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Disaster risk index: How far should it take account of local attributes?

Mohammed Shariful Islam *, Mohammad Shahidul Hasan Swapan, Shamim Mahabubul Haque

Urban and Rural Planning Discipline, Khulna University, Khulna 9208, Bangladesh

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ABSTRACT

The coastal areas of Bangladesh are disaster prone. Along with natural hazards there are persisting local hazards (e.g., salinity, river bank erosion) in the coastal parts. An approach to disaster reduction strategy, therefore, varies here highly with other areas and also with other disasters. Disaster risk that comes from hazard, vulnerability and local capacity can only be applied here if the assessment addresses socio-political aspects as well. In this study we identified prevailing hazards including the ones which are particularly important for the study area. All hazards are then assessed based on local vulnerability and coping capacity. Participatory appraisal has been taken into account to understand the level of devastation of the disasters. All these qualitative aspects are then categorized to fit in mathematical model of disaster risk estimation. A GIS based approach of multi-criteria analysis has been applied to incorporate the spatial factors in the index. Therefore, the final output is enumerated for each land parcel (locally called mouza) where spatial variability is represented and shown on maps. There are 11 identified hazards in the study area which have association with 11 social factors of vulnerability. The disaster risk index (DRI) also takes account of three geographic factors of vulnerability that are aggregated with the social factors to calculate a reliable DRI. The aggregated outcome is finally validated with historical data of disaster occurrences in the study area and found significant correspondence.

1. Introduction

Disaster reduction strategies include an assessment of vulnerability and risk, as well as assessment of institutional capacities describing an operational framework [1]. The assessment of vulnerability essentially includes the characteristics of critical facilities, social and economic infrastructure, the use of effective early warning systems, and the application of scientific, technical, and other skilled abilities [2]. Risk is the probability of harmful consequences, or expected loss (of lives, people injured, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human induced hazards and vulnerable/capable conditions [1]. Beyond expressing a probability of physical harm, it is crucial to appreciate that risks are always created or exist within social systems. It is important to consider the social contexts in which risks occur because people do not necessarily share the same perceptions of risk and their underlying causes [2].

A fundamental principle of risk assessment is that it can be assessed within an acceptable range of uncertainty if reliable historical and location specific data is available. Risk assessment of disasters has two components: hazard and vulnerability. Hazard is a potentially damaging physical

* Corresponding author.
E-mail addresses: sharifurp02@gmail.com (M.S. Islam), eswapan@yahoo.com (M.S.H. Swapan), shamimhaque67@yahoo.com (S.M. Haque).

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event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation [1]. Vulnerability has two elements: exposure and susceptibility [3]. Exposure is determined by people's dwelling and work places in relation to the hazard. Susceptibility takes into account those social, economic, political, psychological and environmental variables that work together in producing susceptible impacts amongst people within the same exposure [4]. Risk assessment is aimed at providing a model of the disaster risk and generally based on mathematical modeling. The mathematical models which rely only upon the quantitative interpretation, lack in qualitative interpretation of factors which are steamed from the social and political background.

In this study, attempts have been made to develop a methodology that considered both quantitative and qualitative aspects of hazards and vulnerability factors. Participatory appraisal that takes account of people's perception has been employed to identify locally intervening hazards and factors of vulnerability. A participatory GIS based approach has been involved to integrate social dimensions with the geographic variables of risk assessment. The final product is a disaster risk index which incorporates socio-political dimension of vulnerability for a specific type of hazard prevailing in Assasuni sub-district of Satkhira district of Bangladesh. However, this experience of indexing disaster risk is replicable elsewhere in terms of the conceptual framework exercised and the methods of variable selection used.

2. Context

The study has been taken in a coastal area of Bangladesh called Assasuni Upazila (sub-district) of Satkhira district (Fig. 1). Total land area of Assasuni is 220.96 km^2. Tidal Surge and Cyclone are the leading natural disasters in this region. Specially thousands of fishermen's, wood collectors' and marginal people's lives of the study area are under extreme risk due to lack of adequate warning system and essential lifesaving equipment. The study area is relatively free from seasonal flooding which is different from the upstream regions of Bangladesh that experience seasonal flooding almost every year. However, this area is highly vulnerable to the flash flood due to its geo-physical settings characterized by low-lying tidal plain and criss-crossed by a number of rivers and tributaries [5,6]. Several reasons are attributed as major factors for flooding in this area. During 1960s Water Development Board (called as EWAPDA) divided the total district into some polders by creating embankment beside the river to get protection from salinity. This contributed to reduce the natural flow of water and creates water logging during monsoon. There are two international rivers flowing around the study area namely Ichamoti and Sonai. Flood water comes from the neighboring Indian portion by these two rivers and tributaries. Moreover, to drain out the additional stored water, India opens the sluice gate frequently and it creates flash flood [7]. In 2002, 2003, 2004 and 2011 the study area was significantly affected by the flood. In the year 2000 a massive flood occurred in the study area and water remained stagnant for almost 60 days caused a great havoc for life, crops and properties.

Basic facts and figures of the study area.

Source: [8,9].

Area	220.96 km^2
No of union	11
No. of Mouzas (an administrative unit of land parcel)	144
No. of villages	242
Total male population	121,000
Total female population	123,000
Density of population	606/km^2

According to a joint study conducted by British Geological Survey (BGS) and Department of Public Health Engineering (DPHE) of Bangladesh, the average arsenic concentration in ground water for shallow tube wells of Assasuni is 100–200 μg/l [10] which is far above of acceptable level. i.e., 50 μg/l prescribed by World Health Organization (WHO) [11]. Therefore, the arsenic contamination in the study area can be regarded as the biggest calamity in last decade. River bank erosion is another major hazard for the study area. Every year hundreds of hectares of agricultural and settlement land adjacent to the river is grabbed by the river; especially the area adjacent to the river Kholpetua is highly vulnerable for river bank erosion. Cyclone is another hazard prevailing in the study area. Cyclone Aila affected Assasuni Upazila in 2009 causing damage to around 10,000 households [12]. The study area is highly vulnerable to climate change as well. Assasuni Upazila has been identified as one of the eight hotspots that are vulnerable to climate related hazards by a study titled economics of climate change conducted by the World Bank [13].

3. Concept

Disaster risk index (DRI) monitors the evolution of risk [14] which aims at outlining the relationship in which an area is indexed for each hazard type according to their degree of physical exposure, their degree of relative vulnerability and their degree of risk [2]. Within a DRI framework, vulnerability is seen as a factor that describes why people in a same exposure can be more or less at risk [15]. Therefore, indicators of risk and vulnerability can provide a tool to examine the root causes of risk and vulnerability [16]. The Community-Based Risk Index aims at identifying and quantifying the main risk characteristics within a community [3,17]. This research has undertaken two elements that are essential in the formulation of risk: the probability of occurrence for a given threat—hazard; and the degree of susceptibility of the element exposed to that source—vulnerability [18]. They also argue that risk of a disaster is the compounded function of a hazard and the number of people, characterized by their hazard specific vulnerability. Risk and vulnerability are distinguished by Alexander [19] by stating risk to be the probable loss caused by a hazard and vulnerability to be the potential for loss or disruption. Wisner et al. [18] explained the relationship between risk, vulnerability and hazards by saying that a disaster is the intersection of two