Sea level rise induced impacts on coastal areas of Bangladesh and local-led community-based adaptation

Bishwajit Roy (biroy@fc.ul.pt), Tiago Capela Lourenço, Gil Pessanha Penha-Lopes.
cE3c – Centre for Ecology, Evolution and Environmental Changes & CHANGE – Global Change and Sustainability Institute
Faculdade de Ciências, Universidade de Lisboa, 1749-016 Lisboa, Portugal.

1. Introduction

Bangladesh is as a low-lying country, that is experiencing the effects of sea level rise (SLR) on many of its coastal ecosystems and associated livelihoods. Flooding, for example, is expected to worsen in the future for most of low-lying coastal countries (Jongman et al, 2012). Numerous studies have focused on the flooding aspects of SLR (Wong, 2014), but empirical studies that acknowledge local population's perceptions of multiple SLR induced physiographic impacts, as well as their effects on communities have not received the same attention. In this work we addressed how SLR has already impacted the lives and livelihoods of coastal communities in Bangladesh and how these have been responded by adopting different adaptative strategies and measures.

2. Profile of the study area

This study focused on two case study areas: Sutarkhali and Banishanta, two coastal Unions (lowest administrative unit in Bangladesh), both belonging to the Dacope Upazila (sub-district unit) of the Khulna District (Figure 1).

Geographically, they are located on the coast of the Bay of Bengal and inundated by diurnal tidal waves by the river Ganges in Bangladesh. Major livelihood activities include agriculture, fishing and the collection of non-wood forest products (NWFPs) from mangrove forests.

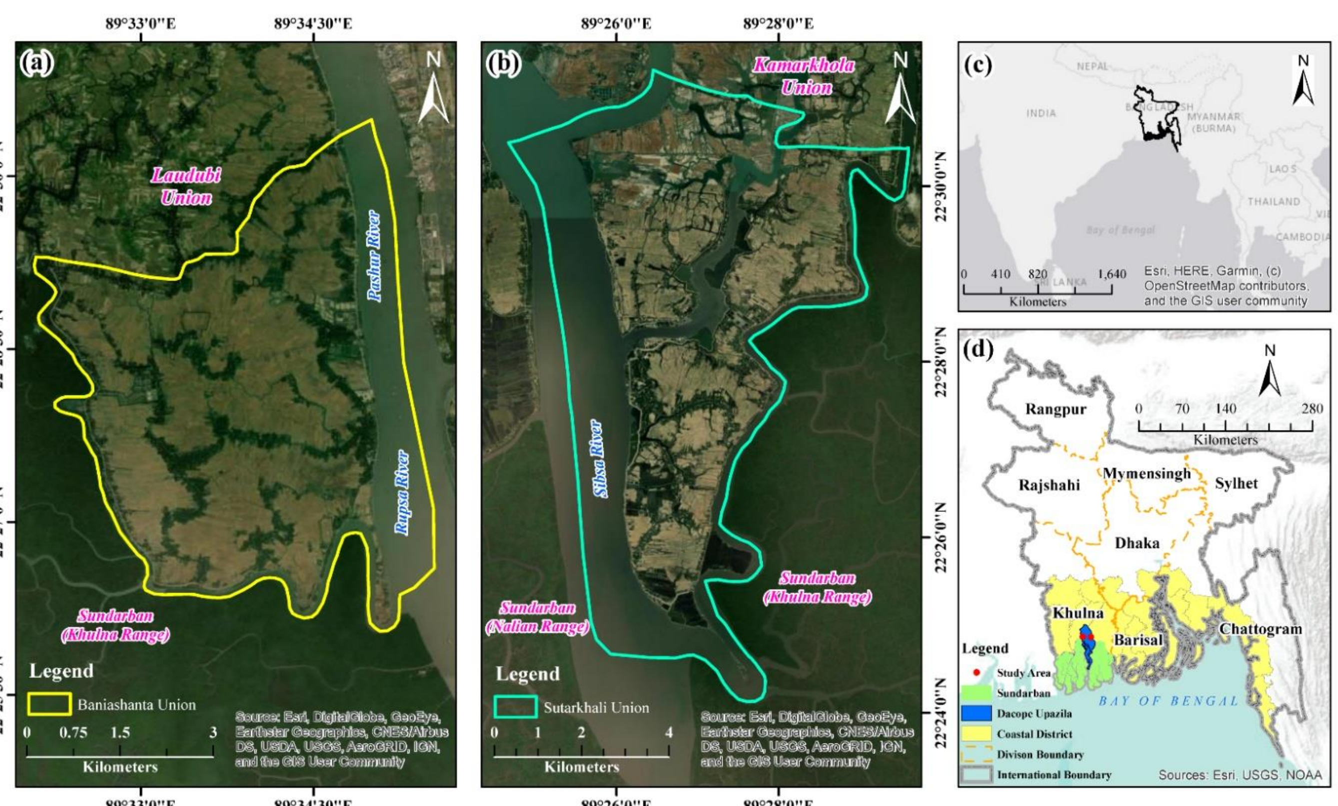

Figure 1: Location of the two case study areas: (a) Sutarkhali and (b) Banishanta, in (c) Bangladesh and its (d) administrative units.

