An assessment of the livelihood vulnerability of climate induced migrants: A case study on Sagar Island, India

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Abstract

The effects of climate change are causing large scale human displacements all over the World over past few decades and climate refugees are putting biggest challenges to the geophysical biological and social system. This paper attempts to assess the vulnerability of both the refugee and regular settlers of selected mouzas of Sagar Island, south 24parganas, India where people are witnessing their lands vanishing under their feet in these constantly sinking and shrinking deltaic estuaries. Findings of LVI and LVI-IPCC analysis indicate that the climate induced migrant communities are more exposed to climatic variability due to poor adaptive capacity. Poor access to food, water, health facilities are making them extremely vulnerable with lower resilience as these mouzas are facing frequent flooding, severe coastal erosion, embankment breaching and higher storm surges on an annual basis. The outcomes of this study could be beneficial for effective on site risk management, adaptation strategies and further planning propositions.

Introduction

The effects of climate change are causing large scale human displacements all over the World over the past few decades. With a rise in both rapid-onset extreme events and slow onset climate phenomena, people are more and more forced to leave their habitat and migrate elsewhere. These climate induced migrants; climate refugees are putting biggest challenge to the humanity as climate change can jeopardize many geophysical, biological and social system (Zhang et al,2008).

Over 19.3 million people were displaced worldwide in 2014, which could be one billion by 2050 (Internal Displacement Monitoring Centre, Geneva). The most vulnerable groups are poor in the coastal areas and small islands of developing countries due to their poor adaptive capacity and lack of sustainable livelihoods which demand broader aspects of effective governance and management policies. The 16th session UNFCC 2011 has called for a better understanding of this looming crisis from the angle of human rights of these socially disposed and displaced people (Zhang et al 2008).

Livelihood vulnerability to climate change is a product of both bio-physical and social factors (Cutter et al, 2000). Bio-physical vulnerability emerges from the exposure of communities to climate changes, while social vulnerability is the product of those factors that make communities more susceptible to such phenomena (shah et al, 2013). Landmark research on climate change has correlated such phenomena with a greater disruption of food, water, health and livelihood security (FAO, 2007) of the individuals, households and community concerned (Dankelman, 2010). IPCC warned in 2014, that the low-lying coastal areas will continue to experience sea level rise, increasing winter temperature, intensification of cyclones. Coastal flooding, salt water intrusion and loss of land and mangroves (IPCC, 2014)

This imprints of despair are evident in the Sundarban where the fragility of the ecosystem, underdevelopment and an over dependence of the people on climate sensitive substance have made the

population more vulnerable (Ghosh, 2012). World's largest contiguous mangrove forest, a UNESCO World Heritage site and one of the mostly modified and highly vulnerable deltaic estuaries in the World is already reeling under the impacts of climate change in the form of more turbulent seas, increasing salinity and frequent storm surges. Indian Sundarban originally consisted of 102 islands but now 98 islands are in existence as 4 I islands have been submerged and nearly 6000 families turned into environmental migrants (WWF India, 2009). Due to accelerating rate of sea level rise, embankment breaching and coastal erosion nearly 1.4 million people in 53 Islands are facing serious threats of becoming homeless. Some Islands are fast vanishing from the map causing thousands of people displaced from their original habitat. (Mitra et al.) The level of sea around the island is rising at an alarming rate of 2.36 mm per year, higher than Global overage of 2.0 mm year. Based on the current habitation and density, by 2020, more than 30,000 people residing in Sagar Island will be displaced from their habitat. (S. Hazra, 2002). People of these constantly sinking and shrinking landmasses are also threatened by unmanageable demographics, large scale poverty, marginalized livelihoods and limited economic development.

Globally, research concerning the human dimensions of environmental change and policy formation applies vulnerability assessment methods to identify vulnerable areas and population to frame and implement policies for possible mitigation and disaster risk reduction (Erickson et al, 2011, Abson et al, 2012, Mondal et al, 2018). Flagship studies have already been assigned vulnerability in the context of climate change and outlined its main components as Exposure, Sensitivity and adaptive capacity. Exposure is the extent to which a system is in contact with a change in climate; sensitivity is the degree to which the community is affected by the exposure and adaptive capacity is the system's ability to withstand or recover from the change in climate (Ebi et al, 2006; Pandey et al, 2014). Livelihood vulnerability Index (LVI) developed by Hahn et al, (2009) following the IPCC livelihood vulnerability framework is one of the most effective methods used by researchers World Wide. It provides a precise indication of a household's ability to maintain sustainable means of living (Chambers & Conway 1992). Though the complex phenomena of climate change have been generalized by the vulnerability indices, the advantage of such assessment is its instrumentation. As this can be used to determine and evaluate policy requirements, adaptation strategies and mitigation of climate risks.

