** = Feb-Mar; **Chaitra** = Mar-Apr

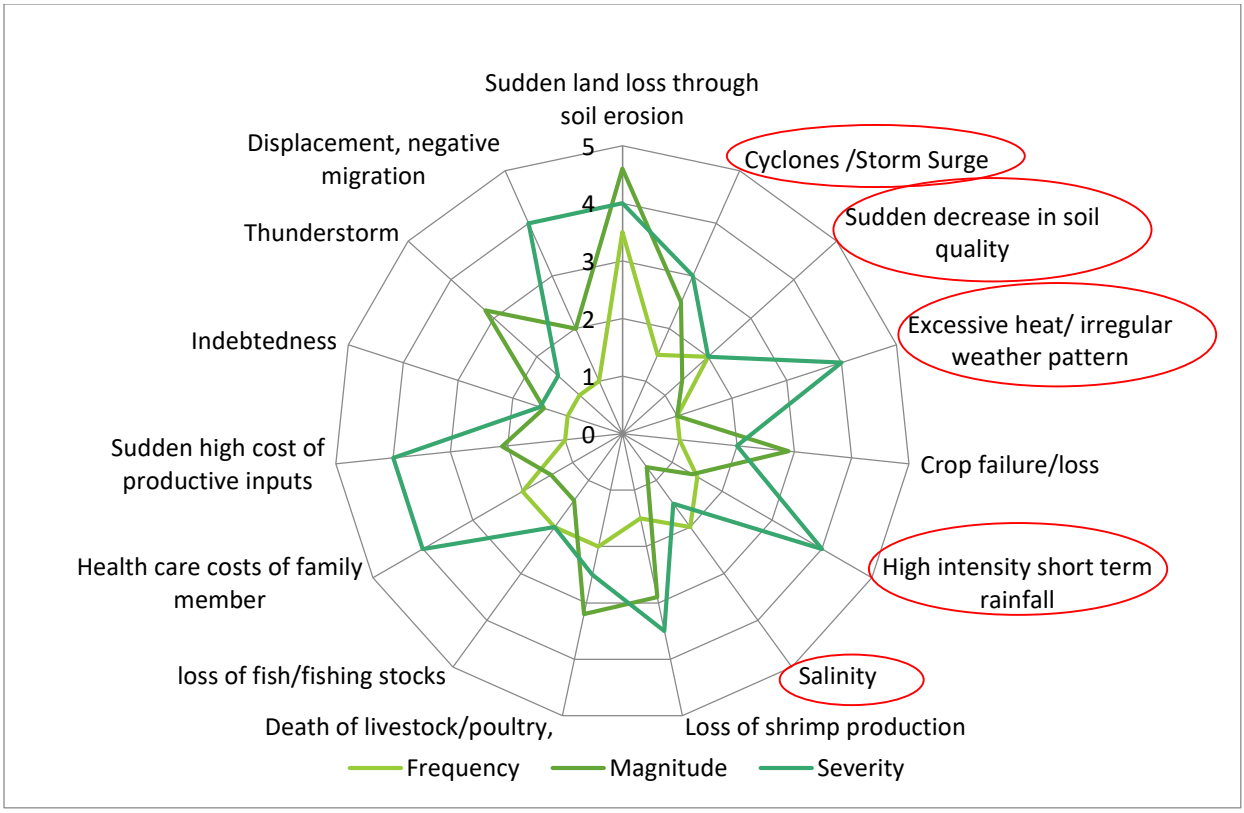

Figure 9: Spider diagram generated during the livelihood shock analysis in Garuikhali village

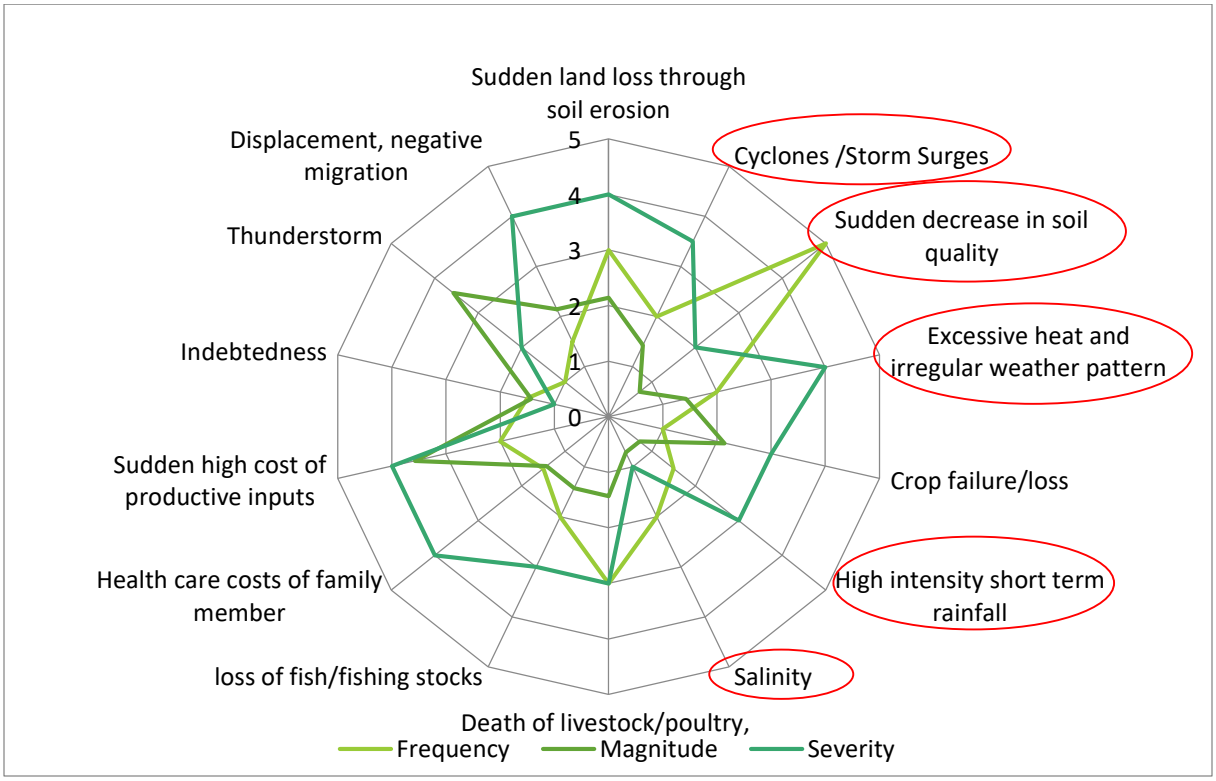

Figure 10: Spider diagram generated during the livelihood shock analysis in Kumkhali village

Cyclone/storm surge was identified by respondents in both the villages as one of the most frequent, most severe and highest magnitude climatic events affecting local communities. Proximity of these villages to two rivers, namely Minaj river and Ghoshkhali river, has been attributed as a key factor driving the severity of storm surges associated with cyclone occurrence. Village timeline exercise revealed that cyclones and storm surges have been a regular phenomenon in the area, generally occurring during the months of Agrohayon (Nov – Dec), Poush (Dec – Jan) as well as Baishakh (Apr – May). Respondents in Garuikhali stated that cyclones and storm surges occur more than once a year, while frequency of cyclones and storm surges were reported to be generally less frequent by respondents in Kumkhali.

According to the respondents, the first earthen embankment in Garuikhali was built in 1974, while Kumkhali have also had an embankment for as long as they could remember. However, both these embankments were damaged during a severe cyclonic storm in 1988, resulting in flooding in the villages and causing destruction of assets and farmlands. Despite suffering little damage from Cyclone Sidr in 2007, Cyclone Aila in 2009 caused massive losses of lives and property in these villages as well. Aila is considered as one of the most severe natural disasters to have hit the area. Respondents in both the villages reported a significant intrusion of salinity in both groundwater and soil following Cyclone Aila, and the effect of which they believe are persisting to the present day.

> *"The devastating Aila destroyed most of the houses, took away the roof of most of the homesteads. Significant intrusion of saline water caused death of fishes, crop damage and destruction of livestock. It also destroyed the embankment in our village. Besides, some roads were also destroyed."* (Female, Livelihood shock, Garuikhali, 2018.07.20).

Due its slow onset nature, the salinity has major implications for local communities, particularly on their availability and access to freshwater. While some degree of salinity has historically always prevailed in the villages due to their locations near the coastal belt, respondents reported a gradual increase in their level with the consecutive and increasingly frequent occurrence of cyclones over the last 30-40 years. Cyclone Aila in particular, resulted in substantial saline water intrusion and the area subsequently experienced a sudden spike in both soil and groundwater salinity. According to the respondents, salinity levels tend to be high during the dry, summer months of Falgun (Feb-Mar), Chaitra (Mar-Apr), Baishakh (Apr-May) and Chaitra (May-Jun), and gradually wane off with the advent of rainy season in the months of Ashar (Jun-Jul) and Srabon (Jul-Aug).

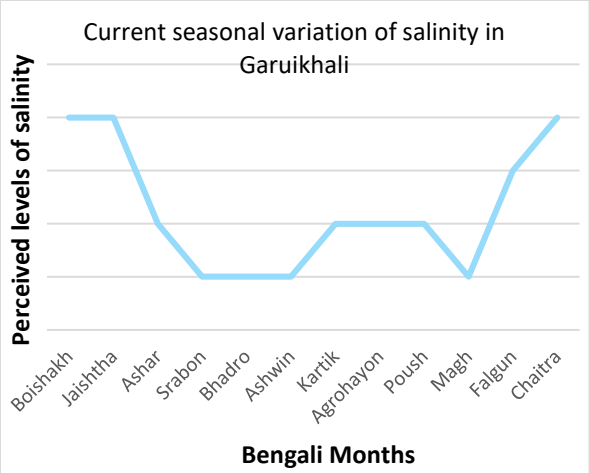

Figure 11: Current seasonal variation of salinity in Garuikhali village

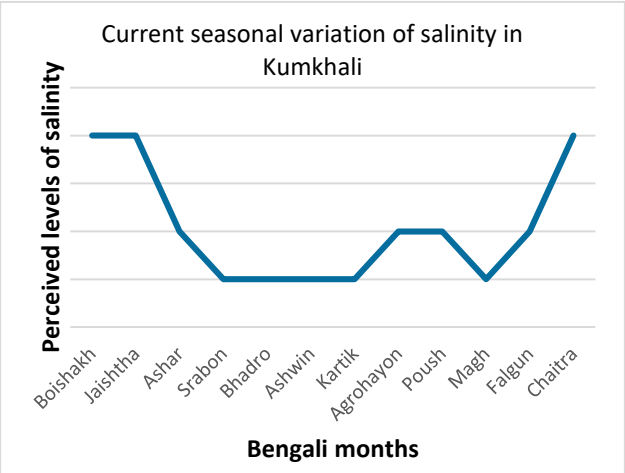

Figure 12: Current seasonal variation of salinity in Kumkhali village

Respondents in both the villages considered salinity to be an acute climatic stressor affecting the area. In addition, salinity in these villages is being exacerbated by a number of sociopolitical factors. Due to already saline conditions in the Garuikhali, there has been an emergence of shrimp farming in the area, particularly by local elites, due to its high profitability. Respondents reported a rise in large scale shrimp farming practices to be a major driver behind increasing levels of salinity in Garuikhali. In addition, poor management of sluice gates, wherein they are operated in favor of shrimp farming, was reported by respondents in Garuikhali to be further exacerbating the issue. On the other hand, communities of Kumkhali have largely refrained from engaging in shrimp farming practices. As a result, relatively lower levels of salinity were reported by respondents in Kumkhali. However, due to being quite nearby Garuikhali village where shrimp farming is highly prevalent, Kumkhali has to bear some of the effects.

> *"From the emergence of shrimp farming, intrusion of saline water into the rivers has been intensified. Local moneyed men and land owners first began doing shrimp farming for its high profitability, disregarding environmental degradation."* (Nazrin Nahar Dipa, Female Leader, KII, 2018.06.27)

High-intensity, short-duration rainfall is another major climatic phenomenon reported by respondents in both the villages. Respondents have observed a change in the seasonal variation of rainfall over time, as depicted in the graphs below. Historically, it used to rain regularly over the monsoon months Ashar (Jun-Jul) and Srabon (Jul-Aug), but the villages tend to receive the highest amount of rainfall during the month of Bhadro (Aug-Sep). Rainfall patterns have also altered with the villages experiencing heavy rainfall over a short duration, as opposed more balanced distribution of rainfall over the monsoon months. Such high-intensity, short-duration results inundation and waterlogging affecting everyone. However, any losses experienced can be recovered in less than 5 years.

"Historically during the month of Ashar and Srabon it used to rain the most. But now, it rains the most during the month of Bhadro." "(Female, Village calendar, Garuikhali and Kumkhali, 2018.07.19). (Frequency score 1.5)

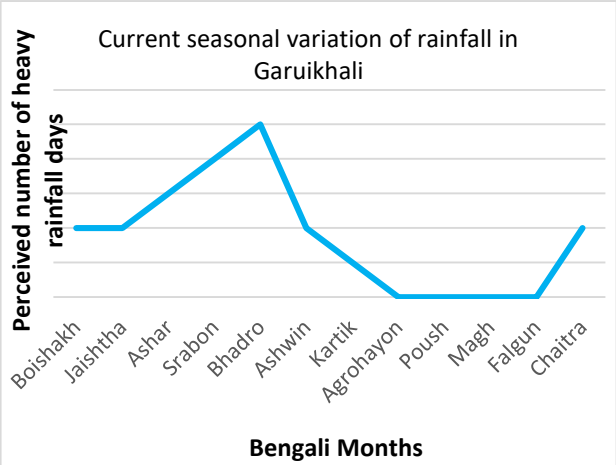

Figure 14: Current seasonal variation of rainfall in Garuikhali village

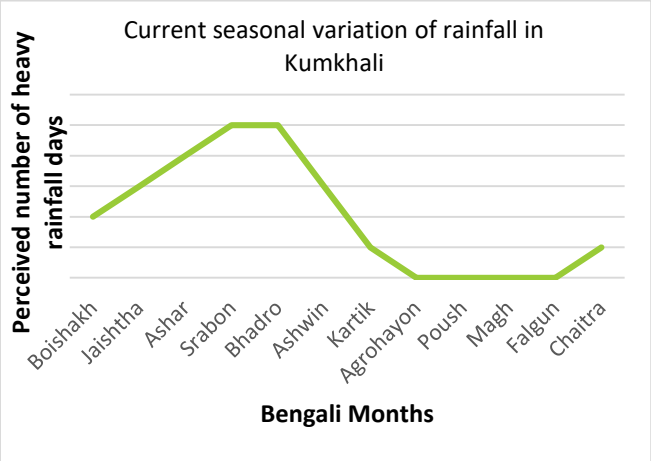

Figure 13: Current seasonal variation of rainfall in Kumkhali village

Excessive heat has also been observed by the respondents in both the villages in recent years and has been identified as another key climatic stress affecting the community. According to them, the traditional seasonal pattern has also changed and now they mainly experience two seasons – warm season (summer) and cool season (winter), as opposed to the six-seasons climate Bangladesh has long been known for. When the participants were asked about the changes of heat across the year, they have mentioned that, temperatures now tend to remain warm nearly all throughout the year except for the extreme cold months and excessive heat is felt during the month of Chaitra (Mar-Apr), Baishakh (Apr-May) and Jaishtha (May-Jun).

"It's relatively warmer all throughout the year than in the past, except for the peak winter months. It appears that the seasons have been reduced to two - warm season and cool season." (Male, Livelihood shock, Garuikhali and Kumkhali, 2018.07.20).

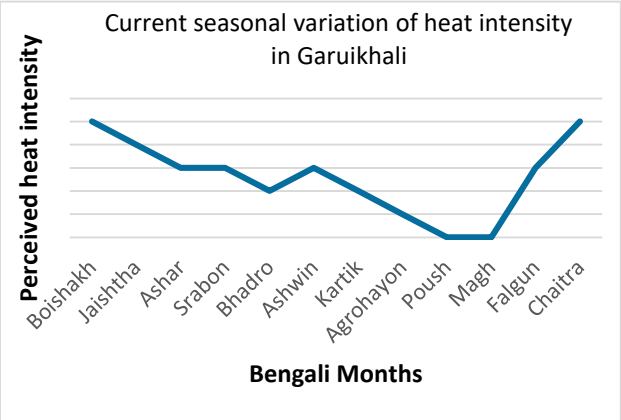

Figure 15: Current seasonal variation of heat intensity in Garuikhali village

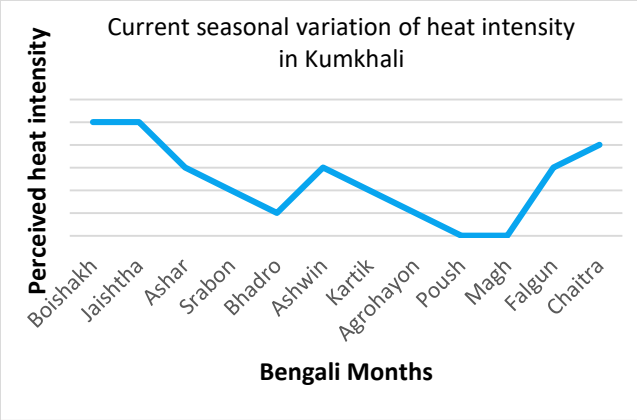

Figure 16: Current seasonal variation of heat intensity in Kumkhali village

3.3 Impact of Climate Change on Livelihood Security

For decades, communities in both the villages have largely been dependent on natural resources for their livelihoods, with majority of the population being engaged in either agriculture or fishing for income generation. However, with noticeable changes in the intensity and frequency of slow onset stresses and sudden shocks as a result of climate change, people's livelihood choices and patterns in the study area have also changed.

Respondents of household survey in both the villages were inquired about their present livelihood activities, their or their fathers' livelihood activities 5-7 years ago and their or their fathers' livelihood activities 10-15 years ago. The findings are represented in the graphs below.

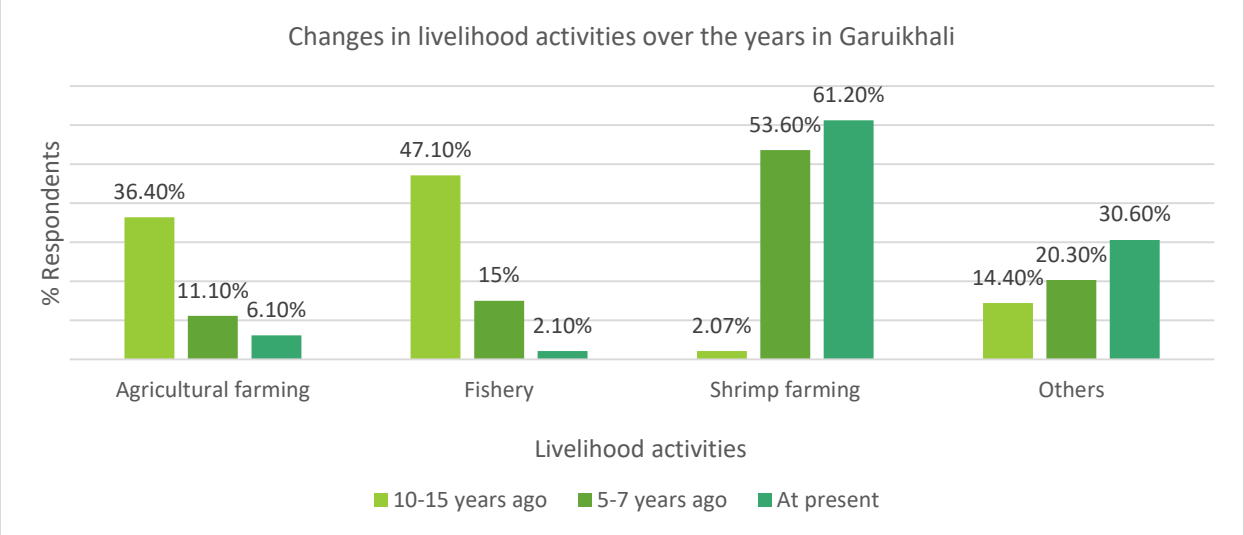

Figure 17: Changes in livelihood activities over the years in Garuikhali village

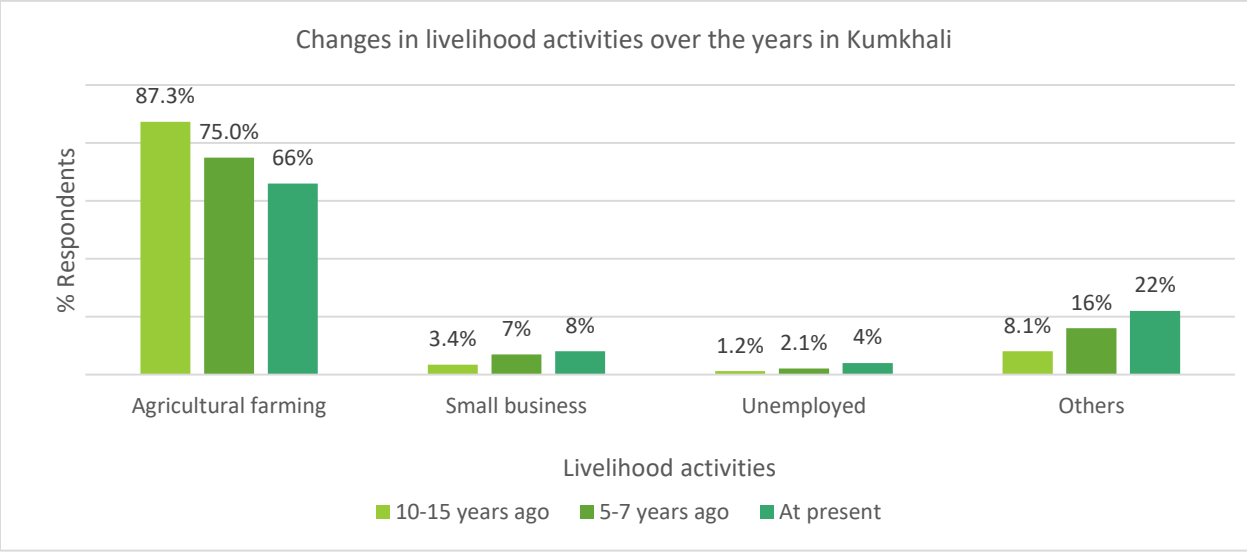

Figure 18: Changes in livelihood activities over the years in Kumkhali village

It is evident from the findings that livelihood activities and choices in the villages have seen a shift over the last 15 years. In Garuikhali, there has been a significant decline in the number of people engaged in agriculture and fishing. On the other hand, shrimp farming in the village has gone up substantially. About 76% of the respondents in Garuikhali were found to have changed their income generating activities in the last 10-15 years. Kumkhali has also seen a modest decline in agricultural farming, however the change is relatively low. On the other hand, engagement in non-farm activities such as shopkeeping, brick kiln labour etc. (as denoted by 'others' in the graph), for income generation has been on the rise in the village. About 16% of the surveyed households in Kumkhali reported changing their main income generating activities over the last 10-15 years. One prominent difference between the shift in livelihood activities in the two villages is that, shrimp farming is not practiced in Kumkhali.

