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How do climate change and associated hazards impact on the resilience of riparian rural communities in Bangladesh? Policy implications for livelihood development

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ABSTRACT

Despite the increasing recognition of the need for building resilience among poor farmers in developing countries in the face of changing climate conditions, there is a lack of information on the various factors influencing their resilience capacity. This paper develops an indicator-based Resilience Capacity Index (RCI) aimed at a better understanding of the factors influencing resilience capacity of the most hazard-prone riparian rural households in Bangladesh, as a case study in a developing country. The RCI is a relative measure and the value ranges between 0 and 1, where the higher the value the higher the resilience capacity. The index value of 0.297 for riverine mainland households is significantly higher than that for *char* (island) households (0.201). However, the lower index values in both locations infers the households' inability to cope with and adapt to the impacts of climate change and associated hazards due to a lack of adaptation options along with their poor socio-economic conditions. The main drivers of the resilience capacity include livelihood strategies, level of education, and access to food, water and health services. Creating employment opportunities, increasing the level of education, and ensuring access to food, water and health services are potential climate-resilient strategies that are likely to enhance the resilience capacity of most vulnerable riparian households across Bangladesh, with some experiences which may be replicable elsewhere.

1. Introduction

Climate change is a matter of prime concern to Bangladesh. Due to its low-lying deltaic geographical position, the country is regarded as being among the nation's most vulnerable to climate change (IPCC, 2014, 2007; WB, 2013; GoB, 2010). However, the impact of climate change varies spatially and over time meaning that all communities are not vulnerable equally (Gentle et al., 2014; Fussel, 2007). To minimize negative livelihood impacts, differential and more targeted livelihood options and resources for adaptation need to be considered (Alam, 2016; Gentle et al., 2014; IPCC, 2014).

Coastal and riverine households in Bangladesh are the most susceptible to the impact of climate-driven hazards, including riverbank erosion (Alam, 2016; GoB, 2010). Recent models of the hydrological impact of climate change in different climatic zones have shown this to be true across Asia (Eregno et al., 2013). Moreover, Bangladesh has a monsoonal climate that creates frequent and heavy rainfall resulting in a higher frequency of catastrophic floods in the country (Huq et al., 1996). Increased monsoonal flows result in greater sediment transport capacity and so the morphologic dynamics of the rivers leads to increased riverbank erosion along the Ganges–Brahmaputra–Meghna delta (Alam, 2016; Gain et al., 2013; Huq et al., 1996).

Riverbank erosion, a factor which accounts for the largest losses in Bangladesh, occurs gradually but has long-term impacts and is not recoverable naturally (Alam, 2017; Penning-Rowsell et al., 2013). Approximately 8700 ha of homestead and farming land are lost due to riverbank erosion each year, which displaces approximately 200 000 people annually and contributes to an increase in their vulnerability in terms of food security and poverty (IFAD, 2013; Penning-Rowsell et al., 2013; GoB, 2010). Due to the dynamics of erosion and accretion in the

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rivers of Bangladesh, some land emerges as *chars*[1] (sandbars/sand and silt landmasses) within the river channel or attached land to the riverbanks. Households in *char* areas are marginalized from the benefits of mainland people due to poor infrastructure and communication networks (Alam et al., 2017a,b; Alam, 2016; Sarker et al., 2003). Resource-poor households in the riverine areas are more exposed to the impact of frequent floods and waterlogging because of their proximity to the rivers, which also increases their vulnerability. Moreover, due to climate change, the households are also expected to experience projected increases in mean annual temperatures, uncertainty in rainfall, a likely reduction of cereal crop productivity, and surges in disease, pest and weed pressure on their crops and livestock (Alam, 2016; Niang et al., 2014).

In such unavoidable circumstances, there is an increasing recognition by many government and non-government agencies globally of the need for resilient practices and for building the resilience capacity of the poor and small landholder farmers in order to cope with increasing climatic hazards (IPCC, 2014; UN, 2013; WB, 2009). Increasing resilience generally reduces vulnerability (Folke, 2006). A lack of resilience may lead to migration, as seen in Bangladesh and India (e.g., Alam et al., 2017a,b; Jha et al., 2017). Rural households have always faced extreme and unexpected events, but their ability to respond effectively to the increasing incidence of shocks needs to be strengthened (de Bruijn et al., 2017; Alam, 2016). Scholars have argued that resilient households are more likely to anticipate, resist, cope with and recover from shocks (Barua et al., 2014; Fan et al., 2014). However, there has been a lack of information about the factors influencing such household resilience, particularly the socio-economic resilience of disaster-prone households (Qasim et al., 2016; Speranza et al., 2014; Akter and Mallick, 2013; Cutter et al., 2008). Despite much attention to the notion, policy makers and practitioners are not yet clear how resilience thinking can translate into practical implementation strategies while they refer to resilience as something to pursue for facilitating long-term adaptation practices in particular (de Bruijn et al., 2017; Dhar and Khirfan, 2017; Crowe et al., 2016; Tambo, 2016).

