Why Gher Cannot Serve as a Climate Change Adaptation Model: A Case Study on Shrimp-Rice Intercropping in Joymoni, Mongla, Bangladesh

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A Thesis submitted to the Faculty of Graduate Studies
In Partial Fulfillment of the Requirements for the Degree of
Master of Arts

Graduate Program in Geography
York University
Toronto, Ontario
September 2016

Abstract

With the intricate and growing impacts, it has become obvious that adaptation is one of the keys to combat with climate change in Bangladesh. Many strategies are implemented in response. In 2014, the Government of Bangladesh identifies a four decades of intercropping method of cultivating paddy, shrimp and fin fish, called gher as an adaptive model. Massive scale commercial shrimp farming that began in the'90 s has made shrimp the second largest export item by volume. Researches show that gher already caused much harm to croplands and waters affecting vegetation, livestock and livelihoods of the people. It continues to degrade the environment, estuaries, forests, and biodiversity. It furthers the existing threats of Sea Level Rise, salinity intrusion, and erosions. Taking Vulnerability (Adger, 2006) and Theory of Access (Ribot & Peluso, 2003) as research framework, this Human Geography study explores the limitations of gher as an adaptive model in Joymoni, Mongla, Bangladesh.

Keywords: Climate Change Adaptation, Shrimp-Rice Intercropping, Vulnerability, & Gher.

Babunti

Acknowledgements

I thank Mother Mary, and Her Son our Lord, for Their continuous blessings.

I am grateful to Dr. Richard Anderson, York University, who inspired and supported to pursue my education in the Graduate School. Thank you Karen Tait, Dr. Steven Pinter, Dr. Fahimul Quadir, Afsan Chowdhury, Dr. Carlos Torres, Dr. Joseph Mensah, Dr. Peter Vandergeest, Dr. Philip Kelly, Dr. Raju Das, the one and only Valeri Preston for your support, inspirations and blessings.

My heartfelt thanks go to my committee, Dr. Justin Podur and Dr. Brenda Longfellow. I couldn't complete this work without the obvious guidance from them. My committee walked extra miles to get this thesis done on time; their efforts towards the completion of this study are enormous. This hardly can be explained in words. I just want to say, Thank you, from bottom of my heart.

Special thank goes to Joychad Mondal, who worked tirelessly during the fieldtrips. I couldn't complete the fieldwork without his continuous support and dedication for this project. Thank you Joychad. Thank goes to Sutopa, as well. Despite of her illness and exams, she transcribed all the interviews on paper, and on time. She did extremely well. Thanks, again.

Attending Graduate School has been quite challenging. Much of this were reduced with the active support from Yvonne Yim, Laura Walton and Alicia Filipowich. Thank you so much.

Finally, my heartfelt gratitude goes to my parents, my siblings, my wife and my daughter. We had to sacrifice countless precious moments as I spent my days and nights in my office. I believe all these sacrifice are worth and will definitely inspire our little ones and others to know and feel more about Bangladesh and love Bangladesh. Thank you for your unconditional support and inspirations as always.

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Chapter 1

Introduction: Gher and Climate Change

Bangladesh, a disaster prone country, has become more vulnerable to climate change in recent years. Adaptation strategies have been taken at the state level. One of the practices recommended in the National Shrimp Policy 2014 by the Government of Bangladesh is called *gher*, which involves the intercropping of shrimp in rice paddy fields (Karim, 2006, p. 61). Local farmers have used this practice for nearly four decades (Food and Agriculture Organization of the United Nations, 1990) for its low investments and high returns. Categorized as an adaptive model with government subsidies available, gher is likely to expand in the coming years. Existing researches (Deb, 1998; Karim, 2006; Azad, Jensen, & Li, 2009) show that gher deteriorates soil quality, causes lesser yields to rice and other crops over time, and increases vulnerability to unemployment, as I will review below. This study problematizes the possibilities of gher as a climate change adaptation model and explores the vulnerabilities that it may impose through a study in Joymoni, Mongla Upazila, Bangladesh.

Ghers have become quite popular in the coastal areas of the country since the early '70s (Food and Agriculture Organization of the United Nations, 1990). Coastal areas have complex arrays of river estuaries that fish use to hatch their eggs in. The Sundarbans provide them with an even safer environment with an ideal temperature in the waters. The huge availability of shrimp and fish larvae in the estuaries has led to a gher boom. Initially, only fresh water shrimp was cultivated. As the demand increased for brackish water shrimp this market expanded as well. Farmers store the brackish water in their land, and change as needed, especially during the 'gon'. The days between a new moon and a full moon are considered as one gon. During that time they

open the sluice gates of the gher and allow free flow of the water from the nearby canals or from neighbouring ghers. This is also the time when gher farmers get new stock of fin fish with the incoming water as well as crabs. This is to ensure the quality of the water stays suitable for a successful harvest of the shrimp.

However, as the climate changes, it brings negative impacts in this sector, as it has done with almost all the sectors of agriculture in the country. The coastal belts are threatened primarily with Sea Level Rise (SLR), floods, cyclones, surges, erosion, and salinity intrusion. All of these impacts contribute to the increase of salinity both with the water and soil in the regions. Salinity reduces soil quality, and can force farmers to use fertilizers and pesticides at extra expense. This does not bring sufficient production, but harms the natural quality of the soil further. As people do not get a good harvest from their rice paddy, they try to do gher with the idea that they could revive their losses by selling shrimp and fish. Continuous gher, instead of promising sustainable income, deteriorates the soil quality further. Ultimately farmers do not get crops, nor do they get shrimp and fin fish.

Their situation gets worse at the time of calamities such as cyclones, surges, erosions and floods. This study focuses on incidents from 2007 till 2016, and takes impacts done by two major cyclones namely Sidr in 2007 and Aila in 2009 into account. The respondents who used to do gher in 2007 say that, Sidr heavily destroyed the embankments that resulted in the washing away of their ghers. An embankment is an alleviated land located on the bank of a river to protect areas from flooding. By the time they somehow recovered the loss, Aila came and washed away everything including their houses, livestock, and left their villages submerged under water for days. They suspect it was Aila that brought the saline water into their ghers, and water systems

which continue to become of an issue till today. This salinity worsens as people continue to do ghers, as they find no hope and no support from the government in adapting with the issues.

The government tries within its capacity to restore the affected embankments. However, in Joymoni at least, it fails in continuously monitoring the infrastructures and maintenance in their operations. As a result, river erosion maintains its rank as one of the most prominent and visible threats in the village of Joymoni. This makes saline water intrusion easier and the seepage of saline water from one gher to other continues. With ample saline water in the gher, people again are somewhat forced to cultivate brackish water shrimp. It becomes a cycle, they do ghers for some years, then a cyclone, or surges come and wash out everything. Then they start from the beginning, as happened recently with the cyclone Roanu on May 22nd, 2016.

The human element of this story started with the idea of getting huge profits by doing shrimp farming in the Chokoria Sundarbans in the mid 70's when villagers chopped down trees on thousands of acres of land to do shrimp farms. The mangrove forests used to work as barriers against surges and cyclones and saved people and their livelihoods for decades. The aftermath of chopping down the trees becomes dire. For instance, the cyclone Roanu caused a net loss of estimated over 882 million taka in terms of households, infrastructures, agriculture and fisheries in Chokoria Upazila, Cox's Bazar in late May of 2016, reports newspaper The Daily Prothom Alo ("কক্সবাজারে মৎস্য খাতে ক্ষতি ৩৫০ কোটি টাকা," 2016). In the Sundarbans, people have deliberately torched down trees to clear areas near the estuarine canals so that they can have a good harvest of larvae. Climate changes and peoples' continuous in/voluntary dependency on gher has created a complex situation where people have no option but to seek more resources even via illegal and unauthorised means.

This study focuses on gher, assesses its vulnerabilities on the people of Joymoni through a vulnerability (Adger, 2006) and access (Ribot and Peluso, 2003) framework. “Understanding the physical and economic effects of salinity diffusion and planning for appropriate adaptation will be critical for long-term development and poverty alleviation in countries with vulnerable coastal regions” including of Bangladesh (Dasgupta, Hossain, Huq, and Wheeler, 2015, p. 815).

1.1 Literature Review on Gher

The premise of this study can be traced in the broader spectrum of issues around climate justice, a term that was first discussed in 1999 right after the Conference of the Parties (COP) 6 negotiations (Routledge, 2016, p. 68). Climate justice can be defined as "the principles of democratic accountability and participation, ecological sustainability, and social justice, and their combined ability to provide solutions to climate change. Such a notion focuses on the interrelationships between, and addresses the root causes of, the social injustice, ecological destruction, and economic domination perpetrated by the underlying logics of pro-growth capitalism…[it] articulates a rejection of capitalist solutions to climate change…and foregrounds the uneven and persistent patterns of eco-imperialism…" (Routledge, 2016, p. 69). Routledge (2016) argues that interpretation of climate justice "involves a politics of antagonism, commons, and solidarity" (p. 69). Politics in occupying land bring people to a hostile relationship with capital through their means of survival. This broadens existing "uneven and exploitative social and environmental relations, as well as broader trajectories of contestation that attempt to make the power relations that compromise neoliberal capitalism localizable and contestable. Further, such antagonisms are generative of actions to create, defend, and expand the common(s), especially given accumulation by dispossession", argues Routledge (p. 69).

Routledge mentions that, "Accumulation by dispossession has entailed the privatization of key "common" resources…and state redistributions…as well as the deregulation of the global financial system…and the management and manipulation of financial crises" (Harvey, 2003; Routledge, and Cumbers, 2009; as cited in Routledge, 2016, p. 67). Dispossessions of primary resources from the marginalised in the global south has increased their vulnerabilities (Routledge,

2016, p. 67), such a phenomena is not uncommon in Bangladesh, and the National Shrimp Policy (2014) is a perfect example. This policy can be seen as the continuation of existing ones in support of private investments in shrimp production, shrimp exports, expansion of shrimp cultivation areas- sectors in which much funding and supports were injected through the government and several development agencies since late '70s.

Amidst the restructuring phase of the country in the post liberation period in 1971, and the famine in 1974, the then government led by Bangabondhu Seikh Mujibar Rahman started the process of allocating lands to the marginalised landless farmers was met "with limited success" (Adnan, 1993, as cited in Porkant, 2014, p. 113-115). The Mujib government was overthrown in a coup in 1975. The new military government headed by Ziaur Rahman took more radical approaches such as prioritizing export oriented economic policies, and allowing private investments which continued till to date (van Schendel, 2009, as cited in Porkant, 2014, p. 115). The significant growths in private investments in shrimp production, developing technologies in post-larvae management, and water maintenance can be found in Bangladesh Second Five Year Plan (1980-1985). Such steps were popularly supported by international development agencies and economic institutions such as Food and Agricultural Organisation (FAO), Swedish International Development Agency (SIDA), World Bank (WB) and Asian Development Bank (ADB) (Porkant, 2014, p. 115). These policies and incentives, nonetheless, have proliferated the shrimp industry that we have today. In doing so, this industry has uprooted a large number of peasants from their traditional ways of farming, made them vulnerable as the production declines with associated factors such as increased salinity, infertile soil, and climate change, as I review in this paper.

"Since the early 1990s, the government of Bangladesh has implemented structural adjustment programmes, including trade liberalization of agriculture, involving the withdrawal of

input subsidies, privatization of fertilizer distribution, and seed production, and elimination of rural rationing and price subsidies" (Murshid, n.d., as cited in Routledge, 2016, p. 70). This resulted in "farmers' indebtedness and landlessness as they struggle to secure the capital to pay for expensive agricultural inputs" (Routledge, 2016, p. 70). Hossain (2009), and Seabrook (2013) mention that, "Functional landlessness (i.e. ownership of less than 0.2 ha) affects 69 per cent of the population" (as cited in Routledge, 2016, p. 70). Routledge argues, "Brought about through land grabs by rural elites, local government corruption, and environmentally induced displacement, landlessness deterritorializes the poor" (2016, p. 70).

This erects the need for a brief discussion on the ways in which rural power structure operates. Although a much complex issue, significant development in understanding the power structure emerges from the discussions of Rahman (1981), and Boyce (1987) who view local elites as hurdles "to progress with poverty reduction, exercising power through control of land and tenancy relationships, the 'capture' of external development resources provided by government, and the creation and maintenance of patronage networks for personal gain" (as cited in Lewis & Hossain, 2008, p. 24). This view still is very much traceable in this study as I discuss the ways in which larvae collectors at the grassroots maintain their relationships with the local elites, mainly the gher owners, to fish in the river, and the ways in which the elites prioritize their relatives over vulnerable victims in delivering aid during any disasters, such as cyclones and surges.

Using an "actor-oriented" approach, Lewis (1991) analyzes how power gradually starts to shift from land-based elites to less powerful people as they increasingly take advantage of newer technologies in agricultural practices (as cited in Lewis & Hossain, 2008, p. 25). As a result, the understanding of "conflict and capture" becomes blurred in the presence of such agrarian change (Wood, 1999, as cited in Lewis & Hossain, 2008, p. 25). Lewis (1991), and Wood (1999) thus

conclude that, "the local power structure, though pervasive, is far from static. Land ownership alone is no longer the main determinant of rural power" (as cited in Lewis & Hossain, 2008, p. 25). However, this analysis of power structure is not applicable throughout the country. The more appropriate analysis for Joymoni would be of Rahman (1981), who finds that, "primary economic strength and social status of local leaders depended on the extent of land ownership. However level of education was also an important asset for attaining leadership…" (as cited in Mozumdar, Ali, Farid, and Kabir, 2008, p. 430). Mozumdar et al. (2008) analyze how local leaders maintain close relationships with the "administration and non-agricultural sources of income", which along with control over land allow them to access rural power structure (p. 430), as it happens in Joymoni. Quite a large amount of lands are being bought by private companies. The local gher owners maintained good relationships with these companies which then allowed them in obtaining leases on these lands from the companies. This allowed them to continue with their gher farming on these lands with greater control and power over natural resources. They have now leased out the river to larvae collectors. Natural resources thus become commodified by these elites who often maintain close relationships with the local leaders of the ruling parties, and as such, the marginalised people have little power to voice against these practices, says Azad (personal communication, 2015).

