



Impacts and responses to environmental change in coastal livelihoods of south-west Bangladesh

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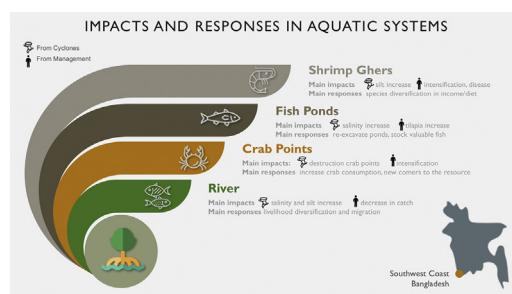
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HIGHLIGHTS

- Coastal livelihoods in Bangladesh face a number of natural and anthropogenic impacts.
- We conduct a series of focus groups to understand the perceptions of local livelihoods on aquatic systems.
- Biodiversity greatly decreased in rivers and ponds, while crab points are increasingly productive.
- Adaptation responses include livelihood diversification and migration.
- Need for biodiversity conservation, and address gender and poverty gaps identified in the region.

GRAPHICAL ABSTRACT



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ABSTRACT

Aquatic ecosystems are of global importance for maintaining high levels of biodiversity and ecosystem services, and for the number of livelihoods dependent on them. In Bangladesh, coastal and delta communities rely on these systems for a livelihood, and the sustainability of the productivity is seriously threatened by both climate change and unsustainable management. These multiple drivers of change shape the livelihood dependence and adaptation responses, where a better understanding is needed to achieve sustainable management in these systems, while maintaining and improving dependent livelihoods. This need has been addressed in this study in the region of Satkhira, in the southwest coast of Bangladesh, where livelihoods are highly dependent on aquatic systems for food supply and income. Traditional wild fish harvest in the rivers and aquaculture systems, including *ghers*, ponds, and crab points have been changing in terms of the uses and intensity of management, and suffering from climate change impacts as well. By means of six focus groups with 50 participants total, and validated by expert consultations, we conduct an analysis to understand the main perceived impacts from climate and human activities; and the adaptation responses from the aquatic system livelihoods. We find that biodiversity has decreased drastically, while farmed species have increased and shrimp *gher* farming turned more intensive becoming the main source of income. All these changes have important implications for food supply in the region and environmental sustainability. Dramatic responses taken in the communities include exit the fisheries and migration, and more adaptive responses include species diversification, crab fattening and working more on the pond and *gher* infrastructure. This study evidences the results of the combination of multiple stressors in productive systems and the barriers to adaptation in aquatic ecosystem dependent communities.

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1. Introduction

South Asian (SA) countries in the Arabian Sea, Bay of Bengal and East of Indian Ocean share similarities in its fisheries environment, socio-economic characteristics and problems (Stobutzki et al., 2006). These countries fall in the region of heavy rainfalls in the monsoon belt. As a result, they are endowed with many rivers, frequent floods and river bank erosion in delta regions. These factors contribute to ecosystems of high biodiversity and natural capital richness (ecosystem services) such as mangroves, wetlands and coral reefs (Tittensor et al., 2010), and also contribute to the vulnerability of people living in these areas (Allison et al., 2009; Barange et al., 2014). Bangladesh is a salient example of vulnerable livelihoods dependent on aquatic systems, that are impacted by climate change and where fishing and aquaculture have evolved rapidly in the last decades with important consequences for sustainability (Faruque et al., 2017). The country is on the top ten national economies most vulnerable to the impacts of climate change on fisheries and aquaculture (Allison et al., 2009). Despite being ranked first among countries vulnerable to climate change (Ahmed et al., 2009), research and development programs might have contributed to reduce its vulnerability rating to the current sixth position (Kreft et al., 2016).

In Bangladesh, aquatic ecosystems supply fish and other aquatic resources to 160 million Delta inhabitants. The country is ranked fourth for inland fisheries production in Asia, behind China, Myanmar and India (FAO, 2016). Many aspects of the Bangladeshi culture, economy and tradition are rooted on fishing and fish culture activities. Fish is a natural complement to rice in the national diet, giving rise to the adage “*Machhe Bhate Bangali*”, literally meaning – ‘fish and rice make a Bangladeshi’. Fish contributes about 60% of the total animal protein intake in the diet of the people from Bangladesh (DoF, 2013), while the integrated coastal and freshwater systems contribute to household food security, nutrition and income (Faruque et al., 2017). The fisheries sector provides full-time employment to an estimated 1.2 million fishers and an estimated 10 million households, where as much as 64% are partly dependent on fishing (e.g. part time fishing for family subsistence in flooded areas) (DoF, 2015). Among the employments associated with the fish sector in the country, only 10% are occupied by women (Islam et al., 2016). However, when considering fish processing plants and fish drying centres in the coast, women occupy 80% of the jobs (Hossain et al., 2013a).

