



Vulnerability of rural livelihoods to multiple stressors: A case study from the southwest coastal region of Bangladesh



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ARTICLE INFO

Article history:
Available online

ABSTRACT

The coastal area of Bangladesh has been a focus of climate change and hazard research due to its extreme vulnerability to tropical cyclones, often leading to disaster. While there have been recent studies on the nature of these disasters, people's vulnerability and responses, little is known about how other key stresses, interacting with these extreme weather events, impact natural resources and the flow of ecosystem services that sustain local livelihoods. In this paper, we explore the process by which major stresses and hazards shape the vulnerability of people's livelihoods in dynamic social-ecological environments in the southwest coastal region of Bangladesh. Drawing on qualitative and quantitative data from a case study, we identify the key drivers of change in social-ecological systems and evaluate whether these drivers have affected livelihood outcomes and various components of human wellbeing. This analysis suggests that increasing salinity intrusion, tropical cyclone and land-use change (directly and through changes in ecosystem services) affect the access to livelihood assets at household scale. This undermines social wellbeing by seriously impacting food and water security. Through identification of key stresses and their interactions, and the consequent impacts on ecosystems services and household capitals, the current study proposes a conceptual framework to understand the present day vulnerability to multiple stressors in the context of the coastal region of Bangladesh.

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1. Introduction

Coastal and marine ecosystems are among the most productive ecosystems in the world that provide a range of services to human society (UNEP, 2006). Human well-being is inevitably associated with the availability of these services. In particular, for the people living in the coastal areas in developing countries, it has been essential to have access and use these ecosystem services for their livelihoods (Siddique and Adrika, 2011; Ratner et al., 2013). Despite their importance, a wide array of anthropogenic and natural factors have caused alteration, degradation, or extinction of coastal and marine ecosystems. These include land use change, and habitat loss, harmful fisheries practices, introduction of invasive species, pollution and climate change (UNEP, 2006). The implications of ecosystem degradation for the natural resource-dependent societies can be cascading and have long-term in effects on livelihoods and their well-being (Kofinas and Chapin, 2009).

The day-to-day livelihoods of the poor people in many developing countries are disproportionately vulnerable to

multiple shocks and stresses (Ribot, 2009). Many of these livelihood disturbances, superimposed on the ecosystem changing processes, can amplify human vulnerability, and that, in turn, adversely affects the prospects of the rural livelihoods (Sallu et al., 2010). The poor, therefore, not only experience threats from exposure to stressors alone but also from the changes to ecosystem services caused by these factors. Natural hazard studies have mostly focused on physical elements of hazards and societal responses to specific hazard events (Alam and Collins, 2010; Berkes, 2007; Burton et al., 2003; Paul, 2012; Rashid, 2011). This study integrates human and natural systems to explore the processes that shape the vulnerability of rural livelihoods facing multiple stresses. In doing so, our approach is first to identify the key hazards and stresses that cause social-ecological system changes in the context of southwest coastal region of Bangladesh. We then seek to understand how these changes impact environments and ecosystems. Finally, by examining effects on household's assets, we evaluate both direct and indirect impacts on livelihood outcomes and other components of human wellbeing.

Through identification of key stresses, interactions, and processes of altering ecosystems and various forms of household capitals, the current study provides a conceptual basis to

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understand the present day vulnerability to multiple stresses in the context of coastal region in Bangladesh.

2. Theoretical framework

2.1. Drivers of ecosystem change, ecosystem services and human well-being

The current interest in ecosystem services and human well-being has partly come from the Millennium Ecosystem Assessment (MA), which was the first comprehensive global assessment of the impacts of ecosystem change on human well-being (Leauthaud et al., 2013; Daw et al., 2011). One of the important features of the MA is to direct attention to the dependency of human societies on services (provisioning, regulating, cultural and supporting services) delivered by ecosystems for human survival and well-being. The flow of the ecosystem services to the society depend not merely on ecosystems *per se*, but also on actions of human society, the dominant force driving the global changes (Kofinas and Chapin, 2009). Within MA framework, natural or anthropogenic factors (directly or indirectly interacting at multiple temporal and spatial scales) cause changes in ecosystems and thereby affect ecosystem services and human well-being (Carpenter et al., 2006; UNEP, 2006).

Numerous studies have documented the shifting of ecosystems from productive state to less desirable states where the transition between states can be incremental or sudden and rapid (Folke, 2006). These studies show that an array of human-induced factors have pushed ecosystems into degraded states, and such shifts have profound effects on the capacity of the ecosystem to provide services to dependent societies. This has led to communities having difficulties in securing their livelihoods and wellbeing. In this study, the MA framework is used conceptually to visualize the complex relationships among endogenous and exogenous factors, ecosystem services, livelihoods and human well-being in coastal area in Bangladesh.