The creation of Export Processing Zones by converting agricultural farmlands has contributed significantly in turning Mongla Upazila into a food deprived area, says Humayun (personal communication, 2016). On their website the India-Bangladesh Chamber of Commerce and Industry (IBCCI, 2016) mentions Bangladesh "Industrial Policy 2013", in which it is stated that, "Foreign direct investment will be encouraged in all industries in Bangladesh except those in the reserved lists, banking, insurance and other financial institutions" (Chapter 14, para. 14.1); "Export Processing Zones have been set up in the country under the Bangladesh Export Processing

Zones Act 1980 in order to help establish export-oriented industries" (Chapter 16, para. 16.1). The website also includes the government document (Notification no. 99/2011-Customs) published by Depart of Revenue (2011), Government of India, that states the nature of its foreign investment in Mongla Export Processing Zone. It covers 186.21 hectares of land where 124 industrial plots measuring 2000 square metre (sqm) each with a tariff of US $1.25/sqm, and a standard factory building measuring 9000 sqm at a rate of US$ 1.60/sqm are to be built. Sweet water is to be purchased at a rate of tk. 22.43/cubic metre (1 cubic metre is equal to 1000 litre) from the Public Health Engineering Department who own the supply network for these facilities (IBCCI, 2016). This projects a stark contrast on existing inequality among resource sharing, resource mobilization and distribution, and the ways in which marginalised communities access resources. For instance, Anis, a larvae collector in Joymoni purchases a 30 litre tub of pond water at a rate of tk. 40 for drinking and household purposes that lasts for two days. When he cannot afford to purchase, his family is forced to drink the saline water from the river.

Impacts of climate change, nonetheless, make this situation more complex, and hence, prioritizes adaptation among others. Adaptation, however contains "individual and collective choices taken at different levels of decision making in the context of present and predicted climate change impacts, other social concerns and priorities, and the existing institutional framework that engenders a particular distribution of resources, wealth, and power" (Paavola, Adger, & Huq, 2006, p. 264-265). Adapting with climate change in this context requires modification of agricultural practices, for instance gher cultivation in the South. So far the ruling class, the elites and private investments have their voices reflected in policies such as the National Shrimp Policy 2014, where much of the wellbeing of the rural poor, peasants and environment have been overlooked. As much as the policy poses gher as an adaptive model, the literatures on gher, its

impacts on the environment and on people, and adaptive capacities remain polarized. Some tend to explore the possibilities of gher, its importance in strengthening the national economy. This literature, for instance Saroar (2015a) identifies gher as a potential adaptive model to combat the impacts of climate change. Literature in this sector considers factors such as access to microloans to farmers, growing demand for shrimp feed production, newer technologies, and advanced crop rotations which, it is argued, are to be incorporated functionally in building a robust shrimp cultivation system, such as gher. Much of this literature, however, is contradictory. On the one hand, they (Saroar 2015a, Rahman & Islam, 2013; Alam, Ahammad, Nandy, & Rahman, 2013) acknowledge that gher contributes to the existing intricate vulnerabilities imposed by climate change. On the other hand, they bypass the critical discussion of a sustainable adaptive model but propose to overcome factors such as institutional challenges, overfishing, and lack of strict laws to maintain gher and suggest potential means to increase production capacity. Other literatures (Karim, 2006; Chowdhury, Khairun, Salequzzaman, & Rahman, 2011) are concerned with vulnerabilities posed by ghers on agriculture and on people's livelihoods and analyze its contribution to the existing impacts of climate change.

The point of diversion among these authors largely lies in two categories. One, Saroar (2015a), Rahman & Islam (2013), Alam, Ahammad, Nandy, & Rahman (2013) identify lack of infrastructure, lack of knowledge, lack of planning aided with poor management of aquaculture affecting livelihoods, and gher as an intercropping method that affects the environment negatively. Two, Karim (2006), Chowdhury, Khairun, Salequzzaman, & Rahman (2011) identify gher as the ultimate reason behind the transformation of livelihoods that further exaggerates the impacts of climate change. However, authors in both categories agree that there are negative impacts associated with such intercropping method gher.

With a 710 km long coastline between 89.0 degrees East and 92.20 degrees East in the northern and northeastern part of the Bay of Bengal, Bangladesh's coastline is divided among the southwestern, central, and southeastern region; the first two regions lie in the Ganges-Brahmaputra-Meghna flood plain, and the third region lies in the Matamuhuri flood plain (Azad et al., 2009, p. 800). During the 60's, the Food and Agriculture Organization of the United Nations (FAO, 1990) initiated programs to encourage cereal crop cultivation which motivated the Pakistan government to build polders and to raise embankments along the coasts of what was then East Pakistan, now Bangladesh. A polder is "a low-lying tract of land enclosed by dikes that forms an artificial hydrological entity, meaning it has no connection with outside water other than through manually operated devices" (Wikipedia, 2016). This served two purposes: the embankments prevented salinity intrusion in the coastal areas, and saved lands from being flooded. With these infrastructures available many farmers started to cultivate fin fish and fresh water shrimp farms on a small scale. Brackishwater shrimp farming, i.e. Bagda cultivation started during the early '70s, when techniques of catching larvae were introduced to people.

One of the oral stories suggests that Hormuz Ali of Basantpur village in Satkhira once observed people carrying some sort of nets catching something in the Ichamati River on the Indian side. He crossed the river and learned that it was Bagda larvae they were catching. Learning the technique from them, Hormuz returned to his village. On the way home he brought materials from India and started collecting Bagda larvae in the Ichamati River on Bangladesh's side. During that time people used to cultivate Golda on a smaller scale in the ghers largely because the Bagda larvae was unknown to people. Hormuz convinced the gher owners with his catch and distributed larvae free of costs with a condition that within 15 days when the larvae turn into shrimp, then they have to pay him. People disbelieved him first, but as the larvae turned into shrimp, more people joined

with Hormuz and took it as a profession. This is how the larvae collection technique got popular in the Satkhira/Khulna region (p. 2).

A massive number of people took this as their profession with the beginning of commercial shrimp production during the '90s argue Miah, Bari, & Rahman (2010, p. 436). Most of these people belonged to the "resource-poor households, e.g. landless and marginal household members" mention Miah et al. (2010, p. 436). With over 400,000 people estimated involved in larvae collection, up from estimated 160,000 during the '80s (Porkant and Reeves, 2010, p. 375), there are almost 0.7 million people involved in/directly with shrimp farming in Bangladesh at present (Azad et al., 2009, p. 800). The Ministry of Fisheries and Livestock (MoFL) 1997 report shows that the fish cultivation in the coastal areas increased from 20,000 ha in 1994-1995 to 135,000 ha in 1996-1997 (as cited in Karim, 2006 p. 62). These numbers increased to 276,492 ha in shrimp farming alone in 2010-2011 (MoFL, 2016). One of the reasons behind this massive expansion lies with the adoption of newer and improved technologies, which, nonetheless, have immense negative effects on both the environment and agriculture, argues Karim (2006, p. 62).

Azad et al. (2009) identify the lack of planning which triggered excessive unplanned shrimp farms taking over the coastal areas and contributing to various social problems (p. 804). This is, however, not uncommon across Southeast and South Asia where mangrove forests, croplands, fallow lands, burial ground, and wetlands have been converted to cultivate shrimp and related activities (Azad et al., 2009, p. 804; Primavera, 1997, p. 819). The government owned properties commonly known as 'khas jamin' (Azad et al., 2009, p. 804) are leased out, although unintentionally, for shrimp cultivation that belong to the wealthy. The Land Reform Act 1989 suggests that the landless people should be the primary beneficiaries to access the khas jamin for agriculture purposes (Azad et al., 2009, p. 804). Unfortunately "'sufficiently powerful' shrimp

farmers, including political leaders, relatives of bureaucrats, bankers, and businessmen" got hold of most of the 'khas jamin' (Azad et al., 2009, p. 804; Deb, 1998, p. 76).

Deb (1998) writes that the grassroots farmers who refuse to lease out their lands to the wealthy and the powerful become the victims as their lands get deliberately inundated with saline water from neighbouring ghers owned/ leased by those people (p. 76). As their crop production fails, they become obliged to then lease out their lands (p. 76). Similarly, in the coastal regions of Bangladesh, a vast amount of croplands are illegally occupied by politicians and local leaders (Azad et al., 2009, p. 804). In Joymoni, the gher owners control access to the river and in some cases lease out a portion of the river to larvae collectors, a fact that I discuss in depth later. Azad et al. (2009) find conversions of "beel (natural depressions) areas" into ghers with the connection of disappearing "spawning and nursery grounds of small indigenous species (SIS)" (p. 804).

The point of diversion in this scholarship, despite arguing the damaging impacts of shrimp farming, however, becomes evident as the scholars (Azad et al., 2009, p. 807) claim that, shrimp as a cash crop helps reduce poverty and creates employment opportunities for grass root farmers. This furthers food security as farmers can cultivate rice, fin fish and shrimp in their limited land simultaneously. Moreover, brackish water in ghers provides a source of nutrients to rice plants, they argue. Thus, they claim that the "ecological footprints may not be large in the case of small-scale integrated gher farming" (Azad et al., 2009, p. 807). Azad et al. (2009) suggest that priority should be given towards post larvae production and low cost and affordable feed development. They recommend to the local banks and NGOs to provide micro-credit loans to the farmers. In addition to this, they suggest land zoning in the coastal areas which would help in identifying breeding grounds, habitats for larvae, and hence could protect estuaries, mangroves, and the creeks. They also suggest taking control back from the people who illegally occupy land and to

distribute land among the landless (Azad et al., 2009, p. 807). Nonetheless, the authors do not assess the growing vulnerabilities and existing socio-economic and environmental impacts that ghers already put in communities. Hoq somewhat echoes with Azad et al. (2009) as he argues that, the 'blue-green revolution' "not only holds out huge economic benefits but also solves growing climate change crisis" (as cited in Haq, 2013). The blue revolution means the boom of shrimp cultivation as the green revolution is often used to mean a boom in "terrestrial agriculture" (Deb, 1998, p. 65). The blue-green revolution is to address the boom in these two sectors combined.

Karim (2006) assesses vulnerabilities imposed by shrimp cultivation in farms and ghers in Rampal Upazila. A slight distinction between shrimp farms and gher is that shrimp farms are croplands that are primarily used to cultivate shrimp only that may or may not include fin fish, whereas ghers are lands that are used to cultivate paddy, shrimp and fin fish. He finds that the cropping intensity in Rampal Upazila was 113% in 1975. That fell to 105% in 1985 when the then country average was 151%. Karim (2006) identifies shrimp cultivation as the sole reason behind this as the cropping intensity reduced to 100% by 1999 (p. 63). Analyzing the socio-economy of the people in the upazila he finds that peoples' dependencies on their lands got diverted onto trees and forest vegetation for fuel resource. Decreasing vegetation further led to soil erosion, sedimentation in the waters including of the rivers and in the crop fields. Livestock suffered from a lack of grazing land, while a rapid decrease in grass affected their diet. Croplands suffered from not having natural fertilizer such as cow dung, as more and more cattle were not allowed to get on the gher (p. 67). These outcomes affected the employment sector- and total unemployment was increased from 0% to 19% among men, and 46% to 55% among women. This contributed towards a sharp decline in agricultural employment – from 75% to 38% among men and from 37% to 0% among women in the period of 1975-1999 (p. 68). Women used to work along with men in the

fields and took part in activities such as harvesting, husking, and rearing livestock-poultry, vegetation and others. With much of their participations not required, a large chunk of the population became unemployed. Karim states that "Brackish-water shrimp production in Rampal Upazila gave higher income than rice cultivation, but its expansion has had negative effects on the physical, social and natural environment" (p. 69). In their study, Porkant & Reeves (2010) mention that many people who used to work as "sharecroppers and agricultural day labourers on *khas* and zamindary land", grew their own vegetation in the gardens that were sufficient enough in meeting their family demands. Now, they purchase their daily needs including vegetable as they become associated with gher (p. 377).

Chowdhury et al. (2011) in their study find an intrinsic connection between increased soil salinity and gher in the areas of Mongla, Shyamnagar, and Rampal during the period of 1991-2008. They identify shrimp farming as one of the biggest contributors of soil salinization besides climate change due to its nature of storing brackish water in the croplands all year round. Farmers intentionally maintain a higher saline environment for shrimp cultivation. Salinity thus leaches out to neighbouring croplands. Saline water that is often being discharged in the waterways through sluice gates thus contributes salinity in the surface and groundwater (Azad et al., 2009). Emphasis is given here on storing and maintaining a higher level of salinity in the gher which in turn stabilizes salinity (Karim, 2006, p. 64) in the soil. This, in the long run, contributes to lesser crop yields. Deb (1998) takes it to a deeper level as he argues that aquaculture in the mangroves contributes to highly acidified soils due to their exposure to air (p. 75). The consequences are lower pH and sometimes a high level of aluminum presented in the pond water. This gradually creates a toxic environment for the aquatic species. This environment becomes even challenging to cultured species, such as shrimp in ghers, and makes them prone to diseases, initiates attacks from parasites

and eventually causes death. “During rain, the sudden influx of toxins from the sides of dikes are commonly lethal to a large proportion of fish and shrimps. In southeast Bangladesh, several shrimp disease syndromes and production losses are linked to acid sulphate soils”, argues Deb (1998, p. 75). The recent outbreak on ghers resulting in the death of shrimps due to unknown reason already incurred a huge financial loss to farmers in Paikgacha Upazila, Khulna, reports newspaper the Daily Prothom Alo (“পাইকগাছায় বাগদা চিংড়ির ঘেরে মড়ক,” 2016). A similar outbreak last year prevented their target in achieving 6,000 metric tons of shrimp. Paikgacha Upazila has an estimate of 4,000 ghers comprising of 17, 075 ha of land. This year, the Upazila Fisheries Officer claims that fewer waters in ghers and excessive heat have caused this outbreak. However, farmer Ayub Ali Molla, who has been doing ghers since 1987, argues that he has sufficient waters in his ghers; he regularly provides quality feeds in his ghers, and yet, his shrimps are dying. Farmers in the upazila claim that the dead shrimps soften and change colours as soon as they are put into ice. As a result, farmers are unable to even sell the shrimps. Nearly 10% of shrimps from 30% of the affected ghers are dying during this outbreak, mentions the Daily Prothom Alo (“পাইকগাছায় বাগদা,” 2016).