3. Research methods

This study used a qualitative multistage sampling procedure to scope four villages (out of 23) in Banishanta, and three mohallas (out of 18) in Sutarkhali. These were selected for Focus Group Discussion (FGD) following a 20% sampling intensity. Two supplementary community meetings (CMs) here held to document additional views from an enlarged community perspective, complement and cross-check the FGD findings. Four different metrics were used to evaluate SLR induced impacts (Figure 2). Only severity ranking and problem ranking results are discussed here.

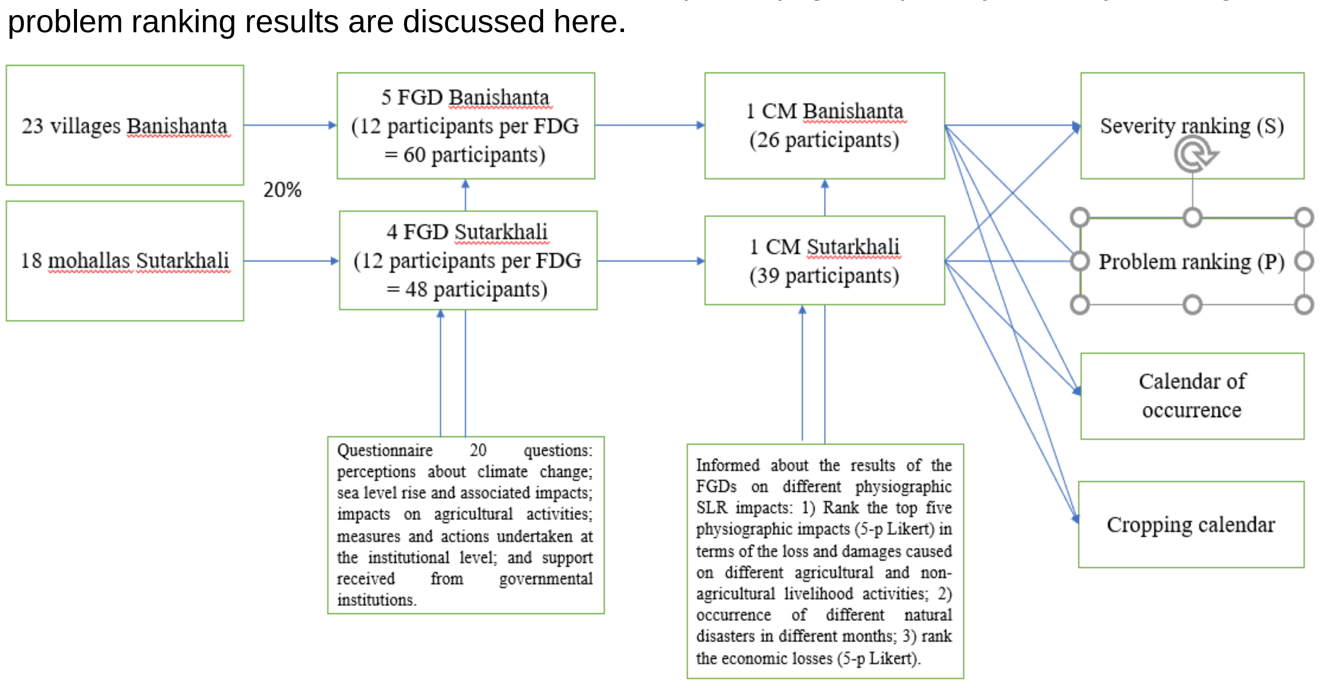

Figure 2: A schematic diagram of the research process highlighting data collection tools and evaluation metrics.

3.1. Analysis

$$Severity\ score\ (S) = \frac{1}{N}\sum_{j=1}^{j=5}(nL)_j \quad \text{(Eq 1)}$$

Where, N = Total number of participants, j is the severity level (i.e., 5 - very severe; 4 - moderately severe; 3 - severe; 2 - less severe; 1 - least severe), n is the total number of people selected in j^{th} category and L is the value of the severity level.

$$Problem\ ranking\ (P) = \frac{1}{N}\sum_{j=1}^{j=5}(nD)_j \quad \text{(Eq 2)}$$

Where, P stands for problem ranking, N = Total number of participants, j is the extent of damage (i.e., 5 - very huge loss; 4 - moderately severe loss; 3 - severe loss; 2 - less severe loss; 1 - least loss), n is the total number of people selected in j^{th} level and D is the value of the extent of damage.

4. Results

Participating groups showed different responses in terms of severity level towards five major physiographic impacts of SLR. Salinity increase was the most severe problem (4.85) and water-logging the least severe impact for both Sutarkhali and Banishanta (Table 1 and Figure 3).

Table 1: Sea level rise induced physiographic impacts and their level of severity according to the perception of local people from Sutarkhali and Banishanta Union.