Several reasons for these shifts were highlighted by the respondents. Significant crop failure and low profitability of agricultural farming in recent years, has opted people in Garuikhali to drop out of agriculture. Groundwater and soil salinity in the village was attributed by the majority as a key driver for this change. 10-15 years ago, men used to work on the paddy fields and women used to grow vegetables both on farmlands and on their front yard. However, gradual increase in the levels of groundwater and soil salinity, which the regular and frequent occurrence cyclones have contributed to, have resulted in low crop yields over the years. Cyclone Aila in 2009 caused a sudden surge of salinity intrusion and resulted in massive crop losses and destruction of farmlands. From village calendar exercise, it has been found that, during the dry months, seeds of rabi crops like okra, pumpkin etc. are generally sown and paddy is harvested. Both the activities require good amount of fresh water. Scarcity of water, compounded by salinity,

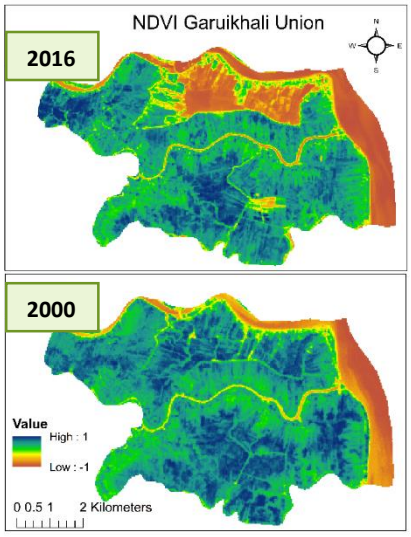

Figure 19: Change in vegetation cover between 2000 and 2016

during this season, hampers harvesting and reduces crop yield. Most of the households have now given up agricultural farming, however vegetable production is still practiced by women from households that are situated in comparatively higher elevation and have a yard in front of their houses. However, vegetable production is affected by elevated degree of salinity and growth is only possible during the rainy season when salinity levels are low compared to the rest of the year.

Due to rising levels of salinity in Garuikhali, many people, mostly local elites and landowners have shifted to shrimp farming practices. Several farmlands have been converted to 'ghers' and there are now large-scale shrimp farms in the area due to the high profitability of shrimp production. This further exacerbates the issue of salinity and hurts agricultural yield in the village, affecting the mostly poor population while a small proportion of wealthy locals continue to be well-off. Shrimp farming in the village emerged in 2002 and in just 16 years, a massive vegetation loss is visible as depicted in the image provided. With the rapid growth farming more vegetation loss is likely to happen in future.

> *"Till 2001, people used to do agricultural farming and there were paddy fields. Agricultural farming was the major income generating activity of the village. But soon after 2001 and from the beginning of 2002 people took interest in shrimp farming and started doing shrimp cultivation in ghers."* (Male, Livelihood shock, Garuikhali, 2018.07.20).

Kumkhali, on the other hand, is subject to lower levels of salinity due to the absence of shrimp farming in the village. However, there has still been some decline in people engaged in agriculture. Cyclone Aila in 2009 also affected Kumkhali significantly and the village saw a substantial intrusion of salinity following the cyclone, leading people to opt out of agriculture. There has been however a rise in people engaged in small businesses such as shopkeeping, as natural resource dependent livelihood options are becoming increasingly unprofitable.

Decline in agricultural practices in both the villages can be attributed to a number of other climate change induced shocks and stresses. Changes in rainfall pattern over the years have had an adverse bearing on agricultural yield in the area. Cropping patterns employed by the local communities and their harvesting period had historically been dependent on rainfall patterns. But the seasonal variation in rainfall experienced at present, demands a change in agricultural practices which local communities are largely unaware of. Also, high-intensity, short duration rainfall often leads to inundation and heavy waterlogging, damaging farmlands, homesteads as well as roads and infrastructure. According to the respondents, waterlogging as well as excessive heat during the summer months, perpetuates pest infestation which also affects crop yield. Right before the vegetable harvest months of Ashwin (Sep-Oct) and Kartik (Oct-Nov), villages see infestation of 'current poka' which affects vegetable production as well. To address the issue, people often resort to low quality pesticides as most cannot afford higher quality ones, which leads to further degradation of soil quality. The poor are also unable to avail saline tolerant seeds and lack of storage facilities, especially in Kumkhali, results in low shelf life of seeds, affecting agricultural yield. These problems are also exacerbated by limited access to markets for the residents of Kumkhali. High transport price cost and unavailability of time and resources are a couple of reasons for farmers in the village are unable to sell their produce in nearby markets. Often, crops are sold to local intermediaries (bepari), who buy them off the farmers at a much lower rate than ones they would get in the market.

> *"We remain very busy in the field during harvest period. My husband cannot find any time to go to Garuikhali bazar and sell the crops/vegetables on his own. We sell our crops to the local*

"bepari" who attempts to swindle us and offers us a price which is much lower than the market price." (Female, Livelihood Shock Analysis, Kumkhali, 2018.07.20)

Historically, a sizeable population in Garuikhali, mostly males, have also been engaged in fishing for their livelihoods but have given up freshwater fishing due to significant decline in fish stock in recent years. People had been highly dependent on the nearby Shibsa river for their fishing. The river was previously freely accessible for everyone and served as a major source of income generation. However, rising levels of salinity in the river has led to a decline in fish supplies, opting people to moving out of fishing as a profession. People also used to cultivate fishes in village ponds. Gradually increasing levels of salinity in these ponds have diminished cultivation potential. Sudden spike in salinity following Cyclone Aila, resulted in massive losses of fish stock in both the river and village ponds. Subsequently, cultivation of freshwater fishes in the village experienced a sharp decline.

Major losses in fish yield started when the widespread practice of shrimp farming began. At first the practice of shrimp farming was in small scale and people could cultivate some amount of freshwater fishes. But with time, saline water from the shrimp 'ghers' began intruding into nearby freshwater ponds, further reducing cultivation potential. At present, levels of salinity are considered to be so high that freshwater fish farming as a livelihood option is nearly non-existent in the village.

Freshwater fish cultivation in the village was also significantly affected by virus attack, which the community respondents attributed to salinity as well as excessive heat during summer months. Even though many people have given up fishing and started engaging in shrimp farming using saline water, cultivation of shrimps is also hampered by the same viruses according to respondents. During the months of excessive heat, shrimp production is also adversely affected as a result of virus attack. While wealthy shrimp farm owners can afford medicines to address the problem, the poor shrimp farm owners suffer from a significant loss of shrimp production. Besides, respondents perceive that waterlogging and inundation as a result of high-intensity short-duration rainfall days' also propagates virus growth affecting freshwater fish supplies. Shrimp ghers are also often inundated, resulting in reduced shrimp production. Socio-political factors such as government restriction on accessing to Shibsa river as well ban on using ghillie nets, have compelled local communities to opt out of fishing as a source of income generation.

"Well off people started doing shrimp farming at small scale but soon they realized that, if they do it in large scale it will be more profitable. As a result, saline water began to get spread in fresh water sources. Because of the increased salinity in water, fresh water fish cultivation has been significantly reduced and now it is almost impossible to cultivate fresh water fishes." (Male, Livelihood shock, Garuikhali, 2018.07.20)

From the evidence presented above, it can be observed that recent proliferation of shrimp farming in the study area, particularly in Garuikhali village, has emerged as key non-climatic factor driving levels of climate change induced salinity in these two villages. Higher levels of salinity in Garuikhali compared to Kumkhali, can be attributed to the rapid growth of shrimp farms which thrive on saline water. However, Kumkhali has also experienced gradual rise in salinity levels despite the absence of shrimp farming practices. Respondents cited proximity to Garuikhali as well as poor management of sluice gates in the area, as a reason for saline content spilling over and intruding into the village. It can also be inferred that the effects of climate change, characterized by irregular rainfall pattern, increased incidence of cyclones as well as rising sea levels, have mainly been responsible for rising

salinity levels in the village. However, considering the scope of the study, it is contentious to isolate climate change as the sole reason for increased salinity in Kumkhali.

To explore future vulnerability of climate change in the area, participatory scenario analysis and role-play exercise was undertaken with male and female groups separately in both the villages. The analysis revealed that most people feel that the impacts of climate change induced shocks and stresses will worsen in coming years and will affect human and ecological systems as well as socio-economic development in the area. Observance of trends over the past several years, has led local people to believe that salinity levels will continue to rise in the area, more frequent cyclones will occur, and rainfall patterns will become even more erratic, affecting livelihood opportunities for the entire village.

Increased incidence of cyclones is expected to lead to persistent waterlogging and further diminishing agricultural and fishing potential in the area. Salinity has also been perceived to become worse as a result, and with rainfall patterns becoming more unpredictable, local communities feel that they might be unable to adapt their cropping and harvesting practices accordingly and agriculture, as well as fishing, might not be livelihood options anymore in 20 years' time. People who are already poor, would be driven to extreme poverty. More intense cyclones may also affect forest cover, and the small proportion of those that are still dependent on the Sundarbans will be compelled to seek alternative livelihoods. Rising temperature along and persistent inundation from storm surges, might lead to worse cases of pest infestations in both crop fields as well as water bodies further reducing potential for agriculture and fishing.

3.4 Impact of Climate Change on Water Security

Increased incidence of different climatic shocks and stresses in the villages pose significant threats to water security for local communities. Primarily, increasing levels of salinity across different water resources in the villages mean people are subjected to an array of water related issues. Household survey revealed that in Garuikhali, for around 80% of the population, ponds serve as the primary source of drinking water, while the rest rely on rainwater. However, among the 80%, only about 5% are able to avail water from the only freshwater pond available in the village which is more than 1 km away. These are mainly people who drive auto-rickshaws and can travel this long distance. They collect the water and end up selling them to other villagers. Majority of the population are unable to afford the water and end up consuming water from other saline sources. In Kumkhali, on the other hand, there are several tube-wells as well as ponds that serve as sources of drinking water for the villagers. 58%, 29% and 13% respondents reported ponds, tube-wells and rainwater respectively as their primary sources of drinking water.

Most households in Garuikhali have ponds alongside their homestead, while the number of ponds are comparatively less in Kumkhali. These ponds have long been major sources of freshwater but respondents in both the villages reported gradually increasing levels of salinity in these ponds over the past several years, particularly after the incidence of Cyclone Aila in 2009, which resulted in a substantial surge of saline water intrusion into these water bodies. Respondents in Kumkhali also reported increased salinity levels in tube-wells than in the past. These observed changes in salinity levels were largely attributed to more frequent occurrence of cyclones as well as increasing heights of tidal surges, by respondents in both

the villages. In addition, high-intensity, short-duration rainfall in the area often results in inundation of large sections of the two villages, including latrines. Inundation for extended periods of time mean that impure water from these latrines intrude into freshwater sources. Mobility for accessing freshwater sources is also restricted as a result of inundation. Freshwater access is further hindered by pollution of water bodies. A significant number of people in both the villages wash their cloths, cattle, dishes, take baths in the same pond where they also collect their drinking water from. For about 57.5% of respondents in Garuikhali and 40.5% in Kumkhali, the source of water for household activities was found to be the same as their drinking water source.

According to the respondents in both the villages, consumption and household usage of highly saline and contaminated water results in different water-borne diseases, such as diarrhea, cholera, stomach bugs, skin diseases etc. Women and children [3]are the ones most afflicted by these diseases. Cases of pregnancy related problems such as hypertension during pregnancy and also premature birth of children, have been observed in recent years, which the respondents attribute to saline water consumption. Rise in malnutrition among children was also reported in Kumkhali. The graphs below demonstrate the distribution of these diseases across different demographic groups.

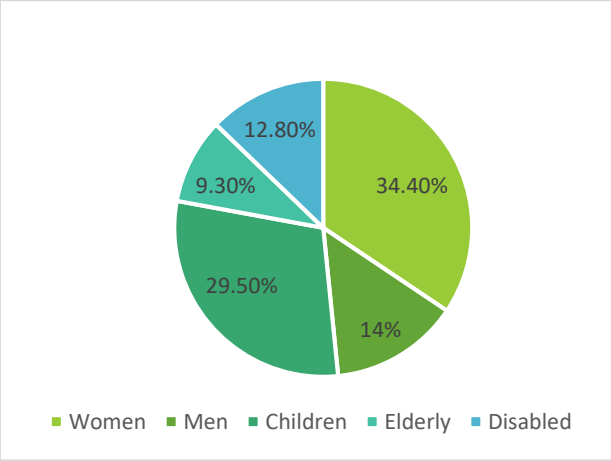

Figure 20: Percentage of disease affliction by population groups in Garuikhali

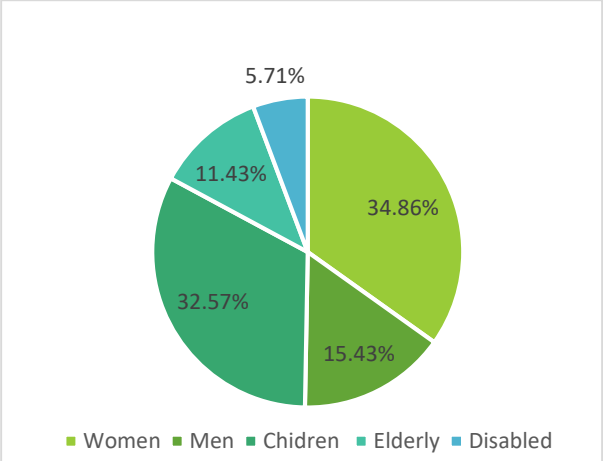

Figure 21: Percentage of disease affliction by population groups in Kumkhali

With the sources of potable and freshwater becoming increasingly scarce over last 5-7 years in Garuikhali, physical labor required for collecting water has also increased. For more than 90% of the respondents in survey, the primary source of drinking water was found to be between 0-1 km away from their households, while only about 9% had to travel more than 1 km. Due to homestead ponds in Kumkhali possessing lower levels of the salinity, 70% of the respondents have to travel less than half a kilometer to collect water for drinking. See graphs below.

[3] *Children refers to persons below 15 years . According to UNICEF, youth refers to people ranging from 15-24 years; so any person below 15 years have been considered as children*

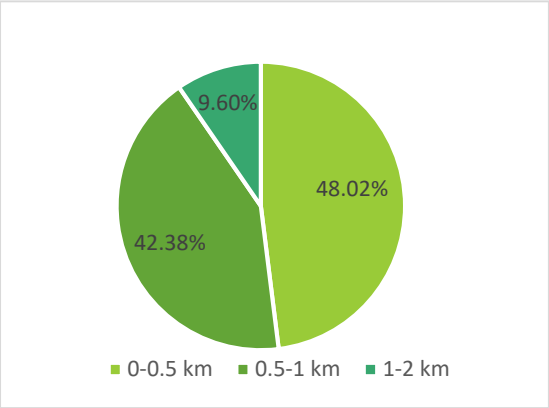

Figure 22: Distance to the main source of drinking water in Garuikhali

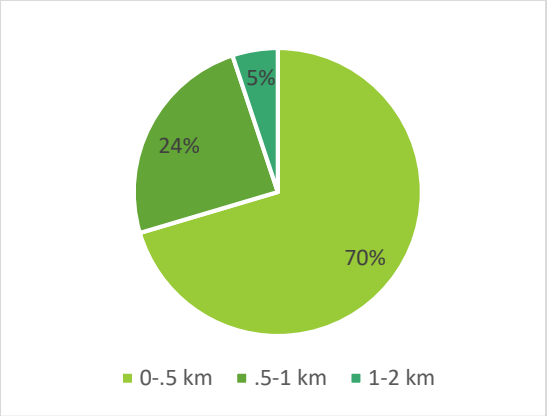

Figure 23: Distance to the main source of drinking water in Kumkhali

Women were found to be disproportionately affected in this regard as well. Traditionally, in rural Bangladesh, women are largely responsible for fetching drinking water from these sources and were found to be so in about 55.2% cases in Garuikhali and 73.5% cases in Kumkhali. Women have to travel the distance once or twice every day. Despite the availability of a number of tube-wells in Kumkhali, they have mostly become dysfunctional. Time required for fetching water was also observed to have increased over the years. About 58.2% respondents in Garuikhali and 38.2% in Kumkhali, now require about half an hour to collect water from their source. Travelling such long distances everyday, leads to physical exhaustion and also occupies substantial amount of time which could have gone towards other productive uses.

> *"Sometimes we have to go far away to collect potable water and it causes physical stress and sometimes illness to us. If I can save the time from fetching water, I can give more time in tailoring"* (Mahmuda, Livelihood History, Garuikhali, 2018.07.20)

The issue of freshwater access in the two villages is further exacerbated by the lack of adequate water storage facilities available to local communities. To offset the problem of water scarcity during dry summer months, people tend to collect rainwater during the wet season and try to preserve them as long as possible. However, they often run out of water too soon due to insufficient provisions for storing water. The graphs below delineate the state of having water reservoirs in the two villages.

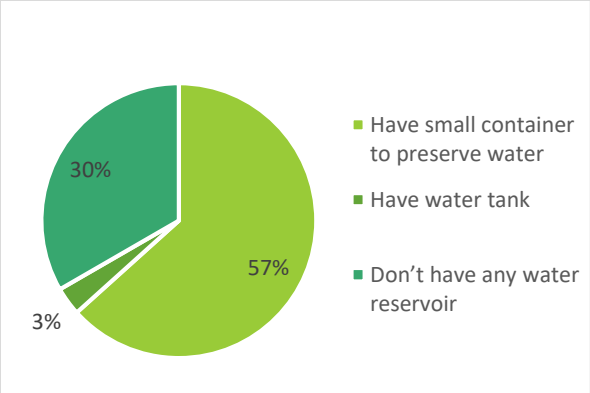

Figure 24: Percentage of people in Garuikhali with water storage facilities

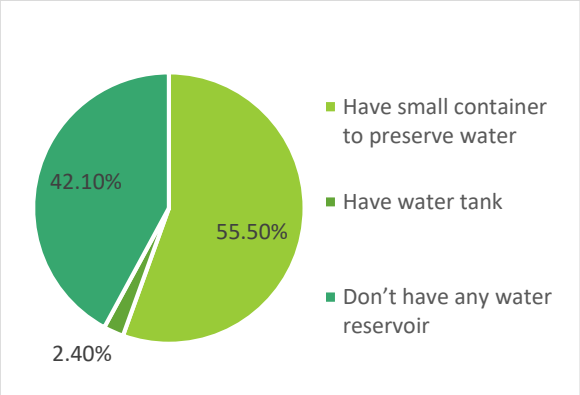

Figure 25: Percentage of people in Kumkhali with water storage facilities

Unfortunately, none of the water reservoirs and tanks are functional currently. Furthermore, inadequate drainage mechanisms, supplemented by poor operation of sluice gates tend to prolong inundation and waterlogging following days of heavy rainfall, thereby further contaminating water bodies in the area.

> *"Most of the people here have problem of storing fresh water/rain water as they don't have a reservoir/ water tank to store water. Only some of the effluent people who are politically affiliated with UP chairman, members have water tanks at their home."* (Male, Village calendar, Garuikhali 2018.07.19).

During the participatory scenario analysis and role-play exercise undertaken with the local communities, respondents primarily expressed concern regarding levels of salinity becoming worse in the coming years, further threatening water security in the area. Higher levels of salinity would mean higher incidence of health issues and diseases among the population. This would be accompanied by higher medical costs. Also, scarcity of nearby freshwater sources would lead to increased time and effort, especially from the women, in collecting water, thereby reducing productive hours. As a result, respondents felt that that people who are already poor, would become poorer over time and overall socioeconomic condition of the village will deteriorate as the impacts of climate change take precedence.

3.5 Migration Dynamics in the Context of Climate Change

For decades, temporary or seasonal migration for secondary occupation and additional income generation has been employed by community members, mostly males, in both the villages. Household survey revealed, for about 53.5% households in Garuikhali and 21.4% households in Kumkhali, at least one family member or relative has migrated in the last 20-30 years to seek alternative income generating opportunities. Until 10 years ago, male members of the community would typically migrate to nearby cities like Khulna, Gopalganj during paddy cutting season in search of additional income and would return to their villages to continue their primary occupation. However, loss of livelihood opportunities and increasing water insecurity, induced by various climatic shocks and stresses, have led to a shift in migration

patterns over the last decade or so in the two villages. People now migrate to other places besides paddy cutting season and all throughout the year in search of alternative livelihoods.

In the last 10 years, 42.7% of the households surveyed in Garuikhali and 14.7% of the households in Kumkhali, reported having at least one member, usually male primary earning member, migrate to other other places. Out of the those that had migrated in the two villages, about 80% engaged in seasonal migration while the rest had permanently migrated.

The major push and pull factors for migration have been demonstrated in the graphs below.

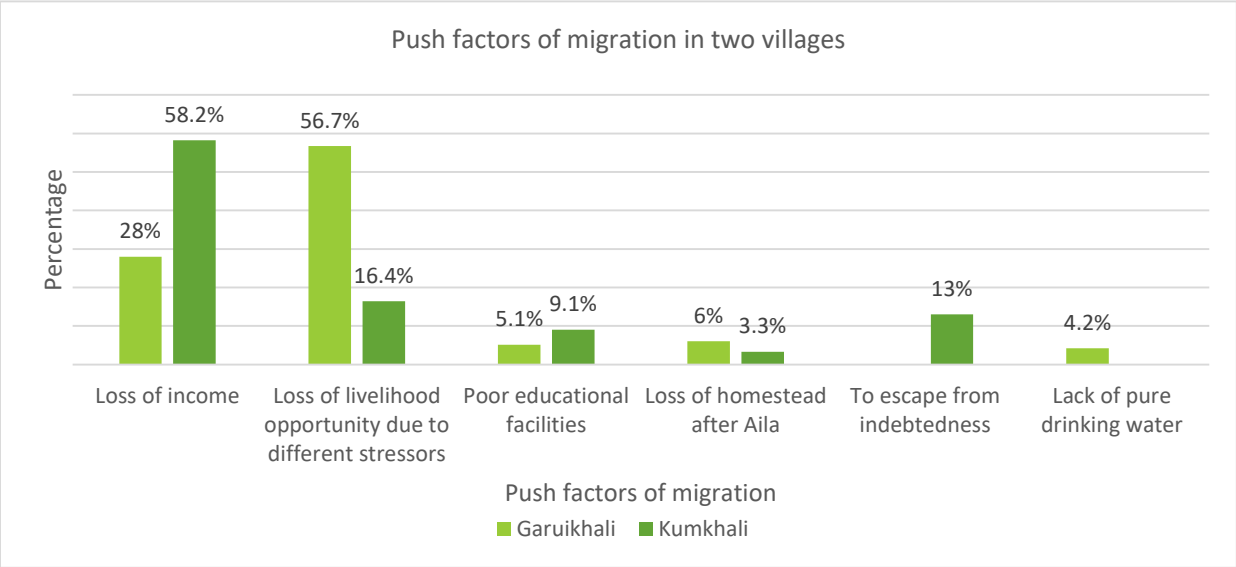

Figure 27: Different Push factors of migration in two villages

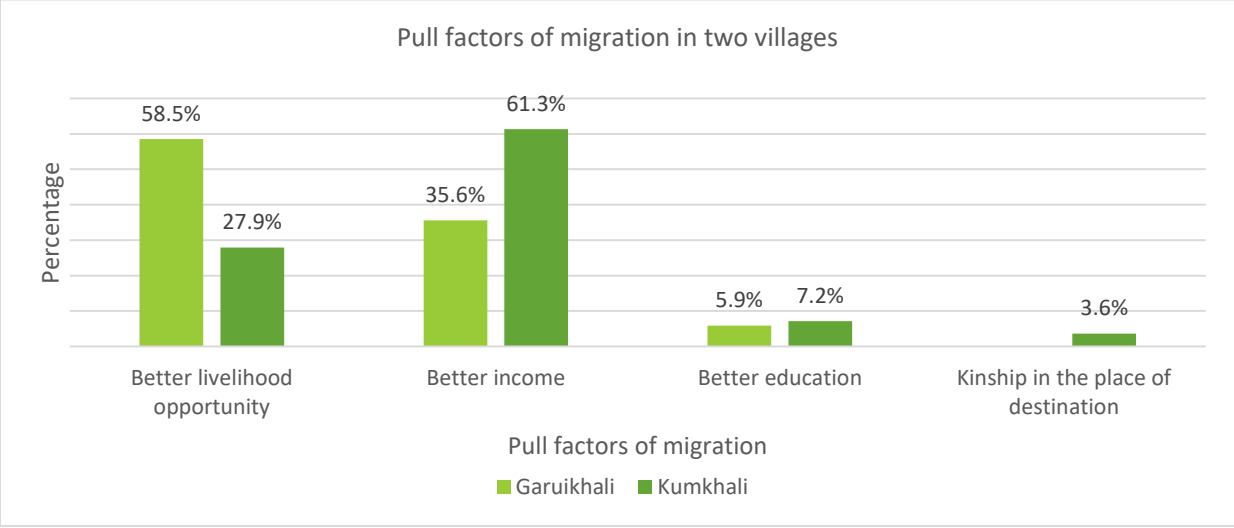

Figure 28: Different pull factors of migration in two villages

Differences in patterns of seasonal migration have been observed in the two villages. In Garuikhali, seasonal migration generally starts during the months Ashwin (Sep-Oct) and Karthik (Oct-Nov) and increases during Poush (Dec-Jan), Magh (Jan-Feb) and Falgun (Feb-Mar). During these dry months, water scarcity worsens in Garuikhali and so does salinity. As a result, people migrate to nearby cities such as

Gopalganj, Khulna and Barisal in search of alternative livelihoods. On the other hand, in Kumkhali, seasonal migration begins around Bhadro (Aug-Sep) and becomes most prominent during Agrohayon (Nov-Dec). Food scarcity becomes prominent during Kartik and Agrohayon since by then people are usually done with paddy cutting and have had run out of rice and fish supplies.