Despite the continuous damage incurred from doing gher, it seems that there is an unstoppable force that encourages farmers to invest in ghers. FAO reports that Bangladesh ranked eighth among other shrimp producing countries in the world by volume in 2008, yielding 67,197 metric tons of shrimp (as cited in Chowdhury et al., 2011, p. 1194). According to the Bangladesh Frozen Foods Exporters Association (BFFEA), the total earning from exporting shrimp in the year 2013-2014 alone is US $550.16 million, and fish is US $52.64 million, totalling US $602.80 million combined (accessed online, 2016, July, 12). About a decade ago during 2004-2005, the total earnings by exporting shrimp and fish combined were US $420.74 million. The earnings in

this combined sector increased by 43% to US $182.06 million. Porkant & Reeves (2010) argue that "The Bangladesh shrimp sector lies at the extraction, production and processing end of an extended global value chain dominated by restaurants, supermarkets, seafood companies and buying agencies located in Europe, North America and Japan" (p. 360). It competes with other shrimp producing countries such as Thailand, India, and Vietnam with the growing demands "from overseas buyers for assured quality, prompt delivery and competitive prices" (p. 360). This is the second largest export earner after readymade garments (RMG) in Bangladesh according to Porkant & Reeves (2010, p. 360). This discussion intensifies the need for Bangladesh to improve this sector when it enters to the middle-income country list in 2015 (World Bank, 2015).

Since gher produces the majority of the country's shrimp, it is important to analyse the socio-political and environmental costs and impacts under climate change. Take, for example, the issues of bycatch and shrimp feed damaging biodiversity. Approximately 2,000 million larvae are collected annually from the wild; approximately 40% of these die prior stocking while transported into facilities (Azad et al., 2009, p. 803). Hoq, Islam, Kamal, and Wahab (2001) estimate that, "to catch a single *P. monodon* [Bagda] PL [post larvae], 12-551 post larvae of other shrimps, 5-152 fin fish post larvae, and 26-1636 other macro-zooplankton are wasted, a high rate of 'wastage'" (p. 99). Used as shrimp feed, the over collection of "apple snail (*Pila globosa*) meat" has furthered the extinction of this species from many of the waters in southwestern Bangladesh (Azad et al., 2009, p. 804).

Chapter 2

Climate Change Impacts: Cyclones and Salinity in the Coastal Areas

An average of 12-13 low tropical depressions, out of which 5-6 that gain cyclonic strengths with wind speed more than 118 km/h occur at the Bay of Bengal yearly (Paul 2009, p. 290). Although this area contributes only 5-6% of the world's total cyclones, cyclones here cause 80%-90% of total damage and destruction worldwide (Paul, 2009, p. 290; Deb, Kumar, Pal, & Joshi, 2011). 42% deaths due to tropical cyclones in the past two centuries have occurred in Bangladesh (Paul, 2009, p. 291). Six characteristics of the Bay of Bengal exacerbate the impacts of the "abnormal surges" responsible for the most destructive impacts. These are: "(1) the overall concave shape of the Bay of Bengal; (2) the way the northern tip of the Bay converges, like a funnel, toward the Meghna River estuary; (3) the large continental shelf adjacent to the Bangladesh coastline; (4) the large tidal range experienced here; (5) the complex coastline; and (6) the innumerable inlets from land to the Bay…" (pp. 290-291).

The largest cyclone to date, in 1970, killed 500,000 people. In 1991, Cyclone Gorky killed more than 140,000 people (Paul, 2010, p. 484). Cyclone Sidr slammed on the coasts of Bangladesh on 15 November 2007 with a wind speed of 220-240 km/h cost more than US$1.7 billion and killed an estimated 3,046 people (Badarinath, Kharol, Sharma, Ramaswamy, Kaskaoutis, & Kambezidis, 2009, p. 3708; Paul, 2010, p. 484). Cyclone Alia crashed on the coastal districts on 25 May 2009 during the high tide cycle, rising up to 22 feet high and killing 190 people with over 100,000 livestock killed. More than 340,660 acres of cropland were washed away, more than 6,000 km of roads were destroyed and 375,000 people were left without homes (International Agencies, 2009, p. 2). Aila washed away 52,961 acres of ghers and 1074 acres of ponds affecting 60% of the

people who depended on fishing and fish farming for their livelihoods. It was estimated 1.5 billion tk. as the total loss in the fishing industry, as farmers were just about to harvest their fish. (p. 4). In Satkhira and Khulna, the total number of displaced persons was estimated 201,982, 70% of whom stayed in temporary shelters even after 5 months after the incident occurred (p. 2). Aila damaged more than 166 km of coastal embankments. To repair these, US $ 1.1B million were required (p. 2). The loss of 44% of peoples' income led over 60,000 people to migrate elsewhere (p. 2). During a previous study conducted months after Aila damaged Soronkhola severely, one of the villagers whom I interviewed mentioned that they somehow survived through Sidr, but many of them could not survive through Aila due to its longer presence in the village. His son, along with his family, chose to migrate elsewhere and so did many of the families (Boiragi, 2012).

One of the reasons for the decreasing numbers of casualties that the United Nations' and Oxfam officials in Bangladesh identify is the early warning system (Paul, 2009, p. 290). But the impacts of such calamities continue to affect people. Indirect health impacts, including outbursts of communicable, waterborne, and other diseases- "diarrhoea, hepatitis, malaria, fever, pneumonia, eye infections and skin diseases" (Paul et al., 2011, p. 843) remain a challenge. Most of these develop once the calamities are over, and from within the damaged environment that suffers from having a lack of water, food, hygienic toilets, and temporary shelters which are damp and crowded (Paul et al., 2011, p. 843). "Such conditions facilitate spread of numerous adverse health effects from person within the household" (Paul et al., 2011, p. 843).

The initial assessment done by the International Federation of Red Cross and Red Crescent Societies (IFRC, 2015) reveals that the impacts due to existing flash floods and landslides grew as Cyclone Komen hit the southeastern part of the coastal region on 29 July 2015. Komen uprooted 1.8 million people from 186 Unions damaging 27,269 houses totally (p. 1). Low lying areas,

croplands, and ghers got severely affected, in some places water stayed 5-6 feet on the ground level for days (p. 2). Komen killed 45 people in the region, states IFRC (2016, p. 1). On 21 May 2016 Cyclone Roanu which affected the central and southeastern coastal regions (Azad et al., 2009, p. 800) killed 27 people, 2601 livestock, 35,942 poultry; damaged 119 km of polders, destroyed (completely and partially) 171,995 houses, and washed away 54,849 acres of croplands (Ministry of Disaster Management and Relief, 4 June 2016).

Due to its topography and low-lying deltas, the surges brought by the cyclones have destroyed livelihoods. Over the years the impacts have gotten worse in the presence of increased salinity. In their study, Bhuiyan and Dutta (2012) identify sea level rise (SLR) as the reason for coastal erosions which lead to loss of land including agricultural, roads, communication infrastructures and habitat for a wide range of diversity, as well as a contributor to increasing water salinity (p. 226). They warn that increased salinity may hinder the natural growth of some species living in the Sundarbans. SLR would divert the estuarine locations hampering habitat and breeding grounds. For instance, the Penaid prawns that breed and develop where the fresh and salt water mix would lose their habitat as these areas would shift backwards (p. 226).

"Sea water inundation" has affected traditional agriculture in which rice crop yields have gone down regressively, mention Wong, Losada, Gattuso, Hinkel, Khattabi, McInnes, Saito, and Sallenger (2014, p. 384). The authors claim that the joint impacts of inundation of land and deteriorating crop productions affect the entire production in the country (p. 384). According to the Soil Resources Development Institute (SRDI) (2010), there are soluble salts on soils that plants intake as part of their nutrients. Soil salinity occurs when soils absorb excessive amounts of soluble salts that plants cannot keep up with their intake (p. 4). The report made by SRDI shows that salinity is not uncommon in the coastal areas in the tropics, as well as semi-arid, and arid regions.

Salt usually works as ions in the soils. The report points out that these "Ions are released from weathering minerals in the soil. Soil may be saturated with soluble salts due to sea water flooding. They may also be applied in irrigation water or as fertilizers, or migrate upward in the soil from shallow ground water. When precipitation is insufficient (December- June) to leach ions from the soil profile, salts accumulate in the soil and soil salinity can result in Bangladesh" (p. 4). The combination of both has created a mess from which it is quite hard to get out. It includes deteriorating crop yields. So far no salt resistant rice breeds been created, says Humayun (personal communication, 2016); there are breeds that are salt tolerant which are only capable of tolerating salinity to a certain level, and in some areas this level has been surpassed beyond their capacity. This results in crop production failures (personal communication, from whom? 2016). The Farraka dam that was built in 1976 plays a significant role and contributes, to a large extent, in developing salinity as it prevents fresh waters from the Ganges flowing in Bangladesh allowing salinity intrusion into the main land, argue Miah, Mannan, Quddus, Mahmud, & Baida (2004, p. 1322). The authors suggest that the current saline aquifer has entered about 151 km from the coast towards Khulna. The minimum salinity recorded is 0.5dsm-1 in October at some places where the maximum salinity reaches to 68.2dsm-1 at the end of dry season in some places (Miah et al. 2004, p. 1322).

According to SRDI (2010), more than 30% of cultivable land in Bangladesh lies in the coastal areas. 1.056 million ha out of 2.86 million ha of lands are already been affected by salinity. Traditionally the low-yielding rice variety is popular here that farmers cultivate during the wet season; farmers keep their lands fallow during the dry season in the presence of excessive salinity, lack of fresh water and late draining condition (p. 1). SRDI mentions that, "It is anticipated that withdrawal of fresh water from upstream, irregular rainfall, introduction of brackish water shrimp

cultivation, faulty management of the sluice gates and polders, regular saline tidal water flooding in unprotected area, capillary rise of soluble salts etc. are the main causes of increased soil salinity in the top soils of the coastal region" that includes Joymoni (p. 4). The institute suggests that there are 18242 ha of land in Mongla of which, 14583 ha are suitable for crop cultivation. Among these 14330 ha of land which is about 98% of 14583 ha have varied degrees of salinity: 1080 ha has 2.0-4.0 dS/m, 1660 ha has 4.1-8.0 dS/m, 4380 ha has 8.1-12.0 dS/m, 4130 ha has 12.1-16.0 dS/m, and 3080 ha has more than 16.0 dS/m (p. 31).

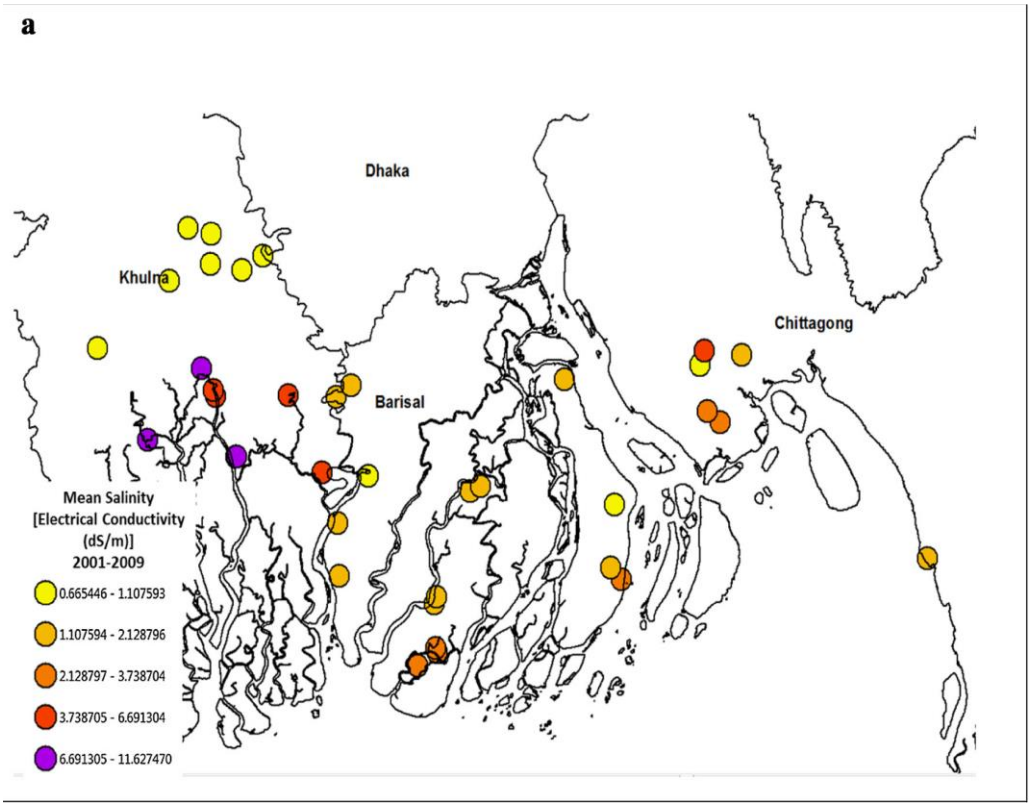

Figure 1: (a) Mean salinity measures for land stations (dS/m): 2001–2009, (Dasgupta et al., 2015, p. 818).

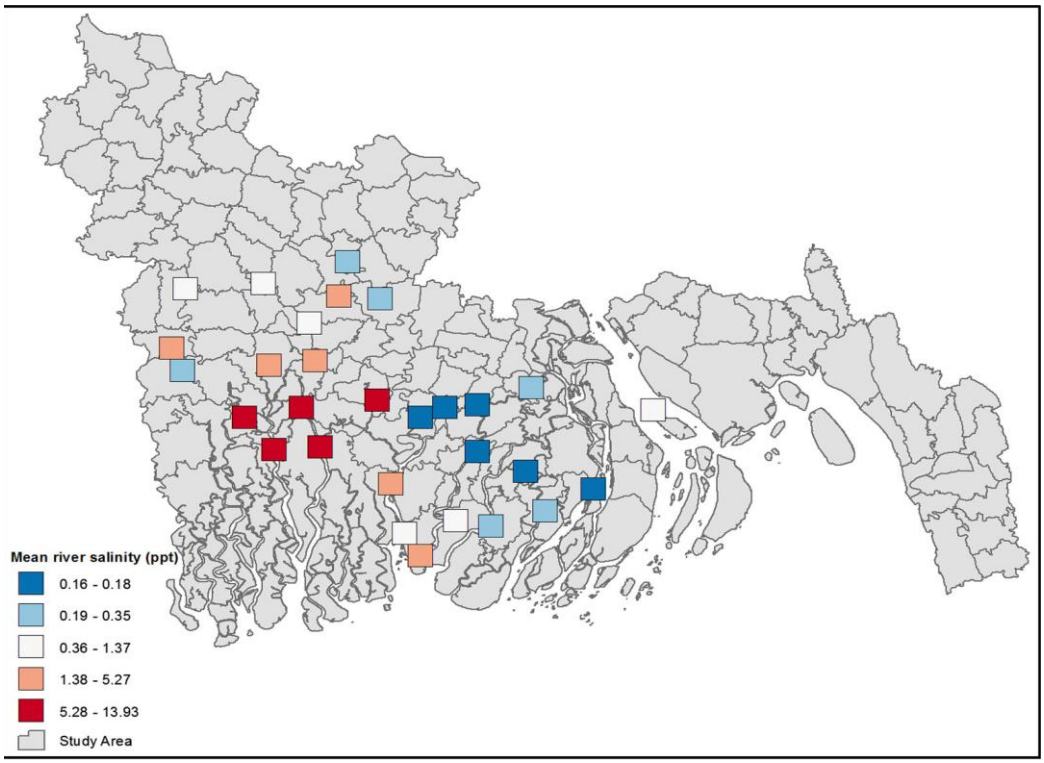

Figure 2: (b) Mean salinity measures for river stations (ppt): 2001 and 2008, (Dasgupta et al., 2015, p. 818).

