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ASSESSMENT OF SOCIO-ECONOMIC RESILIENCE AGAINST COASTAL DISASTERS IN SANDWIP ISLAND OF BANGLADESH

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Abstract

A study was conducted to unveil the socio-economic resilience of coastal communities through questionnaire survey in 14 Unions of Sandwip island against climate related disasters. Four indicators, namely (i) demography and health, (ii) living conditions, (iii) economic status and (iv) education and awareness along with 12 variables were adopted for the resilience study. The integrated resilience scores varied from 2.17 to 4.12 where almost all of the Unions have fallen into moderate category, with two at the top (e.g., Musapur and Gachhua) and two at bottom of resilience (Azimpur and Digghapar). This pragmatic approach would be beneficial for the coastal planner and decision makers to take necessary initiatives for disaster risk reduction and adaptation in a coastal community.

Key words: Coastal community, coastal disaster, socio-economic resilience, disaster risk reduction

Introduction

Climate change induced hazards and the subsequent vulnerability of people have become the 'bug zapper' for research community in recent years. The Intergovernmental Panel on Climate Change (IPCC) has authoritatively predicted the likelihood of increased temperatures, sea level rise and increase in extreme weather events due to anthropogenic activity (Jordan 2009) and Bangladesh is considered as one of the most vulnerable countries of the world to the impacts of climate change (Islam *et al*. 2015, Khan 2013, Warrick and Ahmad 1996, Cruz *et al.* 2007, Nicholls *et al*. 2007, Karim and Mimura 2008). Coastal communities are fragile and sensitive to these adverse conditions. To assess such complex system resilience is a concept being used extensively over the decades. Resilience can be defined as the capacity of a particular community to absorb external shocks without significant deformation (Cutter *et al.* 2008). However, researchers such as Cutter *et al.* 2008, Béné *et al.* 2012 described 'resilience' as 'pre-event', 'holistic' and 'adaptive' concept regarded as an effective tool for quick decision making and relevant action planning. Over the past few decades, quite a few scholars have attempted to framing quantitative as well as qualitative indicators with particular relevance to community resilience against natural disasters (USIOTWSP 2007, Cutter *et al.* 2008, Cutter *et al.* 2010, Peacock *et al.* 2010, Uy *et al.* 2011, Joerin and Shaw 2011, Joerin *et al.* 2012, Teo *et al.* 2013, DasGupta and Shaw 2014). Many research studies pertaining to socio-economic aspects have been carried out in the coastal areas of Bangladesh.

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However, index based resilience assessment targeting a small island in Bangladesh has not been attempted so far. The Sandwip has recently become the center of attention to climate scientists, social researchers and administrative authorities due to the gradual exposure to high frequency of coastal hazards. Statistics showed that this island was struck by several tropical cyclones during the period since 18th century to recent times. Scientific evidence reveals that, the total area had shrunk from 258 square miles in 1920 to 137.16 square miles in 1981, and 100 square miles in 1987 (Humayun 2012). Over the last 25 years, large chunks of the island have gone under the Bay of Bengal. All these factors should lead to the dynamic vulnerability of the communities of this island and it is a big question now whether the communities of *Sandwip island* are prepared enough to withstand these drastic hits or not. The long queue of academic literatures trying to measure resilience of coastal communities has failed to show any beacon here. Three distinct lacunas come to surface while assessing the grand literatures in this arena. First, most of these studies have tried to measure resilience of communities from macro perspectives by using national database. Breakdown data is not available from these literatures and they are too broad to explain diversities. Secondly, local level problems and needs have been overlooked by them. Thirdly, they do not help to explore the distinct capacities of local level communities. Keeping these in our mind, the study attempts to develop a set of appropriate indicators to assess disaster resilience of 14 Unions of *Sandwip island* of Bangladesh.

