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Vulnerability to climatic change in riparian *char* and river-bank households in Bangladesh: Implication for policy, livelihoods and social development

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ABSTRACT

Bangladesh is vulnerable to climate-driven hazards, including river-bank erosion causing the loss of land and associated natural resources of riparian households, which threatens the livelihood, health and food security of these vulnerable communities. This study, building on an IPCC framework, developed a holistic approach to assess the livelihood vulnerability of 380 resource-poor, rural riparian households from *char* and river-bank communities in Bangladesh. Two key vulnerability assessment approaches – the Livelihood Vulnerability Index (LVI) and Climate Vulnerability Index (CVI) – were customized to incorporate local and indigenous knowledge into the selection of sub-components and indicators. This approach is predicated on the notion that vulnerability to climate change does not exist in isolation from wider community's socio-economic and bio-physical attributes. The LVI and CVI values were found to be different between *char* and river-bank communities, with households inhabiting *char* lands displaying the most vulnerability to climate change. The main drivers of vulnerability were found to be livelihood strategies and access to food, water and health facilities. Riparian households were also found to be vulnerable due to their relative inaccessibility and low livelihood status which coupled with climate impacts on river morphology drive erosion and loss of land with consequent decrease in economic potential, and thus creates a vicious cycle of poverty. Targeted policies and developmental approaches are needed to enhance the adaptive capacity of *char* land and river-bank households across Bangladesh.

1. Introduction

Bangladesh is particularly vulnerable to climate change hazards to its low-lying topography, its geographical position which makes it susceptible to cyclones and tidal surges, its high population density and rural poverty, and an economy based on agriculture and fisheries (IPCC, 2014, 2007; World Bank, 2013; Thomas et al., 2013; Pouliotte et al., 2009; Paul, 2009; Huq and Ayers, 2008; Shahid and Behrawan, 2008). Model-based predictions of future climate change indicate that for Bangladesh, an increase in both mean annual and seasonal temperatures in the order of 2.0–4.7 °C will occur by the end of this century, coupled with an intensification of the hydrological cycle (Christensen et al., 2007). The winter dry season is predicted to become significantly drier, whilst the wet season will see an 11% increase in precipitation; cyclone frequencies and intensities in the Bay of Bengal are also predicted to rise causing further heavy precipitation in the coastal regions resulting in widespread flooding and sea incursions (Christensen et al., 2007). The challenge for Bangladesh is how best to adapt to these changes (GoB, 2010) and their implications for landscape change, water resource availability (including provision of appropriate quantities of water for agriculture and clean water for domestic use) (Choudhury et al., 2005) and food production

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(Jordan, 2015; Asaduzzman et al., 2005). This is of particular concern given that Bangladesh belongs in the group of seven countries that accommodate two-thirds of the 906 million undernourished people around the world (FAO, 2011).

Since independence in 1971, Bangladesh yet remains a low-income country with nearly 50 million people still living in poverty and impacted by climate change (World Bank, 2013). The Bangladesh Ministry of Environment and Forests (MoEF) is responsible for legislating against the impacts of climate change and current legislative instruments include the National Adaptation Program of Action (NAPA) and the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), the latter of which has been criticized for not prioritizing activities to help the most vulnerable (Alam et al., 2011). It has been argued that the linkages between climate change and development make it critically important to synergize climate and development policy actions to support adaptation (Alam, 2016; Rai et al., 2014).

Adaptation is a key factor that will shape the severity of future climate change impacts on social development, agriculture and food production; however, successful adaptations will require significant investments by farmers, governments, scientists, technologists and development organizations, all of whom face other demands on their resources (Rasul, 2014; Lobell et al., 2008). The developing countries and their poorest citizens are most vulnerable to climate change because of high economic dependence on agriculture and low household income (UNDP, 2008); however, such adversity may catalyze the latent adaptive capacities of rural communities (Nelson, 2011; Nelson et al., 2007; Folke, 2006; Pelling and High, 2005). Vulnerability to climate change is driven by a range of physical, social, economic and environmental factors and/or processes that increase the susceptibility of a community/system to the impact of climatic hazards (Ford and Smit, 2004; O'Brien et al., 2009). However, impacts vary spatially and over time (Fraser et al., 2011; Füssel, 2010), meaning that not all communities are equally vulnerable. To minimize negative livelihood impacts, a place and context-specific method is needed for assessing and measuring vulnerability to enable appropriate targeting of adaptation policies and strategies at local, national and international levels (Alam, 2016; Below et al., 2012; Mano and Nhemachena, 2007; Adger and Vincent, 2005; Cutter et al., 2003). There are a number of benefits that vulnerability assessment can offer: vulnerability indicators/indices can be used as an instrument for evaluating development policy frameworks (Eriksen and Kelly, 2007); provide information for developing adaptation and mitigation plans (Gbetibouo et al., 2010); and for comparison of different contexts, and monitoring vulnerabilities over time and space, and setting priorities in resource allocations for adaptation and mitigation (Preston et al., 2011). The challenges are to develop robust and sound measures of vulnerability given the complexity of the factors impacting upon communities (Adger, 2006).