In other words, 50.314% of the total cultivable area has salinity level more than 12.1 dS/m in this upazila. In 1973, the total salt affected area in Bagerhat District was 107980 ha which got increased to 125130 ha in 2000, and 131120 ha in the year 2009. This is a steep increase by 21.42% of salinity over the past 4 decades (p. 37). Areas around Mongla ferry ghat (terminal), Mongla proper has a pH level of 7.6, and 25.3 dS/m salinity in Pashur River' surface water, while Joymonirghol, and Chila have a pH level of 7.8, and 19.4 dS/m in their Chechang River' surface waters (39). Dasgupta et al. (2015) estimate that the rising salinity would reduce output by 15.6% in nine upazilas by the year 2050 should the salinity exceeds 4dS/m on top of existing prior 2050 (p. 824).

2.1 Adaptation Strategies

Recent climate change literature suggests adaptation, "is generally 'adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which moderates harm or exploits beneficial opportunities'… adaptation describes adjustments made to changed environmental circumstances that take place naturally within biological systems and with some deliberation or intent in social systems…" (Adger, Dessai, Goulden, Hulme, Lorenzoni, Nelson, Naess, Wolf, & Wreford, 2009, p. 337).

To Adger et al. (2009), "the potential insights offered by historical antecedents of change in human societies and their environment…the contemporary discourse of climate change adaptation has two quite distinctive foci" (p. 336). One of them is, the extent to which adaptation strategies would sustain to several generations in the 21st century; the other is, to explore the limits to adaptation, suggest Adger et al. (2009, p. 336). The second is however, "bound up in the discourse of 'dangerous climate change', where the implication is that adaptation by society is limited, in some way, once climate change crosses some danger threshold" (Adger et al., 2009, p. 336). As they analyse the discourse of "limits to adaptation", the authors suggest "ecological and physical limits, economic limits, and technological limits" which enhance analytical discussion and offer various ways to study adaptation and to include in the policies (Adger et al., 2009, p. 337). However, on to the contrary, Adger et al. (2009) mention that, "limits are endogenous and emerge from 'inside' society…what is or is not a limit to adaptation becomes a contingent question. It all depends on goals, values, risk and social choice. These limits to adaptation are mutable, rather than how they are discovered, becomes the operative question" (p. 338).

Nonetheless, the ongoing exploration and practices with the various adaptive measures that Bangladesh has taken are driven by the donors' choices and preferences that and do not agree about the limits of adaptation. Saroar (2015b, pg. 261) suggests that "although for building a resilient community there is a need for package of programs which should include minimization of exposure and sensitivity and enhancement of adaptive capacity, analysis of recent trend shows that nearly all programs are targeted toward mainly adaptive capacity enhancement and, in some cases, sensitivity minimization of poor and marginalized coastal population" (Saroar, 2015b, p. 261). Donors focus on community centred interventions and fund many grass root level NGOs that prioritize engaging with the local community. Saroar (2015b) suggests that investments should also be made in physical infrastructures, enhancing communication, securing access to sanitation and water, building shelters, and embankments (p. 262).

The need for robust embankments is felt after Sidr in 2007 and Aila in 2009 which fully destroyed and, in some areas, partially, more than 1,200 km of embankments. Fragile embankments led to damage of roads, highways, communities, schools, croplands, and other infrastructure. Therefore, ensuring strong and sustainable physical structures like embankments should also be given urgent focus when dealing with adaptive interventions suggests Saroar (2015b, p. 260). Some of the projects funded by Asian Development Bank (ADB), the World Bank (WB) and the International Finance Corporation (IFC) already take similar actions including the promotion of climate resilient agriculture and food, improvements of coastal embankments and afforestation, climate change capacity building and knowledge management, conducting feasibility studies in building climate resilient housings in the coastal belt (p. 270).

Additionally, Saroar and Routray (2015) suggest that policymakers should consider distinct characteristics of different regions across the coastal belt, and develop policies and action

plans based on the geography, socio-economic practices of the people and their exposures to climate change impacts (p. 426).

One of the ways people can adapt to increasing salinity intrusion is through diverting their croplands into ghers, or into shrimp farms, suggests Saroar (2015a, p. 1462). He explores how education plays a role the decision making of the farmers. The choices made by the educated farmers involved the associated risks, for instance, the possible viral attacks with the shrimp and fish, factored in while calculating the risks. With this calculation, farmers continue doing intercropping in their ghers. Farmers who have less education may face dilemmas choosing gher or shrimp farms over paddy cultivation. However, this requires more analysis and discussion given the fact that salinity level is increasing due to a number of factors and any intercropping methods that contribute more to this problem cannot be considered adaptive (p. 462).

Other studies suggest gher as one of the ways that people in the coastal belts can adapt. Abedin and Shaw (2013) state that, "In slightly saline and moderately saline areas, cultivation of Boro rice and sweet water shrimp will help reclaim soil salinity. In Khulna-Bagerhat region it is called "Lockpur model" (p. 219). Rahman and Islam (2013) show how the rapid expansion of saline prone areas and salinity intrusion has made rice production less profitable. As a result shrimp farming, therefore, can potentially replace rice crop and at the same time be adaptive to climate change (p. 320).

To be an adaptive practice Alam et al., (2013) emphasize the need to incorporate a technologically advanced crop rotation system. This would allow farmers to cultivate freshwater shrimp along with paddy during post monsoon season and harvest the crops by November, and cultivate brackish water shrimp Bagda in the dry season from December to June (pp. 266-7).

Other research emphasizes building climate resilient agriculture. Ahmed (2015) argues that farmers in the south-west coastal belt need to adopt modern technologies and practices in their croplands which would reduce climate vulnerabilities and risks (pp. 1903-4). In doing this, four objectives can be achieved: sustainable food production, poverty alleviation, access to health and nutrition, and conservation of local resources (1904). Although Ahmed (2015) emphasizes the need to have salt tolerant rice varieties, priorities for demonstrations to encourage farmers and to incorporate the idea resilient agriculture, Humayun criticizes these suggestions and discusses some of the shortcomings (personal communication, 2016). He argues that the rice varieties in labs are produced in a controlled environment whereas climate variability as well as geographic locations are not always factored in. As a result, the rice varieties they get from the lab produce lower yields in high salinity. Finally, there are studies which prioritize strengthening people at the grassroots and suggest for bottom up approaches to build coping mechanisms in the communities concerned. They suggest that indigenous knowledge can be transferred to the generations ahead to adapt to climate change. Alam, Asad & Parvin (2015) mention that "It is the "learning by doing" evolution which makes use of indigenous knowledge gained over centuries. The indigenous knowledge is constituted through the gathering of social memory of past weather extremes… [these are] "intuitive data" derived from individual perception of recent experience of weather guided by historical weather data. Since data are always context specific, grassroots responses are highly localized, generating community-wide ownership and commitment…" (p. 2016).

Chapter 3: Study Area and Methods

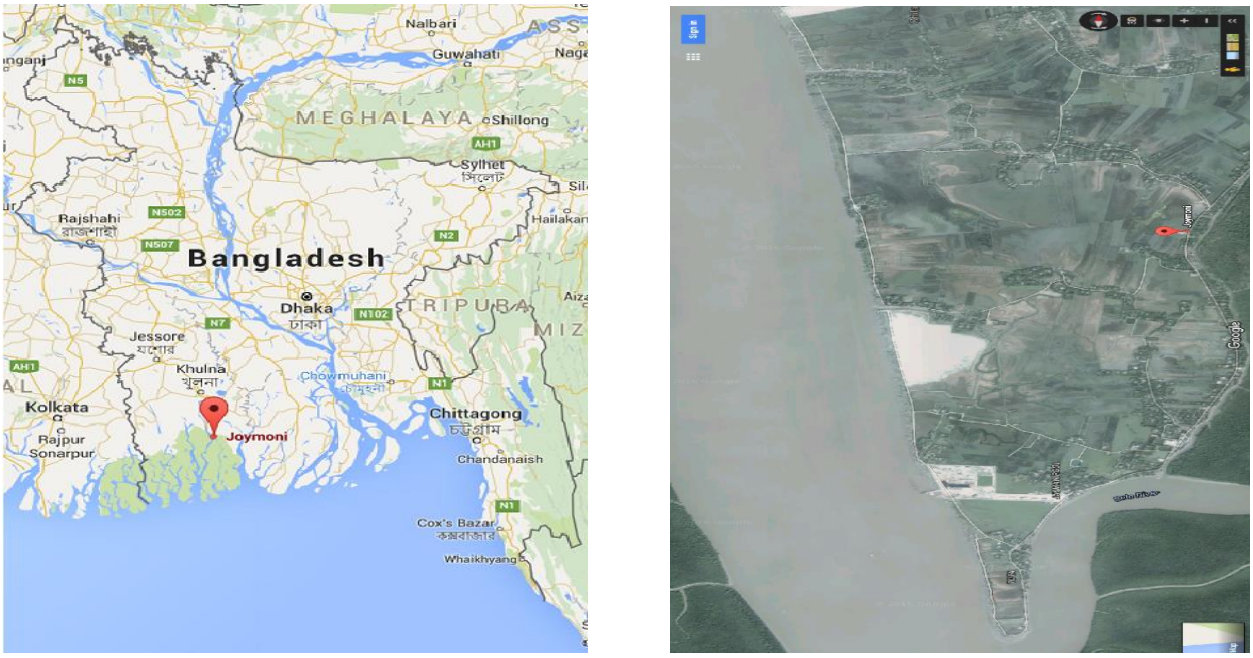

Figure: Map of Bangladesh, Map of Joymoni (Google Maps 2016)

Joymoni is located in Chila Union, south of Mongla Upazila, Bagerhat District, Khulna Division. It is situated near the Chadpai Forest Range of the Sundarbans. The Pashur River flows from the West of Joymoni, Shela River on the South-East. The estuary is located right at the end of Joymonirghol, south of Joymoni. This study takes place in three areas of Joymoni: Joymonirghol, Gilekhal and the area situated west of Gilekhal by the river bank.

This study has two formats which are complementary to each other: a written component, which is this document, and a video documentary titled Salt in the Soil. Qualitative in nature, I conducted this research on various steps using various tools, methods and equipment. I conducted extensive field work, interviewed people and recorded in video, audio, and paper (notetaking) format. With their consents, I used a Sony HXR-MC2500 shoulder mount video camera, and a standard Zoom H1 audio recorder to collect and record data. I trained my research assistants

Joychad and Sutopa (last names omitted) to operate the equipment in advance. Most of the interviews were covered by Joychad using the video camera, while I shot the rest of the video footage included in the documentary. It was mostly Joychad who asked the participants if they were okay with the video recordings and got their consents. I used Sony Vegas Pro 10.e software to produce the 29 minutes long documentary into a Digital Versatile Disk (DVD) format.

Finally, with the help of Sutopa, I arranged a focus group discussion. Initially I planned to organize two FGDs, with 7 female and 7 male participants in each group. However, I had to change my plan due to some challenges I faced that I discuss later in this chapter.

The conception, inspirations, and rationale of conducting this research came from my village, Holdibunia which also belongs to Chila Union. Distance from Mongla Port (central) to Holdibunia is about 4 kilometres, and from Joymoni approximately 17 kilometres. For the past few years my relatives and the villagers kept saying that they do not get expected output from their croplands. My extended family members also suffered from lesser crop yields. The dominant farming practice they do is gher. I wanted to know if climate change has anything to do with gher. As I started to do some academic research, I found that this is the intercropping method that contributes to lesser crop yields, exacerbated by climate change. I wanted to know how the people living in more vulnerable places are doing with their cropping yields. From an earlier fieldwork in 2012, I was aware of the devastations that Joymoni faced during cyclones Sidr and Aila. Joymoni has always been more vulnerable to climate change than my village. Meanwhile, the National Shrimp Policy 2014 came out that suggested potentials of gher becoming an adaptive model. But in practice, I see people doing ghers are suffering the most. This came up as a solid idea to do a thesis project for my Graduate School. This gives me an opportunity to do something for my people and at the same time make meaningful contribution to the academic literature.

I visited Joymoni, Machmara, Kanainagar, Holdibunia, Mongla, Chunkati in Bagerhat. I went Chunkati in the middle of my fieldwork to see how the people in that area are adapting with climate change issues, the sorts of technologies they are using in their agricultural practices, and if they are facing any issues in getting government support and services. This was to expand my knowledge, and to experience the different usage of technologies that I was introduced there.

I began my fieldwork by visiting a tea stall located at the end of Joymonirghol. I visited this place several times and built relationships with the shopkeeper and the villagers. Some of the villagers recalled me from my earlier project in 2011-2012. To them, I explained my study, and intentions to interview some of the local people who own, work or someway are associated with gher. This resulted an interview appointment with Mokbul. Joychad took me to Joymonirghol on the day of the interview. After the interview, I realized most people living in the Joymonirghol depend on fishing and go to the forest; they are less associated with gher. Finding people who were more associated with ghers at this location became time consuming. So I moved northwest along the shoreline.

Traveling by the shoreline, we spotted several people catching larvae in the river. One of them was Anis. We got down from the embankment, walked through the knee high water and reached an elevated land where Anis had built his house. He allowed me to record the entire process of him setting up the net with my video camera. Later we spoke for half an hour. After the interview, Joychad took me to the other side of the embankment to Bormon who owns a large gher there. Bormon gave us more than an hour and shared his experiences in doing ghers for the past decade. We returned to our place after the interview that day. A few days later we returned to the same place and spotted Munira. She and her son were setting up the net in the river. There we found Azad, too. We approached them, both Munira and Azad agreed to answer some of my

questions. After all these interviews, I set a date and time for the FGD with Sutopa who is pursuing her undergraduate degree in Mongla College. She helped me in arranging the FGD, notetaking and coding the interviews. We reached her courtyard in one fine afternoon to hold the FGD. The FGD lasted for 45 minutes. I took my final interview with Humayun. He is one of the agriculture officers in the Upazila. He agreed for the video interview that lasted for about 45 minutes.

