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ORIGINAL RESEARCH ARTICLE

Projected Impacts of a 1-Meter Sea Level Rise on the Coastal Zone of Bangladesh in Relation to Proposed Adaptation Methodologies

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Abstract

Bangladesh is extremely susceptible to sea level rise due to the fact that it is a coastal country and it is densely populated (Brammer et al., 1993). It is projected that a 1-meter sea level rise at the coastal zone of Bangladesh will occur by 2030, and this would seriously impact 16% of the total landmass area which sustains a population of 17 million (15% of total population) (UNEP, 1989). As a result of the geographical location of Bangladesh, two thirds of the country is less than five meters above sea level (SPCR, 2010). Therefore, this makes the country vulnerable to sea level rise and also tidal flooding generated by storms. Sea level rise resulting from climate change will generate erosion of low lying coastal areas which will result in losses in shelter and livelihoods (Biswas, 2011). A 1-meter sea level rise

would also impose a catastrophic impact on the biodiversity of Bangladesh (Hossain and Hossain, 2008). This paper asserts that these environmental phenomena can actually be minimized and managed through certain adaptations methodologies which are presented and explained.

Keywords**:** sea level rise, climate change, coastal zone, impacts, erosion, adaptation.

Introduction

Bangladesh has been identified as one of the most affected countries throughout the period of 1992-2011 in terms of climate change impacts (Germanwatch, 2011). The geographical location of the coastal zone of Bangladesh is dynamic, with extensive and heavily populated coastlines and many low-lying remote islands ((Huq, 1999). Inconsistent environmental patterns occur in this region due to erosion and flooding (Shamsuddoha et al, 2009). The coastal zone dominates a 47,201 square kilometer land area, which is 32% of total landmass of the country (Hossain, M. Lokman and Hossain, M. Kamal, 2008). There is discharge of numerous rivers including the Ganges-Brahmputra-Meghna (GBM) river system in the southern part and this system qualifies this area as one of the most productive ecosystems in world (Agrawala, 2003). Matthews (2009) discovered that consequences of climate change within the context of Bangladesh are varied and that social and economic structures and the overall quality of life will be impaired as a result of these consequences. Sea level rise and severe flooding will affect those who live in the coastal zone, causing many of them to become homeless and climate refugees.

