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Livelihood exposure to climatic stresses in the north-eastern floodplains of Bangladesh

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ABSTRACT

In this paper, we seek to better understand the temporal and spatial aspects of climatic stress on local resource production systems and resource-use behaviors by including the perspectives of resource-dependent communities. Field research was conducted over a nine-month period in the remote north-eastern floodplain communities of Bangladesh, considered one of the most climate-vulnerable, least developed and under-studied regions in the country. This area is heavily dominated by wetland ecosystems, and subjected to regular seasonal flood and extreme rainfall events. Beyond these regular stresses, flash-floods and drought are the two most destructive climatic stresses on livelihood sustainability in the area. Data were collected in 12 villages bordering two significant wetlands (Hakaluki *haor* and Tanguar *haor*), involving focus group discussions (n = 14), key informant interviews (n = 35) and household surveys (n = 356). Our results show that climatic stresses on rural livelihoods are catalyzed by human-induced environmental degradation and local resource use behaviors, contextual features that include both socio-economic and bio-physical properties. A climatic event appeared as a stress to livelihood sustainability when it happened in an untimely manner (e.g., flooding during resource harvesting periods) and directly affected the production process (e.g., agriculture and fisheries). We also found that human stress perceptions varied with the level of locally-driven innovation and adoption of technologies, which supports the important role of local experience and knowledge in adaptation planning. Further research is needed into how communities in different settings are already organizing to manage perceived climatic stresses, including traditional knowledge systems, local innovation networks and livelihood practices to help better contextualize adaptation policy.

1. Introduction

Livelihoods are the resources and activities undertaken by a community for their subsistence (IPCC, 2012). Rural smallholders in many developing area contexts depend heavily on natural resources for their livelihoods (Goulden et al., 2013), the availability of which is influenced by accessibility issues arising from social inequities, economic disparities and governance failures (Ferrol-Schulte et al., 2013; Rahman et al., 2015; Ribot, 2011; Swinton and Quiroz, 2003). However, resource access and uses are also challenged by external uncertainties such as climate change, which is often considered to be a global phenomenon, although felt locally.

In order to address the relationships between climatic uncertainties and sustainable rural livelihoods, the concept of exposure is widely used (Turner et al., 2003). Exposure includes "the presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets in places that could be adversely affected" (IPCC, 2012). IPCC (2014) has posited that local-level meteorological properties like temperature and precipitation will be altered by global climatic change, resulting in climatic stresses (e.g., prolonged drought, excessive or too little rainfall and flood) that will affect the use of, and access to, different assets by household and communities (Reed et al., 2013). Such resource-use constraints due to climatic uncertainties, when compounded by non-climatic factors (e.g., the local structure of resource use, transnational and international market mechanisms), are generally identified as involving multiple or

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double exposure (McDowell and Hess, 2012; Leichenko and O'Brien, 2002, 2008).

There are two main approaches to analyzing livelihood exposure to climate change. First, exposure is often characterized by the nature, frequency and extent of different climatic extremes from a meteorological perspective (Antwi-Agyei et al., 2012; Hahn et al., 2009; O'Brien et al., 2004). This approach generally uses historical data for different climatic variables to predict future changes and identify potentially extreme events, in order to show how extreme events potentially affect livelihood productivity (e.g., agriculture, fisheries) as an 'outcome' of global climatic change (O'Brien et al., 2007). The second main approach centres on the socio-economic dimensions of exposure. This more 'context-specific' approach involves considering the resource access and use constraints in order to help answer how climatic uncertainties are compounded by local resource use systems (Bunce et al., 2010; Feola et al., 2015; O'Brien et al., 2007). In some studies, both approaches are combined to explore the interactions between climatic and non-climatic factors when studying the behavior of affected communities (Hall, 2011; Ford et al., 2006; Smit and Wandel, 2006).