The livelihoods of resource-poor rural households in developing countries like Bangladesh are generally dependent on natural resources and the capacity of the households to cope with and adapt to the compounding influences of climate change and its associated hazards is largely uncertain due to the poor socio-economic condition of the households (WB, 2013; IPCC, 2007). A loss of resilience of a natural resource-dependent household contributes to an increase in its vulnerability to shocks which could have been absorbed previously (Kasperson and Kasperson, 2001). One of the principal objectives of disaster risk mitigation strategies is to achieve disaster-resilient communities (IPCC, 2007). Policy makers are interested in knowing what affected people can do for themselves and how to best support the capacity of resource users to cope with and adapt to climate change and its associated hazards (Kulig et al., 2013; Nelson et al., 2007; Walker et al., 2004).

Given the severe climate-related hazards, the Bangladesh Government has given a high priority to improving the livelihoods of rural people, particularly the marginalised riparian households (GoB, 2016). Therefore, it is crucial that household resilience strategies resulting from their long-term knowledge, experience and practices are understood better so that policy makers will be enabled to ensure policies are targeted to appropriate climate adaptation processes to mitigate the effects of an adverse climate and associated hazards in the country (Alam, 2016; Preston et al., 2011; Marshall, 2010; Tompkins and Adger, 2004). Although the resilience concept is applied in diverse field with varied definitions, in this study resilience is defined as the ability of households or communities to effectively cope with and adapt to the riverbank erosions and other climatic hazards in such a way that helps to minimalize the loss of life and economic assets.

Despite the increasing focus on the resilience concept, limited attention has been paid to the resilience measurement aspect. Therefore, the focus of this study is on assessing the resilience of vulnerable riverine households from socio-economic perspectives by developing an indicator-based Resilience Capacity Index (RCI). The assessment method will enable policy makers to know where policies need to be directed to build livelihood resilience, to reduce the vulnerability of individual households and the community, and to monitor the effectiveness of the policies and practices targeted to build resilience. There are two research questions to be answered:

i What factors influence the resilience capacity of riverine mainland households and *char* households in Bangladesh?; and
ii Are the riverine mainland households in Bangladesh more resilient than the *char* households to riverbank erosion and other climate change issues?

The rest of the paper is organized as follows: section two describes the methodology for assessing the resilience capacity followed by the description of the study area and the data collection procedure. The paper then shifts to the survey results followed by a discussion in section three. Section four provides the policy implications and section five concludes the study.

2. Methodology

2.1. Study area and sampling

About 20 out of the 64 districts in Bangladesh are prone to riverbank erosion that causes displacement of people along the estimated 150 000 km of riverbanks annually (GEGIS, 2012; GoB, 2010). Therefore, two riverbank erosion affected districts, two Upazila[2] and villages were selected based on the degree of severity of erosion that was identified through a review of the literature, reports in newspapers and consultations with local experts. Respondents were selected randomly from each village. For the field survey, the Chauhali Upazila of the Sirajgonj district and the Nagarpur Upazila of the Tangail district were selected (Fig. 1), as they were representative of severe riverbank erosion-affected riparian environments in Bangladesh. The area is about 200 km north of Dhaka, the capital of Bangladesh. The study area contains the Jamuna[3] riverbank erosion zone where about 2000 ha are eroded each year (GEGIS, 2012). In the coming decades the households are expected to face even more flooding, increasing drought conditions and water supply pressures, higher temperatures, sea level rise and more intense storms (Alam, 2016; WB, 2010).

The study households were divided into two groups based on their location, namely; riverine mainland households and *char* households. Although both groups of households are affected by riverbank erosion and other climatic hazards, their different locations with respect to the river means the impact on livelihood vulnerability is different for each and they adopt different response strategies. Households in the *char* area are isolated from the mainland by the river and are deprived of all standard government services, whereas the riverine mainland households are relatively better off through being better connected to transport and other services. The *char* villages included were Moradpur, Datpur and Kairat, and the mainland villages were Atapara, Kash Pukuria and Kash Kawalia.

[1] According to the estimates of EGIS (2000), the *char* area covers about 5% of the total land area of the country and it contains about 6.5 million people (5% of the total population of about 156.6 million in 2014; BBS, 2014).

[2] Lower administrative unit of government; below district level but above village level.

[3] Bangladesh is composed of the floodplains and delta of three main rivers – the Padma (Ganges in India), the Jamuna and the Meghna (Brahmaputra in India). There are more than 230 rivers in the country. These three rivers and their tributaries are prone to continuous erosion and are one of the most significant hazards in Bangladesh.