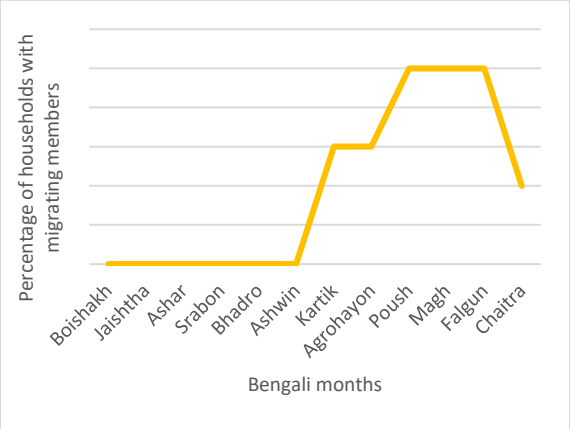

Figure 29: Seasonal variation of seasonal migration in Garuikhali

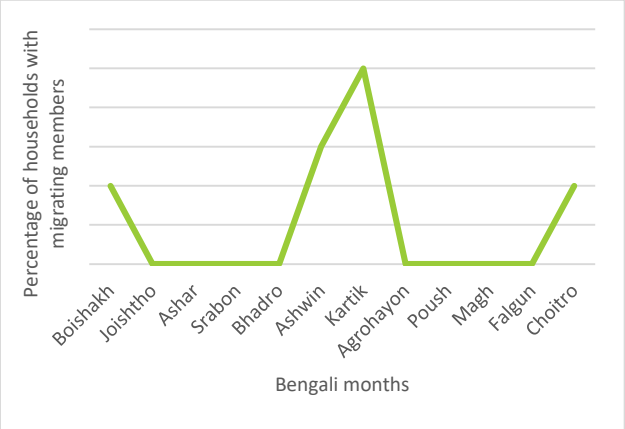

Figure 30: Seasonal variation of seasonal migration in Kumkhali

People generally migrate to nearby cities Gopalganj, Khulna and Barisal seasonally in search of alternative livelihoods, where they engage in rickshaw pulling, day laboring in brickfields, crop farming or garments factory work. However, when it comes to permanent migration, Dhaka seemed to be the primary destination and migration to Khulna was also observed in some cases. Seasonal migration constituted 79% of the cases while permanent migration made up 25% of the share. A notable observation was made in Kumkhali, where 13% of the people were found to have migrated across the border to nearby India. Better income, services and facilities were all highlighted as reasons for choosing India as a destination. In the past, people would cross the border illegally and often ended up getting apprehended and deported back, and as a result ended up worse off than before. But presently, most of the migrants have passports and travel to India legally. Female members of households have also been found to migrate to India with their spouse or children.

> *"My husband was a plumber here, knowing the higher income India we went there illegally from the help of a dalal. But after 6 months he got caught and sent back to the village. After coming back he remained unemployed for 6 months." (Aroti, Livelihood History, Kumkhalii, 2018.07.22)*

Participatory scenario analysis and role-play exercise with the community further explored how migration patterns may evolve as the impacts of climate change become more and more prominent. Respondents perceived that with livelihood and water insecurity rising in the area, an increasing number of primary earning members of households will consequently take up permanent migration to different destinations, leaving female members and children behind. This is expected to place extra burden of managing household chores on the remaining family members and in the process reduce productive opportunity options for women in the village. Also, migration decisions in some cases prove rather unfruitful wherein migrants end up in worse conditions in their new destination. This might exacerbate the socioeconomic

conditions of households and the already poor might end up poorer. Furthermore, to support migration, families often take loans from NGOs and other villagers, which they would face even more difficulties to pay back given a migration decision is unsuccessful, thereby ending up in a vicious cycle of indebtedness.

3.6 Impact of Climate Change on Overall Well-being

Dwindling livelihood opportunities, increasing water insecurity and shifts in migration patterns, as a result of climate change induced shocks and stresses, have substantial bearing on the overall wellbeing of communities in the two villages.

Emergence of livelihood insecurity in the last decade or so, have resulted in significant income losses for households. Household survey findings revealed, that, more than 41% respondents in both the villages do not have any monthly savings and 31% have less than BDT 1000 savings. According to the participants of livelihood shock analysis, even 7-8 years ago, fishermen and farmers could save up to BDT 1000-3000 monthly from the sale of fishes and crops. Presently, they are unable to ensure any savings but instead suffer from month deficits of between BDT 1000-3000. Those with savings of between BDT 3000-5000, haven taken up small businesses or have migrant family members who remit money to their families. Similarly, monthly deficit of small scale shrimp farmers in Garuikhali is also in between BDT 1000-3000 due to significant losses in yield faced as a result of virus attack as well as inundation of ghers during heavy rainfall. In some case, monthly deficit of these shrimp farmers exceed BDT 5000.

The majority of the people in these village used to consume fishes, rice, vegetables from their own cultivation in the past. However, with reduced yield of crops and fishes as a result of environmental shocks and manmade stresses, they can no longer to do so. As a result, monthly expenditure on food for families have risen without any noticeable increase in income levels. Those that are unable to incur additional expenses for food have shifted their diet with reduced consumption of nutritious foods such as milk, eggs, fishes, vegetables etc.

Consumption and household use of highly-saline water, polluted water in addition to rising heat levels, have resulted in increased incidence of water borne and vector borne diseases in the villages. 10-15 years ago, diseases like diarrhea, food poisoning, skin diseases were not as prominent as they are now. As a result, households now need to incur additional expenditure for medical treatment.

> *"Now almost in every month at least one person of my family gets sick and on an average I need to spend BDT 1000-1500 per month for treatment purpose."* (Shahida, Livelihood History, Garuikhali, 2018.07.21)

Reduced income levels, mean that poorer households are unable to afford factors of production, further diminishing their ability to recover from their deficits. Children's education is often given up due to unaffordability.

Increase in monthly expenditure and deficit compels households to borrow money and take up loans from different sources. The tendency of taking loan has increased than what it was 10 years ago. Sources include local NGOs, samity (associations), as well as money lenders. NGOs generally provide the largest volume of loans. However, due to gradually diminishing income generating opportunities

in the area, households are often unable to pay back these loans on time and end up borrowing loans from a different source to repay the former. As a result, households are often trapped in a vicious cycle of indebtedness.

Migration for alternative livelihoods, both seasonal and permanent, are often taken up by members of the community to cope with both climatic as well socio-political shocks and stresses that they are subjected to. During periods of seasonal migration, by generally the male members of households, women have to bear significant burden on managing family affairs and household chores. Children's education is also affected as a result as they need to stay at home to support household activities. Furthermore, women find it difficult to perform evacuation measures during disasters without the assistance of a male household member. All these lead to physical exhaustion and mental stress for the families.

Examining the above, it is apparent that as the impacts of climate change manifest themselves in the form of further losses of livelihood opportunities and increased water insecurity, the already impoverished state of wellbeing of these communities will significantly worsen. It is therefore imperative that concerted and targeted actions are undertaken to help boost the adaptive and absorptive capacity of affected households and communities in the study area.

3.7 Current Coping Strategies

Various climatic shocks and stresses have always been prevalent in Bangladesh to some degree, particularly in the coastal belt, and communities in the region have been coping with them via an array of mechanisms for generations. Local people address these shocks and stresses and cope with their impacts, drawing from indigenous and learned knowledge. Simultaneously, different stakeholders including national and local government, NGOs, training institutions have in the past and continue to offer support to affected local communities in the form of different interventions. The study explored some of the key coping strategies presently employed by people in the two villages to tackle the impacts of different climatic shocks and stresses. These strategies were drawn out from participatory consultations with local communities in the two villages and the key objective was to assess whether these strategies are sustainable and identify potential interventions and solutions that can complement existing strategies. The table below provides a summary of the different strategies.

Table 6: Current coping strategies with response to different climatic shocks and stresses

Climatic Shock/Stress	Impacts[4]	Current coping strategies	Is the strategy sustainable? If not, why?
Cyclones	• Loss of livelihood options	• Hold the chal (roof) of house and place poles to protect the roof	• None of these are sustainable

[4] Women, children and other vulnerable groups are often disproportionately affected by most of these impacts due to a plethora of reasons explored in the earlier sections.

Climatic Shock/Stress	Impacts[4]	Current coping strategies	Is the strategy sustainable? If not, why?
	• Destruction of homestead, crops, infrastructure • Loss of lives • Intrusion of salinity due to storm surges	(chal) from being flown away by strong winds • Take shelter in strong homesteads/ cyclone shelters • Early warning system (EWS) issued by Red Cross as well as local volunteers • No effective current strategies are undertaken by the community to protect crops and farmlands	• They might be able to protect 1/3rd of the crop if they receive early warning, otherwise they lose all of it. • Due to financial incapability, they are unable to use strong, wind-resistant construction materials to build their houses with
Floods and waterlogging (heavy rainfall)	• Reduced mobility and disrupted communication due to severe waterlogging • Loss in agricultural production • Contamination of drinking water • Inundation of ghers and intrusion of salinity into other freshwater bodies	• Store rain water for drinking and cooking purpose • Construction of small mud walls to keep waterlogging out of house yards • Protection of shrimp ghers using bamboo fence	• Largely unsustainable • Unavailability of sufficient storage facilities causes scarcity of water • Mud walls often not strong enough to keep the water out of the house
Salinity intrusion (soil, water resources, groundwater)	• Degradation in soil quality and strength. • Vegetable and crop production loss • Loss of fishery. • Restricted mobility • Incidence of diseases from consumption and usage of saline water (diarrhea, skin diseases etc.) • Outbreak of diarrhea and Income loss	• Collect water from nearest fresh water source. • Consumption of freshwater to avoid health problems • Use water purifier (fitkiri) to avail clean water • Collect and harvest rainwater during wet season	• Largely unsustainable practices • Increasingly limited access to freshwater sources • Unaffordability of water purifiers • Insufficient number of tanks, water reservoir possessed by local people to collect rain water and fresh water • Over application of fertilizers will further degrade soil quality over time

Climatic Shock/Stress	Impacts[4]	Current coping strategies	Is the strategy sustainable? If not, why?
		• Use of different fertilizers to tackle soil salinity in agricultural production • Shift towards saline tolerant shrimp farming practice	• Shrimp farming further increases salinity in the area. It cannot be taken up by the mostly poor population and benefits a select few, while adversely affecting the poor
Irregular weather pattern and excessive heat	• Desertification Physical exhaustion reducing productivity • Loss in crop production due to pest incidence • Changes in cropping patterns and practices • Income	• Shower/bathe about two-three times a day • Use of pesticides as well as medicines to tackle pests • Irrigation using water from canals	• Largely unsustainable • Pesticides can only yield about ¼ of expected production without pest infestation • Use of pesticides likely to degrade soil quality for crop production • Unaffordability of high-quality pesticides by the mostly poor population • Drying up of canals due to poor operations and management of sluice gates

In addition to the community practices, different organizations including government and non-government have implemented several projects in the area to provide support to communities in addressing the impacts of these shocks and stresses. One common support is that immediately after the incidence of a severe cyclone or a major flood, government bodies, international and national NGOs as well as charity organizations deliver relief including food and immediate support materials. Apart from that, the Local Government Engineering Department (LGED) and the Bangladesh Water Development Board (BWDP) have constructed cyclone shelters, embankments along the village, concrete roads, sluice gates and also dug a canal to serve irrigation purposes. However, most of these are subjected to poor operations and maintenance by responsible authorities. Several households in the villages have been provided water tanks by the local government, however these are insufficient in number and does not cover the entire area.

Different NGOs are also working with these communities on different issues water security, hygiene, sanitation as well as livelihood support. These NGOs have provided latrines to the community people, water tanks for rain water harvesting, loans and training for livelihood support. Most of these initiatives

were appreciated by the community people, except loans and microcredit as they tend to push people into debts and they have to severe consequence if they are unable to repay their loans on time. Respondents stated the need for these initiatives on a larger scale so that they can benefit all of them.

Having assessed the current coping strategies of both the villages it can be summarized that, despite being affected by similar climatic shocks and stresses and suffering from similar impacts, two villages have differentiating factors that need to be targeted accordingly. Predominant practice of shrimp farming in Garuikhali is responsible for perpetuating high levels of water and soil salinity, rendering people more vulnerable. On the other hand, Kumkhali is entirely based on agricultural production with a big canal in the middle of the village and consequently the community has comparatively less issues with salinity. With cyclones, both the villages are in a similar situation and going to the nearby cyclone shelter appears to be the lone option. In the present context, existing coping strategies available to local communities are perceived to only serve as temporary solutions and are deemed to be largely unsustainable. As the impacts of climate change become more and more prominent, there is a significant need to scale up existing solutions and introduce new ones to help transform adaptive capacity of these communities to survive as well as thrive under challenging conditions in the future.

4. Towards Building Resilience

On the basis of reviewed literature, participatory consultations with local communities as well as with key stakeholders, the study identified few relevant solutions that can help enhance the adaptive capacity of people in these two villages to the impacts of climate change. This chapter provides a description of different interventions that can lead to enhanced adaptive and absorptive capacity of affected communities, helping them become resilient to the imminent impacts of climate change.

4.1 Ensuring Livelihood Security

Presented below are of the some of the solutions recommended by the local communities to ensure livelihood security in the area.

- **Equitable distribution of agriculture and shrimp farming**

Respondents in both the villages mainly highlighted the need for a revival of agricultural practices in the area alongside shrimp cultivation, to ensure livelihood security of local communities. While shrimp farming benefits only a small group of people, the majority are left with inadequate livelihood options within their locality. Some of the shrimp farms in Garuikhali will also need to be removed in order to retrieve land for agricultural production.

The National Shrimp Regulation, 2014 also supports the idea of having shrimp farming along with vegetation and destroying complete vegetation has been discouraged. According to the document, shrimp farming by changing the land use pattern has been discouraged and without prior permission from the owner of the land, one is not allowed to inter saline water in a land to cultivate shrimp. Also, to keep the environmental and socioeconomic balance in an area, a 'gher' or a shrimp farm has to be limited to 30 acres.

The National Fisheries Policy, 1998 also aligns with the similar idea. It describes it as follows. "Measures will be taken to conserve biodiversity in the coastal region and necessary steps will be taken to culture fish/shrimp along with rice crop, either in rotational or concurrent phases."

In that context, bringing back of agricultural practices along with shrimp farming in this region could prove to be a resilient practice, as Kumkhali has already demonstrated that it is possible to do agricultural practices in this region, despite salinity.

- **Saline tolerant rice seeds**

Respondents mentioned that they have always bought different seed varieties from the market and with increasing salinity, yield from different rice seeds have been declining in recent years. They would prefer if agricultural departments and agencies of the local government could provide them samples of free seeds of saline tolerant species so that they can make a reasoned choice in purchasing newer seed

varieties. The saline tolerant seeds could also be subsidized and made available at a lower rate than the current market price.

- **Access to market**

Respondents suggested establishing a wholesale market or a well administered collection centre in their locality, so that they are able to easily avail market facilities for selling different crops. This could counter some of the problems with market access, such as poor road communication, high transport costs and dealing with fraudulent intermediaries. Respondents believed it would help boost their income.

- **Alternative livelihoods training**

To empower local women as well as youth to engage in economic activities, technical and vocational skills training should be provided on a regular basis. Skills may include sewing, handicraft etc. To supplement this, NGOs or other charity organizations can promote and sell their handmade products outside of their locality. Respondents expressed receiving limited training on rearing livestock and poultry. So, training on how to properly rear animals in saline-affected areas, particularly targeted at women, could also prove beneficial for the community. Knowledge training should also be provided on more responsible use of natural resources, particularly from the Sundarbans, to ensure sustainability of natural resource dependent livelihood options.

4.2 Ensuring Water Security

Presented below are some of the solutions recommended by the local communities to ensure water security in the area.

- **Rain water harvesting**

People in both villages mostly drink water from few selected ponds and in the very few tubewells present in Kumkhali. Since salinity is expected to persist in the villages, harvesting rainwater appears to be a feasible approach to ensuring access to freshwater. There are currently a few rainwater harvesting tanks in both the villages, but most of these do not have sufficient capacity to sustain water for long periods of time. Local government bodies and different NGOs have provided a few large sized tanks to selected households to be availed by everyone in the village. But in many cases, the host house does not allow others to use the water from these tanks. Respondents therefore expressed that they will be benefitted if each household in the village could receive a water tank. In addition to ensuring access for everyone, this will also reduce the potential for inter-community conflict over water use. Distribution of water tanks should also be based on needs.

The initiative could be taken up by some of the NGOs present in the area. Households also expressed willingness to invest some of their money for establishing these tanks. Respondents mentioned that the plastic water tanks are better than concrete ones, as soil salinity tends to damage the concrete tanks and plastic ones are also cheaper. Presently, plastic rainwater harvesting tanks cost about BDT 3000-4000, and

each family is willing to contribute 1000-2000 taka towards that. Adequate availability and access to freshwater can ensure good health and also save time for collecting water and enhancing productivity, thereby enhancing the overall well-being of people.

- **Desalinization Plant at Community Level**

To combat the issue of salinity in both drinking water as well as water for other usage, a desalinization plant can be set up at the community. There are some examples of community level desalinization plants established in nearby Satkhira district by different NGOs and few of the respondents have had experience of consuming water from such filters.

- **Fresh water irrigation system**

There is no proper irrigation system in these villages. In Kumkhali, they have to draw water from the pond or tube well and use for irrigation. While the entire area is prone to salinity, a freshwater canal from where they can do irrigation for cultivating their lands would be a good solution for improving agricultural production and promoting livelihood empowerment. Shrimp farming is not feasible for the largely poor population and hence a robust, freshwater irrigation system can allow people to grow crops and vegetables to supplement their incomes. Respondents suggested a proper irrigation system that can serve as a pipeline distribution of water from a definite source or pump system, which is currently unavailable in their village.

- **Proper management of sluice gate**

According to the respondents, the sluice gate should be operated and managed properly by the local government. The closing and opening time should be maintained properly. There is no person in charge in operating sluice gate at the moment and for this reason, they have to suffer from unwanted saline water intrusion. Saline water should also be drained out from the area on time so that saline water inundation would not occur. In addition to proper management of sluice gate, respondents highlighted the need for more responsible use of water. This includes reducing wastage and refraining from contaminating water bodies by littering waste. This will help reduce health-related impacts in the village.

- **Canal dredging**

Kumkhali village has a canal and they believe it is very unlikely to get another canal nearby. If this canal can be properly managed, it can provide fresh water irrigation for the entire area. But the canal has never been dredged in its entire period and over the time has filled up a lot. At this rate, it is expected dry up soon and respondents have already observed that its depth has reduced in the last 20 years. Respondents emphasized the need to dredge the canal to ensure freshwater flow and reduce water scarcity.

4.3 Strategic Migration

Participatory resettlement exercise with local communities in the two villages to identify priorities and factors that will determine migration choices. Listed below are some of the key indicators, composed

mainly of pull factors that respondents would prefer when moving to a new place. A mechanism for planned migration as a solution can be developed accordingly.

- **Secure sources of income -** The most preferred indicator by respondents was a secure source of income in the new destination. People are unwilling to risk moving to a new place if they are uncertain about a secure income source. Also, income levels would need to be higher than their current income.
- **Low susceptibility to climatic shocks and stresses -** Respondents stated willingness to move to a place that is subject to fewer climatic shocks and stress. This includes locations that are prone to cyclones, riverbank erosion, salinity. Monsoon flooding was not considered as much of a deterrent however.
- **Quality education -** Certainty of quality education was another factor of importance driving migration decisions. In Kumkhali, most children attend school and respondents would want to ensure the same continues if they move to a new place with their family. On the other hand, school attendance is low in Garuikhali due to the closest school is being about 10 kms away. Respondents therefore expressed preference to move to a place where schooling would be easily accessible. Also, it would be important to ensure education facilities are reasonably affordable in the new destination.
- **Health facilities –** Both the villages suffer from the lack of good health facilities. There are community clinics which are largely inactive. Respondents would prefer to move to a place where health services are accessible as well as affordable
- **Housing –** Although not highly important, respondents mentioned a preference for similar housing facilities in their destination. However, provided the income levels are considerably higher, they would be willing to settle for worse conditions

These indicators serve to provide guidance on promoting migration of affected communities to suitable locations, as a means of transformative adaptation that helps them maintain their present levels of well-being and also enhance it over time.

4.4 Local Level Climate Financing Mechanism

To support vulnerable communities' across the globe to tackle the growing impacts of climate change, several financing mechanisms have been established, both at the global and national levels. Over the last decade or so, Bangladesh has been a major recipient of international climate funds for supporting climate change mitigation and adaptation activities in the country. Concurrently, the Government of Bangladesh has taken important strides to promote climate action using domestic resources. For the purpose of the study, the potential for leveraging national level funds, namely the Bangladesh Climate Change Trust Fund (BCCTF), to support resilience building in the study area, has been explored.

In 2009, the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) was prepared which serves as the primary strategic framework document for climate change action in the country. It underlines 44 programmes of action to be undertaken over the short, medium and long term, within six thematic areas (BCCSAP 2009). The six areas are listed below. Thematic Area 1 has been recognized to be mainly relevant

for the context of the project. Programmes of action that are relevant to the solutions and recommendations proposed in the study have also been listed below.

- **T1: Food Security, Social Protection and Health**
    - P2: Development of climate resilient cropping systems
    - P4: Adaptation in fisheries sector
    - P6: Adaptation in health sector
    - P7: Water and sanitation programme in climate vulnerable areas
    - P8: Livelihood protection in ecologically fragile areas
    - P9: Livelihood protection of vulnerable socio-economic groups
- T2: Comprehensive Disaster Management
- T3: Infrastructure
- T4: Research and Knowledge Management
- T5: Mitigation and Carbon Development
- T6: Capacity Building and Institutional Strengthening

Subsequently, the Bangladesh Climate Change Trust Fund (referred to as the Climate Change Trust Fund (CCTF) at present) was set up. The fund is capitalized by a 'block budgetary allocation' in the form of an endowment resourced entirely from GoB's non-developmental budget. Annually, a fixed amount is allocated to the fund. 66% of the total amount is assigned for the funding of projects and programmes, whereas the rest is reserved as a 'fixed deposit' for emergencies. The interest accrued on the 34% is also used to fund project implementation. 90% of the assigned funds are allocated to different government agencies for implementation of priority projects in the area, the fund has a 10% civil society window (BCCT 2018). Since its inception, over BDT 30 million has been allocated to the fund.

A recent analysis of 400 implemented projects under the fund revealed that the highest number of projects has been allocated to T3, with second highest allocation going to T1. It is worth noting however that comparatively smaller volumes have been disbursed to the most vulnerable sectors of agriculture, livelihoods and health (Firoz, 2018).

Despite GoB's commitment to providing substantial financial support for climate action in the country, whether such support would truly meet the needs of poor and excluded communities is dependent upon how funding is disbursed, managed and governed. Effective channelization of funds to the local level such that it reaches the most vulnerable is of utmost importance. This is where the role of local government institutions (LGI) becomes critical.

