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Assessing risks from climate variability and change for disaster-prone zones in Bangladesh

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ABSTRACT

We have measured livelihoods vulnerability indices for four disaster prone zones in Bangladesh, namely saline, flood, flash flood and drought. A total of 2558 households were surveyed to collect data on socio-demographics, livelihoods, social networks, health, food and water security, natural disasters and climate variability. The data were aggregated using a composite index and vulnerabilities across the four disaster prone areas were compared. Our results show that the flash flood zone is the most vulnerable zone followed by the saline, drought and flood zones respectively. The flash flood zone is mainly a mono-rice crop area and local livelihood opportunities are uncertain and limited. Road infrastructure is poor as a large part of this zone remains under water in the wet season. Public health services are underprovided and the hospitals are understaffed, sanitary conditions are poor and the households suffer a longer period of food insecurity. The poor households living in the saline zone have to depend more on social networks and local authorities to withstand livelihood shocks brought about by natural disasters such as tidal surges, cyclones and increasing salinity. The drought and saline zones are highly vulnerable to water. Water in these zones is not only scarce but also unsafe for drinking. The saline zone also suffers from salinity in water used for irrigation which has already affected productivity of land. We suggest an increase in public spending on sanitation and drinking water, health and rural infrastructure particularly in the disaster prone areas where incidence of poverty is high.

1. Introduction

Climate vulnerabilities and associated impacts vary by spatial, temporal scale and socio-economic condition of communities. For instance, Bangladesh faces too much water in the monsoon causing floods and too little water in the dry season causing droughts. The coastal area of the country is prone to salinity intrusion and tropical cyclones; floodplains in the central areas are prone to flood; north western region of the country is prone to drought; and the north-eastern part of the country is prone to flash flood. Variation in climate vulnerabilities and associated impacts demand different, disaster specific, adaptation measures and actions. In order to do this, however, there is a need for a thorough understanding of the nature of vulnerabilities and its magnitude and determinants in different disaster zones in Bangladesh.

Disaster risk reduction agenda has gradually shifted from public reaction to prevention [5]. Natural disasters may be considered as rapid, instantaneous or profound impacts on natural environment upon the socio-economic system [3,4]. The risks involved in disasters are connected

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with vulnerabilities people face in their normal existence [9,36]. Vulnerability can be defined as "the conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of a community to the impacts of hazards" [41, p. 16]. Disaster risk is developed because of hazards and the vulnerabilities of the social and the physical environments to hazards [32]. Thus disasters are also product of social, political and economic environments. Wisner [43] has shown that the effects of Hurricane Mitch in Honduras are caused also by misguided political decisions and vulnerability in rural South Africa is largely determined by apartheid's spatial planning, rural poverty and mismanagement of land resources.

Vulnerability assessment helps understand the complex set of factors that contribute to adaptive capacity of the households and describes a diverse set of methods used to systematically integrate and examine interactions between humans and their physical and social surroundings. Hahn et al. [20] estimated the livelihood vulnerability index (LVIs) as well as LVI–IPCC indices for two districts in Mozambique but suggested that the scale of vulnerability can be extended to include other dimensions such as communities or regions. The LVI is comprised of a composite index comprising seven major components while LVI/IPCC aggregates these components to IPCC's three contributing factors to vulnerability: exposure, sensitivity, and adaptive capacity. Eakin and Bojorquez-Tapia [15] have also emphasisedthe need to compare vulnerabilities across larger regional processes. Both have found that the indicators considered to measure vulnerability index do not vary much within a smaller region. More heterogeneous regions in the context of larger size and climate variability may provide larger divergence in the indicators of vulnerability.

We have harnessed the flexibility and advantages of the indices proposed by Hahn et al. [20] to measure livelihoods vulnerability in four disaster prone zones in Bangladesh, namely saline, flood, flash flood and drought by using primary survey data. We have presented the results from using the two alternative approaches; the LVI and LVI/IPCC. We have not preferred one approach to the other but following Hahn et al. [20] only presented them as alternatives. Each approach provides detailed depiction of factors driving livelihood vulnerability of the households in a particular region [20, p. 86]. This has never been done in Bangladesh and existing studies on vulnerability assessment suffer from at least two major drawbacks. First, the studies have taken the qualitative route [36] and lack systematic identification and measurement of the determinants of livelihood vulnerabilities. Second, there is a disproportionately larger focus on coastal vulnerability at the expense of vulnerabilities in other parts of the country [40,2]. We do not know which region can be most affected by climate change in terms of livelihood vulnerabilities as expressed through factors such as health, water, food and so on. As a result Bangladesh is yet to develop region-specific coping and adaptive strategies, although information on some aspects such as health or water is already available.

The next section describes how LVIs are constructed and that is followed by a brief description of the disaster zones (Section 3). The household survey is described in Section 4 and the results are discussed in Section 5. Finally, conclusions are drawn in Section 6.

2. Livelihoods vulnerability indices

Livelihood vulnerability indices are constructed from factors that are thought to affect vulnerability across regions. There is no single theory that helps to identify these factors. The sustainable livelihoods approach initially developed by Chambers and Conway [11] often offers the starting point. This approach assumes that a household is endowed with natural, social, financial, physical, and human capitals. These are employed to withstand shocks and stresses to generate a favourable livelihood outcome. The use of this approach is rather limited as it fails to integrate "climate exposures and accounts for household adaptation practices… needed… to comprehensively evaluate livelihood risks resulting from climate change" [20, p. 75]. The method proposed by Hahn et al. [20] uses "multiple indicators to assess exposure to natural disasters and climate variability, social and economic characteristics of households that affect their adaptive capacity and current health food, and water resource characteristics that determine their sensitivity to climate change impacts" [20, p. 75].

Hahn et al. [20] proposed a simple livelihood vulnerability index (LVI), as well as an IPCC–LVI approach, to capture and rank vulnerability associated with climate change factors. The LVI approach expresses LVI as a composite index based on seven major components which, in turn, are determined by several sub-components. IPCC–LVI, on the other hand, integrates these major components to IPCC's three contributing factors to vulnerability – exposure, sensitivity, and adaptive capacity.

Hahn et al. [20] used two approaches to calculate LVI, the composite index approach and the IPCC framework approach.

2.1. The composite index approach

LVI is composed of seven major components and each major component is further composed of several sub-components (Table 1). Hahn et al. [20] considered 7 major components: socio-demographic profile (SDP), livelihood strategies (LS), social networks (SN), health (H), food (F), water (W), natural disasters and climate variability (NDCV).

Hahn et al. [20] used a balanced weighted average approach where each sub component contributes equally to the overall index even though each major component is comprised of a different number of sub-components. Since each sub-component is measured on a different scale, they are standardised using the following equation:

$$\text{Index}_x = \frac{X - X_{min}}{X_{max} - X_{min}} \quad (1)$$

X is the original sub-component, X_{min} and X_{max} are the minimum and maximum values, respectively, for each sub-component. For example, X may represent the average number of natural disasters in the past 5 years in a given zone. For variables that measure frequencies, the minimum value is set at 0 and the maximum at 100. Some sub-components, such as "average agricultural livelihood diversity index", are inversed because an increase in the indicator variables such as the number of agricultural livelihood activities undertaken by a household is assumed to decrease vulnerability.