Apart from Humayun, I offered 500 tk. to each of the respondents. Giving money or honorarium to Humayun could potentially erect debates across this government office. Sutopa received a stipend of 5,000 tk. and 1,000 tk went to the person who introduced her to me. Joychad, who helped me the most with transportation, networking and logistics for two months, received 10,000 tk. stipend.

I should make my readers aware of the few challenges I faced while conducting fieldwork, and limitations with my chosen research framework. At the beginning of the fieldwork, it was quite difficult to gain public trust, for which I had to look for connections that would introduce me to the locals and ease their acceptance. Often locals identified me as a NGO worker and they were very selective in what they spoke. There is a tailored version of language that people often use in the presence of NGO workers that I experienced when I visited Gilekhal. It was the time of Kali Puja (a religious festival for the people belonging to Hindu religion) and I found villagers were busy with Puja preparations on the day I visited in Gilekhal. During the conversation with them, I understood that much of those people volunteer themselves with any kinds of FGDs organized by several NGOs. From there, I made myself cautious in selecting the villagers. I decided to host the first FGD comprised of 7 female participants. Although all of the participants knew each other, which is not unusual in a small community such as Gilekhal, I found that some of them are related to each other and have family ties. Right then I changed my mind of hosting another FGD for male

participants as I feared they would also be somehow related to these female participants. Hosting such FGD would therefore not produce any significant data for my study. So I decided to conduct individual interviews.

Selecting individuals, especially female participants (including FGD) was challenging for an outsider like me. Since both of my research assistants belonged to the communities, I had to request them to introduce myself to the villagers. In the most cases, Joychad went to talk with the individual participants first, explained my intent of doing this research, and finally introduced me with them. Luckily, in all the cases, he was successful.

Albeit, my research framework has few limitations, it serves the purpose of this study as intended. This frameworks helps us to understand the various means through which people of Joymoni (who are associated with gher) access resources, and the multifaceted forms of vulnerabilities to which they are exposed. It suggests that the complexities associated with vulnerabilities imposed by climate change and gher need to be analysed as the compound outcome of the two given that gher has been a practice in the south for the past forty years. Now accompanied by climate change, gher is no longer a practice on which people can rely for their future be they the larvae collectors, workers in the processing units, or transporters of shrimp, shrimp feed, and larvae. The majority of the shrimp that Bangladesh exports come from these gher cultivations. On one hand, a straight withdrawal from such cultivation practice would force all these people into unemployment and the country into major economic loss. On the other hand, waiting much longer risks further damage to the forests, livelihoods, agriculture, and biodiversity. One possible policy answer could be "loss and damage" (Warner, van der Geest, Kreft, Huq, Harmeling, Kusters, & Sherbinin, 2012) concept.

"Loss and damage refers to negative effects of climate variability and climate change that people have not been able to cope with or adapt to" (Warner et al., 2012, p. 20). Warner et al. (2012) describe this definition comprising peoples "inability to respond to climate stresses (i.e. the costs of inaction) and the costs associated with existing coping and adaptive strategies (cf. erosive coping strategies and mal-adaptation)"; where these costs can be non/monetary (p. 20).

3.1 Vulnerability - Access Framework

The vulnerability framework used in this study is two-dimensional. First, the Intergovernmental Panel on Climate Change (IPCC) defines vulnerability to climate change as "the degree to which geophysical, biological, and socio-economic systems are susceptible to, and unable to cope with, adverse impacts of climate change" (2007). Second, "Vulnerability is driven by inadvertent or deliberate human action that reinforces self-interest and the distribution of power in addition to interacting with physical and ecological systems" (Adger, pp. 206-270).

The first dimension of vulnerability is to analyse the impacts of climate change in Joymoni. The cyclones, sea level rise, river and coastal erosions, increasing salinity in the waters and in the soil are some of the forms of climate change in this region. Some of these forms, for instance, Cyclone Sidr in 2007, Aila in 2009, and Roanu in 2016 have ripple effects once they had occurred. As the people revived from the damages done by Sidr, they faced Aila, and so forth. The other forms of climate change impacts simply add up. The scope of increased water salinity, for instance, has reached a point where there are fewer varieties of grass available for cattle grazing; cattle become ill after drinking saline water and often suffer from diarrhoea. The physical structures such as the embankments built around the village become fragile as these are continuously being hit by cyclones, surges and furthered by ongoing erosions. The natural polders that save this area are the Sundarbans. For generations people have been going to the forests to collect honey, wax, timber, crabs and others means of resources (Saroar, 2015a, p. 1463). However, as resources get scarce, people divert their profession- and many choose to go to the forest. The rising numbers of forest goers create a challenge in securing resources inside the forest. There have been numerous

incidents where people ignited forest fires in order to clear lands by the estuaries as a preparation to catch fish and Bagda larvae in the upcoming monsoon season, writes Ahmed (2016).

The second approach to vulnerability is to analyse the probable negative impacts of gher if it considered as an adaptive model. Humayun claims that ghers contribute to the increase of water and soil salinity in the croplands (personal communication, 2016). The Ministry of Fisheries and Livestock (MoFL), on the other hand, approved the National Shrimp Policy 2014 that encourages shrimp farming in ghers and counts gher as a possible adaptive model. The assessment of the vulnerability of gher therefore needs serious attention.

Vulnerability is constituted by exposure, sensitivity to external stress, and adaptive capacity (Adger, 2006, p. 270). "Exposure is the nature and degree to which a system experiences environmental or socio-political stress" (Adger, 2006, p. 270). Features of these stresses are their "magnitude, frequency, duration and areal extent of the hazard" (Adger, 2006, p. 270). "Sensitivity is the degree to which a system is modified or affected by perturbations. Adaptive capacity is the ability of a system to evolve in order to accommodate environmental hazards or policy with which it can cope" (Adger, 2006, p. 270). I apply the two-dimensional vulnerability framework to a specific geographic location- Joymoni where a large chunk of the population do not own cropland but work on others' and depend on various means of accessing resources. Joymoni raises the question of the ways in which people ought to use natural resources and whether the resources they need to cope with these changes are available to them in their communities. Approaches on vulnerability alone fall short if we do not discuss the notion of access.

Access is defined not in the form of property rights, but, the ways in which people are able to get benefits; these can include benefiting from material objects, people, institutions and symbols (Ribot & Peluso, 2003, p. 153). This broadens the scope to analyze various ways in which people

benefit from resources, and does not shrink to one particular way of understanding access in the form of rights, argue Ribot & Peluso (p. 154). Access differs from property since the "distinction lies in the difference between "ability" and "right" (Ribot & Peluso, 2003, p. 155). Ability parallels with power and is multi-dimensional. One, it is the capacity to affect one's practices and ideas (Weber, 1978; Lukes, 1986, as cited in Ribot & Peluso, 2003, p. 156); and, two, power emerges from people. Power is fluid and travels through means of social relations and through their un/intended consequences (Foucault 1978a, 1979, as cited in Ribot & Peluso, 2003, p. 156). For this study, I consider the natural resources such as croplands and the waterways to explore the "range of powers-embodied in and exercised through various mechanisms, processes, and social relations-that affect people's ability to benefit from resources. These powers constitute the material, cultural and political-economic strands within the "bundles" and "webs" of powers that configure resource access" (Ribot & Peluso, 2003, p. 154). To Ribot & Peluso (2003), positionalities of people and institutions are different during historical moments and across geographical scales. This shapes the ways in which power works and the ways people access resources. There are institutions as well as people who control the means to access resources, and there are others who maintain certain kinds of relationship to sustain their access. There are also those who control access to resources despite not having any rights. The respondents who live on the banks of the rivers take lease 60 yards of the river per season from the gher owners in Joymoni. Although these gher owners do not own and have no rights over the river, they control the access to it. Only the people who maintain relations in most cases through financial correspondence with them can actually catch larvae in this area.

The idea of access helps us to understand who gets what, through what process, and when (Ribot & Peluso, 2003, p. 154) to assess the exposure, sensitivity and adaptive capacity (Adger,

2006, p. 270) of vulnerability. The people of Joymoni are not simply vulnerable to climate change and to gher. Their controls over resources also become vulnerable; similarly peoples' capacities to gain and maintain access to resources become vulnerable.

Any actions wrongly taken amidst the existing disruptions cause more vulnerability. In other words, the material resources that people possess and the relations people maintain with each other and with institutions become vulnerable as they alter the ways in which they get benefits. In this study, I emphasize the latter- on the relations that people maintain to sustain their livelihoods.

One respondent mentions that they stitched 'nakshikatha' in earlier days during their leisure. People used to come from Mongla to buy these nakshikatha from them. Now everything has changed; they do not even get the time to sew nakshikatha anymore. This example is not only about how and when their leisure activities got changed but the ways the space and place of socializing with others have changed. Women used to come together at a place where they shared their sorrows, happiness, issues and collected information. It was a networking event for women while working on a piece of cloth that would generate extra income for the families. Thus, access becomes "*all* possible means by which a person is able to benefit from things" (italics in original) (Ribot & Peluso, 2003, p. 156).

To Rangan, control is "the checking and direction of action, the function of power of directing and regulating free action" (as cited in Ribot & Peluso, 2003, p. 159). The corresponding relations between control and maintenance are to manifest social positions that are "constitutive of relations among actors in relation to resource appropriation, management, or use" argue Ribot & Peluso (2003, p. 159). Ribot & Peluso (2003) further mention that "To maintain access, subordinate actors often transfer some benefits to those who control it. They expend resources to cultivate relations or transfer benefits to those who control access in order to derive their own

benefit" (p. 159). The fishermen, who take 60 yards of the river lease from the gher owners is a good example for this discussion. The price they pay for each lease period is the monetary benefit the gher owners receive by controlling access to the river and its resources even though they do not have any sole rights over the river.

The vulnerability-access framework prioritizes analysing the relations that people maintain in getting benefits from and through their networks, social positions and actions in respect to each other and institutions, over discussing the extent of vulnerabilities they face from climate change and from doing gher. Thus, it assesses individuals, their collective bonds and prior relations, the extent of vulnerabilities. Prior relations shape the ways in which people suffer, cope or adapt during and after disasters.

3.2 Gher Imposed Vulnerabilities in Joymoni

The vulnerabilities imposed by ghers are complex. The mangrove forests Chokoria Sundarbans is located in Cox's Bazar, Chittagong, south-east of Bangladesh in Cox's Bazar. These natural forests acted as barriers against surges, saved nearby villages in 1960 from tidal waves, before they were destroyed. In 1975, people cleared out most of 7500 ha of mangrove forests to do shrimp farming. Only 973 ha of the forests remained in 1988. The protective barriers against hazards were thus destroyed. As a result, the aftermath of the cyclone in 1991 was dire as it destroyed the villages and properties including those shrimp farms. (Primavera 1997, p. 818). Cyclone Roanu washed away 1740 ghers, 20 fish farms, and 747 ponds on 22 May 2016. At a news report with the Daily Prothom Alo ("কক্সবাজারে মৎস্য," 2016), the Upazila fisheries officer estimates that the net loss for the Upazila has been more than 880 million tk. which includes losses incurred in the fishery sector as well.

Hossain (2016) reports 25 fires over the past 14 years in the newspaper Dhaka Tribune at the same place within Chadpai and Sharankhola ranges of the Sundarbans. Joymoni neighbours these forest areas. Between April and May 2016 there were 4 counts of deliberate ignition of a forest fire. The law enforcement agencies managed to capture six people involved with these acts; one of them was a member of the ruling political party and holder of the position of vice president in Sharankhola Upazila unit. Locals mention that every year people usually set fire during the dry season to clear estuarine land so that they can catch larvae of Bagda and fin fish in the rainy season (Hossain, 2016). Chandan (2016) reports with newspaper The Daily Star saying that "some local elites deliberately destroyed the forest to expand their fishing canals. After clearing the forest, they

will set nets and huge traps in the shallow rivers…Setting fire to the forest has become frequent in every dry season".

Joymoni and the neighbouring areas, i.e. most of the coastal areas of the country are facing SLR, river erosions, cyclones, surges, and salinity. The impacts of these result in a downfall in crop production, which leads people to cultivate brackish water shrimp in ghers. People try to balance their income by cultivating shrimp given declining crop production in Joymoni. This can be seen as a cost cutting mechanism. While a lot of human labour is needed in cultivating, harvesting, husking paddy and with other activities in traditional farming, farmers require less labour when they do ghers. So the losses incurred from not having a good harvest get balanced. However, doing ghers require another complex set of employment to meet the growing demands for Bagda larvae, that has negative consequences on biodiversity and the environment.

As Ahmed and Troell (2010) state, extensive larvae collection involves a huge amount of bycatch that contributes to the declining fisheries and affects biodiversity. They argue that "Intensive fishing can also result in the physical destruction of nursery grounds, decreased prawn broodstock, the prevention of fish migration, and reduced wildlife" (Ahmed & Troell, 2010, p. 24). On top of that SLR threatens to change estuarine locations affecting fish habitats and breeding grounds. "Penaid prawns breed and develop in brackish water, where fresh water and salt water mix. SLR would turn this interface backward, changing the habitat of prawns. Migration and unavailability of fresh water fishes may be detrimental to the fishing community of the region", argue Bhuiyan and Dutta (2012, p. 226). This directly affects the availability of larvae to collect and cultivate in ghers. Primavera (1997) finds that, instead of alleviating poverty, ghers actually did much harm including worsening the socio-economic status of fishermen, labourers, contributed in declining grazing land, and in creating a pool of unemployed labour force in Chokoria

Sundarbans (p. 820). Primavera (1997) mentions that rice production of 40,000 ton in 1976 in Satkhira decreased to 36 tons in 1986 due to salinization and saline water flowing from shrimp ponds across paddy fields (p. 820).

Participants in this study identify gher after climate change as causing much harm to their livelihoods. Participants of the FGD claim that they are living in disasters. They do not get a good harvest from their land, there are barely any fish in their ghers to sell, their vegetation and the number of trees in their backyards has declined. In his study Karim (2006) finds that "In some homesteads, betelnut, coconut, Palmyra palm and date palms were present but did not bear fruits" (p. 65). Karim (2006) argues that "One of the reasons for the decline in vegetation cover and biodiversity affecting livelihoods of farmers is the encroachment of shrimp ponds towards the homestead" (70). Vegetables that they grow in their yards hardly meet household nutrition demands. One respondent took loans to do gher this year, but there are simply no fish to make profits and repay the loans (personal communication, 2016).