In Bangladesh, LGIs at the rural level are composed of three tiers – Union Parishad (UP), Upazila Parishad (UzP) and Zila Parishad (ZP). LGIs are the significant institutions at local level which are closely involved with social, political and economic lives of the people living in rural areas. LGIs have diverse set-ups in their localities and have mandate to mobilise and disburse resources to support development initiatives and therefore offer a great opportunity for efficient and effective delivery of interventions to combat climate change issues. Bottom-up approaches that recognise the crucial factors of local contexts, local actors and institutions (Fenton et. al., 2014) are essential for building resilience at local level. And local governments are generally considered to be the key players in local climate governance (Mah and Hills's 2014). The role of the LGIs in reducing vulnerability to climate change has also been recognised in UNDP's

Adaptation Policy Frameworks for Climate Change. The UNDP has foreseen the role of local government in preventing local climate damage and disasters (UNDP, 2004). It is also widely acknowledged that building local level capacity including the LGIs in reducing vulnerability of affected areas is crucial (Mintz 2008).

In Bangladesh, all LGIs are in the purview of the Ministry of Local Government, Rural Development & Cooperation (MoLGRDC). Under the MoLGRDC, Local Government Division (LGD) is the implementer of all projects allocated for the entire ministry. As of June 2016, MoLGRDC has received the highest number of projects from the BCCTF compared to other line ministries. However most of these projects have gone to cities and towns while UPs and UzPs have received limited consideration. Despite MoLGRDC listed as one of the key ministries under BCCSAP, very limited allocation has been received by them under the pillar of capacity building and institutional strengthening - a critical need for LGIs.

Some building blocks are already in place to help disburse funding support for climate action at the local level. This includes GoB's Local Governance Support Programme implemented by LGD. Currently in its third phase, the programme aims to strengthen UPs and UzPs through particularly in the areas of financial reporting, universal auditing and direct disbursement of funds. Also, Union Parishad Governance Project (UPGP) and Upazila Parishad Governance Project (UzPGP), which are working to strengthen governance mechanisms within the lowest tiers of LGIs. In addition, every union and upazila has a Union Disaster Management Committee (UDMC) and a Upazila Disaster Management Committee (UzDMC) set up, to facilitate disaster risk reduction in their respective localities via developing local warning system, risk reduction programming, rescue and recovery strategy as well as awareness raising strategy. These initiatives offer opportunities for effectively channeling funds to local communities in the study area.

The proposed financial mechanism has been developed on the basis of a previous study on the topic undertaken by ICCCAD, review of relevant literature as well as consultations with key stakeholders at the local level.

BCCTF could establish a dedicated funding of 20% or more to be allocated/transferred to the Local Government Division for undertaking projects at the local level. Existing Disaster Management Committees (DMC), both UDMC and UzDMC at Garuikhali Union and Paikgachha Upazila to be scaled up and expanded to Climate Resilience Committees. To be able to manage direct funds and implement projects at the local level, these institutions would require capacity building on both climate change knowledge, climate project designs as well as on financial management and disbursement. NGOs and other relevant training institutions active in the area can be advocated to carry out said capacity building interventions. ICCCAD, with its significant climate change expertise, can also play the role of a key training partner. Over time, these institutions will develop significant capacity to be considered as robust and Union Climate Resilience Committee (UCRC) and Upazila Climate Resilience Committee (UzCRC). At the relevant Local Government Division, a Climate Resilience Technical Committee will be formed consisting of climate change experts. The UCRC and UzCFC will then develop quarterly Climate Resilience Action Plans, comprised of priority climate action interventions for their localities to be forwarded to the CR Technical Committee for their approval. The CR Technical Committee will employ rigorous indicators on climate vulnerability to determine allocation of funds. Once approved, funds will be directly transferred to the UP or UZP accounts, employing similar mechanism as the LGSP-III grants. To ensure transparency and accountability, as well as effective disbursement of fund allocation, participatory processes of

monitoring and evaluation will be set up, led by local community as well local NGOs and government representatives.

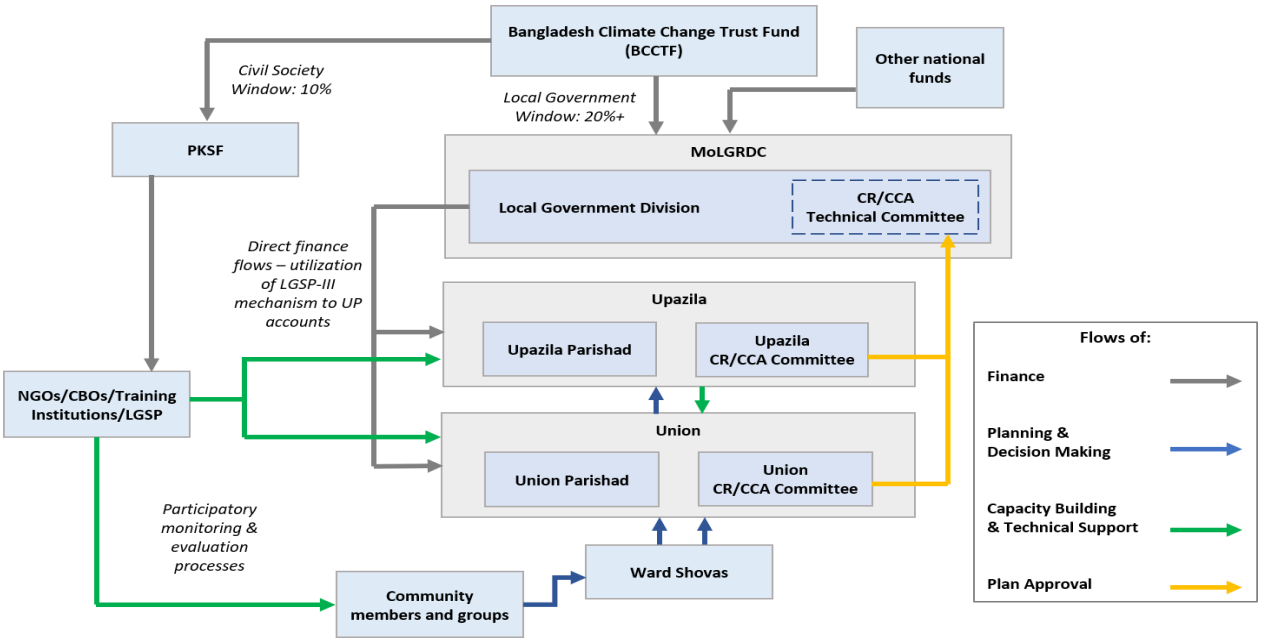

Figure 31: Proposed financial mechanism

The proposed mechanism will be guided by the following core principles:

- **Bottom-up approach** with strong community participation in all aspects of the planning, budgeting, implementation, monitoring and evaluation processes
- **Direct finance transfers to LGIs (UPs and UZPs)** to empower them with the authority and flexibility of utilizing funds as deemed necessary for the community
- **Minimization of political influence and bias** in allocation of funds via setting up safeguards
- **Capacity and knowledge building** at all levels, particularly to strengthen LGIs, through coordinated efforts and support from relevant government agencies and NGOs
- **Enhanced coordination** among different tiers of the LGIs as well as relevant local government bodies
- **Rigorous monitoring and evaluation (M&E) systems** to ensure effectiveness as well as transparency and accountability

5. Conclusions and Way Forward

This research study sheds light on the current scenario of the coastal region of Bangladesh and possible future climate change consequences. Furthermore, the research explores how different environmental stressors and other factors are causing loss of livelihoods and negatively affecting water security in coastal Bangladesh. Being at such close proximity to the sea and rivers, salinity intrusion is one major stressor affecting the local livelihood pattern, which once was fully based on agriculture but now has shifted to shrimp farming, in most of the places. However, shrimp farming has also contributed to further soil salinity affecting nearby agricultural fields and reducing harvest yields. Increased salinity levels in ground water tables have also caused severe drinking water scarcity within the locality and currently there is only one pond for a fairly, large community to access drinking water.

While many poor people are now unable to cultivate their land (mainly due to soil salinity) and shrimp farming is not labor-intensive (does not need large numbers of labor force to operate), this has triggered seasonal migration from this region to nearby cities across Bangladesh. Based on the results of the study, it is evident that climate change induced shocks and stresses are already manifesting themselves in an array of adverse impacts on the social and economic well-being of communities in the two coastal villages. The study aimed to explore how local communities perceive changes in the climate, as observed by higher incidence and severity of climatic shocks and stresses, and identified resultant impacts on their livelihood opportunities, access to water resources, migration dynamics as well as overall wellbeing. Differentiated effects of these changes on different groups and the inter linkages among these impacts have also been recognized. Additionally, data collected shows that in the same union, two different villages can have completely different livelihood practices, resulting in two different scenarios of vulnerabilities. For example, the findings suggest that the village with shrimp farming is facing many more vulnerabilities (e.g. livelihood impacts, water scarcity etc..) than the other village where the people are mainly engaged in crop and vegetable farming. . This suggests that certain agricultural practices can can contribute to reduced vulnerability both in the present in the future.

The study shows that climate change exacerbates vulnerabilities caused by non-climatic factors (such as shrimp farming, poor water resource management, weak governance structures etc.). If the present environmental and socio-political situations persists, livelihood and water security of local communities are likely to substantially deteriorate, further worsening their state of wellbeing. To help build resilience of these communities, there is a need to look deeper into the current absorptive and adaptive capacity of vulnerable communities in the study area - by exploring in detail, different indicators such as knowledge base, asset base, infrastructure availability, natural resource base, access to healthcare, social capital, governance structures etc.

To take the action research forward, ICCCAD plans to continue to explore the above components and undertake capacity building of relevant actors and groups. ICCCAD will also work to promote policy support for action at the national and international level. Next year, the study will be extended to focus more into existing local government processes to identify entry points for mainstreaming climate change action within local level planning procedures. Also, capacity building interventions will be undertaken with local government representatives, local NGOs, CBOs, community leaders and people (women and youth) with a focus on climate change adaptation and disaster risk reduction, to facilitate the implementation of

recommendations made by the study. In addition to the local level engagement, the project intends to do national level policy advocacy by organizing dialogues and consultations with different relevant ministries and departments. Participation in International conferences and workshops will also provide a platform to promote and leverage study findings at a larger scale and help advocate for increased financial support for the coastal belt in Bangladesh from international funding bodies.

The study acknowledges the limitations in terms of representativity of the small sample of just two villages. To address this, same methodology and approaches can be replicated in a different coastal district with somewhat different socioeconomic and geographical characteristics so as to provide a broader representation of climate change induced vulnerabilities experienced in the region. Solutions can accordingly be diagnosed for promoting the overall resilience of affected communities in the south-west coastal region of Bangladesh. Further research will be conducted to examine the opportunities and challenges in implementing the proposed financial mechanism for channeling climate funds to affected communities in the study area.

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Appendix 1: Data Collection Tools

The table below provides a summary of the tools applied at different stages of the study.

Stage	Tool(s)	Description	Objective	Approach and Process	Date	Output
Top-down approaches (to be applied across different stages)	Literature review	A review of existing literature to identify current status of vulnerability and prevalent gaps has been undertaken. This has provided a snapshot of change projection for the region and also future vulnerability (data from bottom up approaches will complement this part).	To identify numerous literatures regarding the project scope area and define a methodology	The literature related to climate change related vulnerabilities to different sectors, such as: livelihood and food security, water security and migration had been reviewed for the cases of Bangladesh. The types of the sources are mainly various journals and working papers published in various journals or renowned peer reviewed journals within the date rage of 2003 to the latest.	April to December	Literature review report, graphs, tables and maps
	GIS modelling	GIS modeling has been used to understand the current and future exposure to climate change impacts and also topographical changes over a period	To predict the future scenarios under climate and non-climate conditions	The data has been collected from various sources and put into the map to get the projected scenarios.	October-November 2018	Maps
Stage 1: Assessing the profile of the	Brainstorming	A semi-structured group discussion was conducted with relevant stakeholders in target	To understand the various components in the village context	A semi developed questionnaire with different local government people and village community	27 June 2018	Village profile

system of interest		areas to get a preliminary idea about the current environmental and socio-political situation of the study sites.				
	Problem tree	A structured group discussion with community people was organized to identify priority problems faced by them and their root causes.	To get the community perception about major problems they face and identify the causes and effects of those problems.	In order to create a trust worthy relation with the research team and ensure proper participation of the community people**,** the rapport building session was done prior the exercise. To ensure gender equality and social inclusion, the problem tree exercise has been performed separately with male and female group. Two major problem exercises called "low access to water for daily use" and "effect of different stressors on people's livelihood" were conducted with the male and female groups separately. In both village, each male and female group had 15-20 participants. At first, participants were asked about the causes of low access to water for daily use and eventually the root causes were identified from the broad causes. After that the effects of this problem were identified and finally a problem tree for "Low access to water for daily use" was created.	26 June 2018: Garuikhali Male and Female Problem Tree Exercises; 28 June 2018: Kumkhali Male and Female Problem Tree Exercises	Problem Trees attached in Appendix
	Transect walk	A structured walk through the area was undertaken to draw out a map of the study sites.	The objective of transect walk is to explore and understand the spatial	The walk is done with the local people who know their locality very well. In this exercise two-three local inhabitants accompanied the research team to while walking. Transect walk	26 June 2018: Transect Walk in Garuikhali village;	Maps for both Garuikhali and Kumkhali

		This would help assess the availability and quality of resources available to the local community, land use and infrastructure in the area as well as problems and risks encountered.	dimensions of people's realities, local perceptions of risks and resources. Besides generating its own data and insights, the transect walk helps the fieldwork team to ask the right questions in subsequent PRA sessions and the other research activities.	provides a cross-sectional representation of the different agro-ecological zones, opportunities and solutions. After the completion of the problem tree exercise, the research team described the participants about the necessity and procedure of transect walk and asked for some volunteers to accompany them during the walk. The full research team with the volunteers started the walk from the sardar bari and walked through the village. While walking, one person was facilitating the session, one was drawing the map and rest of the twos were taking photographs.	28 June 2018: Transect Walk in Kumkhali village	generated from transect walk
Stage 2: Assessing current vulnerability	Household survey	This was a quantitative structured survey to get information understand the overall socio-economic situation of the sites, and a general view of exposure, sensitivity and adaptive capacity of the community.	To have the majority perception under the research issue	A questionnaire both in Bengali and English has been developed and have been conducted by the survey team in both villages. 100 HH surveys have been done in Garuikhali village and 100 HH surveys have been done in Kumkhali villahe	07 – 13 October 2018	Graphs and tables
	Seasonal calendar	A seasonal calendar is a participatory tool applied for documenting regular cyclical periods and significant events that occur during a year and	To understand the seasonal patterns of livelihood activities, human mobility, environmental stress, health hazards and	After the completion of the village timeline, the research team described the process and purpose of seasonal calendar. This exercise was done with separate male and female groups in both of the villages. A facilitator conducted the whole session while the note	20 July 2018: Garikhali Village (Male and Female); 21 July 2018: Kumkhali	2 seasonal calendars for Garuikhali and Kumkhali village combining the responses from

		influence the life of a community. Major climatic and environmental periods and hazards should be marked in the calendar. This helped understand present exposure to climatic shocks and stresses in the area.	food and water scarcity.	taker entered all the data in a pre-determined tabular format in laptop. The tabular format was drawn in a big flip chart for the session. Since the village people are more familiar with Bengali months, the session was conducted using Bengali months. In a flip chart a table was drawn with the names of different events (events have been listed in the paper based on the responses of problem tree exercise) and twelve months of bangla year. The respondents were asked to mention the frequency and intensity of each event throughout the Bengali year. Some seeds were given to the respondents and they were asked to put the seeds in the cell of the months according to their frequency/intensity. The participants repeated this process for all the events. At last they were asked whether there is any event which is important to them but have not been put in the list. If it was the case, that event was put in the list as well with their corresponding month-wise frequency and intensity.	Village (Male and Female)	male and female groups
	Village timeline	These timelines have been developed in consultation with local communities to identify and discuss various	The first objective of the exercise is to get a general overview of events that the people consider to be	The village timeline tool is used to identify events or long-term events. Events could be described as “Things that have happened in a single year which do not usually happen in other years”. Example of events include-	20 July 2018: Garikhali Village (Male and Female); 21 July 2018: Kumkhali	Two village timelines combining the responses of male and female

		environmental disasters and other events that have had a certain impact on the community over previous decades which would help the community to understand the trends and/or changes in the frequency of environmental hazards over time.	important in the history and development of the village. The second objective is to get an insight into environmental and other events that affected people's livelihoods.	weather/climatic events, disease outbreaks, conflicts, political events, and development related events. In order to ensure gender equality and social inclusion, village timeline exercise has been performed separately with male and female groups (approximately 15-20 participants in each group) in both villages. A specific tabular format for data entry had been prepared beforehand in which the data were entered directly on field. One facilitator conducted the whole session whereas a note taker entered all the data. The participants were asked to mention the events that took place in their village from the time they remember till now with mention of approximate decade or year. Participants were also asked to mention the impact of the events in their village. Data have been entered using a comparative scale where the highly positive event was assigned with "+++" and highly negative event with "- - -". There were some debates among the participants regarding the time of occurrence of an event or its effect on the community, but after debating in some cases, all came to one decision.	Village (Male and Female)	groups in Garuikhali and Kumkhali village
	Community mapping	Community mapping involved facilitating	The objective of the community mapping	Conducting the community mapping ensures gender equality and social inclusion women,	20 July 2018: Garikhali Village	Community maps of

		community members in developing spatial representations of their areas by creating maps on the ground or on a large piece of paper. This map helped to portray sensitivity, exposure, and adaptive capacity of the sites. It provides an overall picture of the community and village at a glance in a hand drawn map where the important resources, landmarks, physical structures, organizations, institutions, services are being highlighted.	exercise is to identify peoples' perception regarding their community, natural and social resources, basic infrastructure etc. It will also help to identify the geographical vulnerability of the community.	elderly people, youth and adults during the sessions. The research team gathered at the 'Sarder Bari' in Garuikhali village and in a household in Kumkhali village. After taking the "no objection" statement from all the members, the sessions were conducted in both villages. At first a progressive/natural leader was identified among the gathered people who could voluntarily draw their village, and one facilitator has helped him/her drawing the map. The volunteer first draw the boundary of the village and the located the position of the rivers and major roads. The facilitator probed them to identify the location of different water resources, landuses, social institutions, roads, embankments etc. Some debates took place regarding the position of some features but all of them were resolved eventually. There was a notetaker during the session taking the notes of the discussion going on. This activity was done in both villages with mix of male and female representations.	(Male and Female); 21 July 2018: Kumkhali Village (Male and Female)	Garuikhali and Kumkhali village
	Livelihood Shock Analysis	This tool is inspired by the livelihood shock spider diagram method of Tschakert et al. The purpose of this research tool is to understand how	To understand how people in the study sites perceive threats of different types of livelihood shocks, how often such shocks	The session was conducted by a facilitator and recorded by a note taker. The note taker entered all the data in a pre-prepared table which already includes name of the major events of this village. Data on the frequency, magnitude and severity of each event have	20 July 2018: Garikhali Village (Male); 21 July 2018: Garikhali Village (Female); 22	Livelihood shock diagram for both Garuikhali and Kumkhali villages

		people in the study sites perceive threats of different types of environmental and other different shocks, how often such shocks occur, the extent to which such shocks have already affected households in the communities, This will categorize different shocks against frequency, severity and magnitude scales to understand their impact, which has been presented in the form of a spider diagram.	occur, and the extent to which such shocks have already affected households in the communities.	been collected from this exercise. Magnitude has been determined in terms of the number of people who have been affected by an event and severity in terms of the number of years required to recover from the shock of an event. Each parameter had a scoring system of its own. For each event, the facilitator asked the frequency, magnitude, severity and observed trends. Impacts and existing coping strategies for each event were also asked. The entire session was recorded through a voice recorder; data were directly entered into the tabular format by the note taker. Additional information was also noted.	July 2018: Kumkhali Village (Male and Female)	
	Livelihood histories	Overall aim of the livelihood history interviews is to understand changes in people's livelihoods and the role of environmental and other shocks. Semi-structured life history interviews allow rural peoples to explain changes in their life using terms, perspectives and	To understand changes in people's livelihoods and the role of environmental and other shocks.	**Approach:** Interviews have been done through semi-structured questionnaire so that it maintains a level of comparability without imposing pre-conceived explanations or variables on respondents, allowing dominant themes to emerge organically from the interview. Initially, the interview was un-probed and respondents were allowed to describe their story the way they want. As the continued their story, the facilitator probed them at some points.	20 July 2018: Garikhali Village (Female); 21 July 2018: Garikhali Village (Male); 22 July 2018: Kumkhali Village (Male and Female)	Quotes

		variables of their own choosing. When interviews are semi-structured, this maintains a level of comparability without imposing pre-conceived explanations or variables on respondents, allowing dominant themes to emerge organically from the interview. This interview was with selected respondents from different group discussions to understand the issues from in depth and cover most of the aspects of the research questions. Livelihood history interviews has been undertaken with selected individuals (two males and two females) to solicit detailed information on changes in livelihood, migration				

		history as well as changes in water use patterns.				
Stage 3: Assessing future vulnerability	Participatory scenario analysis	By employing a 'What if?' tool that entails the development and analysis of participatory scenarios helped assess possible future developments. Considering the uncertainty of the future, this tool would be useful for considering many alternatives of what the future might be, taking account of the full range of imaginable futures.	To help the community perceiving the future scenario of identified current environmental/ climatic/ social-political stressors	The team has developed the initial situation incorporating the current vulnerability, and the consequences associated with that from the findings of the stage 2. The participants were asked to predict if the situation continues, to what extent it can be changed after 20 years.	19 September 2018: Garuikhali village (Male and female); 20 September 2018: Kumkhali village (male and female)	Community perceived future scenarios
	Role-play	Role-playing activities prompt discussion, pave the way for improved communication, and thus stimulate collaboration. Applicable at community and agency levels, these activities involve participants as a group in analytic thinking and assessment.	To understand the community actions in the changing climate scenarios	The team has developed the initial situation incorporating a disaster related to climate change, and other socio-economic conditions of a particular household. The participants were asked to act on the situation and identify different actions.	19 September 2018: Garuikhali village (Male and female); 20 September 2018: Kumkhali village (male and female)	Community perceived actions in changing climate scenarios