2.2. Utilizing livelihood approach to explore the impacts of hazards and stresses on households

Livelihoods of individuals or households 'comprise the capabilities, assets and activities required for means of living' (Scoones, 1998, p.5). Assets in this definition of livelihoods are categorized into five different types of capital. These are: natural capital, physical capital, human capital, financial capital and social capital. The livelihood approach focuses on capital assets that people use to build satisfactory living in interaction with the context of vulnerability, and in transforming policy and institutions. This context of vulnerability includes household's exposure to shocks (e.g., conflict, illness, floods, storms, drought), and seasonalities such as prices and employment opportunities and changes in demography, environment, economy, governance and technology (Serrat, 2008; Malone, 2009). People apply livelihood strategies in these contexts for achieving beneficial livelihood outcomes, including higher material welfare, increased wellbeing, and reduced vulnerability. A livelihood strategy encompasses activities that generate the means of household survival (Ellis, 2000).

In this current study, we applied the livelihood approach to understand the impacts of underlying factors that produce changes in ecosystem services. These changes directly impact on people's asset status and the strategies that are open to them to achieve beneficial livelihood outcomes. The stresses and hazards causing livelihood vulnerabilities comprise many of the same factors characterized as drivers of ecosystem change in the Millennium Ecosystem Framework (UNEP, 2006). Therefore, the terms

stresses and hazards are used synonymously with drivers in this study.

3. Case study description

The research was focused on the southwestern coastal region of Bangladesh, a non-deltaic/inactive delta area with a large network of river systems, tidal channels, and dynamic estuaries. The interaction between fresh water carried by rivers and a saline waterfront intruding inward from the Bay of Bengal generate a highly productive environment. Coastal areas are endowed with very rich aquatic biodiversity that include diverse fish fauna, shrimps, crabs, molluscs and mangroves (Iftekhar, 2006; Ahmed et al., 2012). The largest mangrove forest of the world- Sundarbans is located in this area which was inscribed as UNSECO World Heritage Site in 1987.

The notable intervention that has remarkably altered the agro-ecosystem in the southwestern coastal belt is shrimp farming, mainly by converting rice field into shallow earthen ponds. Shrimp ponds are connected to estuaries and canals through channels and sluice gates. This allows the exchange of brackish water which is very important for trapping wild shrimp fry, supplying natural food and maintaining salinity levels (Paul and Vogl, 2011). Integrated with agriculture, brackish water shrimp aquaculture, in a very rudimentary form had been a casual activity in this region until early 1970s when commercial shrimp farming started here (Karim, 1986). Since then shrimp aquaculture has undergone rapid horizontal expansion, from less than 20 000 hectares (ha) in 1980 to approximately 245 000 ha in 2010, representing a 12.25-fold increase in land dedicated to shrimp aquaculture over the past 30 years (Belton et al., 2011).

Paralleling the expansion of shrimp farming, extensive salinity intrusion has been observed in freshwater and soil in many coastal districts in Bangladesh. According to the Salinity Survey Report 2010 of Bangladesh, about 2.13 million acres of cultivated land is affected by soil salinity in varying degree, accounting for 70% of the total cultivable area in the coastal and offshore regions (SRDI, 2010).

Aforesaid changes to coastal plains come on the back of existing vulnerability to tropical cyclone accompanied by storm surge. Cyclones have been striking the coastal regions in early summer (April–May) or late rainy season (October–November), causing extensive damage to lives and properties of millions of people. On average, a severe cyclone strikes Bangladesh every three years (MOEF, 2009). Due to high population density, cyclones have claimed far more lives in Bangladesh than anywhere else in the world, accounting for 42% of the total cyclone-related deaths of the world in the past two centuries (Nicholls et al., 1995).

This study was carried out in Chila, a union of Mongla Upazila (Sub-district) in the district of Bagerhat. Mongla Upazila covers a total area of 1 461.22 km² and is divided into six unions, which are the smallest administrative units. Each union comprises several villages (Fig. 1). Chila is located to the north of the Sundarbans and borders the Passur River on the west, which flows from north to south and finally discharges into the Bay of Bengal. According to Chila Union Council's report, its population was estimated at 19 150 people in 2011. Mongla and Passur are the two main rivers in the study area. Intra-annual variability in river-water salinity is very high, ranging from 0 to 20 ppt (e-Mongla, 2012).

The livelihoods of the study area are based on shrimp aquaculture and fishing. Currently there are 5 381 registered shrimp farms in Mongla covering 10 895 ha of land (e-Mongla, 2012). Other activities include agriculture, crab fattening, petty trade, migrant worker, wage labourer and collection of fuel wood and honey from nearby Sundarbans forest.

The study region suffers considerably from the impacts of frequent tropical cyclones.

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