To maintain their lives and livestock's has become of a challenge due to fresh water scarcity. Cattle that are forced to drink saline water suffer from diarrhoea. Maintaining livestock gets more challenging with the scarcity of grass such as durba that has become almost non-existent in the areas affected with salinity (Karim, 2006, p. 65). Karim (2006) finds that, many other species such as "baju (*Tamarix troupii*), chehur (*Bauhnia vahlii*), thankuni (*Centella asiatica*), ambalisak (*Oxalis corniculata*) and kachuripana (*Eichhorina crassipes*)" have already disappeared from the coastal areas due to excessive shrimp farming (p. 65).

Participants of this study think Aila brought the saline water to their area in 2009. As people continued doing ghers, salinity got stabilized in the soil and crop production declined as a result. Lower crop yields mean lower earnings for these farmers. This has made it hard for parents to

support their children' schooling. Salinity effects are far reaching: diet, clothing, cleanliness, healthcare, are all affected.

Salinity intrusion reduces soil quality and thus declines crop cultivation; People try to recover from losses by doing gher and through cultivating Bagda especially in the presence of brackish water in their ghers that contribute further in stabilizing salinity on the soil and water (Karim, 2006, p. 64). At this point people in Joymoni do not have success in doing either crop or fish.

Declining crop, fish, and employment, and rising demand for Bagda larvae have intensified the socioeconomic situation and have made some people aggressive in catching larvae. Recently, a group of 35 fishermen from Joymoni, Chila, Sundartola, and Rampal were kidnapped by pirates. These fishermen went in the forest near the Chadpai range to collect Bagda larvae. The pirates asked for Tk. 50,000 each as ransom, reports newspaper the Daily Jugantor ("সুন্দরবনে ৩৫ জেলেকে অপহরণ," 2016). Proper citation

3.3 Interviews

8 female and 5 male participants are included in this study. Among the 8 female participants, 7 of them participated in a Focus Group Discussion (FGD); most of these participants are from Gilekhal area of Joymoni. The other female participant, Munira, is a larvae collector who lives on the bank of the river. Her teen-aged son often helps her in catching larvae. Among the male participants, there are two persons Azad and Anis who earn their living by catching larvae; they also live with their families on the bank of the river. Among the rest, Mokbul is a fisherman, often goes to the forests, lives near Joymonirghol; Bormon is a gher owner, and Humayun is the agriculture officer at Mongla Upazila. To secure their identities all the names have been altered here. Discussions with them are given chronologically.

As we approached the FGD participants one fine afternoon, we started the discussion by asking their birth years. This is to fulfil one of the requirements of participant selection criteria that all participants must stay within 25-55 years age cohort. They are somewhat associated with gher, some of them work in ghers and some own ghers. One of them is a larvae collector. This is to pre-suppose the claim that, impacts of climate change have had damaging consequences for the people who are associated with gher. The purpose of this FGD was to explore: their present occupation in post cyclone Sidr years; their occupation prior 2007; how their occupation and livelihoods got affected; the connection of climate change and gher in deteriorating crop and fish production; and whether larvae collection is a sustainable source of income.

> We live in disasters. Slowly we have been noticing that we are not getting a good amount of rice paddy and fish from our land, our vegetation declined, so do our trees in the backyards. We are living through such hardships…This year I have worked in my gher, but there are barely any fish in it. This has made quite hard in repaying my loans…I try to do some farming in my yards, but for some reason, they are not growing well, and whatever

> I get from there do not meet nutritional requirements of my family…There are difficulties in maintaining the livestock, whatever we do, we need fresh water. But there are hardly any sources of fresh water in our area…We need fresh water to keep them (cattle) alive since they do not drink saline water. If they are forced to drink saline water, they suffer from diarrhoea. Maintaining livestock has become a challenge…Moreover, there is less grass in the area. Due to salinity, there are hardly any grasses. Grasses grow more in fresh water…What I think is that Alia brought the salinity into our area…People are not making any profits from doing gher. With the expectation of having a good amount of fish that will eradicate our poverty, we do gher. But when there is a deficiency in it, the effects are far reaching, they affect our children in going to school because we cannot pay for their education, they affect our diet, our clothing, cleanliness, healthcare, everything. Who is speaking here? You need to name the speaker.

There used to be a husking tool called *dekhi* in the villages. It was made of a wooden log that especially the women used by stepping over one end so that the other end lifts up where there is a piece of long and heavy wooden stick with a metal ring at the bottom is attached comes down and husk on the paddy kept in a small hole. A person usually sits near the edge who puts the paddy in the hole, stirs as needed and pulls back once it is husked. Women who came out to help would get a share of the crop, or the husks. Sometimes neighbours would simply come and help each other. As production fails, people do not get much of the use from *dheki*, they take their harvest to the rice mills, which costs them extra. Women in this FGD state that they used to husk paddy by themselves and often sold rice in the market.

> We used *dheki* to pound local rice breed; we worked in others' fields if we did not have our own. We used dekhi ourselves in husking paddy in the households. These got extinct now. I used to work with these when they were here, now I do something else that are available. Speaker?

When asked about the livestock, the respondents state that the numbers have gone down and there are many families who cannot afford to maintain livestock anymore.

> All the lands are water logged now. Nobody allows cows on their land. Lack of grazing land is the main reason behind the food shortages of the livestock. Even if there are grasses on the aisles, people fear that the cattle may destroy the elevated surroundings. As a result,

> their health got deteriorated, they do not produce much milk these days…Kids of these days have not even seen milk in their own eyes.
>
> When asked whether they put fertilizers on their land, they answered yes.
>
> Surges during Aila made our soil saline and infertile. To be straightforward with you, now we need to put fertilizers that de-saline the soil and water. In addition to it we need to put different kinds of fertilizers and various solutions... [such as] zinc sulphate…Yes, even in the paddy field. Name your speakers

The respondents share how their leisure passing activities have changed. In earlier days, women of the village used to stitch nakshikatha in their leisure time. Traders from Mongla used to come and buy products from them. This was the time when women came together and socialized as they continued making high quality hand stitched products.

The lady who is a seasonal larvae collector sits in the FGD works as a day labourer now. She cuts and carries mud with others in the road construction site every day. She does not go to the river now as it is not the breeding season for the Bagda. However, as the season begins, she carries a traditional net called 'dullo jal' in a boat with other fishers to the river. A dullo jal is usually being pulled in the water by the fishers. They stop for a while to check their catch and store if they get any in the carrier/pot they carry with them and continue pulling. She usually goes by the forests, and on the banks of the river as the fishers using this type of nets need to walk continuously along the shoreline. During the season the price per thousands of larvae ranges from 1000 tk. to 1500 tk.

Recently, attention given by the government in securing safe spaces for spawning near the estuaries and the forests has made lives of the fishers like this lady harder. Raids are practiced by the coast guard officials: they often seize and torch down their nets and equipment. Their raids often lead to physical harms to the fishers, as the officials beat them irrespective of their sex. Loss of earnings and physical assaults leave financial hardships and traumas for the families. It has

somewhat become illegal to catch larvae on the breeding season, as the government places specific guidelines on when and where to fish. But people get desperate; they risk their lives and equipment in this profession. One of the possible reasons behind such strict regulations is to sustain the ever growing demand for both shrimp and fish.

One of the biggest promoters for this is the fish export industry. More live larvae in the water this season means chances of getting more mother fish in the next season and from their even more fish larvae. It is similar to the policies taken by the government to protect the national fish 'Ilish' (Hilsha) from overfishing. According to the Department of Fisheries (DoF, 2016), 11% of country's total fish production comes from Ilish. In 2010-11, the total production of Ilish was 3.40 lakh MT that generated estimated 10,000 crore tk. The steps taken to ensure adequate Ilish in the waters by the Department of Fisheries (DoF, 2016) include "(1) to establish 5 Hilsha sanctuaries, (2) to arrange need based training to involve the Hilsha fishers for effective intervention of alteration income generating activities, and (3) to support the Hilsha fishers with 30 kg food grains/family/month during the ban periods for four months". According to DoF, there are more than 20,000 fishermen benefitting from alternate income generating programs (DoF 2016). Research says that, the government, some NGOs, donor agencies, local communities and others have identified larvae collectors as enemies of sustainable fishing and threats to biodiversity since the mid '90s. Their unregulated actions have halted even the scope of eco-tourism. As such, they are deemed as occasional fishers. They can easily switch their profession. –is this true? Thus any bans or restrictions upon them would not cause harm by any means. The group that lobbied largely for this is made up of hatchery companies and local businesses (Porkant & Reeves, 2010, p. 381).

Introduce this quote: “Meanwhile the state-supported expansion of private hatcheries has placed extra pressure on fry collectors who have lost work, been forced to accept lower prices for their fry, and have had to take more risks in collecting it. The government ban has also subjected fry collectors to harassment and extortion in areas where they catch fry” argue Porkant & Reeves (2010, p. 382). This is nothing but a form of exploitation. As Braverman (1974) writes, “the working class is the animate part of capital, the part which will set in motion the process that yields to the total capital its increment of surplus value. As such, the working class is first of all raw material for exploitation” (p. 377). Recently, a group of fishers was baton-charged by the officials who seized their nets and abducted two women from the group fishing by the Payra estuarine waters in Taltali Upazila. Although, one of the women was later found three kilometres away from the place of incident, the other was not traced till the time of reporting, says Kamal (2016) in his news report with bdnews24.com. On a different incident, 6 people, including 1 from Joymonirghol have been arrested and thrown into jail as coast guard officials found 180 kilograms of bhetki, tengra, poa (mostly brackish water fin fish), and shrimp in their boat from Chadpai Range, reports newspaper The Daily Bangla Tribune (“অবৈধভাবে মাছ ধরার অপরাধে ৬ জেলে কারাগারে,” 2016)—proper citation. Fishing in this area is currently under a ban due to an ongoing investigation on human ignited forest fire which occurred during May 2016. Later the police buried all the catch on the ground (“অবৈধভাবে মাছ,”—need the real citation 2016).

To answer the question on how well they are doing with ghers, the participants of FGD reply:

> I am not getting any profit from gher. Instead, I am incurring losses, and staying in debt. The current situation is scarier. I have not got even half of what I invested this time in terms of buying the lease, working on the land and spending on fish and larvae, and others. We get good crops after using the pesticides. However, if it’s a gher, then pesticides kill fish. So, it has become a double edged sword. To save one, the other dies. As a result, there are

> no profits but simply losses. In a nutshell, we get none, neither paddy nor fish. Both of them incur losses… And there are virus attacks on the fish. We do not see any solution of it. The water becomes red when the virus attacks. Often we put 'chun' (Calcium Hydroxide) to whiten the water. That's all… The situations have become dire after getting the saline water. We were better off in earlier days than at present. We used to get a lot of 'Horina chingri' [*Metapenaeus monoceros*] (FAO, 1989) for free that we did not need to buy the larvae, these have become rare these days. Still, we cultivate paddy. We survive for at least 2-4 months with whatever we get. A good thing of gher is that they meet the daily nutritional needs of our familiWe do not need to buy fish from the market. Moreover, we do not invest on Horina chingri, kakra (crab) which we get for free. Who is this speaker?

To answer the question on how their livelihoods have been transformed after the cyclones Sidr in 2007 and Aila in 2009, they reply:

> Our livelihoods are not even close to the standards of living we had prior Sidr, Aila. We had much better living prior Sidr, Aila. We live in hunger now as the aftermath of those two incidents. We hardly have any source of fresh drinking water. We collect rain water, fetch water from the canals during the rainy season and we put 'fitkiri' (Potassium Aluminum Sulphate) to purify the water prior drinking. But during this time (November onwards) salinity starts to rise. Within not even two months from now all the water in the pond, canal and ghers will become saline. Then we will have no other means to get fresh drinking water. The water we buy is muddy and saline. From nowhere we get to buy water same like the rain water. We then wait until the rainy season comes. The tube wells are of no use here- we will get only saline water from the ground.

Munira lives by the river bank and collects Bagda larvae in the river; sometimes her teenaged son helps her with setting up the net. Their net is different from the dullo jal. This type of nets is quite big and expensive. One net costs about 2000 tk. to 3000 tk. and lasts for about two years. Usually, these nets are tied with bamboo poles dug in the river and set against the tide so that the larvae and fish swimming with the tides can get caught. Munira sells at 800 tk. per thousand live larvae which is much lower than the market rate. Fishers like Munira sell their catch to the local 'arot dars' (commissioned agents; as cited in Porkant & Reeves, 2010, p. 375). This is the only profession that Munira and her son (occasionally) are engaged in. They hardly get 100 larvae in a day. This means their daily income is less than 80 tk. (CAD$1.5).

Mokbul lives in Joymonirghol and has been a fisherman since his early childhood. He obtains a document from the government that allows him to go fishing in the forests. It is a fishing permit. If ever stopped by the coast guard officials, he presents this permit to them and they let him go. He states that he is getting fewer fish. When asked if it has something to do with the changes in the climate, he says, he does not know. He believes that only Allah is the giver, and He is the only one who knows why there are fewer fish in the rivers. Nonetheless, he acknowledges that there are 200-300 more fishermen in the rivers than during his childhood. All he knows and concerned for is that he is getting fewer fish but does not know why such things are happening.

Azad and Anis live with their families on the bank of the river located on the northwest of Joymonirghol, and east of Gilekhal. Azad mentions that he had taken 60 yards of the river lease from one of the gher owners. It surprised me as I did not know of such practices in which one, or in this matter, a group of people can control the access to natural resources, such as the rivers, and makes money by leasing to the larvae collectors. Azad and his family have been living there for years and have lived through cyclones Sidr and Aila. Their one room house stays on a wooden platform raised with bamboo pillars high above from ground so that water can flow through underneath during the tides. Water reaches up to his doorstep in regular tides. When asked if they are afraid of it, Azad replies that he is not. However, they abandon their house during surges and cyclones as they did during Aila in 2009 and took shelter in the nearby high school building in the village. They do not have any cyclone shelters close by apart from this facility. With his limited income, Azad struggles to repay the loans he takes in buying the nets. He earns tk. 2000- 4000 tk. in a season that allows him and his family to live in bare condition. They have their latrine opened at the bottom, stands on four bamboo pillars near the bank of the river. They use the river water for household and hygiene purposes, including washing dishes, clothes, and others. They collect

drinking water from a pond of their neighbours, which, however, remains salty. A drinking water crisis is quite prevalent in their community. He claims that lands in all these areas were bought by private companies who later on leased out to the locals who are doing ghers now. These people now lease out the river to the larvae collectors like Azad and Munira. Azad, quite upset on river waters controlled by the handful, states that, these people have connections with local leaders of the ruling party; if they let them (Azad) earn 5,000 tk. to 7,000 tk. in next 6 months at the expense of 3,000 tk., then they (Azad) are ready to do so.