Sandwip, an off-shore island is located at the estuary of the Meghna river on the Bay of Bengal and separated from the Chittagong coast by Sandwip Channel. It is bounded with Bamni river in the north, Meghna river and Hatia Island in west, Sandwip channel and Sitakunda Upazilla in east and Bay of Bengal in the south. Geographically, *Sandwip island* is confined between 22°24' - 22°36' north, and 91°26' - 91°34' east (Fig. 1) occupying an area of around ~208 km^2. The study area is mostly low lying flat coastal plain elevation varies from 0 to ~ 2.5 meter above mean sea level. Geologically this island is very recent, about ~3000 years old encompassing tidal (e.g., intertidal and supratidal) and fluvio-tidal sediments (e.g., mostly clayey and sandy constituents). Regarding population it is interestingly noted that *Sandwip island* having total population of 2, 92,773 in 2001 and later found 2, 78,605 in 2011 (BBS 2011).The study area experiences tropical climate having warm season persisting through March to May, monsoon through June to October and winter from November to February. During the post monsoon season (September to November), tropical cyclones are extremely common. Amongst all the cyclones during last few decades, the most damaging one took place on 29 April 1991 with a velocity of 225 km/hr affected the island with a death toll of about 40,000. Eighty per cent of the houses in Sandwip were destroyed. Storm surges merely result flooding ultimately breach the embankments leading to the destruction of coastal villages and crop lands.