While these different approaches have helped to improve our understanding of the influence of climatic exposure on rural livelihood sustainability, Below et al. (2012) noted that the resulting analyses have often lacked sufficient capacity to capture the complex nature of adaptation processes (see also Smit et al., 1999). Important aspects that are often missing from local exposure-related studies include social perceptions about the climatic stresses, biophysical changes in a system, the resource use behaviors and production system of a community, all of which are known to be context-specific (Campbell et al., 2011; Shameem et al., 2015; Wise et al., 2014). Such gaps have implications for the accuracy of exposure studies seeking to better understand the complex influences of climatic stresses on rural livelihoods (Smit et al., 1999). Consistent with this observation, van Aalst et al. (2008) suggested that participatory climate risk assessment research offers a useful approach to bridging this gap. Subsequently, a number of studies have adopted more participatory approaches to explain different aspects of climatic risk and stresses and help inform policy (for example Bele et al., 2013; Byg and Salick, 2009; Frazier et al., 2010; Stringer et al., 2009). Berrang-Ford et al. (2011) and Ford et al. (2010) observed that participatory research has made significant contributions to adaptation planning, policy and management. For example, Frazier et al. (2010) reported that participatory research facilitated opportunities to engage multiple resource uses and management groups to exchange their geographically-specific views and knowledge, which generated the common agenda of accelerating community resilience to climate stresses in Florida, USA. However, Birkmann and von Teichman (2010) noted scale, knowledge and norms related to climatic impacts challenges the assessment processes when adopting participatory approaches. Some of these challenges may be better addressed by incorporating the sustainable rural livelihoods (SRL) approach, which is a participatory research framework for uncovering livelihood risk and response perceptions(DFID, 1999). The SRL posits that community risk perceptions are built upon community knowledge concerning the properties, availability and use behaviors of locally available resources (DFID, 1999). As a result, this approach is necessarily place-based, limiting its application to case studies (Morse and McNamara, 2013), which Adger et al. (2009) noted may mislead understandings of cross-scalar cause and consequences of climatic stresses. Nevertheless, as noted by Ford et al. (2010), such case studies can be particularly important for locally-oriented adaptation planning in developing area contexts where research investment is scarce.

Focusing on one of the least developed and most climate exposed regions of Bangladesh, the objective of this study was to better understand the temporal and spatial aspects of climatic stress on local production systems and resource-use behaviors by including the perspectives of communities themselves. Using a participatory research approach, we sought to explain the temporal nature of climatic events from the perspective of local livelihood, production system and resource-use practices with a view to better explaining when a climatic event appears as stress to livelihoods. We also aimed to better understand the contribution of local biophysical changes (in the form of environmental degradation) to climatic stresses on livelihoods to offer a forward looking approach that better acknowledges adaptation constraints. This approach is grounded on Amekawa's (2011) observation that the erosion of resource systems in the present will risk future livelihood adaptation actions.

This paper begins with a brief literature review on climate exposure and the SRL approach, and identifies the resulting conceptual propositions related to exposure. The background to the research setting is then described followed by the data collection and analysis methods. We then describe our results in the context of the identified propositions and discuss the implications for future research and policy.

2. Conceptual framework

The conceptual overview of this paper is built upon the resource use pattern, environmental degradation and human perception of the stresses. Reviewing existing exposure literature, we offer three propositions that capture the temporal, spatial and community perceptional issues of exposure. By testing these propositions in the field, we intend to better understand the context-specific underlying entities of exposure, which are insufficiently discussed in historical data-based exposure studies.

2.1. Temporal properties and climatic stresses

Recognizing the IPCC's (2014) assertion that global climate change has increased the frequency of extreme climatic events, the temporal nature of different climatic events requires that significant attention be paid to understanding their potential influences on rural livelihood and production systems. Importantly, the duration and frequency of climatic stresses may not always fully determine the intensity of the stresses (Karagiorgos et al., 2016; Santo et al., 2015). For example, flash-flooding may have a short duration but may result in the large scale destruction of both crops and property (Gautam et al., 2015; Mahmood et al., 2016). Moreover, successive stress events in the same year (for example, the occurrence of drought in one season and flood in the following season) may severely destroy rural production systems (Shah et al., 2013).

While most of the exposure assessment-based historical data informs our understanding of the slow changes occurring in climatic variables and predicts the future potential of extreme events, it is often not adequately understood how these changes are experienced by the local resource user communities (van Aalst et al., 2008; Bennett et al., 2016). Acknowledging this knowledge gap, Bele et al. (2013) observed that there is a distinction between the scientific reporting of climatic change and affected communities' perceptions regarding a stress, and that the temporal occurrence of climatic stress determines community perceptions. Drawing on the SRL approach, which emphasises the seasonal nature of livelihood practices (Morse and McNamara, 2013), we can assume that affected community members perceive a climatic extreme event as a stress to their livelihoods if it occurs in their production period (e.g., crop harvesting period in agriculture or the fishing season in freshwater wetland fisheries).

Proposition 1. An extreme climatic event is perceived as a stress on local livelihoods when it co-occurs spatially and temporally with livelihood production activities.

Climatic extremes may not be perceived as a stress unless it directly affects livelihood productivity. More generally, all extreme events may not be stresses to livelihoods, although all the stresses may appear as a consequence of extreme events, if other conditions (e.g., bio-physical properties, land use practices etc.) are constant. Confirming Proposition

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