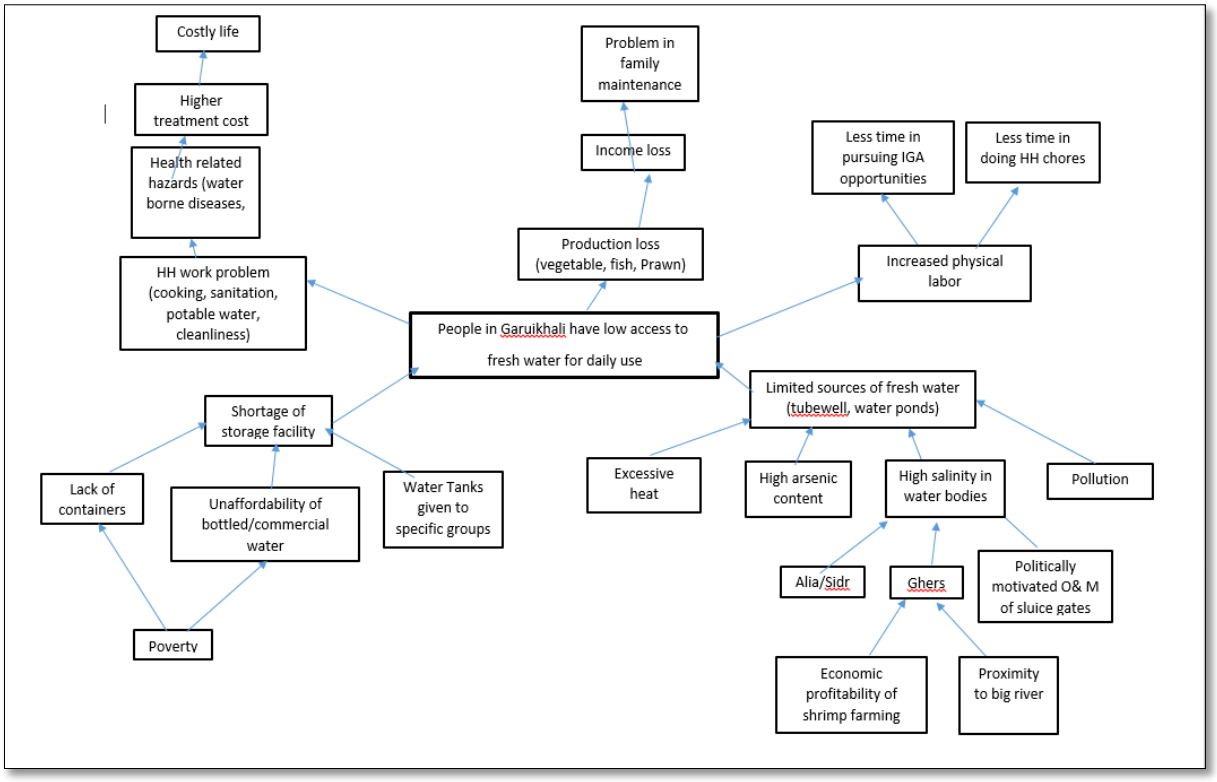
Stage 4: Scoping for possible solutions	Institutional landscaping	This method has been used to evaluate the different organizations affiliated with undertaking climate change actions in the area. Participatory evaluation of interventions and agencies helped understand what is appreciated by community member and what is not and help avoid repetition of interventions in the study area. The needs assessment helps to assess the gaps in policy and action and to learn what people really think could be done to make them more resilient to climatic and other shocks. Better understanding of institutional setup and governance structure at the local level also helped	To identify different projects undertaken by various institutions in the study area and identify community's opinion on that projects	The list of different projects has been prepared of different domains, and the community people were asked to score them in terms of their effectiveness.	October 2018	Institutional map of both villages

		identify the needs for facilitating climate finance.				
	Solution tree	Once the cause and effect relationships of priority problems faced by the community have been expounded upon, this method helped to identify appropriate solutions of prioritized problems and ways to implement them can be developed accordingly.	To explore what solutions the villagers want to explore to solve the problem tree	The diagram is designed opposite to the problem tree and explore the opinion on different strategies. It has been done separately with male and female groups in both Garuikhali and Kumkhali villages.	October 2018	Solution tree diagram
	Resettlement choice exercise	Resettlement Choice Exercise (RCE), adopted from J. Kloos (&) N. Baumert, is an experimental method that has been applied in Egypt. This experiment is based on some hypothetical attributes (e.g. land, housing, compensation, income etc) but mostly relevant to the respondents. The	To identify different factors that the community would prefer during strategic migration	From different combinations of factors, the community were asked to choose the best option for them during strategic migration.	October 2018	Resettlement choice tables for both garuikhali and Kumkhali villages

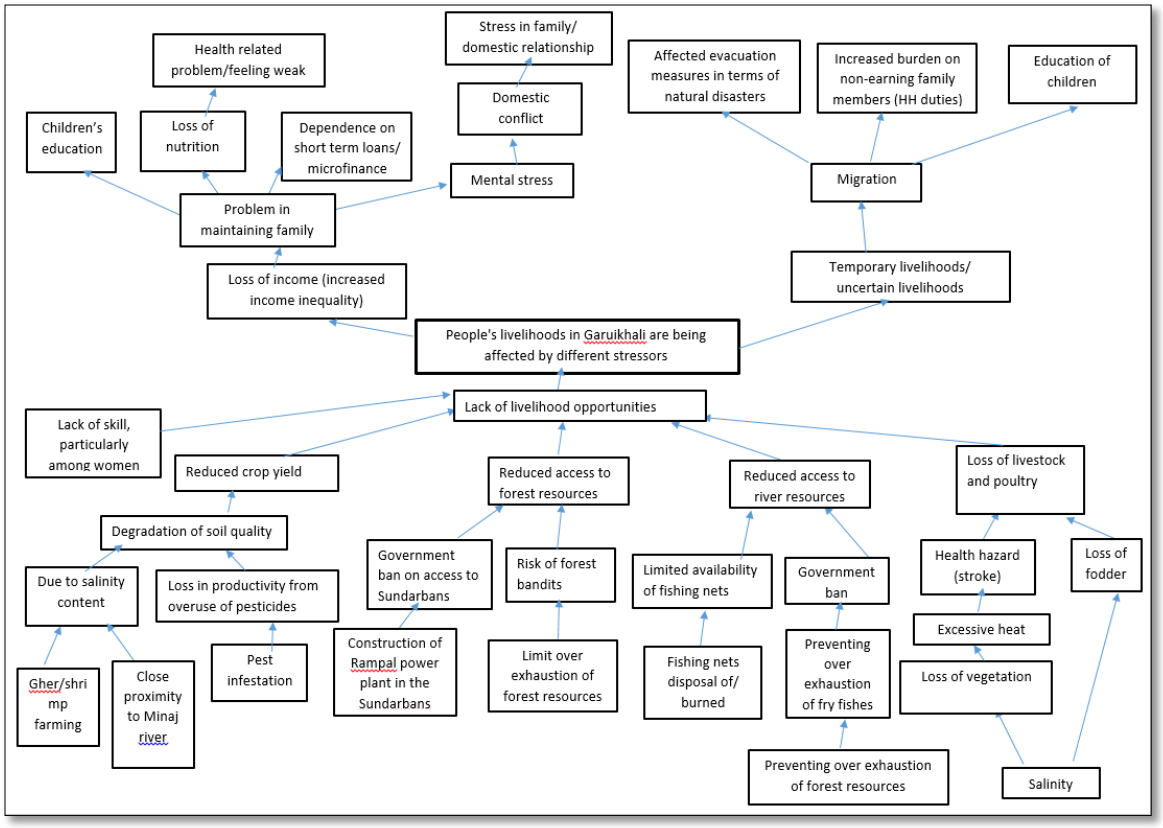
		objective of the RCE was to understand how planned migration for affected communities can be executed. The RCE evaluated different alternatives and preference of participants to do voluntary resettlement and which factors matter the most to them. The exercise can help to identify the household who are willingly or never want to migrate and the factors that constraining them to do so. The RCE method compiles social, financial and environmental factors together and provides preference to the participants to choose the most desirable options to do voluntary resettlement. RCE can help policy makers and practitioners to identify				

		and structure new secondary cities for better planned migration.				

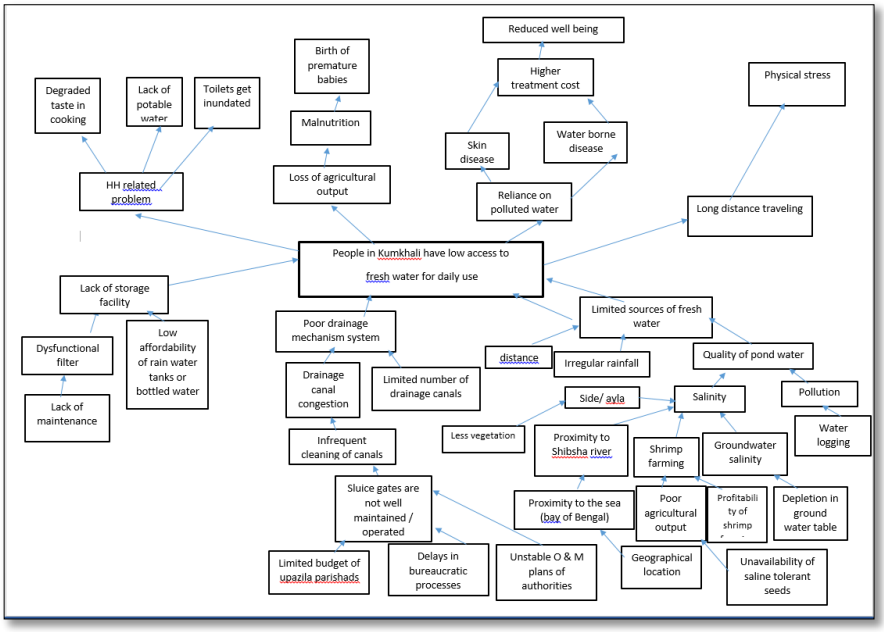
Problem Tree: People in Garuikhali have low access to fresh water for daily use



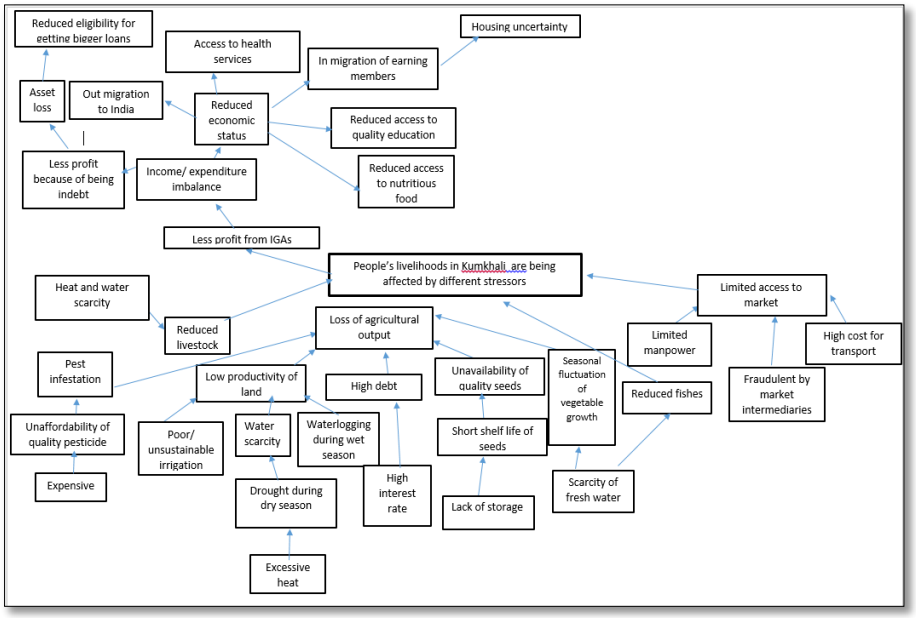
Problem Tree: Peoples' livelihood in Garuikhali are being affected by different stressors



Problem Tree: People in Kumkhali have low access to fresh water for daily use



Problem Tree: Peoples' livelihood in Kumkhali are being affected by different stressors



Checklist/Questions for Key Informant Interviews (KIIs)

1. Existing project activities (sector specific: agriculture, food security, shrimp/crab farming, fisheries, livelihood, water security, water access. Sanitation. Health, education)
2. Project finances (initiatives from government/ local government/ donor funded/ private/local NGOs etc)
3. Do these projects are aligned with the local need and priorities? Do you include the voice of the vulnerable/root?
4. Understanding the livelihood/food security/WASH context
    - What are the main ways in which people make living in the area?
    - What are the main differences between men and women in terms of making living?

- What resources are important to local livelihoods in the project area?
- How the resources/livelihood activities get affected by the current climate/natural hazards?
- Which group of people get affected the most and why?
    - By geographical location
    - By gender
    - By gender of household head
    - By sector, trade or occupation
    - By wealth or socio-economic status
    - By age (young children, elderly)
    - Other factors (health or handicaps, ethnicity, etc)
- How important are those resources to coping strategies?

5. What is the role of your institution/organization when any disaster occurs?
    - How do you disseminate the information of early warning system?
    - Do your organization take part to take people to shelter?
    - Do you help managing or providing relief after any disaster?
    - Do the shelters have sufficient water/food/sanitation facilities?
6. When any disaster happens, how do you ensure the water security for all?
7. How do you ensure the health security of different age group/gender/disabled?
8. Do the current initiatives are effective to reduce the livelihood vulnerability?
9. Do you think that the livelihood vulnerability due to natural disasters leads to forced migration or people are taking this as adaptation option? Why do you think so?
10. Can you predict any risk associated with future climate change in your locality?
11. What measures should be taken to reduce the impacts of existing/future disasters? (immediate/longterm)
12. What mechanisms or procedures should be followed to implement those?
13. In which area your institution can support?
14. Do you need any sort of assistance/support to strengthen the capacity of your institution?
15. Finding out a supportive policy framework

Template for Village Timeline Session

Event	**Decade**	**Year**	**Event description and effects**	**Score** *(According to the impact of the event on villagers. Such as +++ for very high positive impact, - - - very high negative impact)*

Template for Livelihood Shock Analysis Session

Livelihood shock	How often/ Frequency	Intensity/ Magnitude	Severity	Observed Trends	Future Trends Possible Evolution Under Climate Change	Impacts	Current Coping Strategies	Is the strategy sustainable ? If not, why?	Comments:
Sudden land loss through soil erosion									
Cyclones									
Sudden decrease in soil quality									
Flood/ Heavy seasonal rain									
Salinity									
Irregular rainfall or dry spells, and excessive hot sun									
Thunderstorms									
Crop failure/loss									
Loss of shrimp production									
Death of livestock/poultry									

Loss of fish/fishing stocks									
Health care costs of family member									
Sudden high cost of productive inputs									
Indebtedness									
Displacement, negative migration									

Scale used for scoring the shocks

Scales					
Frequency	**Frequency score**	**Magnitude**	**Magnitude score**	**Severity**	**Severity score**
More than 1 time per year	1	1. All	1	--- = Very severe, can never recover	1
Once per year	2	2. Almost all	2	-- = Moderately severe, takes 5 years to recover	2
Once every two years	3	3. More than 1/2	3	- = Bad, but can recover in less than 5 years	3
Once every 5 years	4	4. About half	4	0 = Can recover in less than 1 year	4
Once every 10 years	5	5. Less than 1/2	5		
		6. Very few	6		
		7. None	7		

Template for Village Calendar Session

	Boishakh	Joishtho	Ashar	Srabon	Bhdro	Ashwin	Kartik	Agrohayon	Poush	Magh	Falgun	Chaitra	
Bengali Months	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	Comments
Seasons/Weather													
Rain													
Warm temperatures													
Cyclones													
Salinity													
Livelihoods / Water													
Agriculture													

Harvesting													
Animals													
Fishing													
Shrimp farming													
Food scarcity													
Water scarcity													
Water quality (drinking) reduction													
Out of village													
Non-farm labour													
Migration													
Day labour													
Pest Infestation (current poka)													
Disease Outbreak													

Checklist for Livelihood History Interviews

Personal timeline and context

1. When and where were you born?

1.1 (If born here) When did you move away from your parents to start your own household?

1.2 (If born somewhere else) When did you move here? Why?

2. Did you go to school? Did you learn a certain trade or skill? How did you learn? Who taught you?

3. What was your family like? What did your parents do for a living? And your grandparents?

4. What were your roles in the family livelihood? How did you contribute?

5. Did you work outside of the home? What did you do?

6. Have you ever lived anywhere else for longer periods? Where? For how long? Why did you leave? What did you do there? Was it a good or bad experience, why? Why did you come back?

7. Do you sometimes leave the village during the year? Where? Why? To do what? How long?

8. Are you married? What does your partner do for a living?

9. Do you have children? Where do they live? Did they go to school? What do they do for a living? Do they support you (remittances)? How long have you received remittances? How do you receive remittances? Have you always received remittances the same way?

10. BKash: do you use, since when, how did it change remittances, do you receive, from who, where do they live? Bangladesh? Abroad?

11. Do you go to UDC (Union Digital Centre)? Can you access information from UDC?

Changes in livelihood

12. What are your major livelihood activities? (From most important to least important)

13. What were your major livelihood activities 10 to 20 years ago? (If years are difficult, choose a personal life history event of 10-20 years back, e.g. when interviewee moved out on his/her own)

14. Why did you change your major livelihood activities? When did this happen? Did you have a choice? How did things turn out?

15. Did activities/projects of government institutions or NGOs play a role?

16. Do you (or does your household) own or take part in ownership of land? What kind of land ownership agreement do you take part of? Shared cropping? Borrowed land? Bond to debt?

17. Does any socio-economic or political issue force you to sell out your land?

18. Please estimate the total land size? Drivers of livelihood change

19. What events that happened in the village, such as the arrival of new roads or forms of transport, new schools or clinics, phone network, improved market linkages, access to markets, other technologies, conflicts, political changes, project, etc. were important for you, and the things you do for a living?

20. Have you had any accidents or misfortunes that caused you to begin/end livelihood activities? Did something ever happen to you that really helped you improve the way you make a living?

Environmental change and events

21. What gradual environmental changes do you see (rainfall patterns, sea level, erosion, etc.)?

22. How do these impact your livelihood? What do/did you do to deal with these changes?

23. What environmental shocks or events have you experienced (cyclones, droughts, floods, salinity etc.)?

24. How did these impact your livelihood and food security? What did you do to cope/survive?

25. Do you feel that your household is more or less likely to suffer from the impacts of environmental shocks than other households in your community? Why/Why not?

Water Issues

26. Normally from where do you get water for drinking purpose and daily uses? How far is the water source? How is the water quality? Do you have to pay for the water?

27. Who brings water in your family? Does it effects his/her daily routine/work?

28. Do you get sufficient amount of quality water for your proper use?

Health related issues

29. How many times do you/your family take meal per day? Is it enough for you?

30. Do the food and water you consume daily have any impact on your health? Who suffers the most due to health related risks? Do you have access to any medical/health care when any of your family members get sick? Are you satisfied?

Questionnaire for Participatory Scenario Analysis-"What if" Tool (Garuikhali Village)

1. Salinity has emerged as an issue in this village from the past couple of decades and has been exponentially increasing over the years. With the emergence of shrimp farming, geographical location and other socio-political factors have intensified the problem in such a way that most of the pond water is now

saline contained. Increased salinity in water is leading to different adverse impacts like soil and water quality degradation, production loss, outbreak of skin diseases, diarrhea, and pregnancy related complications. More importantly, people are losing their access to safe drinking water gradually because of the salinity intrusion. To what extent the situation will get worse after 20 years from now, if the saline content in water continues to increase?

2. Cyclone is one of the major environmental stressors in the Garuikhali village. The villagers have already faced major devastation during Cyclone Sidr and Aila. Cyclone affects the livelihood, and thus it has impact on the overall wellbeing of the community. What will happen to the village if it gets hit by consecutive intense cyclones 20 years later?

3. People in Garuikhali are experiencing relatively warmer temperature all throughout the year than the past. It appears that the seasons have been reduced to 2 - warm season and cool season. There are less nuanced changes in seasons. With the time, if the temperature continues to rise in this rate, what possible adverse impacts can people have in Garuikhali face after 20 yeras?

4. Rainfall pattern has changed and now it rains the most during the month of Bhadro instead of the typical monsoon months called Ashar and Srabon. High intensity short duration rainfall creates waterlogging causing difficulty in village people's daily movement and activities. With the time, if there is more intense rainfall, how it will have impact on the village people's livelihood activity and movement after 20 years?

5. Due to the increased salinity in soil and water, emergence of shrimp farming, and pest infestation; most of the arable lands have become infertile and production of crops, vegetables, fishes and livestock have severely hampered. All these lead to food scarcity among the local people and force them to migrate to other places in search of alternative seasonal livelihood strategies. Children's education and financial stability, are being hampered because of the male member's migration to other places and it put the female members in the household into burden. If the agricultural yield continues to decrease due to infertile soil, what will be the consequences after 20 years?

6. Households and individuals are quite dependent on loans and are caught in an endless cycle of indebtedness to fulfill the household activity demands and children's education. If they continue taking loans to fulfill their increasing necessity and demand, what will be the consequences 20 years later?

7. Outbreak of different water borne, and vector borne diseases like diarrhea, food poisoning and skin diseases are very common among children and women. Diseases are prevalent during months of rapid changes in season or weather. Drinking impure water or excessive heat during most of the year are leading to increased frequency of diseases. If the frequency of disease occurrence continues to increase, how it will have adverse impact on the village people after 20 years?

Questionanire for Participatory Scenario Analysis- "What if" Tool (Kumkhali Village)

1. Rainfall pattern has changed and now it rains the most during the month of Bhadro instead of the typical monsoon months called Ashar and Srabon. As cropping patterns depend on rainfall cycle, villagers have adopted cropping practices to cope with the irregular rainfall. High intensity short duration rainfall creates waterlogging causing difficulty in village people's daily movement and activities. With the time, if there is more intense rainfall, how it will have impact on the village people's livelihood activity and movement after 20 years?

2. People in Kumkhali are experiencing relatively warmer temperature all throughout the year than the past. It appears that the seasons have been reduced to 2 - warm season and cool season. There are less

nuanced changes in seasons. With the time, if the temperature continues to rise in this rate, what possible adverse impacts can people in Kumkhali face after 20 years?

3. Cyclone is one of the major environmental stressors in the Kumkhali village. The villagers have already faced major devastation during Cyclone Aila, Sidr. After getting hit by previous cyclones, the village started facing salinity intrusion. Increased salinity in water is leading to different adverse impacts like soil and water quality degradation, production loss, outbreak of skin diseases, diarrhea, and pregnancy related complications. More importantly, people are losing their access to safe drinking water gradually because of the salinity intrusion. What will happen to the village after 20 years if it gets hit by consecutive intense cyclones in future and to what extent the situation will get worse, if the saline content in water continues to increase?

4. Main income source of the inhabitants of Kumkhali is the agricultural yield and do not wish to engage in any other livelihood opportunities, such as: shrimp farming. But they hardly get their desired amount of agricultural yield due to unavailability of quality seeds, lack of storage facility and pest infestation. If the agricultural yield continues to decrease, what will be the consequences after 20 years?

5. Loss of agricultural output coupled with limited access to market have significantly hit the financial situation of the local people. Due to lack of man power and high cost of transport, the farmer themselves can't go to the market and sell their products at market price. As a result, they have to depend on the market intermediaries who do fraudulent and the farmers end up having less price than market. If the situation continues, what sort of difficulties the village people may face after 20 years?

6. People in the village have limited sources of fresh water as most of the pond water is polluted due to improper use of pond water and water logging. Lack of rainfall during dry seasons, coupled with limited access to wells and storage tanks, results in freshwater scarcity. Geographical location, ground water salinity and events like Aila have contributed to the increased natural rate of salinity. All these cause serious health hazards, high treatment cost and reduce overall wellbeing of people. If people's access to the remaining fresh water sources continue to shrink, what will be the consequences after 20 years?

Questionnaire for Role Play Session (Garuikhali)

1. Aysha, a brilliant girl of 18 years old, lives with her parents in a small hut of Garuikhali village. Her father is a poor shrimp farmer who works in another's land. Her mother looks after the home. Aysha has two young siblings. Aisha just passed her HSC examination receiving golden A+. She has the dream of becoming a renowned doctor who will work for the welfare of her village. The villagers have high hope on her. She is now planning to go to the near big city Khulna for her admission coaching. Suddenly, a strong cyclone hits the village. Aysha's hut is in one corner of the village and her family didn't receive the cyclone early warning. Then ……..

2. Rahima is a 34 years old lady. She is a housewife. She maintains all the household chores. She got married when she was 15. Earlier, her husband, Abdullah used to be agricultural farmer. Due to salinity intrusion, their land got affected and now they are not suitable for growing crops. Rahima and Abdullah has four children. Two daughters are already married, their elder son is studying in Dhaka. They need to send him tuition fees monthly. Their younger son is three years old. Rahima has also started doing vegetable production in her little yard to support her family. Last year, she produced vegetables and sold in the market with good price. This year, just before picking up the vegetables, heavy rainfall came in, and…….

3. Salauddin is an owner of two big pieces of land where he does shrimp farming in ghers. There is another small piece of land nearby where crops used to grow. But due to the presence of shrimp gher nearby, this land has become infertile. So, Salauddin bought the land from the poor owner and offered him the job of

the caretaker of the gher which accepted. Salauddin's shrimp farming was going well and he was making good profit out of it. Just when the shrimps got matured, the gher got attacked by virus which destroyed most of the shrimps. Then……..

4. Parvin is 37 years old who lost her husband at the age of 35. She lives with her two daughters in a small house. She does tailoring for living. The elder daughter is 15 years old who goes to school and the younger one is 6 years old. They have a saline water pond beside their house from where they collect water for household chore and drinking purpose. The only pond which provides potable water is far away from their house. Parvin can't go to fetch water from that pond since she can't leave her younger daughter alone at home. So, having no other option, she has to collect water from the saline water pond. During monsoon, she collects rain water and use it for cooking and drinking purpose. But due to lack of storage capacity she can't store much of rain water. One day during the month of Joishtho, her younger daughter started vomiting and got sick due to excessive heat. Then…….