The rich aquatic biodiversity of Bangladesh has been attributed to one of the world's largest wetlands (Bengal Delta) and the aforementioned three large river systems (Bart, 2002). Fisheries are important in the deltaic regions, and contribute nearly to 3.65% to the Gross Domestic Product (GDP), to 23.81% of gross agriculture products and 1.97% to the total export earnings (DoF, 2017). Coastal Bangladesh (47,211 km²) covers 32% of the country and extends over nineteen districts out of a total sixty-four (Shamsuddoha and Chowdhury, 2007).

Bangladesh is at high risk from climate change and the country economy will face the biggest risk from global warming in the next 30 years (Caesar et al., 2015; Kay et al., 2015; Whitehead et al., 2015). The country is susceptible to a range of climate change impacts, from extreme events like cyclones (GoB, 2008) to slow onset processes like sea level rise (Hossain et al., 2012). In addition to Cyclone Aila in 2009, the south-east coast was hit by other high impact cyclones, including cyclone Bijli in the same year, cyclone Rashmi in 2008, and cyclone Sidr, a category 4 cyclone in also in 2008 causing extensive damage to life and property. Since 1970, the country has experienced thirty-six cyclonic storms resulting on over 450,000 deaths and immeasurable economic losses (UNDP, 2010). Events and processes like cyclone, flooding, riverbank erosion, and salinity intrusion in the coast of the country may intensify and become more recurrent and spatially expanded in the 19 districts situated in the coastal zone of Bangladesh (IUCN Bangladesh, 2012). Sea level rise would exacerbate these effects along the coastal margin by altering erosion rates, causing saline waters to intrude further inland,

shrinking protective barriers and increasing flooding by cyclone and storm surges (Erickson et al., 1993).

In addition to climate change, directly human induced impacts come from aquaculture in the coastal waters. Fish biodiversity and catches are adversely impacted by faulty post-larval shrimp (PL) collection, together with water pollution from the industry and agriculture that are causing high fish seed mortality. There is a huge by-catch¹ associated with intensive fishing for PL shrimp to supply shrimp farms in coastal Bangladesh, with hundreds of non-target fish and shellfish removed in this activity (Bhattacharya et al., 1999; Hoq et al., 2001; Toufique, 2002). PL shrimp bycatch could be contributing to the decline in finfish populations and diversity noted by Gain et al. (2005). Additionally, the indiscriminate use of insecticides and pesticides in the crop fields by the farmers are one of the major causes to turn many wild fishes once abundant in the rivers and floodplains to be now threatened (Mazid, 2002). In addition, a range of chemicals were found to be used in the shrimp aquaculture² (Shamsuzzaman and Biswas, 2012; Ali et al., 2016), causing an alarming decrease in population of local fish and shellfish species (Ali et al., 2014; Hossain and Hasan, 2017).

In this study, we explore the recent trends in aquatic ecosystems of the coast of Bangladesh by looking at its aquatic diversity, aquaculture practices and productivity, and a number of associated livelihood changes. For this we use focus group discussions and household surveys in the district of Shyamnagar Upazila in Satkhira, southwest coast of Bangladesh. This case study is selected due to the importance of the natural ecosystems of the Satkhira coast in Sundarbans and the risk of climate change impacts and high livelihood dependence on water resources in the area. The investigation covers the period of 2002–2012 and includes qualitative and quantitative data from primary and secondary sources. The study provides new evidence on the changes and responses in aquatic ecosystems-dependent livelihoods in Bangladesh.

2. Methodology

To study the coastal livelihoods and their dependence on aquatic systems, climate change and management practices in Bangladesh we follow a series of methodological steps depicted in Fig. 1. First is the selection of the case study area based on preliminary consultations, expert evaluation and literature review. Second is the presentation of the characteristics of the study area (Section 2.1) and the identification of the main issues for aquatic systems dependent livelihoods. This step involves an in depth literature review and interactions with stakeholders in order to understand the main concerns in the area from an exploratory perspective. Different methodologies including interviews, focus groups and questionnaires were planned following previous studies in the literature and good practices in qualitative social research (Reed, 2008; Young et al., 2018). Based on this evidence, third is the design of a questionnaire to collect information on the main issues identified in the region (Appendix 1). Fourth is the data collection through implementation of the series of focus group discussions, field observation and interviewing key informants in the study area in order to address the objectives of the study (Section 2.2). Finally, data analysis allows us to understand perceptions, impacts and responses and a report is shared among stakeholders within the DECCMA project (Hill et al., this issue).

2.1. Study area

Through the past experience of the authors and consultation with researchers, a reconnaissance survey was made to select the study area, study participants, and the key informants and to build rapport

¹ The by-catch consists of seeds of many different cyprinids, eels, anchovies, Bombay duck, marine and coastal catfish, gobies, eel gobies, crabs, snails, mussels, bivalves and many other species.

² Including potassium permanganate, sumithion, malathion, formalin, bleaching powder, malachite green and a number of different antibiotics

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