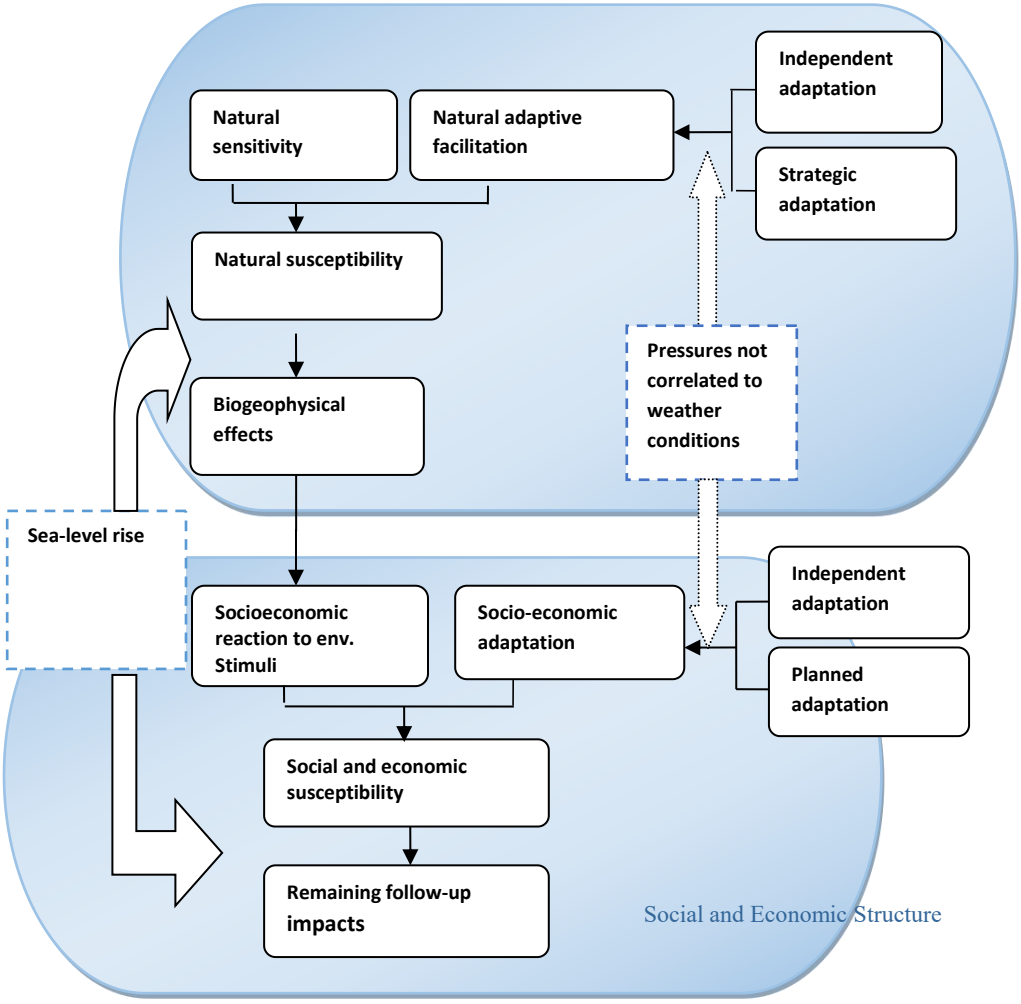

Figure 1: A theoretical structure for coastal impacts and susceptibility evaluation of sea level rise

Projected Flood and Erosion Magnitude as It Relates to Impact Factors

8,000 km to14,000 km of land will be lost as a result of the rise of sea level, of 0.1m, 0.3m and 1.0m respectively (Ali, 2000). The possible land loss anticipated by IPCC (2001) is even more severe. It is publicized that 29,846 km area of land will be lost and 14.8 million people will become climate refugees as a result of a 1-meter sea level rise (Klein, 2003).

Most susceptible shore categories to sea level rise are sandy and silty shores (Kont et al., 1997). The coastal zone of Bangladesh is composed of silty and sandy soils which make it vulnerable to sea level rise (Kont et al., 1997). Sandy and silty shore lines are easily dissolved and broken down by sea level rise. Vellinga (1988; cited in SDNP, 2004) explains that a sea level rise of 1 meter will generate an erosion of

a sandy shore in the order of 100-500 meters and that the erosion rate due to sea level rise along the Bangladesh coast is at a high level.

The "Bruun Rule" connotes that a 1-meter rise would generally generate shores to erode 50 to 200 meters along sandy beaches, even if the visible portion of the beach is fairly steep (Ali, 2000). Parry (2001) explains that there are indications that sea level rise has affected and is affecting Bangladesh by means of land erosion, salinity intrusion and a decline of biodiversity and there will be more severe adverse effects in the coming future. In addition, a 1-meter sea level rise will generate river bank erosion, salinity intrusion, flooding, damage to infrastructure, significant problems among agriculture and fisheries sectors, etc. along this coast (Khan, 2009). Halcrow (2001) explains that a1-meter sea level rise will affect the country's vast coastal area and flood plain zone and that efforts to achieve millennium development goals will be inhibited which will result in an environmental refugee crisis. Most of the vulnerable sectors to a 1-meter sea level rise in Bangladesh are coastal resources, water resources, agriculture and fisheries and ecosystems.