5. Sharif is a landless agricultural farmer who used to grow paddy in another person's land. But due to high saline content both in soil and water, the land become infertile. The land owner stopped agricultural farming and started doing shrimp farming. But Sharif became jobless and stayed unemployed for 2 months. His wife used to do vegetable production at the front yard but that too stopped due to salinity. Seeing the hardship of his family, Sharif decided to take loan from a local NGO of taka 50000 for which he has to pay taka 300 per month and bought an auto rickshaw. But he couldn't repay the monthly fee for three months. Then……

6. Gopal is a 36 years old man fisherman who catches fish from Minaj River. He has 3 children. Elder son also goes with him for fishing; younger son reads in class 4. He has planned to marry his only daughter off this year. Earlier, Gopal used to catch good number of fishes which he used to sell in Garuikhali bazar and earn a decent amount of money. But due to salinity intrusion, number of fresh water fishes has significantly reduced since last 4/5 years. Also, prohibition in the use of current jal has also reduced his yield. Then…….

Questionnaire for Role Play Session (Kumkhali)

1. Sumon is a small farmer who grows paddy and rabi crops in his small piece of land. He has two sons and one daughter. His elder son works with him in the field; younger son is a student and his daughter has studied up to class 8. Earlier he could make a decent life with the agricultural profit but after the intrusion of saline content in water and soil, their agricultural yield has reduced than before. Now he wishes to marry her daughter off. A marriage proposal for his daughter came but they demand a big amount of 60 thousand taka as dowry. Everything was going well; he was anticipating that his agricultural yield will be good this year. But just one month before harvesting, his crops got attacked by "current poka" and most of his crops got damaged. Then……

2. Anup is a landless farmer who works in other people's land and cultivate paddy. He works during the time of sowing seeds and during harvesting. But rest of the time he remains unemployed and stays at home. His wife grows vegetable at home which is mostly consumed by them. So, they face hardship in their daily life. After being unemployed for few months he decided to go to Khulna in search of alternative livelihood. There he learned the skills of a plumber and started working as a plumber seasonally for few months in Khulna. Coming back to Kumkhali, he heard some of his friends are going to India illegally with the help of a broker (intermediary) and making good amount of money. So he decided to go to India in the same way. Leaving his family behind he went to India and started working as a plumber. But one day she heard over phone that her husband was caught for going illegally to India. Then……

3. Shompa, a brilliant girl of 18 years old, lives with her parents in a small hut of Kumkhali village. Her father is a small farmer who grows paddy and rabi crops in his small piece of land. Her mother looks after the

home. They have a pond beside their hut from which they collect water for drinking purpose and household chores. Due to salinity intrusion and pollution, the pond water has become polluted, but they have no other option than drinking that water as the tube well is far away from their hut and Shompa and her mother can't go that far and collect water. Shompa has just passed her HSC examination receiving golden A+. She has the dream of becoming a renowned doctor who will work for the welfare of her village. The villagers have high hopes on her. She is now planning to go to the near big city Khulna in the month of Chaitra for her admission coaching. But suddenly four days before she leaves, she got severe diarrhea. Since this is the time of harvesting Rabi crops, her father is very busy in the field. Then…….

4. Ranjit is a land owner who has 4 pieces of land and leases out lands to farmers for growing crops. He has two daughters and one son. His younger daughter is 10 years old, but she doesn't go to school as she is physically disabled and mostly stays at home. Elder son is doing his diploma in Khulna and younger son is studying in class 9. Ranjit doesn't work in field but he always stays there to oversee the work. One day he was in field and was sending his crops to the local market through a broker. Suddenly a cyclone hit their village of which they didn't get any early warning signal. He was very busy in transferring his crops meanwhile cyclone hit his house and it took away one part of the tin shaded roof. His wife was alone in the house with her daughter. Then……..

5. Rani is a 43 years old woman who lost her husband at the age of 37. Now she lives with her 10-year-old son who reads in class 5. Her daughter is married and lives in a nearby village. Rani and her husband both used to work in the field. During the time of harvesting, she used to stay at the field and cut crops and her husband used to bring the crops to the store in Garuikhali and then at the local bazar for selling. After the death of her husband, Rani continued growing crops in their small piece of land but she faced problem in storing and taking their crops to local market. At the middle of the month bhadro, her crops got matured and she decided to cut the crops within 2-3 days. But suddenly it started raining one day and it rained heavily with small intervals for 2 days. Then……

6. Ismail is a 37 years old man who lives with his parents in a small hut beside the Kali mondir. His father works as a farmer in other people's land and grows paddy. Ismail used to work with his father but 3 year ago he had a road accident and lost his left leg. Since then he couldn't work and mostly stays at home. His mother used to do tailoring but since she now has to take care of her son; she can't manage much time for tailoring. All these have brought hardship in their family. One day cyclone hit the village suddenly. Then…….

Questionnaire for Household Survey

Bangladesh is one of the most vulnerable countries in the world due to climate change. Within the country, the coastal regions are being considered the most vulnerable victims of climate change. People living in this region are already facing various disaster and environmental related risks, and the climate change will exacerbate the situation. The project "Water is Life", funded by HELVETAS Swiss Intercorporation, has been taken to explore the impacts of various disasters, environmental stressors and climate change on the livelihood and water sector of the people of Khulna, Satkhira and Bagerhat area; and above all how these are affecting the overall quality of life. The project is being implemented by four organizations named International Center for Climate Change and Development (ICCCAD), Development Organization of the Rural Poor (DORP), Bangladesh Disaster Preparedness Center (BDPC) and Ovibashi Karmi Unnayan Program (OKUP). The goal of this project is to improve the quality of lives of the climate vulnerable community and build their resilience, especially women and youth, in the South-western region of Bangladesh.

All the information provided for this survey will be used solely for the research purpose and project implementation. We will not disclose any sort of identity.

If you agree to be interviewed, please provide your consent below:

Name: _____

Mobile No. (optional): _____

Signature: _____

Questionnaire No.: _____

Village: _____

1. HOUSEHOLD INFORMATION OF THE RESPONDENT

1.1 Respondent's Name:	
1.2 Sex	☐ Male ☐ Female
1.3 Age (years)	☐ Below 15 ☐ 15-25 ☐ 25-35 ☐ 35-45 ☐ 45-55 ☐ Above 55
1.4 Education	☐ Never been to school ☐ Primary ☐ SSC ☐ HSC ☐ Graduate ☐ Others
1.5 Main Occupation	☐ Agricultural farming in own land ☐ Agricultural farming on others land ☐ Livestock

	□ Fishing □ Shrimp Farming □ Student □ Shop keeping □ Unemployed □ Housewife □ Handicraft □ Small business □ Vegetable farming □ Wood/Golpata/Honey collector □ Others				
1.6 Secondary occupation	□ Agricultural farming in own land □ Agricultural farming on others land □ Livestock □ Fishing □ Shrimp Farming □ Student □ Shop keeping □ Unemployed □ Housewife □ Handicraft □ Small business □ Vegetable farming □ Wood/Golpata/Honey collector □ Others				
1.7 Position in family	□ HH head □ Others: ……				
1.8 Religion	□ Muslim □ Hindu □ Others				
1.9 Marital status	□ Married □ Unmarried □ widowed □ Others				
1.10 Total number of HH members		1.11 Total number of women (more than 15 years of age)		1.12 Total number of youth in the family (15-25)	
1.13 Highest education level reached by a household member	□ Never been to school □ Primary □ SSC □ HSC □ Graduate □ Others				

2. INFORMATION ON HOUSEHOLD STRUCTURE

2.1 Ownership status	□ Owner □ Tenant
2.2 Number of owned structure	
2.3 Total number of rooms	

2.4 Structure type	□ Pucca (mix of concrete/tin or above) □ Semi-pucca (mix of tin /chon/bera) □ Kutcha (only chon/ mud etc)
2.5 Distance from nearby river/ canal (meter/km)	
2.6 Is there any embankment in your village?	□ Yes □ No
2.7 Condition of embankment	□ Good □ Bad □ Other
2.8 Ever faced any structural problem caused by bad weather?	□ Yes □ No
2.8.1 If yes, what caused the problem?	
2.8.2 How did you solve those?	
2.8.3 How much did it cost you to solve?	

3. HOUSEHOLD AND LIVELIHOOD ASSET AND WEALTH

Sl. No.	Items	Number / size or other units (as appropriate)	Used for household	Used for income generation
1	Homestead land			
2	Agricultural land			
3	Kitchen garden			
4	Khat			
5	Tube-well			
6	Water reservoir (if any)			
7	Cell Phone (if any)			
8	Chair			
9	Table			
10	Almery			
11	Alana			
12	Boat			
13	Bicycle			
14	T.V			
15	Pond			
16	Radio			
17	Poultry			
18	Cow			
19	Goat			
20	Buffalo			
21	Agriculture Small tools			
22	Rickshaw			
23	Van			
24	Cart			
25	Nets			
26	Fish Traps			

27	Food Storage			
28	Fish/shrimp storage			
29	Water tank			
30	Solar panel			
31	Generator			
32	Sewing machine			
33	Motorcycle			
34	Torch			
35	Other (specify)			

4. WATER	
4.1 Main source of drinking water	☐ River ☐ Khal ☐ Rain water ☐ Pond ☐ Tube-well ☐ Others
4.2 Quality of drinking water	☐ Good ☐ Average ☐ Bad
4.3 Presence of arsenic content	☐ Yes ☐ No
4.4 Presence of saline content	☐ Yes ☐ No
4.5 Distance to the main source of drinking water (in km)	☐ 0-.5 ☐ .5-1 ☐ 1-2 ☐ 2-5 ☐ >5
4.6 Time required to collect water from the main source	
4.7 Who fetches drinking water?	☐ Male ☐ Female ☐ Both ☐ Supplier
4.8 What are the alternative sources of drinking water?	☐ River ☐ Khal ☐ Rain water ☐ Pond ☐ Tube-well ☐ Others
4.9 Source of water for livelihood activities (irrigation, washing cattle, aquaculture, Aquaponics)	☐ Same as drinking water ☐ Different (Please specify)
4.10 What is the source of water for other household uses	☐ Same as drinking water ☐ Different (Please specify)
4.11 Has the quality or quantity of water declined in your water source in the past years?	☐ Yes ☐ No
4.11.1 If yes, Since when?	
4.11.2 Why?	☐ Ground water salinity ☐ Pollution ☐ Arsenic

	☐ Sidr/Aila ☐ Flood ☐ Shrimp farming ☐ Poor drainage ☐ Others
4.11.3 What has been your immediate response with this problem? (Multiple responses allowed)	☐ Shifted to another source of water ☐ Did purification before using the water ☐ Continued consuming the impure water ☐ Others
Cost of Recovery	
4.11.3.1 Monetary	☐ 0-5000 Taka ☐ 5000-10000 Taka ☐ 10000-20000 Taka ☐ 20000-40000 Taka ☐ > 40000 taka
4.11.3.2 Time	☐ 0-1 Month ☐ 1-3 Months ☐ 3-6 Months ☐ 6-12 Months ☐ >1 year
4.11.3.3 Physical Labor (Traveling far from the previous main source (in km))	
4.12 Has any of your family member got infected with any type of diseases in past 5 years?	☐ Yes ☐ No
4.12.1 If yes, what are the diseases?	☐ Diarrhea ☐ Cholera ☐ Food poisoning ☐ Skin diseases ☐ Malnutrition ☐ Arsenicosis ☐ Gastric ☐ Pregnancy related problem ☐ Others
4.13 Who suffers the most from these diseases? (multiple responses allowed)	☐ Women ☐ Men ☐ Children ☐ Elderly persons ☐ Disabled ☐ Other
4.14 Has the mother or a girl in the household stopped working/studying to take care of other household members affected by those diseases?	☐ Yes ☐ No
4.14.1 If yes, how many days she stopped working/studying in the past 5 years?	☐ <1 ☐ 1-3 ☐ 3-5 ☐ 5-7 ☐ >7
5. SANITATION	
5.1 What type of sanitation you use?	☐ Kutcha ☐ Sanitary ☐ Ring slab ☐ Hanging ☐ Open

	☐ Others
5.2 Is it hygienic?	☐ Yes ☐ No
5.3 How far is your latrine from the water source? (in meter)	☐ <50 ☐ 50-100 ☐ 100-200 ☐ 200-500 ☐ >500
5.4 Where is sludge disposed?	
5.5 Is disposed sludge properly managed?	☐ Yes ☐ No
5.6 If the nearby water source is being contaminated by the disposed sludge?	☐ Yes ☐ No
5.7 Have you ever had problems with the latrine in the times of disasters?	☐ Yes ☐ No
5.7.1 If yes, which problems?	☐ Inundation ☐ Clean water get mix with polluted water ☐ Inaccessibility of latrine ☐ Others
5.8 Are disease outbreaks common following a natural disaster?	☐ Yes ☐ No
5.8.1 If Yes, what are the common types of diseases?	☐ Diarrhea ☐ Cholera ☐ Food poisoning ☐ Skin diseases ☐ Malnutrition ☐ Arsenicosis ☐ Gastric ☐ Pregnancy related problem ☐ Others
5.9 Who suffers the most from these diseases? (multiple responses allowed)	☐ Men ☐ Women ☐ Children ☐ Elderly persons ☐ Disabled persons ☐ Others
5.10 What did you do during that time?	
5.11 Are your latrines now prepared in case of disaster?	☐ Yes ☐ No
5.11.1 If yes, what did you do to solve the problem?	☐ Elevated above the plinth level ☐ Constructed new latrine far from water source. ☐ Better management of sludge ☐ Others
5.12 If new latrine constructed, how far it is now from the water source? (in meter)	☐ < 200 ☐ 200-500 ☐ 500-1000 ☐ 1000-2000 ☐ >2000
5.13 Do the public institutions (schools/colleges/hospitals) have separate washroom facilities for male/female?	☐ Yes ☐ No
6. **FOOD AND NUTRITION**	

6.1 How many meals do you /your family members take in a day?	☐ 3 Times ☐ 2 Times ☐ 1 Time
6.2 Quantity of food	☐ Sufficient ☐ Insufficient
6.3 Quality of food	☐ Good ☐ Average ☐ Bad
6.4 What do you usually have for three main meals?	
6.4.1 Breakfast:	
6.4.2 Lunch	
6.4.3 Dinner	
6.5 Has your household diet changed in the past 10-15 years?	☐ Yes ☐ No
6.5.1 If yes, how?	
6.5 2What are you consuming more?	
6.5.3 What are you consuming less?	
6.5.4 Why?	
6.6 Are you satisfied with your nutrition content?	☐ Yes ☐ No
6.6.1 If no, what should be added in your daily meals?	
7. LIVELIHOOD ACTIVITIES AND STRATEGIES	
7.1 Has your household changed the income generating activities in the past years?	☐ Yes ☐ No
If the first response is “yes”, continue, if the response is “no”, then continue from 7.11	
7.2 If yes, which main activities did you stop doing?	☐ Agricultural farming ☐ Fish cultivation ☐ Shrimp farming ☐ Small business ☐ Vegetable farming ☐ Livestock rearing ☐ Wood/Golpata/Honey collection ☐ Garment workers ☐ Others
7.3 Why did you stop doing it?	☐ Salinity ☐ Environmental shock (cyclone, flood, excessive heat) ☐ Lack of quality seeds ☐ Disposal/burning of nets ☐ Lack of quality fertilizer ☐ Govt. ban ☐ Others
7.4 Did you try to resolve the problem with those main activities?	☐ Yes ☐ No
7.5 What did you do to solve the problem?	
7.6 What alternative did you choose?	☐ Agricultural farming ☐ Fish cultivation ☐ Shrimp farming

	☐ Small business ☐ Vegetable farming ☐ Livestock rearing ☐ Wood/Golpata/Honey collection ☐ migration ☐ Rickshaw/van pulling ☐ Others
7.7 Which other activities you tried that failed?	☐ Agricultural farming ☐ Fish cultivation ☐ Shrimp farming ☐ Small business ☐ Vegetable farming ☐ Livestock rearing ☐ Wood/Golpata/Honey collection ☐ migration ☐ Rickshaw/van pulling ☐ Others
7.8 And why?	
7.9 Did other households in your community experience the same problems?	☐ Yes ☐ No
7.10 Which activities worked for other households in your community?	
7.11 To what activity does your household dedicate most the time now?	
7.12 Do you think your household can continue depending on that activity for many more years?	☐ Yes ☐ No
7.12.1 If not, why?	
7.12.2 If not, what economic activities do you see as promising for your household for the future?	
7.13 Are you expecting support from the local government and/or government departments for pursuing those activities?	☐ Yes ☐ No
7.13.1 If yes, what type of support?	☐ Monetary support ☐ Micro finance ☐ Training/ workshop/meeting ☐ Asset provision (land, livestock, agricultural tools etc.) ☐ Others
7.13.2 What would be the best way for the local government and/or government departments to offer you that support?	

8. MIGRATION

8.1 Did anyone from your household migrate anywhere previously?	☐ Yes ☐ No
If yes, continue from 8.2 to 8.18, if no go to question 8.19 and continue.	
8.2 Who was involved in migration?	
8.2.1 On the basis of role in the household	☐ Father ☐ Mother ☐ Brother ☐ Sister ☐ Husband ☐ Wife ☐ Children ☐ Other
8.2.2 At what age he/she migrated?	☐ Below 15 years ☐ 15 to 25 years ☐ 25 to 35 years ☐ 35-45 ☐ Above 45 years
8.3 With whom he/she moved out?	☐ With family ☐ Individually
8.4 Did any of your other relatives migrate from this village?	☐ Yes ☐ No
8.5 Who influenced the migration decision?	☐ Self-realization ☐ Family members ☐ Local political leaders (chairman, member etc.) ☐ Local school teacher ☐ elderly people ☐ NGO ☐ Other (Please specify): ……
8.6 Main reason for migration (multiple responses are allowed)	
8.6.1 Push factors	☐ Loss of Income ☐ Loss of livelihood due to any environmental stresses ☐ Loss of land due to river bank erosion ☐ Loss of land due to salinity intrusion ☐ Lack of pure drinking water ☐ Social dispute ☐ Loss of homestead ☐ Other (please specify): ……
8.6.2 Pull factors	☐ Better job opportunity ☐ Better income ☐ Better services and facilities ☐ Better education ☐ Better health care ☐ Kinship in the place of destination ☐ Other (please specify): ……

8.7 What kind of jobs he/she was involved in village before they migrated?	☐ farmer ☐ landless farmer ☐ fisherman ☐ livestock farmer ☐ day laborer ☐ unemployed ☐ wood collector in Sundarban ☐ honey collector in Sundarban ☐ Others (please specify): ……..
8.8 Where did they go? Mention the name of the place of destination	☐ Another village of the union: …… ☐ Another union of the upazila: …….. ☐ Another upazila of Khulna: …….. ☐ Small city/town close to Khulna: …… ☐ Big city: …… ☐ Outside Country: …….. ☐ Other: ……
8.9 What do they do after migrating from their origin	☐ Same job as before ☐ Different job (please mention): ……
8.10 What was the pattern of their migration?	☐ Seasonal ☐ Permanent
8.11 Did any of them come back?	☐ Yes ☐ No If yes, why? ……
8.12 Please briefly mention his/her migration history. (If he/she moved more than once/twice, mention where did they go and why they switch their destination place?)	
8.13 Has the migration decision changed the financial and social status of your migrant family member?	☐ Yes ☐ No 8.13.1 If yes, is the change positive or negative? Please mention briefly: …….. …… ……
8.14 Have you ever migrated by yourself?	☐ Yes ☐ No
8.14.1 If yes, please mention the pattern of your migration	☐ Seasonal ☐ Permanent
8.14.2 If no, do you want to migrate too?	☐ Yes ☐ No 8.13.2.1 If yes, why do you want to migrate: ……

	…… ……
8.15 Where do you want to migrate and Why?	
8.16 Do the influential people/NGOs/local government have taken any project/initiative that influence the migration decision of the people of your locality?	☐ Yes ☐ No 8.16.1 If yes, mention the project in brief: …… …… …… …… …… ……
8.17 Do you think migration is a good alternative way to minimize the loss of livelihood here?	☐ Yes ☐ No Please mention the reasons: …… …… ……
8.18 What sort of mechanisms can be taken to make migration more planned?	
8.19 Did you or any of your family member feel like to migrate but couldn't?	☐ Yes ☐ No 8.19 .1 Please mention the reasons:
8.20 How did you manage here?	

9. HOUSEHOLD INCOME, EXPENDITURE AND SAVINGS

INCOME

Source of Income	Approx. Annual income from this source	Who is the main contributor for this income?	Who takes decisions over the use of this income?	Greatest threats affecting the source of income in past years (hazard / year) e.g. pests / rainy season 2016	Has this ever changed due to any environmental stressors? (Increased=I or Reduced=R or
1. Agriculture					
2. Shrimp Farming					

3. Vegetables					
4. Wage labor					
5. Small Business					
6. Rickshaw, van, cart puller					
7. Fishing					
8. Handicrafts					
9. Livestock					
10. Service					
11. Remittance					
12.Wood/Golpata/ Honey Collection					
12.Others					
TOTAL					

EXPENDITURE

Expenditure	**Annual amount spent**	**Who takes the expenditure decisions**	**Who spends the money**	**Has this ever changed due to any environmental stressors? (Increased=I or Reduced=R or Neutral=N)**
1. Rice				
2. Pulses				
3. Meat				
4. Fish				
5. Vegetables and fruits				
6. Clothes				
7. Household				
8. Education				
9. Transport (both person and fright)				
10.Health/Medicine				
11.Electricity				
12. Water (if any)				
13. Fuel for cooking				
13. Repairing/Buying agricultural/ fishing tools				
TOTAL EXPENDITURES				

SAVINGS

What is your household's average gross monthly savings? (in BDT)	
Who takes the decision on the mode of savings? (in BDT)	
What is your household's average gross monthly deficit? (in BDT)	
Which are the months when your deficit is maximum?	

Why?	
Which are the months when you receive a larger income?	
Why?	

10. ACCESS TO CREDIT

10.1 Did you ever apply for a loan from a bank or other sources?	□ Yes □ No
10.1.1 If yes, were you successful and received a loan?	□ Yes □ No
10.1.2 What difficulties you faced in applying for the loan?	□ Lack of credit giving institutions □ Lack of trust □ Lack of access for women □ Lack of education □ Others
10.1.3 What difficulties you faced in paying the loan?	□ High interest rate □ Short time duration for repaying □ Limited income generating opportunities. □ Uncertain events □ Extreme weather events/ natural disaster □ Others
10.2 Is there any specific loan provision for women?	□ Yes □ No
10.2.1 If yes, for what purpose?	□ Vocational training □ Poverty reduction □ Children's education □ Small business □ Others

10.3 If you ever received a loan, please describe it by filling the next table

Sources of Loan	Amount of Total Loan Received (TK)	Outstanding Amount (Tk)	Rate of Interest	Who applied for the loan in your household?
1. Bank				
2. NGOs				
3. Money lender				
4. Relatives				
5. Samitty				
6. Others (specify)				

11. HAZARD APPRISAL

11.1 Which were the three most important problems your household faced in	Last 3 years- □ Problem 1:

(Please consider everything, from illness to property destruction, crop failures, economic problems, death)	☐ Problem 2: ☐ Problem 3:
	Last 10-15 years- ☐ Problem 1: ☐ Problem 2: ☐ Problem 3:
11.2 Which are the main hazards impacting your locality?	☐ Cyclone ☐ Salinity intrusion ☐ Water logging ☐ Heavy rainfall ☐ Drought ☐ Excessive heat ☐ Cold wave ☐ Storm ☐ Flood ☐ Pest infestation ☐ Death of fishes ☐ River bank erosion ☐ Others
11.3 Among all the hazards, which one caused the most damage to your family and community?	
11.4 What sort of damage has been caused and how?	
11.5 Who suffers the most from the disasters?	☐ Men ☐ Women ☐ Children ☐ Elderly ☐ Disabled ☐ Others
11.6 Why do they suffer the most?	☐ Physical vulnerability ☐ Social/position/status ☐ Lack of education ☐ Attachment to belongings ☐ Lack of decision making power ☐ Others
11.7 Why was the hazard so damaging?	
11.8 What was your family's immediate response towards it?	
11.9 What are you doing now for this not to be repeated?	