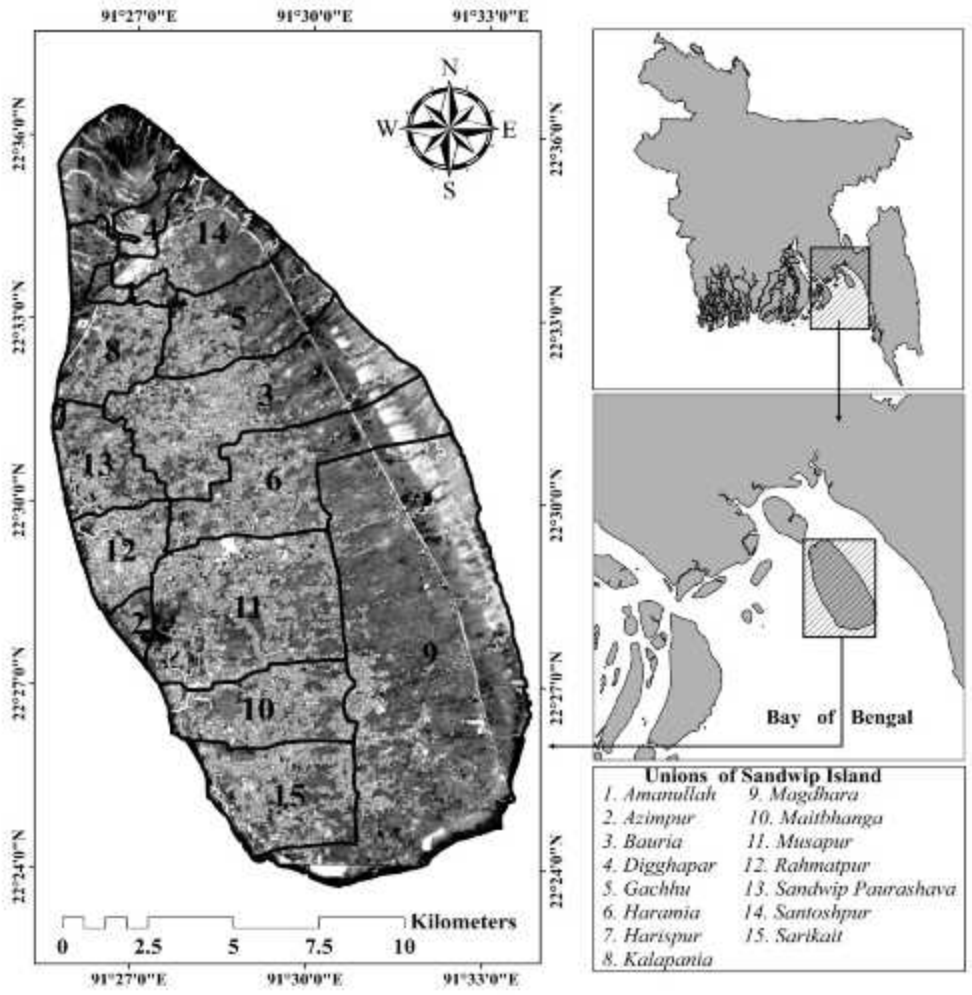

Fig.1. Location of the study area, the aerial extent of the present Sandwip island has been taken from the recent satellite image (Landsat 8 OLI and TIRS) dated 11 December, 2014.

Methodology

The research methodology was initially commenced by developing conceptual frameworks of socio-economic resilience with four indicators and 12 variables (Table 1). After some initial analysis of the framework, a quantitative questionnaire survey was developed to test research framework as well as conducted to collect data on indicators associated 12 variables. Field survey was conducted during September 2015 in all the 14 Unions and responses were gathered mostly by interviewing local people and the officials of Union information center. Respondents were asked to prioritize the conditions of a particular variable. A likert scale of 1 to 5 was used to rate each variable where '1' refers as 'less resilience' and '5' as designated as 'high resilience'. At the

same time a weightage has been assigned upon the variables following the cutting edge academic standards.

The final index score for a particular indicator is calculated as,

$$\text{Socio-economic indicator resilience} = \frac{W_1V_1 + W_2V_2 + W_3V_3 + W_4V_4}{W_1 + W_2 + W_3 + W_4} \quad (1)$$

where, V_n represents the assigned value of the variables inspected from the survey and W_n represents the assigned weight to each variable. Weighted score of the all the indicators were derived from the equation (1). Once the score of all the indictors have been derived, the composite socio-economic resilience was calculated by assigning a rank over the indicators (Table 1). The weighted mean score of socio-economic resilience is calculated as follows.

$$\text{Composite socioeconomic resilience} = \frac{W_1I_1 + W_2I_2 + W_3I_3 + W_4I_4}{W_1 + W_2 + W_3 + W_4} \quad (2)$$

where, I_n represents the score of indicators obtained from equation 1 and W_n represents the assigned rank to each indicator (Table 1). At the end, a composite index has been developed and communities (Unions) were classified into three categories of resilience, namely: High (greater than or equal to 4), moderate (greater than/equal to 3 but less than 4), and low (less than 3).

Table 1. Theoretical framework for the socio-economic resilience study.

Index	Indicator	Rank	Variable	Weight
Socio-economic resilience	Demography and health	5	a) Population density	5
			b) Doctor-population ratio	3
			c) Condition of public health	4
			d) Safe drinking water	5
	Living conditions	4	a) Flood and cyclone center	5
			b) Access to road communication	4
			c) Source of energy (solar)	3
			d) Forest density	3
	Economic status	3	a) Income per capita	5
	Education and awareness	2	a) Literacy rate	5
			b) Primary School	4
			c) Mobile phone use	5

Results and Discussions

Fig. 2 illustrates the domain based resilience rank of the study area and Fig. 3 illustrates the composite resilience status (e.g., spatial variability and database) of all the Unions of the study area. A detail illustration has been given pertaining to the resilience indicators in the following sub-sections.

(a) Demography and health: Data analysis reveals that of the 14 Unions surveyed, *Azimpur* Union had the lowest score of 2.78. *Magdhara, Haramia, Bauria* and *Musapur* Unions appeared with the highest score of 3.89. None of the Unions individually scored above 4, which has been the benchmark for high resilience in composite index. Except *Azimpur*, rests of the 13 Unions have been within the range of 3 to 4. The situation clearly reflects success of government in ensuring health services at the doorsteps of people by establishing community clinics. Almost all of the respondents have referred to services from community clinics. Despite having equal facilities, it was found that the social capital among the top 4 Unions were high in comparison with others. Local leaders and elected representatives were vibrant in *Magdhara, Haramia, Bauria* and *Musapur* Unions by regularly consulting people about government services, arranging meeting with health workers and Union parishad officials etc. to name a few other activities. Availability and access to safe drinking water was quite fair in most of the Unions. Population density data of BBS (2011) shows *Amanullah* Union has a density of 2350, making it the highest while *Azimpur* Union had only 115 people living per square kilometer. *Amanullah* Union barely remained above *Azimpur* with a score of 3.06. Therefore, it appears that high or low density do not inherently push down or up resilience of any community.