Recent research works on Sagar Island have explored aspects like environmental hazards, shoreline change, coastal erosion, degradation of ecosystem, depletion of mangroves. Realizing the need of better understanding of the impact of climate change on livelihood vulnerability in Sagar Island, the present study is an attempt to compare the cumulative effects of natural hazards, storm surges, coastal erosion, embankment breaching on the livelihood vulnerability of regular and refugee population of the Gangasagar Gram Panchayat of Sagar Island under the Indian Sundarban.

The LVI carries multiple indicators to assess the exposure of the community to climate variation and natural disasters through the perception survey in selected mouzas. Current health and food status, water resource characteristics are calculated to determine the adaptive capacity. This evaluative study on the degree of vulnerability of two distinctive communities to climate change can be used to formulate

appropriate adaptation strategies for the government and non-government organization to address area and community specific intervention and policy development.

Study Area

The study area is the GangaSagar Gram Panchayat in the Sagar block of Kakdwip sub-division of South 24-Parganas district of India. Sagar Island, the largest Island in the Sundarban is part of a tidally active delta formed by alluvium of Ganga and Brahmaputra and their tributaries.

These low lying marshy alluvial plains are still in the process of being formed and reformed by continuous siltation and tidal erosion. Land reclamation started in 1811, under the British rulers. The total geographical area of the Pahchayat consisting of 8 mouzas namely Sagar (dialuvated), Beguyakhali, GangaSagar, Mahismari, Chandipur, Bishnupur, Natendrapur, and Narayani Abad is 41.27sq km. There are 2030 houses and total population of 10,340 in Gangasagar mouza. Sex ratio is 978, literacy rate is 83.56% and poverty ratio is 44.46% (2011 Census). Out of 3755 total workers, 1498 people are marginal workers. Majority of population make out a precarious living on this flood and cyclone prone land by farming, fishing, collecting prawn seeds. Marginal workers depend on seasonal tourism during the annual fair at Gangasagar and for the rest of the year they become daily laborers. After 2009 cyclone Aila, agricultural lands became barren and converted into aquaculture ponds due to saline water intrusion.

Table-1: Study area at a glance

Mouza	Gram Panchayat	Block	Area (sq.km)	Population	Population density
Gangasagar Beguyakhali	GangaSagar GangaSagar	Sagar Sagar	12.25 6.49	10340 5683	844 876

Source: Gangasagar Bakhali Development Authority & Census 2011

Objectives & Methodology

Greater exposure to climate-driven hazards and a high dependency of rural people on a rain feed agrarian economy means the island for a significant part of the global climate change debate and discussions (Mondal and Chowdhury, 2015, Mondal et al.2017)

The main objective of this study is to investigate the impact of climate change on migration, assess their socio-economic vulnerability, associated problems, and evaluate rehabilitation strategy, policy response and suggest effective adaptation measures.

On the basis of District Disaster report, World Bank report, consultation with expert officials and local indigenous people, two mouzas of Gangasagar Gram Panchayat were selected to comprise the reviewed area. Extensive primary field surveys with secondary official data were collected to identify the immigrated areas, where they were resettled on rayati lands from 1980s.

The mouzas located in the South-Estern part of th Gangasagar Gram Panchayat, i.e. Beguyakhali and part of Mahismari have experienced greater erosion compared to the rest of the mouzas. Both the random and purposive sampling techniques were applied to collect household data of regular and refugee settlers of Gangasagar and Beguyakhali mouza as rest of the mouzas is not affected by climate induced migrant population. Structured questionnaires were prepared to survey 15 percent of the households with no bias correction because of the homogenity of the population. This comparative analysis survey was conducted from May-July 2019 on socio-demographic profile, livelihood strategies, health, food water, social security, natural disaster and climatic variation indictors of the selected sample population.