12. TRADITIONAL HAZARD IMPACT PREPAREDNESS AND COPING STRATEGIES / COMMUNITY INITIATIVE APPRAISAL

12.1 Has your community started to do something to be less affected by the hazards that affect them the most?	☐ Yes ☐ No
12.1.1 If yes, what and how?	

12.1.2 Do you get any benefits from these initiatives for your household? Explain	

12.2 What has your community traditionally done to prepare and deal with the following hazards?

Hazard	Traditional (Usual) Household disaster reduction and climate change adaptation strategies	Limitations / problems associated to the disaster reduction or adaptation strategies
Salinity		
Cyclone		
Flood		
Heavy rainfall		
Excessive heat		
Water logging		
River bank erosion		
Drought		
Pest infestation Death/ illness of livestock		
Death of fishes		
Cold waves		
Storm		
Reduced agricultural yield		
Lack of access to market		

12.3 Do you follow any of those traditional methods? (If yes, which?)

……
……
……
……

12.4 Can you think on new activities that could help you prepare and deal better with the impact of the frequent hazards?

(If yes, which?)

……
……
……
……

12.5 What have been the most important factors that have helped you prepare for and recover from damage hazard impacts?

……
……
……
……

13. LOCAL GOVERNMENT ENGAGEMENT

13.1 Does the local government take steps when there is a disaster or problem your community face?	☐ Yes ☐ No
13.2 What are those steps or initiatives?	
13.3 Are those helpful?	☐ Yes ☐ No
13.3.1 If yes, how? If no, why?	
13.4 How local government can play a role to ensure resilience/ make it better?	
13.5 Do the government departments take steps when there is a disaster or problem like this?	
13.6 Which departments?	
13.7 What are activities they carry out?	
13.8 Are those helpful?	☐ Yes ☐ No
13.8.1 If yes, how? If no, why?	
13.9 How government departments can play a role to ensure resilience/ make it better??	

14. NATURAL CAPITAL

14.1 Which natural resources you use the most in your daily life and to generate income?	☐ Forest ☐ Rivers ☐ Agricultural land ☐ Fisheries ☐ Others
14.2 For what purpose, these resources are used?	
14.3 Have you noticed any changes in the natural environment in last 30-40 years?	☐ Yes ☐ No
14.4 What are those changes?	

14.5 Did it affect you?	☐ Yes ☐ No
14.6 How did it affect you?	
14.7 Did it affect the entire community?	☐ Yes ☐ No
14.8 How did it affect the entire community?	
14.9 Is there anything you (or your community) could do to reverse the situation? If yes, what?	

14.10 With all the changes in the environment and the climate that you have described, do you see opportunities for your household to engage in new activities that could fit the new conditions?

☐ Yes

☐ No

14.10.1 If yes, which activities? And how?

……

……

……

……

14.11 Have you seen other people in your community or neighbor communities undertaking new activities and making an income out of those?

☐ Yes

☐ No

14.11.1 If yes, which activities? Where? And how?

……

……

……

……

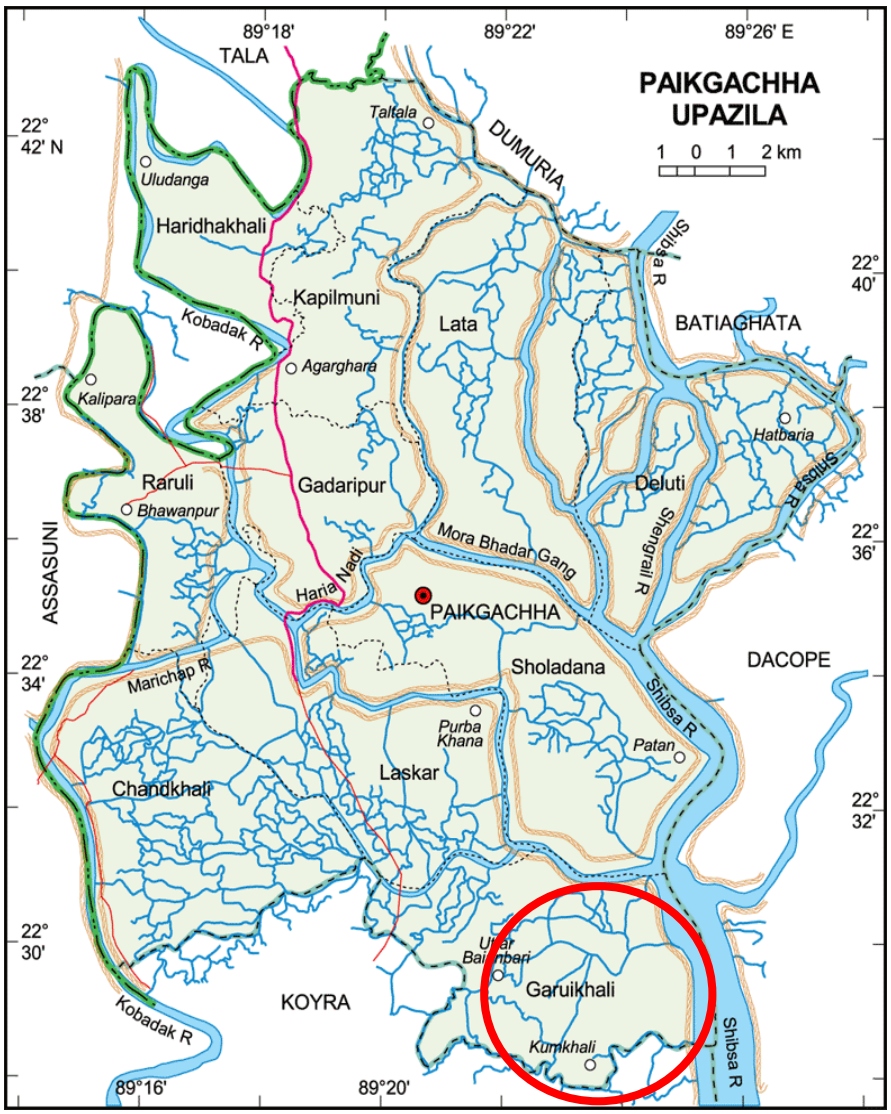
……

……

Thank you for your cooperation

Appendix 2: Village Profiles

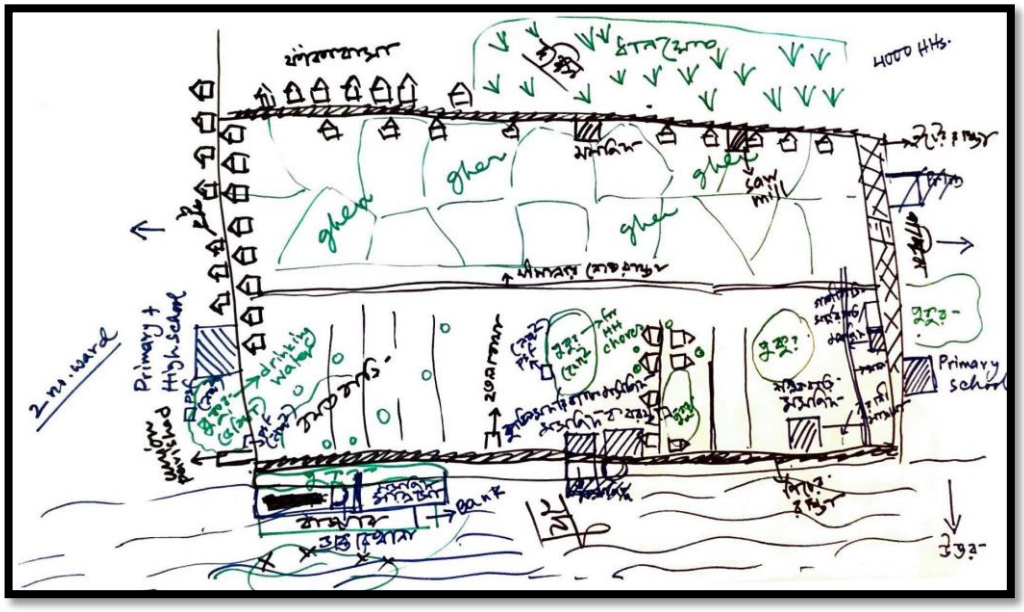
The study sites of this action research are Garuikhali village and Kumkhali village of Garuikhali union, Paikgacha Upazila, Khulna. The village profile has been developed using the findings of household survey, transect walk through the villages, community mapping, key informant interviews (KIIs) and problem tree sessions with the local community. The village profile gives an idea about the natural resources, the socio-economic conditions and community facilities of the villages.



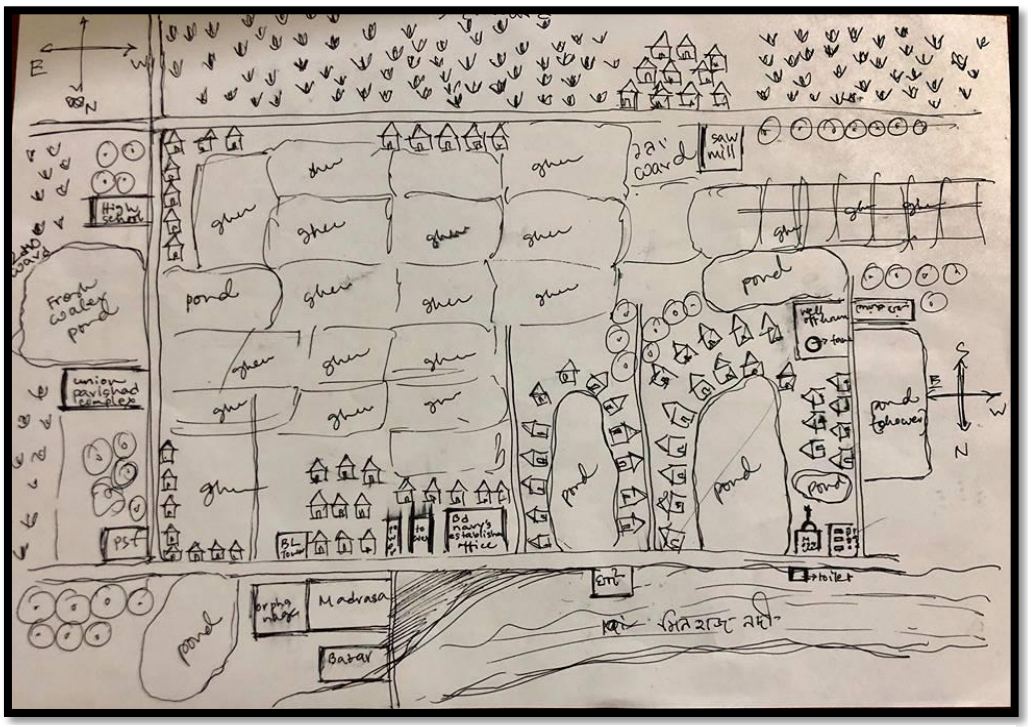
Location of the study area

Garuikhali Village Profile

Garuikhali village is located about three and a half hours drive, 150 kilometers south-west from the Khulna City. It is ward no 1 under Garuikhali union (union number 10) of Paikgacha Upazila. During the community mapping exercise the village along with all its facilities have been drawn by the participants and during transect walk all these features have been physically visited and marked in the map.



Community map of Garuikhali Village



Map generated from transect walking through Garuikhali village

Natural Resources

River

A part of Shibsa river flows along the north-east side of Garuikhali village which is locally known as Minaj River. This river is freely accessible by everyone and used to be one of the main livelihood generating sources where people used to do fishing. But government has prohibited the use of current (electric) net for fishing and catching of fish fries. Saline water has also intruded in this river.

Shibsa River

From the village timeline exercise it has been identified that, the first ever earthen embankment in this village was built in 1974. But it got broken during cyclone Aila. After Aila, the embankment was repaired again but when the current condition of the embankment was asked, 39.4% respondents have replied that the current condition of the embankment is bad.

Water Resources

Most of the homesteads have a pond alongside. People have been using the pond water for all household chores and drinking purpose for years. But due salinity intrusion over the years and shrimp farming, water in most of the ponds has become saline and not usable for daily purpose. But due to water scarcity they have no other choice than using this water for washing dishes, cloth, cattle etc. In the entire Garuikhali village, there is only one fresh water pond which provides potable water. But this pond is located beside the primary school which is more than 1 km away from the neighbourhood. Besides, there are some beels in this village where people used to do fish cultivation but due to saline water intrusion, fishes no longer grow there.

Saline water intruded pond along homesteads

Only fresh water pond of Garuikhali Village

Sundarbans

The world's largest mangrove forest Sundarbans is at close quarter. People used to collect honey, wood from Sundarbans but after the prohibition on resource collection from Sundarbans from 2013, people no longer go there.

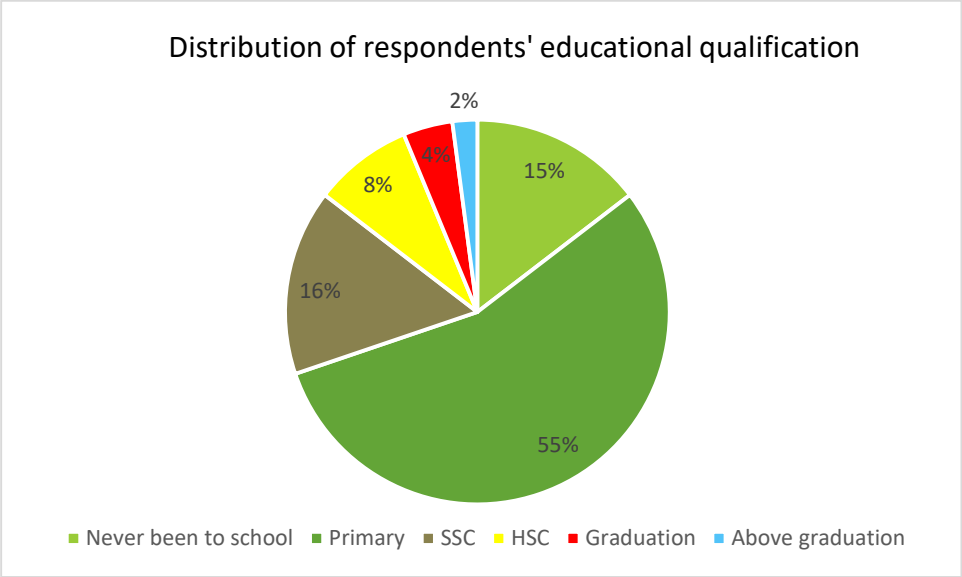
Socio-economic Dynamics of the Village

Demographic profile

The villages have an average population of around seven thousand and among them 96.94% are Muslim and 3.06% are Hindu. From the community series of Khulna 2011, the identified male and female ratio is almost same which is 1.1:1. Number of school going children is high and the number of youth is comparatively less in this village. From the household survey it has been identified that, in 24% households there is no young member and in 49% households there is only one young member.

Educational profile

According to the Women Entrepreneur and Judge at the Village Court, literacy rate in this village is around 80%. But From the household survey it has been identified that 55% of the respondents have obtained only primary education and 15% have never been to school.



**SSC= Secondary School Certificate; HSC= Higher Secondary Certificate

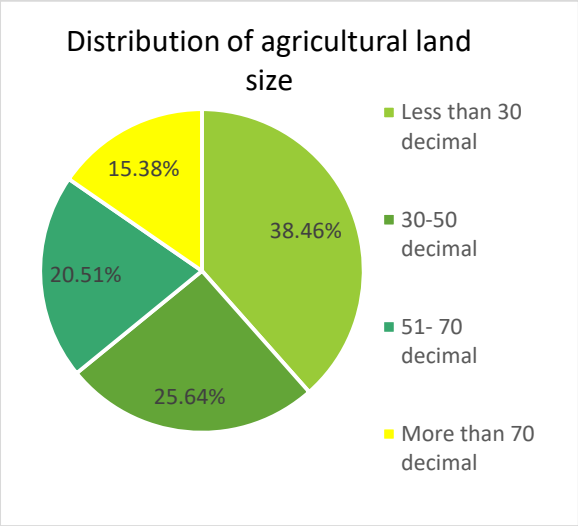
Distribution of educational qualification of people in Garuikhali Village

Not much discrepancy among males and females are prominent regarding access to education but during problem tree exercise the women group have stated that, sometimes females get married and become unable to pursue higher education. Even though some women still pursue further education after marriage.

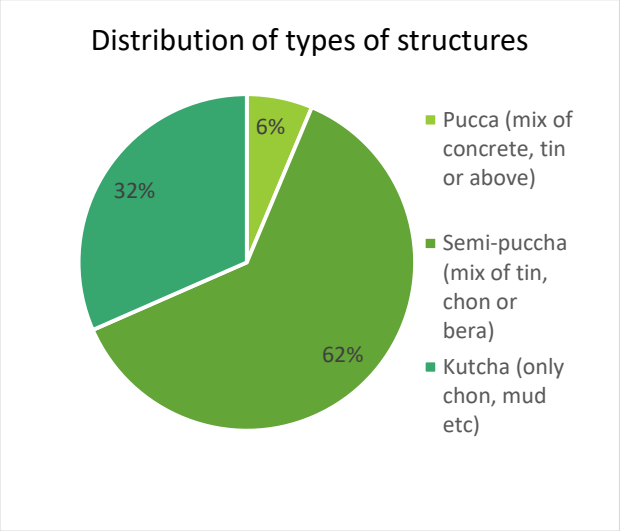
> *"When I was in class six I got married. After that I couldn't continue my studies and appeared in SSC exam. This is very common in our village. Girls are married off at an early age and cannot complete their study after marriage. "(Mahmuda, Livelihood Shock, Garuikhai. 2018.07.20)*

Land Ownership and Structure Type

Eighty nine percent (89%) of the respondents in the village own some amount of land but majority are poor. The size of homestead land of all the respondents is not more than 50 decimal. In case of agricultural land, only 39.8% have agricultural land and among them 38.5% households have less than 30 decimal of agricultural land. When the structure type of the inhabitants has been asked during household survey, it has been identified that, 62% have semi-pucca type structure.



Distribution of agricultural land size in decimal

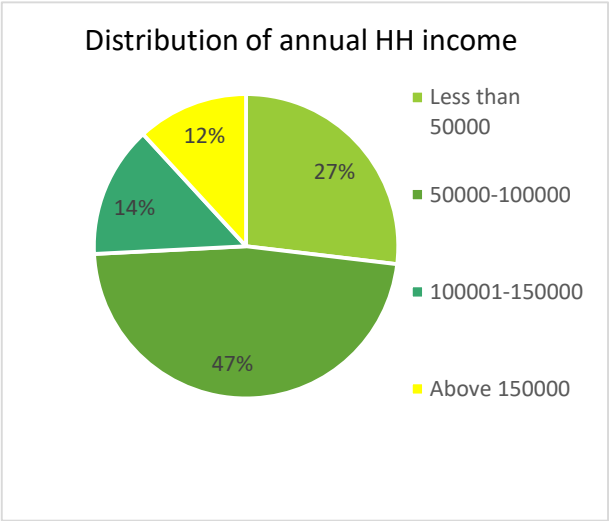


Distribution of structure type

Wealth Classification

To identify the wealth classification of the village, the respondents have been asked the annual household income. Forty seven percent (47%) of the respondent's annual household income is between fifty thousand to one lakh Taka. Only 12% have annual household income above one lakh fifty thousand taka. Households those have large areas of land and practice large scale shrimp farming, fall under this category. But all the participants of problem tree exercise have mentioned that, poverty is a big issue here.

Some consequences associated with poverty i.e. malnutrition, poor access to education, indebtedness are also prominent here.

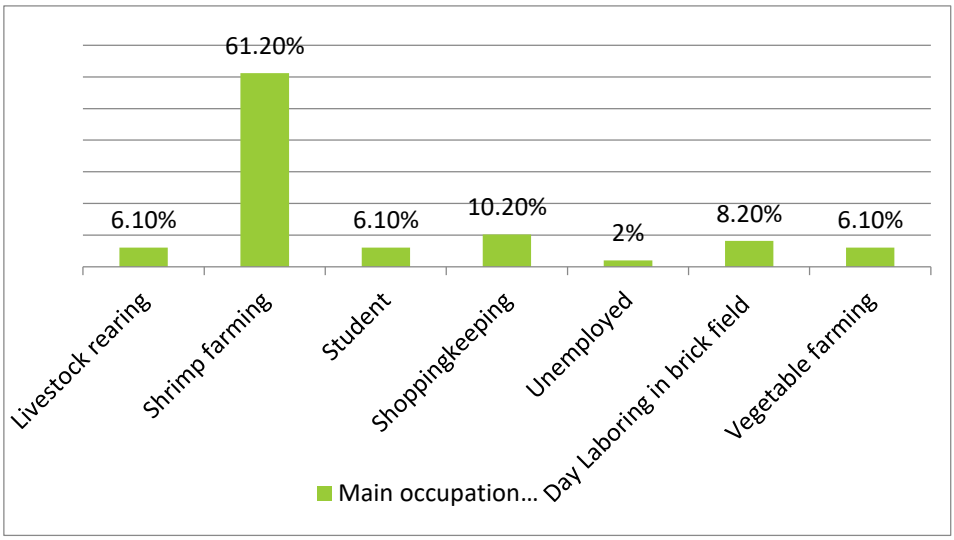


Distribution of annual household income (in BDT) of the inhabitants

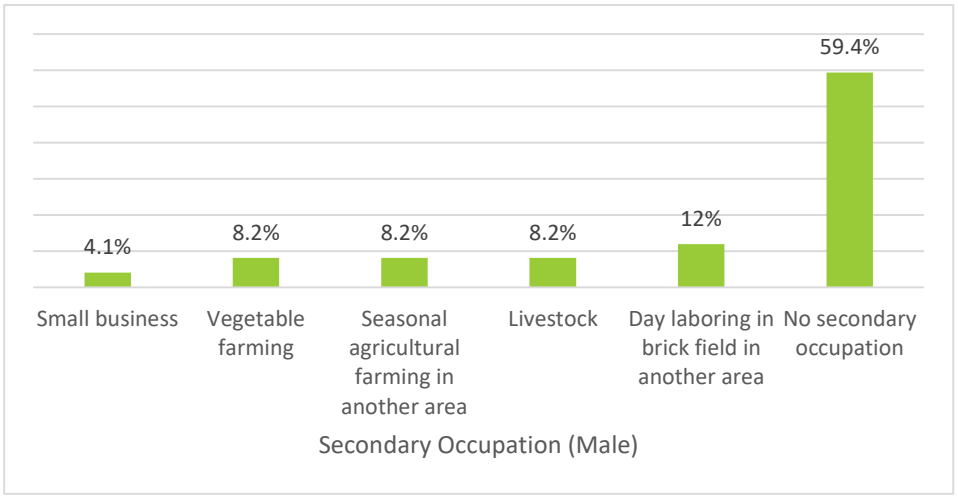
Occupation/ Livelihood Context

During the problem tree session all the participants have mentioned that, agricultural farming and fishing used to be the two-major income generating activities for the male members of this village. Regardless of the size of the land, all the male members used to grow crops and cultivate fishes in their land. Using this production, they were involved in trading and some of them were enterprise owners as well. But due to salinity, irregular rainfall pattern, excessive heat and other socio-economic reasons most of the people have stopped practicing agricultural farming and fishing. Rather using the saline water people have started doing shrimp farming which is highly profitable when done in large scale. Till 2012, large number of male members used to be wood loggers, but access to Sunderban and collect resources has been prohibited in 2013. Now this source of livelihood no longer prevails.

Women used to do vegetable production in their backyards and farmlands. At present in Garuikali, only 8.2% women are engaged in vegetable farming whereas 30.6% in shrimp farming.