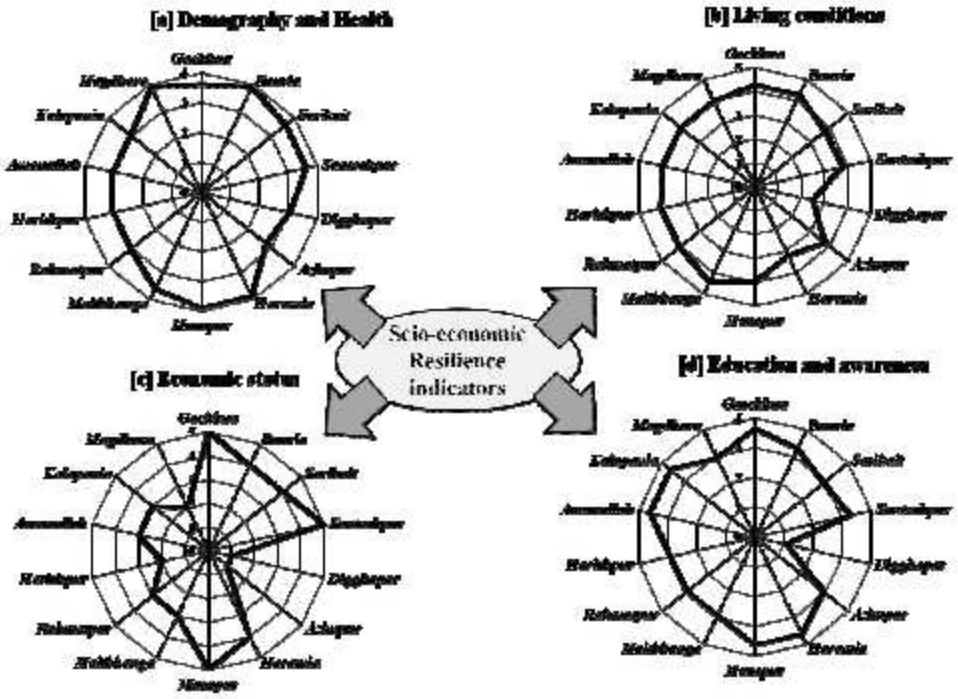

Fig. 2. Indicator based resilience rank of the study.

(b) Standard of living: Real time living condition of people significantly contributes resilience indexing of any community. *Digghapar* Union had worst condition in all of these sectors. There was no cyclone or flood shelters in contiguous areas and people resorted to schools, mosques in

periods of disasters. Road transport and communication was shattered in this union, almost all of the local roads are muddy which get soaked during rainy season. A few metallic roads were constructed but had turned into craters from gradual decay and an overlooking of maintenance. Resilient infrastructural systems, particularly electricity, water and other public services are crucial for minimizing the disaster impacts (McDaniels *et al.* 2008). On the other, *Maitbhanga* Union had enough flood and cyclone centers for tackling emergencies. Local transport infrastructures were integrated and people could swiftly move into other areas in all seasons. Unions like *Harishpur, Amanullah, Rahmatpur, Magdhara, Kalapania, Bauria, Gachhua* and *Musapur* also scored 4 or more in this category reporting a good condition of road transport system. NGO intervention in these 9 Unions was referred by more than half of the respondents. NGOs were providing loans and information about using solar panel in their project areas. A lack of such external intervention was a cited reason for not having access to solar energy by the people in *Digghapar* and other unions. However, absence of any coastal green belt or strong embankment was mentioned by all of the respondents and they urged government intervention to meet those demands.