This paper focuses on riparian (river-bank and bar, locally known as *char*) communities since Bangladesh is located in the delta of the Ganges-Brahmaputra-Meghna (GBM) river systems and sustains more than 230 rivers and tributaries which carry billion tons of sediment every year and discharge vast quantities of water (Sarker et al., 2003; EGIS, 2000). Coastal and riverine households in Bangladesh are the most susceptible to the impacts of climate-driven hazards including riverbank erosion (GoB, 2010); recent models of hydrological impacts 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 resulted in higher frequency of catastrophic flood in the country (Huq et al., 1996). Increased monsoonal flows result in an increased sediment transport capacity and morphologic dynamics of the rivers which lead to increase riverbank erosion along the GBM rivers (Ahmed and Chowdhury, 2006; Huq et al., 1998; Warrick and Ahmad, 1996). River channels may shift laterally >300 m seasonally and frequent flooding causes bank erosion and land loss (Makenro, 2000) along the estimated 150,000 km of river-banks in the country (Hutton and Haque, 2003). It has been estimated that 20 out of 64 districts within Bangladesh are prone to river-bank erosion (CEGIS, 2012) and 8700 ha of land are lost each year to river processes displacing approximately 200, 000 people annually and impacting on the lives and livelihoods of riparian households (Alam, 2016; Ahmed, 2015; Lein, 2010; Hutton and Haque, 2004, 2003; Haque, 1997; Elahi et al., 1991; Zaman, 1989), causing food insecurity and poverty (IFAD, 2013; Haque and Rabbani, 2011; GoB, 2010).

Due to a large and increasing population (156.6 million people in 2014, BBS, 2014) and consequent pressure on the limited land resource, '*Char* lands' comprising sand bars and islands in the riparian zone or within the channel are often inhabited. Households in the *char* areas are considered to be the poorest of the poor and also the most vulnerable to environmental hazards (Islam and Hossain, 2013; CLP, 2010). *Char* inhabitants are also marginalized from the services and associated benefits afforded to 'mainland' people due to poor communication networks (Thompson, 2000). While *char* areas vary temporally as environmental conditions change, EGIS (2000) estimated that 5% of the total land area of Bangladesh is comprised of *char* areas supporting about 6.5 million people (5% of the total population).

For governments to target development programs and initiate appropriate social, economic and environmental policies, it is important that accurate information on livelihood vulnerability is available, particularly for marginalized riparian communities. Indeed it has been argued that policy interventions would do little to affect poverty dynamics unless the context of household vulnerability is properly understood (IPCC, 2014; Shah et al., 2013; Hahn et al., 2009). GoB (2011) has emphasized the need to identify the most vulnerable sectors and geographical areas impacted by climate change and this study aims to fill this critical gap using the IPCC (2007) vulnerability framework to develop a Livelihood Vulnerability Index (LVI) and a Climate Vulnerability Index (CVI). This research seeks to address the following questions in terms of riparian river-bank communities: (i) what are the main drivers of livelihood vulnerability for river-bank erosion hazard-prone rural households to climatic change?; (ii) are households isolated from the mainland more vulnerable to climate change than other riparian households?; and (iii) does livelihood status serve as a driver of vulnerability?

The remainder of the paper is organized as follows: the next section describes the methodology for vulnerability analysis. The results and discussions of the empirical study are presented in Section 3 and 4 concludes and provides some policy implications.

2. Methodology

The Chauhali Upazila[1] in Sirajgonj and the Nagarpur Upazila in Tangail District of central Bangladesh – 200 km north of the capital Dhaka – were chosen for this study (Fig. 1), as these comprise one of the most erosion-affected riparian environments in Bangladesh. The Jamuna[2] river crosses the Chauhali and Nagarpur Upazilas and river-bank losses of around 2000 ha per year to erosion have been reported (CEGIS, 2012). Some pictures of Jamuna

[1] Lower administrative unit of the Government below district level but above village level.

[2] 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). These river and their tributaries are prone to continuous erosion and turned out to be one of the most important hazards in Bangladesh.