The Landsat2(MSS)1977, Landsat5(TM)1989, Landsat8(OLI)2017 were used to identify changes in shoreline and current land use pattern in the study area and maps were prepared using Arc GIS 10.2.1.

The livelihood vulnerability Index (LVI) proposed by Hahn et al. (2009) following IPCC vulnerability framework was adopted in this study. Each major component has various sub components and each sub component contributes equally to the overall index (Table-4). The results are evaluated on a scale of 0 (least vulnerable) to 1 (most vulnerable). A balanced weighted approach was followed for the LVI calculation (Hahn et al., 2009; Pandey and Jha, 2012). The values were standardized as:

Sd = (Sd – S min) / (S max - S min)

Where Sd is the original sub-component for an area d and S min and S max are the minimum and maximum values for each sub-component. After being standardized, the sub-components are averaged by following:

$$\mathbf{Md} = \sum_{i=1}^{n} \mathbf{Sdi} \,/\, n$$

Where Md is one of the eight major components for an area d, Sdi denotes the sub component, indexed by i and n indicates number of sub component for the major components. Once the values of each of the eight major components are calculated, they are averaged to obtain the LVI using.

$$\mathbf{LVI\ d} = \sum_{i=l}^{n} \mathbf{Wmi\ x\ Mdi} \;/\; \sum_{i=l}^{n} \mathbf{Wmi}$$

Where LVl d is the LVI score of the area d and Wmi is the weight given by the number of sub components that make up major component i.

The LVI-IPCC differentiate from the LVI by IPCC vulnerability definition as the major components re combined. (1) Exposure of the community is measured by their perception of natural disasters and climatic variation. (2) Sensitivity is measured by the assessments of food, water, health and security

indices. (3) Adaptive capacity is quantified by assessing the socio demographic profile, livelihood strategies and social safety. This score varies from - 1 (least vulnerable) to 1 (most vulnerable) and is calculated as:

$$\mathbf{CFd} = \sum_{i=l}^{n} \mathbf{Wmi\ x\ Mdi}\ \ / = \sum_{i=l}^{n} \mathbf{Wmi}$$

Where CFd is a contributing factor (exposures sensitivity or adaptive capacity) for mouza d, Mdi are major components for area d indexed by i, Wmi is the weight of each major component and n is the number of major components in each contributing factor. Once the exposure, sensitivity and adaptive capacity were calculated, these three are combined using:

$$\mathbf{LVI - IPCC\ d = (ed - ad)x\ sd}$$

Where LVI-IPPC is the LVI for mouza d, ed is the exposure score for area d, ad is the adaptive capacity score for area d and sd is the sensitivity score for area d.

Result & Discussions

Climate Change and its Impact on Migration:

The impact of continuous erosion and accretion process on human activity and resource utilization patterns is mostly felt along the coastal zones of island systems (Hazra et al, 2017). The study area faced considerable changes in shoreline from 1978 to till date. Heavily eroded vulnerable embankments of Beguyakhali are causing people to move towards interior.

There has been a change in land use pattern due to land loss in the coastal areas. Overall decrease in agricultural land, vegetation and increase in settlement, inundated land is evident. Vanishing lands mean displacements and loss of livelihoods. But the state government is yet to come up with a sustainable and coherent resettlement policy. Refuges from Lohachara and lost bits of Ghoramara and some other mouzas currently add up to almost 6,000 in no. The local government, Sagar block administration has been resettling them on vested land with two to one-sixth acres per family.

Table-2: Resettlements of climate migrants

Resettled in Rayati Settlements of	Emigrated from	Alotte (no. of families)	Area allotted per family in Acres
Gangasagar (Gangasagar Colony)	Lohachara	154	1.30 .05
	Ghoramara	142	.05
	Boatkhali	78	.05
	Mousuni Island	20	.05
	Mahismari	80	.05
			.05
Beguyakhali	Beguyakhali Embankment side	35	.05

Source: Primary Survey and BLRO, Sagar

The paddy grown on these tiny plots fails to feed them for more than a few months. Due to lack of industries or other organized employment options, even regular settlers have to rely on daily wage labor or take up manual jobs in big cities. Around 40% of the population has at least one male member working outside. Household survey revealed that almost 70% of the migrants have lost their original livelihoods for coastal flooding and inundation. Before migration they had 4-5 acres of agricultural lands on an average but now most of them have been turned into seasonal opportunistic laborers.