(c) Income and poverty: Poor rural households are highly exposed to and particularly vulnerable to shocks because they have a few assets to fall back on and limited risk management strategies (IFAD 2015). The survey found *Digghapar* and *Azimpur* Unions show lowest indicator value. Here, most of the people did not own much agricultural land and worked as agricultural labors. Besides, the frequent assault of disasters has thwarted production of sufficient agricultural crops. Shortfall of production reduces the income of people working in the farm. Historical and continuous river erosion had shrunk available agricultural land and turned many 'once landlords' into landless person. *Sarikait, Haramia* and *Bauria* Unions had a score of 4 in this indicator while three other unions namely, *Santoshpur, Gachhua* and *Musapur* touched the highest point in the scale. Income per capita of these 6 Unions is higher than that of others. People of these Unions are the landowners and businessmen who do not solely depend on agricultural production. In addition, large number of working force of these Unions is expatriate labors in Middle East mostly. Poor households of the surveyed Unions were referring to the lack of access they suffer due to their economic incapacity even when the services are provided by government. Poor people are devoid of access from several services that are *de jure* open to all. Overall the economic resilience was in an unforeseeable threat arising from land erosion and other natural hazards in this island.

(d) Education and awareness: Education and awareness for disaster risk reduction can empower normal people everywhere to participate in reducing future suffering (IFRC 2011). Information is considered as equivalent to power in the 20th century. Education and access to electronic devices are the gateways to information. *Digghapar* and *Azimpur* Unions scored 1.07 and 2.64, respectively in this indicator which represents a worst scenario of education and awareness in the area. While, *Gachhua, Amanullah, Haramia, Kalapania* and *Musapur* Unions scored 3.64. All the remaining Unions recorded in between 2 and 3. There were primary schools for children of these Unions but the vibrancy of community and social capital played an important

role in ensuring quality education. School committees had representation of local leaders and guardians are regularly consulted in the best scored Unions. None of the respondents in *Digghapar* and *Azimpur* were aware of any such incidents in their respective communities. Most of them could not explain or recognize the early warning signals and numbers before cyclones. Barely 30% people here had been using mobile phones. Very few among them could use their phones for multiple purposes apart from its only use for talking with others.

Socio-economic resilience of Sandwip: Composite index: The composite index below shows overall socio-economic resilience in *Sandwip island* (Fig. 3). Unions have been classified into three categories: Low, moderate and high. Almost all of the unions have fallen into moderate category, with two at the top and two at bottom of resilience. *Gachhua* and *Musapur* Unions

