

Natural Disasters in Bangladesh: Impact Analysis through Input-Output Model

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Abstract

Flood, cyclone and storm surge, tornado, drought, river bank erosion are common natural hazards in Bangladesh. These hazards strike Bangladesh in regular interval and claim millions of lives, damage properties/assets and infrastructures, influence societal and daily life of people. The disaster caused by each hazard can be classified into direct damages, first-order losses and higher-order/induced losses. In Bangladesh disaster impact assessment are mainly confined with the estimation of direct damages and sometimes with the first-order losses. Assessment of induced losses are almost absent in the disaster related studies for Bangladesh. We argue that assessment of induced losses is necessary to determine individual and community vulnerability, and optimum level of disaster preparedness, mitigation and recovery. This paper demonstrates how Input-Output framework can be employed to analyze higher-order disaster impacts for Bangladesh.

Introduction

Bangladesh is a natural hazard prone country due to its geo-morphological placement. Flood, cyclone and storm surge, tornado, drought, river bank erosion are common natural hazards in Bangladesh. These hazards strike Bangladesh in regular interval and claim millions of lives, damage properties/assets and infrastructures, influence societal and daily life of people. Besides geo-morphological reasons, Bangladesh often experiences severe exposure to these disasters owing to its demographic and socio-economic character (Agrawala *et al.*, 2003). It is helpful at this stage to clarify some key concepts and definitions of hazard and disaster. Otherwise, unclear terminology may create confusion about what the impact analysis should consider. Hazard is the occurrence of a physical event like flood, earthquake while disaster is the consequence of a hazard (Okuyama, 2007). Not all hazards lead to catastrophic consequences. However, each hazard is unique in nature and corresponding disaster may vary widely in effect. Research on hazard involves the means and/or prediction of occurrence of hazard events, while research on disaster investigates the impacts on society, estimates damages/loss and looks strategy for recovery (Okuyama, 2007).

Natural hazard causes both direct and indirect damages. Direct damages include destruction of physical and social infrastructure, transport network, assets etc. The direct

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damages often create interruption in economic activities, i.e. change in production and/or consumption behaviour, change in investment decision and so on. Such interruptions are called 'first-order losses' (Okuyama and Chang, 2004). There are also 'induced' or 'higher-order' effects, which arises from inter-sectoral linkages in an economic system. Albala-Bertrand (1993) though argues that induced effects are "more a possibility than a reality" (p. 104), the estimation seems necessary to assess individual and community vulnerability, determine optimum level of disaster preparedness, mitigation and recovery (Rose, 2004).

This paper demonstrates how Input-Output (IO) framework can be employed to analyze the 'higher-order' disaster impacts for Bangladesh. A wide range of economic models, like Input-Output (IO) model, Computable General Equilibrium (CGE) model, Social Accounting Matrix (SAM) and econometric models, are reported in literature to assess the induced impacts of disasters. Perhaps the most widely used model is the IO framework (for instance, Hallegatte *et al.*, 2011; Crowther *et al.*, 2007; Okuyama and Chang, 2004; Rose and Benavides, 1998; Cochrane, 1997).

Disaster Impact Analysis in Bangladesh: Usual Practices

In Bangladesh, disaster impact assessment is mainly limited in estimating direct damages. When a natural hazard strikes, soon after that usually government and/or any international organizations (World Bank, Asian Development Bank etc.) publish data on damages in different economic sectors namely agriculture, industry, infrastructure, housing, professional service and so forth (for example, JDNLA, 2008; MoFDM, 2007, 2008; MoEF, 2009; ADB and World Bank, 2005; World Bank, 2007). 'First-order losses' in terms of change in consumer spending and public/private investment pattern due to disaster impact are found in literature (Jahan, 2002; World Bank, 2011a,b; MoFDM, 2009; WFP, 2007; UNDP, 2011; Karim, 2011; Chowdhury, 2012). Assessments of these impacts are necessary for government and donor organizations in order to mobilize relief funds and recovery activities. Efforts are also dedicated to assess adaptation practices, options, constraints and capacities (Adger *et al.*, 2007; Alam and Rahman, 2008; Ali, 1999; Jahan, 1991; Karim and Iqbal, 2000; Ahmed, 2005; Ali, 1996; Chowdhury and Ahmed, 2005) to formulate disaster resilient development strategies.

However, a research gap is evident in the disaster impact analysis for Bangladesh. Here, disaster impact analysis is mostly done in sectoral level and in a disaggregated manner. Spatial dimension has remained almost overlooked. For example, the effects of flood particularly on agriculture sector have been reported in the work of several researchers (eg.: Banerjee, 2010; Brouwer *et al.*, 2006) may be because of the sector's importance in the country's economy.

Need for New Approaches: Key Issues

Bangladesh has entered into its new era of development planning process. The Comprehensive Disaster Management Programme (CDMP) of Bangladesh has identified mainstreaming disaster risk management into development planning process as one of its key priorities. Disaster risk reduction (DRR) comprising different regulatory and non-regulatory measures have been argued to embed during land use planning to reduce vulnerability of people to hazards (UDD, 2013). Hence, more rigorous assessment of

disaster impact is necessary. The following sub-sections identify some key issues that should be addressed during disaster impact assessment.