Table-3: Loss of original livelihoods

Change in livelihood	Percentage
Agriculture to daily wage labour	22.76%
Fishing to daily wage labour	8.22%
Original livelihood to opportunistic livelihood	35.32%
Student to child labour	2.35%
Casual labour / agriculture to small business	1.07%
No change in livelihood	30.28%

Source: Primary Survey,2019

Researchers ascertain that Sagar Island is likely to lose another 15% of its lands by 2020. With increasing pressure of refugees smaller parcels of land have been allotted to them over the years. Residents of the refugee colonies say that they are facing the grievance about reduced farm lands, depleted vegetation cover and how they are putting pressure on the Island's resource and ecological balance. Moreover, in coming 10-15 years, remaining 5,400 residents of Ghoramara and some more from surrounding will come for rehabilitation putting significant threat to the existing settlers. Though all measures of

rehabilitations so far have been on ad-hoc basic without any inclusive management plan. Climate induced hazards have been effecting the basic facilities of food, shelter, health, education, drinking water and minimum infrastructural support here.

Table 4: Indexed values for Livelihood Vulnerability Index (LVI) of the two mouzas on Sagar Island

Components	Beguakhali		GangaSagar	
	Regular	Migrant	Regular	Migrant
1. Socio-Demographic Profile	**0.47**	**0.434**	**0.461**	**0.483**
Dependency ratio	0.395	0.385	0.308	0.37
% of female-headed HHs	0.025	0.079	0.17	0.161
% of HH where head of family did not attend school	0.321	0.195	0.45	0.192
% of HHs where head is the only earning member	0.632	0.628	0.657	0.765
Average number of family members in a HH	0.498	0.49	0.39	0.45
% of HHs with a non-climate-resilient home	0.95	0.83	0.795	0.961
2. Livelihood Strategy	**0.56**	**0.697**	**0.409**	**0.562**
% of HHs where family members migrate for work	0.618	0.723	0.585	0.57
% of HHs dependent on natural resources	0.918	0.998	0.449	0.984
% of HHs where agriculture is the main source of income	0.402	0.632	0.272	0.42
% of earning members in a family	0.302	0.435	0.333	0.277
3. Health	**0.547**	**0.501**	**0.165**	**0.515**
% of HHs who find it difficult to reach health facilities	0.825	0.95	0.79	0.96
% of HHs whose family members died without treatment during natural hazards	0.22	0.205	0.313	0.232
% of HHs without a sanitary latrine	0.452	0.692	0.192	0.802
% of HHs where members suffer from illness	0.48	0.578	0.728	0.505
% of HHs not visiting doctors during illness	0.76	0.081	0.482	0.076
4. Food	**0.804**	**0.78**	**0.086**	**0.785**
% of HHs that do not get food from the family farm	0.498	0.479	0.79	0.572
% of HHs reporting decreasing regeneration of green leafy vegetables	0.575	0.798	0.743	0.695
% of HHs losing agricultural land	0.65	0.852	0.79	0.967
% of HHs reporting decreasing agricultural production	0.794	0.639	0.623	0.615
% of HHs reporting increasing food insecurity during natural disasters or other climatic events	0.805	0.98	0.586	0.921
% of HHs reporting decreasing fish production	1.503	0.933	0.827	0.944
5. Water	**0.515**	**0.706**	**0.538**	**0.666**
% of HHs who walk more than 2 km to reach a water source	0.372	0.732	0.515	0.691
% of HHs using unsafe water for drinking, cooking, bathing and washing	0.542	0.768	0.652	0.886
% of HHs reporting water conflict	0.632	0.62	0.448	0.423
6. Social Safety	**0.397**	**0.542**	**0.578**	**0.523**
% of HHs who do not receive assistance from a social network	0.015	0.185	0.413	0.035
% of HHs who do not receive assistance from the Government	0.948	0.825	0.93	0.926
% of HHs who do not receive assistance from NGOs	0.91	0.95	0.966	0.963
% of HHs who do not use mobile phones for communication	0.002	0.032	0.201	0.002
% of unaware HHs	0.112	0.43	0.384	0.69
7. Natural disasters	**0.45**	**0.463**	**0.723**	**0.596**
% of HHs reporting increased frequency and intensity of storm surges and tidal surges	0.941	0.662	0.791	0.895
% of HHs with an injury or death as a result of natural disasters	0.153	0.178	0.588	0.232
% of HHs with an injury or death to their livestock as a result of natural disasters	0.123	0.479	0.481	0.46
% of HHs with losses of physical assets	0.952	0.928	0.966	0.914
% of HHs that do not receive warning before a natural disaster	0.082	0.072	0.793	0.482
8. Climatic Variation	**0.706**	**0.898**	**0.641**	**0.877**
% of HHs reporting a change in summer temperature	0.842	0.972	0.802	0.96
% of HHs reporting a change in winter temperature	0.631	0.612	0.648	0.655