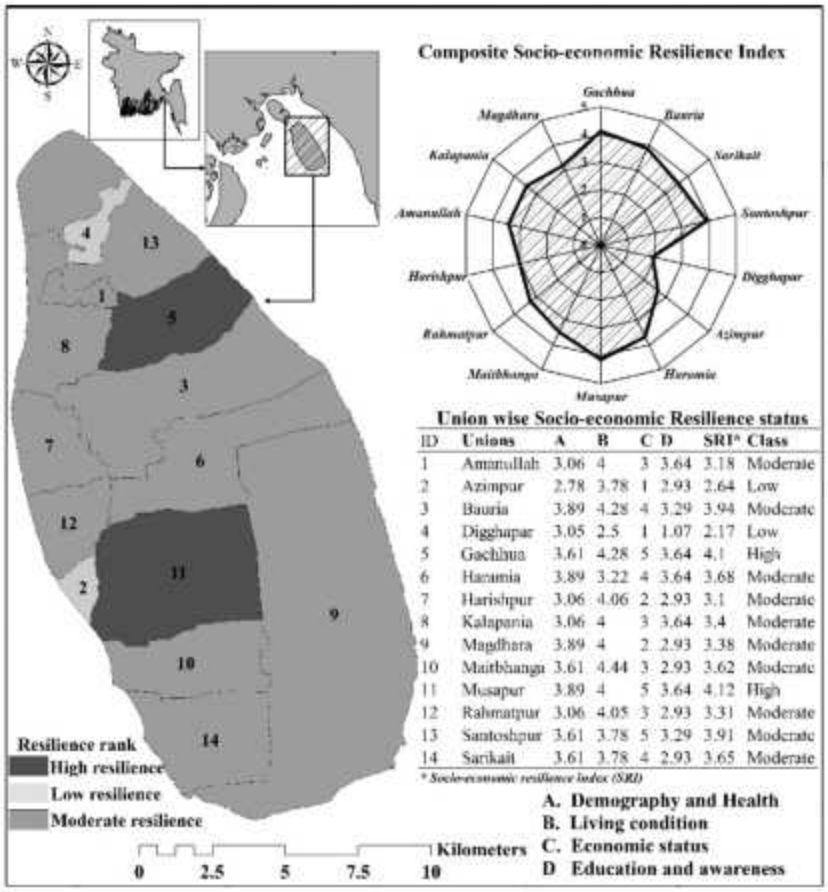

Fig. 3. Map showing the Union wise socio-economic resilience condition of the Sandwip Island, composite graph showing the resilience rank for each and individual Unions with the detailed statistics.

have been hovering on a slight altitude from moderate category, with composite scores of 4.10 and 4.12. Empirical experience does not, however, make a lot of difference between the moderate and low resilient areas. Most of the communities do not have sufficient resources to counter threats

arising from climate change induced vulnerabilities and the promotion of resilience requires external intervention in the identified areas of this research. Thus overall socio-economic resilience of Sandwip could be defined as fledgling. More than half of the population in *Digghapar, Azimpur, Harishpur, Amanullah, Rahmatpur, Magdhara, Kalapania* and *Maitbhanga* unions lived below the poverty line. It was found that government installed several service providing centers for health, education and other utilities. But callous attitudes towards maintenance, absence of strong civil society and destitution of majority in the community have thwarted the quality, availability and access to these services. Fishing has been a traditional occupation for many people of *Sandwip island*. But an undefined property right and increasing number of population has reduced fish catch by approximately 50% over the last decade. Gradual decay of the island from landslides have reduced cultivable land and housing areas. Most of the Unions had poor scores (highest was 3.64) in education and awareness category which demands the necessity of government interventions to be made in manual techniques. Rather than messaging people about hazard awareness, sending their children to school or becoming good citizens, it was rather suggested to be delivered by door to door movement of field workers, arranging group meetings and trainings and workshops etc.

Conclusion

An amalgamation of public perception with educated guess has eventually generated the resilience status of the coastal communities in *Sandwip island*. The theme of this study has been a greater sensitization of needs and priority based resource mobilization ultimately help vulnerable groups to adapt with changes as soon as it strikes while at the same time prepare the administration and policy makers to rationalize resource allocation process and initiate imminent planning in order to minimize the adverse impact of disasters. Moreover, comprehensive analysis of local level dynamics was made to provide deep insights to steer climate change adaptation policy with a focus on disaster risk management in a more sustainable direction. Coastal environment and communities are in a non-linear relationship that makes adaptation challenging and formidable task. Demarcation of communities in such areas is also difficult as the life and livelihood of people in an island are almost interrelated. Conceptual and practical ideas of resilience are dynamic entities that could not be measured or predicted unless monitoring mechanisms are developed to set in place. As a part of recommendation, we are suggesting several structural and non-structural measures. For instance, community infrastructures like transportation and communication need to be strengthened. Alongside communities of the study area require site specific adaptation measures by means of adequate and trustworthy training programs. However, all the aforementioned activities need to be balanced with the physical and ecological aspects of the island. Facing such theoretical challenges to develop compact ideas for providing real life solutions in climate change adaptation is still a journey to be made in the academia. Further research to identify local dynamics and time series analysis of field level data could sustain and promote socio-economic resilience of coastal communities in *Sandwip island* of Bangladesh.

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