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Climate Change and Vulnerability in Bangladesh

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It is predicted that climate change will aggravate the presence of sudden (e.g. cyclones, floods etc.) and chronic (e.g. drought, erosion) hazards to agrarian communities in Bangladesh. According to the Intergovernmental Panel on Climate Change (IPCC, 2001) the exposure, sensitivity and adaptive capacity to climate change determines the degree of vulnerability for a social or ecological system. The agrarian population in Bangladesh is ranked by many studies to be one of the most vulnerable in the world due to the poor socio-economic constituents, the unique geophysical location and its high exposure to climate change impacts (Ramamasy and Bass, 2007).

The current study attempted to quantitatively measure the vulnerability status of selected regions in Bangladesh impacted by climate change.

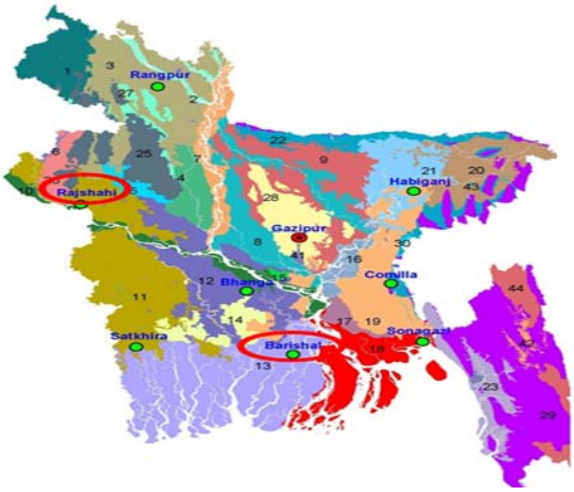

Figure 1. Selected study sites in Bangladesh

Three sub-regions (upazilas) were selected in the drought prone region of Rajshahi, while another three sub-regions (upazilas) were assessed in the saline-flood prone areas of Barisal.

The exposure, sensitivity and adaptive capacity of each upazila was measured through socio-demographic, agro-economic and infrastructural indicators indicated by the literature review and primary data sources from a household survey.

Vulnerability Indicators and Principal Component Analysis

Three groups of vulnerability indicators were introduced, corresponding to the areas of exposure, sensitivity and adaptive capacity, respectively. The Exposure group in Table 1 represents a set of various biophysical and technical indicators originated from RiceClima reports. It should be mentioned that the values of the Exposure indicators represent the weighted mean of a 30-years observations in the selected upazilas.

Table 1. Exposure indicators

Indicators	Unit
Mean Temperature for one year	Celsius
Mean Precipitation for one year	mm
Yield Loss compared to the potential yield without irrigation for T.Aus period	%
Yield Loss compared to the potential yield without irrigation for T.Aman period	
Indicated level of slight loss in % of years for T.Aus period	
Indicated level of moderate loss in % of years for T.Aus period	
Indicated level of severe loss in % of years for T.Aus period	
Indicated level of slight loss in % of years for T.Aman period	
Indicated level of moderate loss in % of years for T.Aman period	
Indicated level of severe loss in % of years for T.Aman period	
Net irrigation requirements for T.Aus period	mm
Net irrigation requirements for T.Aman period	
Net irrigation requirements for Boro period	

In Table 2, the Sensitivity indicators suggested for our study are displayed. As advised by the Bangladesh Rice Research Institute (BRRI), the growing of winter rice (boro) or keeping fallow land in winter time are considered as more sensitive practices to drought conditions than cultivating water resistant crops. Also, the small and tenant farmers are suggested by literature review to be suitable sensitivity indicators for agricultural vulnerability assessments (Biswas et al., 2009).

Table 2. Sensitivity Indicators

Indicators	Unit
Cropping Pattern Boro - Fallow-T.Aman	%
Cropping Pattern Fallow-T. Aus-T.Aman	
HYV Boro	tn/ha
Small Farmers	%
Tenancy Farming	

Note: Tn/ha= Tonnes per hectare, HYV= High Yield Variety

Finally, the Adaptive capacity indicators are displayed in Table 3 as below:

Table 3. Indicators of Adaptive Capacity

Indicator	Unit	Indicator	Unit
Socio-Demographic		Access to brick-made housing and electricity	Nos.
Mean age of adult family members	Years	Community clinics per population	
Mean schooling years of adult family members	Nos.	Post services per population	
Mean Farm experience	%	Veterinary centers per population	
Mean Family Size	Nos.	Cooperatives per population	
Owning Farmland	%	Agricultural extensions per population	
Agro-Economic		Financial schemes per population	
Mean Farm size per household	Ha	Schools per population	
Ratio between gross cropped area and cultivated land	%	Colleges per population	
Benefit Cost Ratio crops/ha	Nos.	People migrating to the upazila per population	
Livestock amount		Distance from local markets	Km
Mean income per household	Tk/hsd	Distance from bigger markets	
Infrastructural		Distance from Hospitals	
Access to tubewell and Latrine	Nos.	Distance from towns	

As presented in Table 3, 5 indicators are attributed to the socio-demographic situation, 5 indicators describe agro-economic activities and 15 indicators refer to infrastructure access.

The relatively small number of agro-economic indicators is due to the summation of individual indicators in some cases.