Natural Hazards and their Spatial Dimension

In Bangladesh, not all districts/divisions/regions are equally vulnerable to all kind of hazards. For example, the North Bengal is more droughts prone whereas the coastal areas are more vulnerable to cyclone and storm surge. Flood affects almost all parts of the country. Each hazard affects geographical territory and economic structure differently. The damages caused by flood are not similar to damages made by drought. Even risk associated with any particular type of hazard, for example, flood is not equally distributed over the whole country and economy i.e. spatially and sectorally. Again, a natural hazard with the greater magnitude and intensity usually create impacts that spread not only beyond geographical boundary but also across sectors. Haque (2005) argues that Bangladesh experiences serious regional imbalance in terms of per capita GDP (Gross Domestic Product) in different activity sectors. One, objective understanding of regional economic structure in response to disaster effect can help to retain region's economic capacity and ultimately the overall growth of the country during disaster. Second, incorporation of spatial dimension in disaggregated understanding of the country's economic structure can act as leverage and seek necessary and adequate investment funding to ensure disaster resilient development. Such analysis can also be helpful for identifying the adaptation deficit for Bangladesh (Stern, 2007).

Model Selection and Data

Input-Output (IO) model, Computable General Equilibrium (CGE), and social accounting matrix (SAM) are the most widely used techniques for disaster impact assessment. Each model renders some advantages as well as disadvantages during disaster impact estimation. For instance, though IO model is a static model and it ignores the economies of scale in production (Miller and Blair, 1985; Wilson, 1974); the model is simple, requires relatively less data during its application and most importantly it comprehensively shows interaction among different sectors of an economy. On the other hand, CGE models are dynamic but require extensive data and often underestimate disaster impacts due to its flexible adjustment feature (Okuyama, 2007). SAM evaluates equity issues for public policies against disasters (Okuyama, 2007) but requires extensive data set.

While selecting a model for disaster impact assessment, researchers, planners and disaster management practitioners should have clear idea about the pros and cons of each model. They should know how each model usually response to the same damage data. For instance, while disaster impact assessment using IO framework produces upper-bound results, there CGE model yields lower-bound estimations. In addition, researcher should be very careful about quality of input data to obtain legitimate results/model outputs.

Disaster Impact Estimation in Bangladesh: Input-Output Approach

Based on the discussion made in the earlier section, we argue that IO framework can provide legitimate estimation about higher-order disaster impacts in Bangladesh. Section 4.1 first discusses the generalized framework of IO model for impact analysis. Section 4.2 focuses on data requirement for disaster impact analysis both spatially and aspatially in Bangladesh through IO model.

Input-Output Model for Impact Analysis

An IO table is constructed for a particular economic area – a nation, a region (however defined), a state etc. for a certain time period (usually a year). As the economic activity of an area is divisible to a number of economic sectors or industries, the IO model is ultimately concerned with the inputs and outputs of these sectors and their inter-relationships. Table 1 shows a simple IO table for a three sector economy. In Table 1, an economy is divided into three sectors and X_i represents the total output (production) of sector i . Y_i and W_i are the total final demand and total primary input for sector i respectively and the observed monetary value of the flow from sector i to sector j is denoted by Z_{ij} .

Table 1: A simple input-output table for three sector economy

| | | Purchaser Sector | | | Final Demand | Total Output |
|---------------|-------------|------------------|----------|----------|--------------|--------------|
| | | Agriculture | Industry | Service | | |
| Seller Sector | Agriculture | Z_{11} | Z_{12} | Z_{13} | Y_1 | X_1 |
| | Industry | Z_{21} | Z_{22} | Z_{23} | Y_2 | X_2 |
| | Service | Z_{31} | Z_{32} | Z_{33} | Y_3 | X_3 |
| Primary Input | | W_1 | W_2 | W_3 | - | W |
| Total Input | | X_1 | X_2 | X_3 | Y | X |

Data Requirement for IO analysis

Available National Input-Output Table for Bangladesh economy should serve the base line data for impact analysis. Ideally the model should be of the previous year of the occurred hazard event for which impact is going to be assessed. The national IO table can be disaggregated into several regions using national and regional GDP (Gross Domestic Product) or income or employment data. Depending on the purpose of impact assessment, the economic sectors can even be aggregated in national and/or regional IO table. However, absence of an inter-regional IO table for Bangladesh economy might limit the scope of spatial analysis during impact assessment.

Conclusion

Simulations of disaster impact using various economic models are aimed not to forecast the disaster or of its consequences; rather, the models try to quantify effects over space once similar kind of mentioned hazard strikes. There is nothing to judge the accuracy of results in disaster impact assessment. Researcher's main concern is, however, to follow sound methodological approach for assessment of consequences to get prepared for what might happen. The present paper highlights the use of IO table in its simplest form for assessment of disaster impact in Bangladesh. Efforts should be dedicated to overcome the inherent problems of IO model making it more dynamic and reliable to suit for impact assessment. Introduction of inter-regional IO table for Bangladesh economy will definitely act as a step forward during spatial assessment of disaster impact.

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