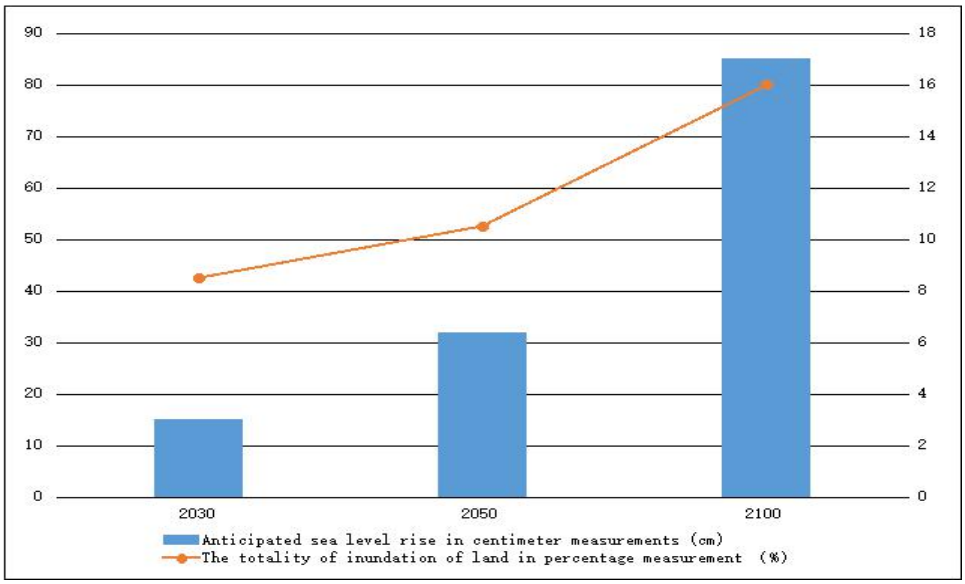

Figure 2: Anticipated land erosion and flooding induced by sea level rise at the coastal zone

Projected Loss of Biodiversity in the Sundarbans Due to a 1-meter SLR

The Sundarbans mangrove forest is the world's largest distinctive mass of mangrove forest, which is located at the southwest part of Bangladesh, dominating sections of Khulna, Satkhira and Bagerhat districts (Iftekhar and Islam, 2004). The area of the Sundarbans fluctuates each year as a result of soil erosion and land accretion (Iftekhar and Islam, 2004). However, its current area in Bangladesh consumes approximately 6,500 square km (FAO, 2003). Sea level rise will inevitably generate an increase in the salinity concentration in the water and soil of the Sundarbans (Islam, 2003). It is projected that the

Sundarbans will be completely eliminated with a 1-meter sea level rise (World Bank, 2000). Elimination of the Sundarbans would result in the extensive impairment in the heritage, a decline in biodiversity, a decline in fisheries resources, mortality and a decline in livelihood (Islam, 2004). The area of the Sundarbans which has been eliminated by a conflicting scale of sea level rise is shown in the Table 1.

Climate Change scenario	*Possible ramifications*
Sea level Rise	10-cm SLR will submerge 15% of the Sundarbans 30-cm SLR will submerge 50% of the Sundarbans 45-cm SLR will submerge 75% of the Sundarbans 60-cm SLR will submerge the entire Sundarbans 1-m SLR will inevitably obliterate the entire Sundarbans The elimination of the Sundarbans and other coastal wetlands would downgrade the availability and accessibility of propagation ground for many estuanne fish, which could have an impact on their population in terms of decreasing numbers Sea level rise would generate the movement of saline water further into the delta and this would produce a domino effect by eliminating habitation for fresh water fish.

Table 1: Projected Outcomes of the Sundarbans with Different SLR Scenarios

Population Displacement Issues

The coastal zone of Bangladesh is composed of 19 districts: Bagerhat, Barguna, Barishal, Bhola, Chandpur, Chittagong, Cox's Bazar, Feni, Gopalganj, Jessore, Jhalokati, Khulna, Lakshimipur, Narail, Noakhali, Potuakhali, Pirojpur, Satkhira and Shariatpur (Ali, 1999). These coastal districts specifically are inclined to flooding and erosion. Loss of land leads to many problematic socioeconomic factors such as loss of agricultural land, loss of road and other communication infrastructure and the loss of an extensive range of biodiversity.