	Sutarkhali (N=39)	Banishanta (N=26)	
	S	S	Fisher's p Value
Salinity increase	4.85	4.85	0.655
Land erosion	3.08	3.54	0.004
Rising water level	2.85	3.58	0.065
Emergence of char land	2.23	3.00	0.034
Waterlogging	1.95	2.23	0.000

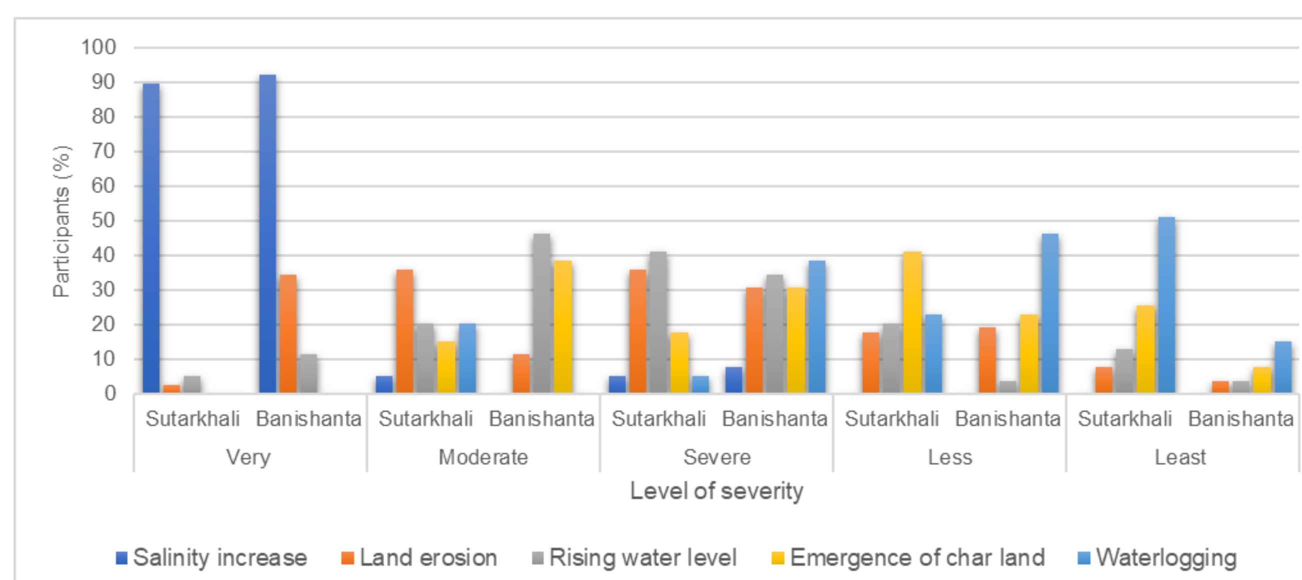

Figure 3: Severity level scoring of different SLR physiographic impacts in Banishanta and Sutarkhali as percentage (%) of responses by participants.

Sea level rise induced impacts had been generating different problems for the farmers to continue their agricultural activities. Table 4 lists the major problems along with the ranking.

Table 4: Major agricultural problems perceived by participants (problem ranking).

	Sutakhali	Ranking	Banishanta	Ranking	T- value	df
Salinity increase	5	1	4.6	2	0.571^{ns}	64.66
Pest infestation (vegetables)	2.6	4	4	3	-3.731***	38.01
Excessive fertilizer	3.8	2	2.4	6	-0.595^{ns}	37
Insecticides	2.8	3	2.8	5	0.638^{ns}	64.92
Pest attack in rice	3.8	2	4.8	1	-0.532^{ns}	56.84
Virus in water resources	2.6	4	3	4	3.495***	49.98
Lack of good quality seeds	2.8	3	4	3	-6.015***	52.11
Soil fertility decrease	2.6	4	4	3	0.513^{ns}	59.47
Waterlogging	2.6	4	2	7	4.87***	51.66
Excessive rain	1.8	5	1.4	8	-1.757^{ns}	30.69

5. Discussion

This study highlights the challenges and effects of each SLR physiographic impact on livelihood activities. It identifies that not only climate change induced SLR, but also anthropogenic activities intensify problems associated with physiographic impacts. For example, polder systems show both positive and negative effects.

Community perception is crucial for the successful implementation of planned adaptation including at the institutional level.

Application of traditional socio-ecological knowledge and local-led adaptation strategies are very effective to adapt to the impacts induced by climate change hazards like SLR.

6. Conclusions

SLR has been intensifying both physical impacts and agricultural problems for the case study areas.

Different types of impacts like salinity increase, water logging and land erosion are gradually decreasing agricultural production and making communities economically vulnerable.

Existing top-down measures are not achieving the desired benefits because they do not consider the local geographic context and community perceptions.

Future research should focus on livelihood insecurity arising from different SLR induced impacts and effects, and the role of indigenous knowledge on SLR vulnerability management.

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