Anis shares similar stories. He lives with his family about a kilometre away from where Azad lives along the shoreline. He earns living through catching larvae; his wife makes traps for fish and crabs. She fixes the nets when they are torn. The scarcity of fresh drinking water is their biggest challenge. They buy tubs of drinking water from the traders on tom tom (a diesel run three wheeler). Traders usually buy water from Koromjol, near the Sundarbans, and sell each 30 litres tub for 40 tk.. This lasts about two days for Anis's family. Anis does not earn close to 80 tk. a day. His wife tries to do some vegetation in their yard, and rears poultry. Despite their hardships, Anis provides private tuitions to his children due to the alleged poor standard of the nearby government school. The vessel carrying oil that sank in the Shela River caused a huge oil spill in the river waters and like many others, affected Anis. His net, Anis estimates, got about a mon (40kg) of oil. Anis did not know that he could have sold oil like many others did. Rather, he bought shampoo of different kinds and powder to clean his net. After failing to clean the net, he buried the net deep in the river for few days. Apparently, this cleared the net, states Anis.

On 9 December 2014 a tanker released approximately 94,000 gallons of fuel oil into the Shela River, reports Alexander (2015) with National Geographic. Another vessel dissolved estimated 200 tons of potash in the Bhola River near the Sharankhola Range on May 5, 2015,

reports online newspaper The New Age ("Fertiliser-laden cargo vessel sinks in Sundarbans's Bhola River," 2015). These are some of the recent incidents that have not only caused harm to nature, the Sundarbans and its biodiversity, but also stopped everyday earnings for a large population who depend on these. Alexander (2015) reports to the National Geographic that the aftermath of these chemicals in the waters continue to threaten the Royal Bengal Tiger and the uncommon Irrawaddy and Gangetic dolphins. Thousands of people like Azad, Anis and Munira, who barely earn 80 tk. a day, cannot engage in their profession for days due to both natural and manmade calamities further spend extra to repair equipment such as nets. Although, there are some disaster relief funds during major natural incidents, people get nothing when vessels like those capsize as compensations. Even with relief, only people who are known to the local leaders get the most. People like Anis hardly get any support unless the distributing bodies come and give them personally and not via mediators, says Anis. Yet, the government has little focus on an average of 200 vessels passing through the Shela and Pashur Rivers daily which shows nothing but the negligence towards the Sundarbans. This exacerbates as the government remains adamant in building a 1,320 MW coal based power plant in Rampal, despite public outrage and demonstrations (The Daily Star, "Vessel owners, cargo traders trivialise Sundarbans, Demand reopening Shela River route," 2016).

We talked with Bormon who takes care of his ghers located closer to Anis's home. Bormon has been sharing earnings from these ghers with four of his friends for the past 10-12 years. On top of his shares, he receives 10,000 tk. in a year and some clothes from his friends as tokens of appreciation. The earnings are shared equally among the partners. At the time of the interview, Bormon was stocking larvae in the ghers. There are two more trips upcoming during this season, one in November, and the other in late January he mentions; on average they stock 6 times a year.

They buy Bagda larvae from the larvae collectors, sometimes from the hatcheries in Foila, Rui (*Labeo rohita*) and Tilapia from Jessore District. Most of their demands are met from the river sources. Bormon says that, buying larvae local costs them less. It takes about 50-55 days for the larvae from hatcheries and about 90-95 days for larvae from the river to grow in full. The larvae collected from the river have more resistance to diseases, says Bormon. He sells 1 kilogram of shrimp at a rate of 800 tk. to 850 tk. to the wholesalers in the market. He complains the price has gone down due to the 'push' shrimp from Satkhira where farmers inject white jelly, 'sabu' or water substances to increase the weight of their products. He suspects that as the misconduct has been found, the price of the shrimp has gone down. But the price generally increases during the off-seasons.

Their ghers are quite vulnerable to cyclonic surges. The only barrier between his ghers and the river is the fragile embankment that was once completely destroyed by the surges during Sidr in 2007. All their investments were lost on that time. Although the embankments were restored, it remained submerged 3 feet under the water for days during Aila in 2009. Surges washed away everything including their houses and damaged the embankments once again. It was just about the time to harvest the shrimp form their ghers when Aila came and left people like him penniless, recalls Bormon. He took 11,400 tk. from a 'mohajon' (money lender) as a loan by securing his three gold rings and re-invested towards stocking larvae. Due to fresh brackish water on that time and as the surges brought more larvae and fish which later grew in the ghers, Bormon and his friends managed to get huge profit at the end of the season. That is how they survived. He says that "There are risks always involved in our case, it is a risky business". At present, they have over one million tk. invested in the ghers.

Bormon says that they do not cultivate paddy because of the salinity that has deteriorated the soil. He blames global warming for this. He acknowledges that gher also contributes towards salinity. However, to him, gher is the byproduct of global warming, as far as the contribution of salinity is concerned. I got surprised listening to Bormon talking about global warming. All the respondents in my interviews had limited knowledge and Bormon stood out as quite exceptional. He revealed that once he went to Libya for a better future but as the war began he fled the country and returned home. He explains that due to massive carbon emissions in the air, the planet is experiencing global warming which causes the ice sheets to melt in the north. This further contributes to the rising of the sea level and strengthens cyclone surges. To protect themselves from such threats Bormon demands secure, concrete embankments that are high enough and are capable of preventing the surges from flooding. This would allow containing fresh water in which they can cultivate paddy, Golda and fin fish all year round. Since they do not have such arrangements, salinity already got stabilized in much of their croplands. As a result, they are not getting enough crops to sustain their livelihoods.

Bormon recalls getting about 10-13 ‘mon’ (400-520 kg) of paddy from each ‘bigha’ (33 decimals of land), now they hardly get 8-10 mon (320-400kg) from each bigha. That is only possible in the areas where they find the soil stronger. Women alongside men used to work in the fields when Bormon and other farmers had higher crop yields. Bormon needs about 3 to 4 people all year round to do some maintenance in their ghers. Bormon states that, as more and more people have chosen gher over crop cultivation, a large sector of human labour became unemployed. Bormon says that all the farmers are challenged with the lower crop yields from their land. Having fewer crops means less fodder for their livestock. Less food for cattle has made it harder to

maintain livestock. Cattle are malnourished and produce much less milk. The supply of milk is about 10% at current situation as compared to earlier years, says Bormon.

Humayun identifies salinity as the prime concern in Mongla and its surrounding areas. He says, "Not only we need fertile soil but also quality water for irrigation purposes. With existing pocket ghers in Mongla, salinity has been stabilizing continuously. Among the recent steps taken by the government, opening up the pocket ghers and connecting those with the river systems are major. This way the lunar tides can reduce the salinity, and slowly we can have the Aush- Boro paddy varieties with the lesser yield now producing more in the future." Opening up pocket ghers and connecting them with the natural waterways would require involvement from the land office and willingness of the farmers. They are the local leaders and the powerful people who often oppose opening up the waterways, says Humayun. This is not a straight forward issue that can be solved within days. He explains:

> In some cases, the work speed is faster. You know how the land offices in Bangladesh work, although these are my colleagues' offices. Due to its various responsibilities, perhaps due to some other factors, works get done quite slowly here. Moreover, there are many influential and powerful people who claim for demarcations of their land, it requires time to figure out their authenticities. This and the bureaucracy involved eat up much of the time before implementing any policies. Everybody has the positive mindsets that it needs to be done; in fact, I have been hearing for the past three years- but few of the works have been accomplished. If there were no administrative bureaucracies, and if our land offices and the political leaders became a bit more active, then I think this can be achieved quite faster.

Humayun thinks that the present condition of agriculture, fisheries, and livestock production are at stake, both due to climate change and human negligence, such as continuous gher cultivation. On top of that, Mongla has been transformed into Export Processing Zone (EPZ) culminating 1060 ha of land that made the upazila a food deprived area. Consultations with SRDI follow in promoting newer technologies to grow crops and vegetation such as usage of "sponge-

wood boxes to plant tomatoes, chilli, etc." on roofs have shown a bit of improvement, but not sufficient. Nonetheless, salinity becomes a practical challenge. He says:

> During our Boro and Aush seasons the crop yields are really low due to salinity; since the existing varieties of salt tolerant rice can bear 8-10 ds/m, but in reality, we have 15 ds/m salinity in some places- as a result, production of crops fails… .I have learnt over these years that the rice varieties we have are saline tolerant, but not resistant. Now the tolerance level has exceeded in this area for these rice varieties to grow… .We have to bring some changes in their genome level which can tolerate 15-18 ds/m, and then some of the areas can be controlled by us." Due to his expertise being an agriculture officer, I find much of his discussion quite relevant for this study. I include some excerpts from this discussion in the following… .What I have seen now is that, we have virus attacks on shrimp and even on the white finfish. Shrimp has already been in jeopardy, we do not get quality shrimp anymore. Sometimes we see shrimp are being sold at 600 tk. per kg which should have been sold for 1200-1300 tk. per kg. As a result, so many of the gher owners have incurred losses.… .All of these are co-related with each other. You do not have grazing land, where you are going to graze buffaloes? They do not have natural habitat; and for how long you are going to feed them with outside food? Perhaps, you could do some poultry, but to what extent can you do so? There is something here; on top of that, you do not have such environment [suitable for buffaloes]. You can go and see how many cattle are there in entire Mongla.
>
> To the question, whether a gher can be an adaptive model, he explains:
>
> A model does not sustain always. More specifically, sustainability depends on many things…what I understand is that there are few important things to consider prior thinking of a project: 1.We need to analyse the situations, a practice that we lack; 2. After setting the objectives, we fail to make the workers understand the project perfectly, we lack in making them realise why we are doing as such; 3. We need to identify the needs of the community. [If we do not do it, then] I am incapable in analysing the demands and needs of the community I am working with. For instance, if I am to take a project of beef production in a Hindu dominated area then will it ever run? As it happens, somehow we pass these projects with many errors exist within. As a result, there is no sustainability. There are errors in the planning, then during the implementation phase in determining responsibilities becomes a challenge, then in the evaluation, and in reconsideration- there are many procedures [with errors]…Nothing can be said in biological science- we cannot even tell if it will run for the next 10 years…Because my climate is not stable- what I have today is no more there tomorrow, in Mongla. Or even in countrywide for instance, there is rain for 1 kilometre here, but none on the next 1 kilometre. Our crop production depends on things- primarily on God gifted such as temperature, etc. That is why we cannot say to any model that it will last like the Bible. But, yes. There will be some benefits, as I was saying, I will not claim that it sits still on the baby phase, but it has crawled, perhaps. Newton had limitations in his laws; it will have limitations, similarly.

But the most important thing I think is, those of us doing research are doing from far, sitting in Dhaka. It should have been spot based research, such problem initiates when it is not a location specific research. Every department at the upazila level should contain a small research cell or wing. Because, development at the upazila means development of the country. There are no other places for development works other than the rural. Countrywide development- for instance reducing maternal mortalities during childbirth, or even gaining our food sufficiency- these are works being done at the Upazila, or Union or even at the village levels. So, personally I say in many places that my research wing should be based on field. Right? What it does is that I am saying that BIRI 41 (rice breed) can produce 8 metric ton/ ha in my research, but that has been done in a controlled environment in a lab, but I am not getting close to 4 metric ton per ha practically. That is why we are urging the research cell to work in the fields practically, what we call multi-location; try for yourself and see if it actually works here. You are saying sitting over there 8/10, but practically that never happens. That is why the research must have to be location specific. A common practice is to outspread newer varieties throughout the country [without considering the climate, soil quality, and etc.]. This is not acceptable if the varieties work in North Bengal but not in South. Specific and different research needs to be done for both North and South Bengal.

Humayun talks a bit about the common practices at present in conducting research:

Now, how can I tell [as an officer]? Actually, those people who guide the researches are also somewhat responsible. After analysing the data, they question how it happened? Practically speaking, you think that this should be the output, but it is not. It does not happen in practice, and there are many supervisors who do not want to agree with the results/ analyses. They claim that effective manipulation has not being done. This is a reality; there are few things like these in research in Bangladesh … . Most of the research experience similar- for instance, there should have been 10 litres of milk being produced, but in practice, we got 2 litres. But, sir wants us to write 5/7 litres. Here data is being [falsely] manipulated- these are not students' faults, the supervisors are also guilty. Some manipulations are being done here... Actually, if it happens to in any research then the results cause harm to a huge population. And this is what happens in Bangladesh- I mean I feel sorry- you are a child of Bangladesh, and I am a child of Bangladesh too, however, the research being done are somewhat similar. What I think is that 60%-70% of the researches done are being manipulated… Sirs quite quickly [select research proposals], they make mistakes right at the selection stage; they cannot identify the basics of many researches in the middle of the way and when the problem occurs then these are done quite irresponsibly…since mainly the poor people live in these places, much of the betrayals are being done with these people. In that case it is better that I do not do any research. I should not do false research in anyway.

Chapter 4: Limitations of Gher as an Adaptive Model

Access, as it has been argued previously, can be understood in the form of a web of relationships that people maintain in order to benefit themselves (Ribot & Peluso, 2003). The larvae collectors living on the bank of the river in Joymoni maintain a relationship, albeit through a form of payments to the gher owners, so that they can fish in the rivers for a season. The gher owners benefit from their control over natural resources such as rivers as they can restrict the number of fishers in the water, exerting power over these marginalised fishers. They gain financially as they lease out portions of the river at a price to the larvae collectors; they save money as they buy larvae collected form the river at a lower price. They benefit from the natural breed of the larvae that have more resistances over diseases. These, in turn, have maintained a steady demand for the larvae, and secured employment for those larvae collectors.

Regardless of the mutual benefits these two groups enjoy, gher owners and larvae collectors included in this study accept the argument that the existing vulnerabilities of climate change are on the rise due to continuous practice of this intercropping method. The female participants in the FGD recall their memories from cyclone Sidr in 2007 till now and believe that much of the salinity brought by the surges in the following years, especially during Aila in 2009 have got stabilized in their croplands. The more they continue doing ghers, the more the quality of the soil deteriorates. To prevent production failure they spend extra in buying fertilizers and pesticides. But with these, they do not get the projected outcome. In the end, they continue to incur losses and live in debt.