Distribution of main occupation of male members



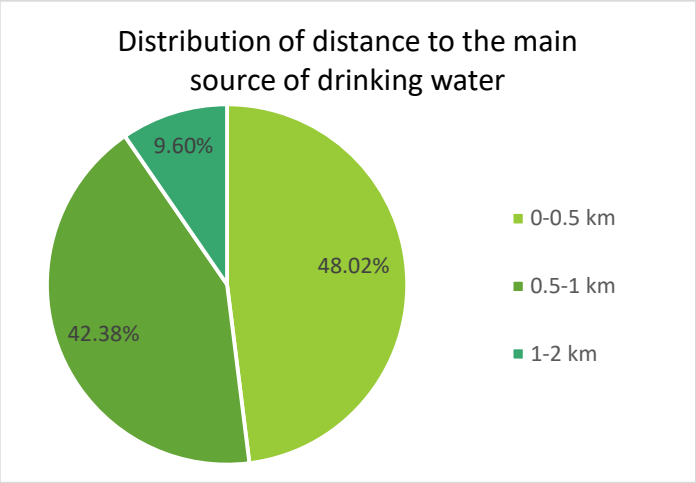
Distribution of secondary occupation of male members

When the main and secondary occupation of the respondents was asked during the household survey, it has been identified that, in 61.2% cases, shrimp farming is the main occupation for the respondents'. Only few of them practice shop keeping, vegetable farming, and day laboring in the brick field as main occupation.

The percentage of respondents practicing shrimp farming may seem high but during problem tree session all the participants have mentioned that, only few moneyed men have large scale shrimp ghers and have annual household income above one lakh fifty thousand taka. But most of the people either work as day labor in the shrimp ghers or practice shrimp farming in a small piece of land which is not profitable. In case of secondary occupation, 59.4% respondents have no secondary occupation. Only 8.2% respondents practice vegetable farming and seasonal agricultural farming as secondary occupation. So, dependence on only one occupation which is not profitable makes the people even more vulnerable.

Position of Women in the Family/Society

Family position of women in this village is just like any other part of Bangladesh. They do mostly household chores, raise children and take care of family. When the occupation of women has been asked, it has been found out that, 82% women are housewife. Few of them help their husbands in shrimp farming or do handcrafting. Practice of vegetable farming in front yards has reduced as vegetables production is hampered due to water logging, salinity and pest infestation.



Distribution of distance to the main source of drinking water

Managing water for family is a big responsibility of women. In 55.3% cases of household survey, it has been found out that, women fetch the water from the water sources. In 42.38% cases the main source of drinking water has been found to 0.5-1 km away. Travelling this far for fetching water not only is time consuming it also causes physical stress to the women. They used to grow vegetables in their back yards when fresh water was in abundance in their village. But from the past few years, vegetable production has reduced, and they can't make much money out of it. It has degraded their social/family position and reduced decision-making power. It has also become a cause of mental stress and domestic conflict.

Community Facilities

Educational Institution

For the entire population of Garuikhali village there is only one primary school in Garuikhali village which has been identified during transect walk exercise. The school is located in a large compound with a big play field. The only fresh water pond in this village is also located beside the school.

Primary School

Religious Institution

Garuikhali village is dominated by Muslim community so few mosques and one madrassa are situated there. Apart from the mosques in Garuikhali bazar and shantar bazar, one mosque was located inside the village. Besides, there is a madrassa which works as an orphanage as well.

Mosque and Madrassa

Bazar

There is a big **Garuikhali Bazar and one Shantar Bazar** within the village. Because of these two, the village people has good access to markets.

Fresh Water Source

Dysfunctional pond and sand filter

During the problem tree exercise all the participants have mentioned that, access to drinking water is one main issue in the village. The only potable fresh water source is more than 1 km away. Taking this opportunity, some people collect water from this pond and sell water at the rate of 10 taka per 15 litre. But most of the people find it difficult to afford water for daily usage, so they have to depend on the saline water available at their door steps**.** There are three pond sand filters (PSF) in Garuikhali village which were set up by different NGO's in different times for providing safe drinking water to village people. But unfortunately, all three of them are not functional currently. Most of the people here have problem of storing fresh water/rain water as they don't have a reservoir/ water tank to store water. Only some of the effluent people who are politically affiliated with UP chairman, members have water tanks at their home.

Union Parisad Complex

The union parisad complex is located close to the primary school. This village court and Madhumati banking service is also located in the same complex.

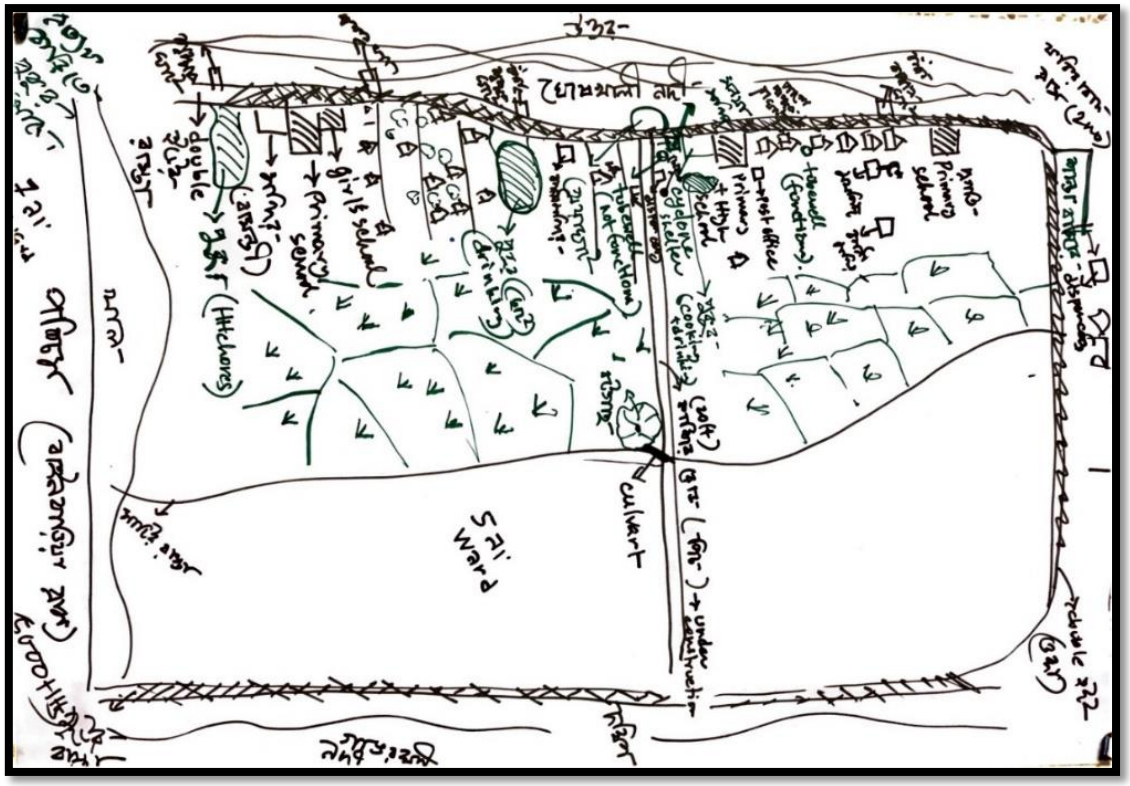
Graveyard

There is a family graveyard inside the neighborhood which is known as "Sardarbari Graveyard".

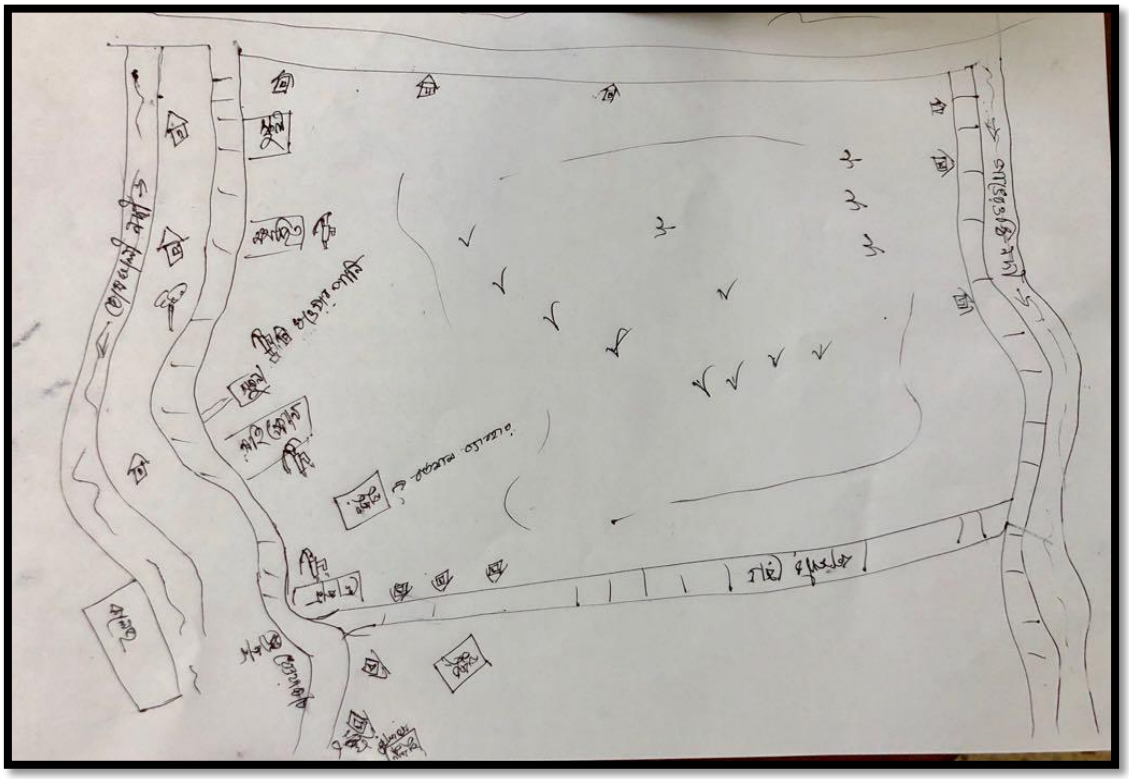
Union Parishad Complex

Kumkhali Village Profile

Kumkhali village is located about three and a half hours drive south-west of the Khulna City. It is the 4 no ward under Garuikhali union (union no 10) of Paikgacha Upazila.



Community map of Kumkhali Village



Map generated during transect walk through Kumkhali Village

Natural resources

Water Resource

Ghoshkhali River passes along the North-East side of the Kumkhali River which provides fresh water that helps kumkhali to continue agricultural production. Even though an outsider (from Khulna) once started shrimp farming at kumkhali but the villagers stood against it and got rid of the outsider to carry out agricultural practices. Most of the ponds inside this village provide fresh water. But due to lack of water, people use pond water for various purposes like washing, bathing, cooking etc. This has made the pond water polluted.

Ghoshkhali River

When the villagers were asked about the embankment, they replied that there has been an embankment from the very beginning but it doesn't work properly. During household survey only 21.4% respondents have said that, the present condition of the embankment is good.

Landscape

Kumkhali village (ward no 4) is known for having fresh water inside paikgacha upazila. Since level of salinity is low, different types of plants which grow in fresh water is available in this village. So the landscape of this village is soothing and gives a wonderful environment.

Green landscape

Green Field

Many large fields are located in this village which is used both as play fields and cattle grazing grounds.

Sundarbans

World's largest mangrove forest Sundarbans is also at close quarter. Some village people are dependent on mangrove plants like Golpata for their livelihood.

Green Field

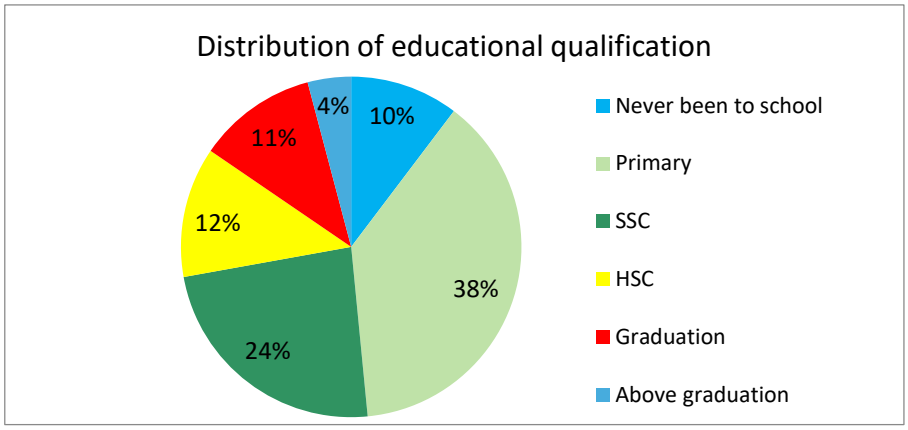
Socio-economic Dynamics of the Village Population

Demographic Profile

The village has an average population of around four thousand five hundred and among them 84.5% is Hindu and 15.5% are Muslim. In the village, Hindus and Muslims live in harmony. The ratio of male and female population is 1: 1.05 (Khumla Community Series, 2011). There is no religious hostility or extremism in the village. The male-female ratio, school going children ratio are more or less same as Garuikhali. But number of youth seemed more than Garuikhali from observation. There are only 17% households where there is no young member and in 34% households there is only one young member.

Educational Profile

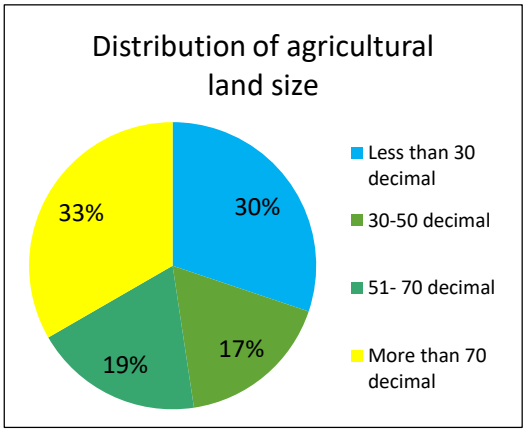
In Kumkhali village as well, highest percentage of respondents has been found to have only primary education. But in this village, the percentage of respondents who have never been to school is lower than Garuikhali village. Also, the percentage of respondents studied upto graduation is higher in this village. The scenario of female education is same as Garuikhali village.



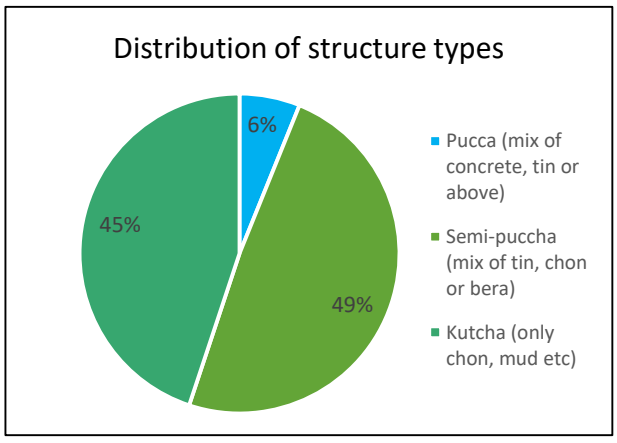
Distribution of educational qualification of people of Kumkhali Village

Land ownership and Structure type

Ninety four percent (94%) respondents of this village own some amount of land but the size of land varies among people. In case of homestead land, 95% respondents' land size is not more than 50 decimal where as in case of agricultural land, 63.4% respondents have agricultural land. Among them, 33% respondents have more than 70 decimal lands.



Distribution of size of agricultural land



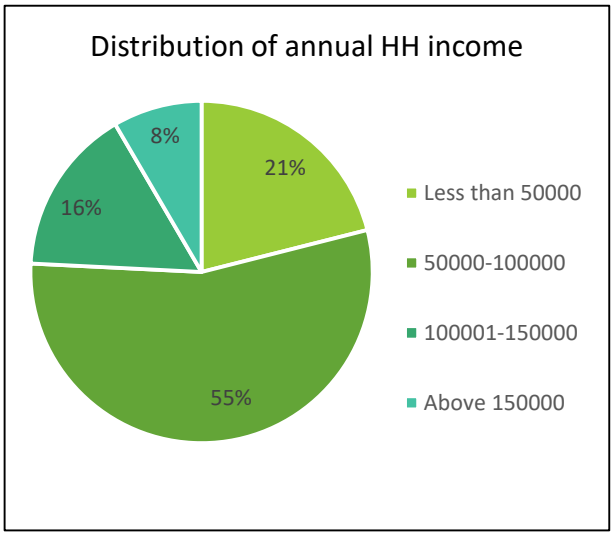
Distribution of structure type

Unlike Garuikhali village, highest percentage (45%) of the respondents has kutcha structures. Most of the homesteads are made of mud and the roof of (chon). A front yard has been noticed in the most of the homesteads.

Typical Homestead

Wealth Classification

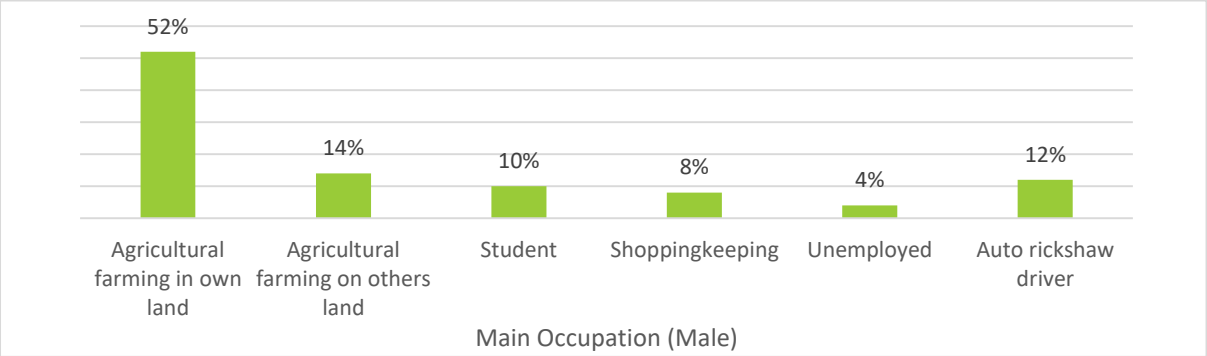
To identify the wealth classification of the village, the respondents have been asked the annual household income. Fifty five percent (55%) of the respondents' annual household income is between fifty thousand to one lakh Taka. Only 8% have annual household income above one lakh fifty thousand taka. Even though agricultural farming still prevails in this village, the financial condition is not that good. Poverty is prominent in this village as well. During the problem tree exercise all the participants have mentioned that, with this limited income they can hardly fulfill all their needs. As a result they have to take loans from different NGOs.



Distribution of annual household income of the people of Kumkhali village

Livelihood Context

During the problem tree exercise all the participants have mentioned that, agricultural farming has always been the main income generating activity in Kumkhali. From the household survey it has been identified that, 66% respondents are engaged in agricultural farming either in their own land or on others land.

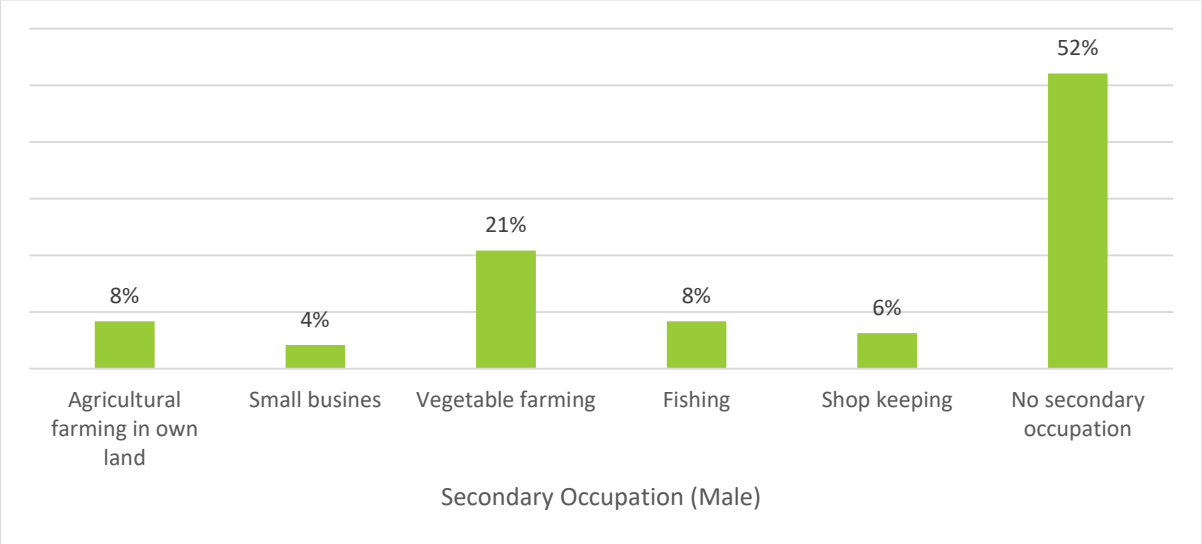


Distribution of main occupation of male members of Kumkhali village

Even though salinity intrusion, changed rainfall pattern, excessive heat, pest infestation, scarcity of water etc. have reduced their agricultural crop yield over the years. But all these issues never forced them to give up agricultural farming. During problem tree exercise all the participants have mentioned that, in spite of being an adjacent village to Garuikhali; people in Kumkhali have still been able to depend on agricultural farming because they don't practice shrimp farming. According to them, it is shrimp farming which has worsen the situation of salinity in Garuikhali. Though an outsider (from Khulna) once started shrimp farming but soon the local people realized that they want the prevailing agriculture practices over profitable shrimp farming, and somehow managed to discourage practicing shrimp farming.

> *"We have always wanted to continue agricultural farming even though it is not as profitable as shrimp farming." (Male, Problem Tree, Kumkhail,* 2018.06.26*)*

When the secondary occupation of the respondents' was asked during household survey, it has been identified that, 52% respondents' have no secondary occupation. Twenty one percent (21%) respondents' do vegetable farming on their front yards as secondary occupation. Vegetable farming in front yard is mainly done by women. Besides, some women do handcrafting (14%) for earning money and some (8%) help their husbands in the field especially during sowing seeds and harvesting.



Distribution of secondary occupation of male members of Kumkhali village

Access to Market

The major income generating activity in this village is agricultural farming and fishing. During the month of harvest, they get plenty of crop and fish at a time. But they can't travel to the local market (Shanta bazar, Garuikhali Bazar) to sell their products during the harvest as they don't have anyone to look after their crop while they go to market. Taking this advantage, some middle men locally known as "bepari" come at their door step to buy their crop. They usually don't give them fair price rather sell their products at high price in the local market. Besides the high cost of transport is also a major factor for local farmers.

Community facilities

Educational Institution

There are two primary schools in the same compound one for boys and the other for girls. These schools are located just beside the temple. In front of the school there is a field where children's play

during their break time. There is one high school in this village as well. During the community mapping exercise, participants have identified the schools and play field in the map.

Primary School

Religious Institution

Kumkhali village is a Hindu dominated neighbourhood where 84.5% people are Hindu. For this reason, some temples have been identified in this village (identified in community map) but no mosque/madrassa was noticed. The nearest mosque is in Shantar Bazar.

Temple

Cyclone Shelter

In the same premises of the high school, there is a three-stored cyclone shelter which during normal times is used as school. The problem tree analysis has been done inside this shelter.

Cyclone Shelter

Village Road

Internal roads inside this village are made of bricks. These narrow roads are mostly for walking purpose.

Village Road

Tube-well

Very few (not more than 3) tube-wells have been set up in this village in different times. But only one of them which is located close to the school is function.

Only functional tube-well

Bazar

There is no big local market within the village. Shantar Bazar is the nearest most bazar to Kumkhali village but still a bit far away from the village so people can't go there for daily purpose. There are some mini bazars inside the village from where people can get daily necessary items.

Local mini bazar

Post-E-Centre

There is one Post-E-Centre in Kumkhai village from where people can have access to internet, computer training, agriculture related information etc.