The adaptive capacity should be enhanced which actually represents the potential of a system to better adapt in climate change. In other words, the higher the adaptive capacity, the lower the vulnerability is. On the contrary, an increase in the exposure and sensitivity indicators means a higher level of vulnerability. In simple mathematical terms, the vulnerability is presented as below:

V=A-(E+S)… (1) where

V = Vulnerability, A= Adaptive Capacity, E = Exposure, S = Sensitivity

The Principal Component Analysis (PCA) technique was used for the vulnerability assessment in the two study regions. The objective of PCA is to analyze potential relations between a large set of independent variables (in our case indicators) with a latent dependent variable - which in our case is the vulnerability level of each upazila.

Results

The findings at upazila level indicate that the lowest adaptive capacity is representented in Amtali, followed by Kalapara, both of which are situated in the flood-saline prone Barisal region. This could likely be attributed to the low mean annual income and the poor performance of infrastructural indicators in these two upazilas. The poor infrastructure could also be in part responsible for the low adaptive capacity score in Patharghata upazila located in the Barisal region, while the small farm experience seems to be a contributor as well. However, the other socio-demographic and agro-economic vulnerability indicators perform much better in Patharghata than in the two other upazilas of the Barisal region and thus Patharghata shows a better adaptive capacity result.

The adaptive capacity indicators for Godagari upazila in drought prone Rajshahi region are

Photo 1. Silted and saline areas at Patuakhali, Barisal

remarkably lower than for the other two upazilas in Rajshahi. However, all three upazilas in Rajshahi score better in terms of adaptive capacity than the examined upazilas in the Barisal region. The lower score for Godagari can be explained due to limited access to household facilities (sanitation, water, electricity). The high scores of Tanore and more distinctively of Gomastapur upazilas in Rajshahi appear to be the result of better performance for most of the socio-demographic and agro-economic indicators.

Conversely, all the drought-prone Rajshahi upazilas attain remarkably low scoring in the exposure and sensitivity indicators which counterbalances the positive performance in terms of adaptive capacity.

This can be attributed to the unfavourable climatic conditions for irrigated agriculture, recorded for the last 30 years, which have hindered agricultural production to a large extent. On the contrary, the higher precipitation in the flood-saline prone Barisal region and the much lower reliance on irrigation has resulted in lower production losses.

Overall, by subtracting the exposure and sensitivity from adaptive capacity it seems that Patharghata but also Kalapara upazilas of the Barisal region are shown to be less vulnerable to climate change impacts (Figure 1). Amtali upazila, although belongs to the Barisal region, seems to perform worse than Tanore and Gomastapur upazilas in the Rajshahi region. The scoring of Godagari's vulnerability is noticeably the lowest among all examined upazilas.

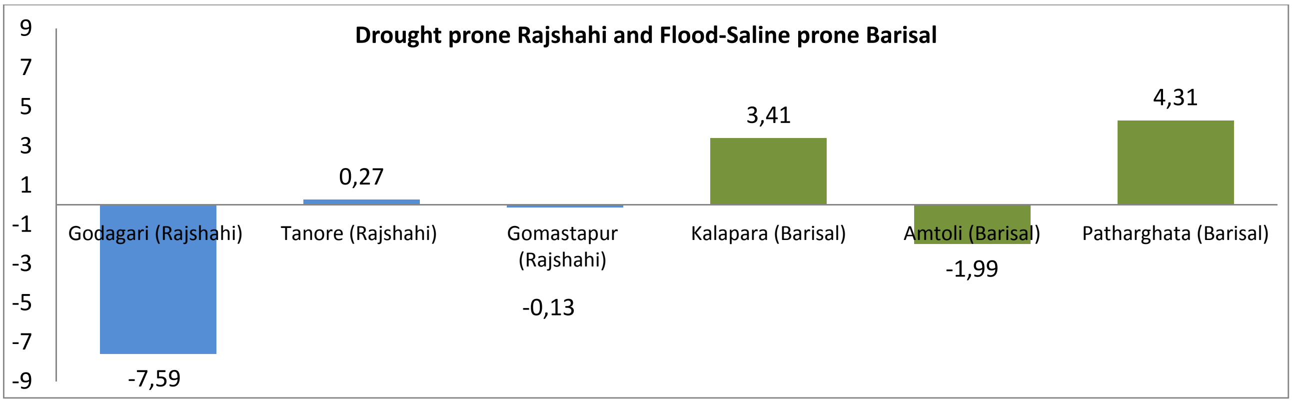

Figure 2. Vulnerability Levels in Rajshahi and Barisal regions

Policy Recommendations

The findings for the drought prone Rajshahi region signified the poor performance in exposure and sensitivity indicators which is much attributed to the increasing water demand for irrigation purposes and the relatively lower rainfall than Barisal.

The groundwater dependent HYV boro rice cultivations in Rajshahi region seem to lack of sufficient irrigation while the situation will get worsen if the current cultivation trends will continue. More efficient irrigation schemes should be developed to meet the current demand while better drought resistant rice varieties should be introduced. Further, a poor access to household facilities also obstructs the adaptive capacity of drought prone Rajshahi upazilas to a certain extent. To this end, there is a need to improve the access to household facilities by providing economic incentives to the local farmers.

The poor access to household facilities and moreover to infrastructure is much more distinguished in flood-saline prone Barisal region. The current infrastructural conditions stagnate the local economy and obstruct any improvement in farmers' livelihoods. The transportation conditions are reported also from other studies to be the major bottleneck of the current situation (Brouwer et al., 2007).

Some strong initiative should be taken on a state level to fundamentally improve the infrastructure in Barisal and help in increasing farmers' income.

It is aspired that the current study could be used as a benchmark analysis for the assessment of vulnerability from climate change in Bangladesh and a knowledge platform for further detailed studies.

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