To have a sustainable and adaptive method of crop cultivation, the government needs to consider practices other than gher. There are scholars who argue that adaptation comes from and

within people when they are aware of the benefits of it (Saroar & Routray, 2015, p. 405). It is important to let people know the various adaptive measures available to respond to climate changes. However, if the people are only left with information and not with any means such as the physical resources to adapt, then the information itself becomes of little help to the people. For Joymoni, it would be unwise to simply let people know that gher cannot be an adaptive model, and not introduce a different mechanism as an alternative. It is not possible unless offering them stable and concrete infrastructures such as solid embankments and ensuring continuous maintenance of those.

There are scholars who give more emphasis to the material resources that people possess that can enhance their abilities to adapt along with disseminated information and knowledge (Saroar & Routray, 2015, p. 405). The gap in this view is the quantifiable material resource, and to what extent this resource can be adaptive (Saroar & Routray, 2015, p. 405). This gap is multi-dimensional. One, for the people who possess the quantifiable land, produce crop and/or fish/shrimp on a rotation basis or perhaps simultaneously can hardly stop doing gher and focus on crops as they are threatened by salinity seepage from the neighbouring farmer who continues with gher farming—this isn't a sentence. A mutual understanding and acceptance from all level of the farmers are required should they all agree to discontinue ghers. Two, for the people who do not own any land but survive on others' by working as labourer get affected if the owners choose different methods of farming—also not a sentence. One's profession as a larvae collector can be threatened if farmers choose not to do ghers. It may open up opportunities for them to work in the field as labourers and look for other opportunities. This remains the core of the argument made by the group that lobbied against the wellbeing of the grass root people involved in larvae collection (as cited in Porkant & Reeves, 2010, p. 381). This shows nothing but negligence at the state level

for these larvae fishers. Scholars argue "psychological and behavioural factors also determine people's adaptive capacity" (Saroar & Routray, 2015, p. 405). This affects insignificantly for the people with scarce material resource depend on others.

The institutional responses and guidelines that may suggest and provide various adaptive measures to the people in Joymoni are insufficient. There is not enough government funding in securing the embankments and there is no form of educating farmers on the negative effects of shrimp farming. There is not enough impetus from the government in relocating the hundreds and thousands of people who form a chain in the shrimp export system. The grass root farmers, larvae collectors and people involved at the bottom of this chain form "a disposable industrial reserve army…[they are] a mass of human material always ready for exploitation by capital in the interests of capital's own changing valorization requirements" (Marx, 1867/1976, p. 784).

For those who suggest that intercropping of this kind can be adaptive, an analysis of the vulnerabilities that deal with the exposure (Adger, 2006, p. 270) can measure the potential of ghers. Joymoni is exposed to the external stresses that climate change produces and so its agriculture is quite sensitive to these sudden changes.

There are two components within this exposure: physical and agricultural. In physical terms, Saroar (2015b) argues that coastal constructions are required in order to secure the sites in the presence of increased water in the rivers which cause flooding even in the lower tides (p. 260). Emphases should be given to the waterways that carry more saline water to the village than before. The villagers' perceptions are that the water brought by Aila did not have any places to go. The villages stayed waterlogged for days through which the salinity got stabilized. One of the villagers claims that there is more silt in the rivers causing floods as the water level increases during the rainy season. Nonetheless, the visible and invisible impacts of climate change in this village are

quite unknown to the villagers, and it is only then they make a sense that climate is changing when they get lower productivity out of their lands.

The second component of exposure is agricultural choices. Adger (2006) mentions that, "vulnerability to environmental change does not exist in isolation from the wider political economy of resource use. Vulnerability is driven by inadvertent or deliberate human action that reinforces self-interest and the distribution of power in addition to interacting with physical and ecological systems" (p. 270). These wilful actions come from the state level as the state destroy huge amount of croplands to establish an Export Processing Zone (EPZ). This has overburdened existing food insecurity in the area, argues Humayun (personal communication, 2016). Therefore, changes in policies, building awareness, providing support and incentives are required among others, if vulnerabilities across Mongla, are indeed to overcome.

Given the magnitude of climate change impacts, scholars suggest that the already vulnerable population would suffer the most with worsening changes in the climate (Adger, 2006, p. 273). To Adger (2006), "Vulnerability is a dynamic phenomenon often in a continuous state of flux both the biophysical and social processes that shape local conditions and the ability to cope are themselves dynamic… Measurement of vulnerability must therefore reflect social processes as well as material outcomes within systems that appear complicated and with many linkages that are different to pin down. Vulnerability is, therefore, not easily reduced to a single metric and is not easily quantifiable" (p. 274).

Gher is not an adaptive model in this context of vulnerability. As gher owners like Bormon say: "[Gher becomes a model] to only the 10% of the population those who own land. This 10% however, faces risks, sometimes makes profit, and sometimes not. There are 90% of the people

left who do not have any land, and [for ghers] have no jobs either. They live unemployed or go fishing in the forests" (personal communication, 2015).

Chapter 5: Conclusion

Adger (2006) suggests that "Given that a key element of socio-ecological resilience is the ability to adapt to new circumstances… a theory of adaptation would explicitly incorporate the formation, persistence and causes of vulnerability" (p. 277). This study proposes: a) that any long range plan needs to avoid generalised policies and research that are inappropriate where different geographies of vulnerability are involved; b) government and its contractors need to be transparent, and to engage in public consultation to avoid vulnerable outcomes with long term impacts within various adaptive measures undertaken, and yet to be taken.

This study agrees with Porkant & Reeves (2010) who argue "an artificial separation of the 'natural' from the 'social' …has resulted in the academic construction of the two ontologically separate worlds of the agrarian and the environmental. Instead, what needs to be recognised is that categories such as 'labour', 'work', 'environment', and 'biodiversity' are social and political constructions that only have analytical and policy significance within particular discursive and institutional contexts" (p. 383). Thus, this study recommends an exploration of economic and agricultural alternatives to gher. Both gher as a system and the people are exposed to climate change. People are vulnerable to ghers and their association with gher farming is exacerbating the existing impacts of climate change in Joymoni.

Although research suggests "saline-tolerant crop cultivation" (Ahmed, 2010; Rabbani, Rahman, & Mainuddin, 2013) – as a type of Community Based Adaptation measure (Wong et al., 2014, p. 391); this research shows that doing gher contributes more to the stabilization of the salinity in the soil and in the water of the land at a rate that not even the current and ongoing intervention of salt tolerant rice breeds can cope with. As Humayun (personal communication,

2016) mentions, the current salinity level in Mongla exceeds 18ds/m, which has already threatened the current breed of salt tolerate rice.

The International Agencies (2009) that prepared an assessment report during post-Alia period, ranked "Embankment repairing and reconstruction work immediately with an appropriate design that can protect climate induced sea level rise and high tidal waves" as their number one advocacy recommendations. During a post Aila visit to Soronkhola in 2011, by the bank of the Baleswar River, villagers reported discrepancies involved in embankment repair and maintenance (Boiragi, 2012). They claimed that where the design suggests repairing the embankment and making it higher for instance by one foot, contractors use low grade materials to repair and increase the height by a couple of inches pocketing the rest of the money. Villagers blame government officials who do not conduct quality checks as the work continues nor do they follow up with locals as needed. The field visits contain images where it can be clearly seen that some of the already damaged (after reconstruction done in post Aila 2009) sections are fixed with tree branches and bamboo.

In a hypothetical scenario, let us assume that the government of Bangladesh has managed to erect solid embankments and create modern polders enclosed by concrete dikes and improve the existing ones to lessen or prevent salinity intrusion into the croplands so that the government can continue exporting shrimp to be cultivated in the ghers. To build all these infrastructures and to maintain afterwards require time and money. The ongoing challenges with salinity intrusion have already made some areas, such as Mongla, food-deprived. New food-deprived areas would pop up as new cyclones and other emergencies occurred. In other words, this hypothetical solution, recommended in the National Shrimp Policy 2014, is not workable. Increasing salinity in the waterways would continue to threaten crop production in the coastal belts. Ghers discharge saline

water in the waterways and stock brackish water. On both sides, soil fertility and crop production stay vulnerable to salinity.

Structural changes and robust policies are needed in places like Joymoni. This requires research that factors specific geography, climate, and socio-economic analyses among others. Future research should understand the history of gher cultivation, analyse the crop production intensity and unemployment for both male and female workers in the communities. This study provokes questions such as: what are the ways forward at the presence of climate change threats? How can we replace maladaptive strategies? In doing so, this study explores some of the vulnerabilities and threats imposed by ghers and climate change in Joymoni. With academic research discussing for and against gher as a potential adaptive practice, this study tries to align its findings, discussions, and observations and shows that gher has many negative outcomes on communities, livestock, the forests and biodiversity. This study explores the limitations of gher as a potential adaptive model. It discusses the loop holes attached in the ways in which researches are being done at the state level, particularly in the agriculture field.

The absence of a robust mechanism to prevent salinity seepage in the croplands requires more research. Developing policies to identify breeding grounds for shrimp, fin fish and to secure these areas from (over)fishing need more attention. Availability and proper distribution of amenities to the vulnerable fishers during any bans need more attention as well. Providing fishers with 30 kilogram of rice during any ban is not adequate. The Government needs to invest more so that the vulnerable fishers can at least maintain the minimum standard of living with enough cash in hand and amenities available to meet other needs. If there are policies preventing both the seasonal and regular larvae collectors from catching larvae, then strategies incorporating this huge population in sustainable employment are a priority.

Physical infrastructures such as the existing embankments and the polders require urgent attention. Ongoing maintenance of these structures should be part of regular activities for the departments concerned. Although the National Shrimp Policy 2014 includes this in its priorities, no sign of maintenance work has been observed during the field visits in Joymoni in 2015. This shows the lack of urgency with policy implementation. It is true, however that, this research has not discussed with respective government bodies regarding their maintenance plans, budgets, time frames, priorities and schedules. Regardless of this, permitting cargo vessels travelling in and around Sundarbans has already caused much damage to the water, the forests, biodiversity and the people. Unless and otherwise government conducts specific research that analyses vulnerabilities associated with these permits and until they do that they do not control vessels from using this route, negligence towards the Sundarbans and its assets remain a key concern for the academics, general public and the media.

One of the possible reasons behind such impulsive policymaking is the failure to properly articulate the projections made about the impacts of climate change. According to the fifth assessment report (AR5) done by Intergovernmental Panel on Climate Change (IPCC), the first five among nine key messages towards South Asia are: "1. South Asia's climate is already changing and the impacts are already being felt; 2. Further climate change is inevitable in the coming decades; 3. Climate change poses challenges to growth and development in South Asia; 4. Adaptation will bring immediate benefits and reduce the impacts of climate change in South Asia; and 5. Adaptation is fundamentally about risk management" (as cited in Carabine, Lemma, & Overseas Development Institute, 2014, p. 1). This study urges the policy makers in Bangladesh to follow the projections mentioned above and come up with strategies other than intercropping methods such as gher farming in the coastal belts. Agrawala et al. (2005) and Adger et al. (2007)

argue that “activities such as shrimp farming and conversion of coastal mangroves, though profitable in an economic sense, can exacerbate vulnerability to sea level rise” (as cited in Klein, Midgley, Preston, M. Alam, Berkhout, Dow, & Shaw, 2014, p. 914).

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Appendix A: Sample Questionnaire

1. In which year you were born?
2. Do you have a family? If yes, how many members are there in your family?
3. What is your occupation?
4. What is your wife's/ husband's occupation?
5. What was your occupation in 2007, and in 2009 respectively?
6. Were you or any of your family members got affected by Sidr, Nargis, Alia, or floods over the course of past 105 months (January 2007- September 2015)?
7. Do you have access to land?
    a. If yes, how much
        i. Do you own? (here access is understood in form of property rights) – go to question 8.
        ii. How much access do you have to land? (here access is understood as the ability to get benefit from, without any rights) – go to question 9 and 10 whichever applicable.
8. Has any of your land been transformed into gher?
    a. If yes,
        i. How much of the land have you transformed?
        ii. How much in BDT (currency) do you invest each year into gher?
        iii. How much in BDT (currency) do you earn from gher each year?
        iv. What happens to your ghers during tidal surges or cyclones?

v. What was the scenario during Sidr, Aila and Nargis? – go to question 11

9. Have you leased out your land to someone who transformed it into gher and cultivate shrimp?
    a. If yes,
        i. How long is the lease period?
        ii. How much do you get in return off the lease?
        iii. Did you lease out land during Sidr, Aila and Nargis?
            1. If yes, were you compensated?
            2. If no, how did you survive without any earnings off the land?
        iv. How do you maintain your diet for fish if you lease out the land?
        v. What is your main occupation now? – go to question 11
10. Are you employed in any of the ghers owned by others?
    a. If yes,
        i. How much is your wage?
        ii. How long do you have to work on ghers each day?
        iii. Does the income provide decent living for your family?
        iv. Were you employed in ghers during Sidr, Alia and Nargis?
            1. If yes, have you got paid?
            2. If no, how have you managed your living?
11. Are you engaged in collecting shrimp post-larvae?
    a. If yes,

i. Are you employed by someone?

ii. Where and at what cost do you sell them?

12. What do you produce in your land?

i. Do you cultivate Aman (the major crop) in the land?

ii. What other types of crops do you cultivate?

iii. Do you cultivate vegetable on the polders?

13. What do you do during dry ("Robi season" November to April) season?

14. Do you have access to cattle (access in the form of property)?

a. If yes, do you find enough grass and food for your cattle?

b. How are they doing in terms of their health and appetite?

c. What do you do with them during cyclones, surges or floods?

15. Do you notice any changes in climate that may have affected your farming practices including fisheries and vegetation?

a. How is the quality of water that you use for irrigation or different farming practices?

16. Are you a beneficiary of any NGO/GO?

a. If yes, how would you evaluate the success/failure?

b. How sustainable these benefits are?

c. Do you think something else would have been instead?

d. Did this NGO/GO include you in pre-planning phase of any projects?

i. If yes, do you see your suggestions being valued?

17. How concerned are you with your family's future if decided living here?

18. Do you consider migrating to somewhere else?

a. If yes, where that place would be, and why do you choose in particular?

19. If you have children/child, do they go to school?

20. How concerned are your children about climate change and adaptation? Do they discuss with you?