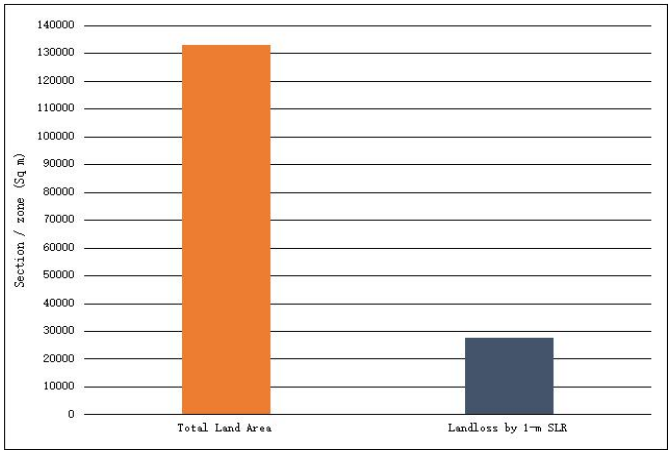

Figure 3: Total section / zone and possible land elimination by a 1-meter SLR

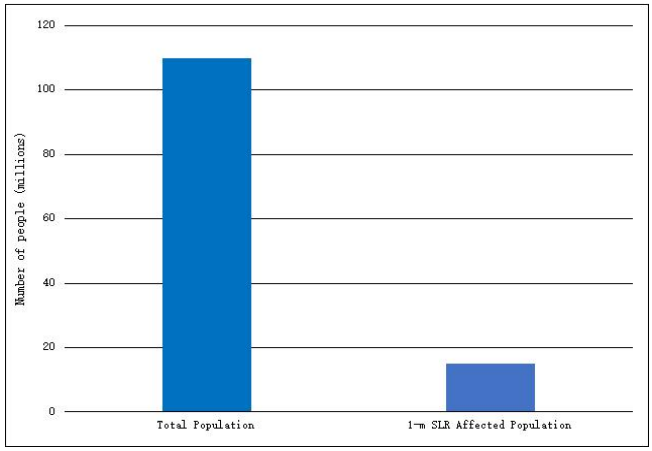

Figure 4: Total anticipated number of people affection by a 1-meter SLR

Discussion / Recommendations Regarding Adaptation Methodologies

It is imperative that centers for research, knowledge management and distribution and also centers responsible for preparatory studies for adaptation against sea level rise be established in Bangladesh by both the government and NGOs for the purpose of accumulating vital information through research and data collection, and distributing this information and knowledge to the general public.

Developing institutional capacity is a vital component under the division of capacity organization. Institutional capacity development focuses on capacity building not only in terms of the provision of education and training, but it also endeavors to improve the capacity of the general public, governments, businesses and NGOs to design and manage the coast proficiently and efficiently. It also aims to improve institutional arrangements for coastal management. This therefore means that focusing on capacity development encompasses models such as leadership, awareness and community development.

Complete and thorough disaster management strategies should be enhanced by the Government of Bangladesh such as development and improving cyclone and storm surge warning systems and technologies. In addition, generating public awareness and widespread publication through media would be very effective.

Construction of flood resistant infrastructure along the coastal zone is paramount, along with the construction of concrete barberries. This has proven to be effective in the case of the State of Florida in the United States. Florida is frequently bombarded with hurricanes and significant flooding is an issue. Concrete barriers have been constructed along parts of the coast of Florida to prevent flooding. Finally, relocation of coastal settlements to areas that are more in-land and not vulnerable to coastal flooding is by all means difficult in terms of interruptions of people's livelihoods, but it is absolutely imperative that this method is put into practice for the purpose of preserving lives and minimizing catastrophic impacts on the country's social structure.

Conclusion

Climate change is a crisis that's currently affecting the entire world environmentally, socially and economically. The devastating effects of climate change can be seen mostly in geographically vulnerable countries, particularly Bangladesh. Every year Bangladesh experiences major declines of much of its resources as a result of natural disasters generated by climate change and these disasters have increased their magnitude and regularities. Furthermore, major environmental distortions such as floods and erosions generated by sea level rise are projected as a result of climate change in future. Communities situated at the coastal zone of Bangladesh have experienced the brunt of severe environmental hazards for decades, obstructing their current livelihood options and socio-economic development. It is imperative to understand that vulnerability is not just a variable of environmental dynamics as agents of catastrophes, but also a variable of the socio-economic conditions of the communities.

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