% of HHs reporting variation in monsoon precipitation	0.895	0.972	0.66	0.806
% of HHs reporting a change in winter precipitation	0.842	0.997	0.712	0.983
% of HHs reporting a change in the frequency of floods	0.323	0.939	0.383	0.981
Score	**0.562**	**0.62**	**0.475**	**0.678**

HH; Household NGO; Non Governmental Organisation

LVI Analysis:

Table :4 displays the values of the main components and standardized sub-components for the comparative LVI analysis of refugees (resettled) and regular settlers of Beguyakhali and Gangasagar mouzas of Ganga Sagar G.P. Higher the index value, higher is the vulnerability and vice versa. Higher vulnerability are observed in refugee settlers of Gangasagar (0.078) and Beguyakhali (0.620), while the regular settlers project lower vulnerability in overall LVI score.

In the index of socio-demographic profile refugee settlers of Gangasagar are more vulnerable (0.483) while in livelihood strategy, refugee settlers of Beguyakhali show more vulnerability (0.697). Inadequate access to health services tends to increase the health index and increase the vulnerability among the refugee settlements. Food security builds resilience to external stressors like extreme climate events. Regular settlers of Beguyakhali have the higher vulnerability (0.804) followed by refugees of Gangasagar (0.785) as the southern parts of Sagar and Beguyakhali have been heavily eroded. The vulnerability index of the water component of LVI showed that refugee settlers are more vulnerable than the regulars due to scarcity of consistent supply and raised water conflict.

In terms of social network refugee community reflects more vulnerability in seeking assistance from local Govt. authorities. Index of natural disaster shows almost same higher vulnerability in both the refugee and regular settlers, while Gangasagar mouza recorded greater vulnerability to the average number of natural hazard events.

The results revealed that both the mouzas are vulnerable to the effects of climate change and variability but the vulnerabilities vary within the settlers which reflect that refugee settlers of both the mouzas are more vulnerable to climate change.

Table:5 Livelihood Vulnerability Index LVI-IPCC

Contributing factors for the two Mouzas on Sagar Island

	Beguyakhali		GangaSagar	
	Regular	Migrants	Regular	Migrants
Exposure	0.578	0.68	0.682	0.736
Sensitivity	0.65	0.7	0.211	0.663
Adaptive Capacity	0.409	0.54	0.486	0.517
LVI-IPCC Score	**0.07**	**0.098**	**0.041**	**0.145**

The LVI-IPCC estimates of vulnerability, which combines degree of exposure sensitivity and adaptive capacity of a community reflects that the refugee population in both the mouzas are not resilient to the climate change situation.

Table :5 Shows that the adaptive capacity of both the population varies from 0.409 to 0.540, the degree of exposure and sensitivity is making the refugee population of both the mouzas are more vulnerable. This LVI-IPCC analysis shows that the resettled refugee population of Gangasagar are highly vulnerable (0.145), followed by the same of Beguyakhali (0.098), whereas the regular population of those mouzas reflect moderate vulnerability with 0.041 and 0.070 score respectively. If both the LVI & LVI IPCC indices are compared, resettles of both mouzas scored maximum as they have experienced severe embankment breaching flooding and coastal erosion.

Interpretation and Suggestion:

This study reveals that a high percentage of households have very low climate resilience with increasing effects of storm surges and embankment breaching. Houses located in marginal areas are damaged every year and people have to live on embankments during the flooding period. Though the Aila and die pitching embankment construction have been completed in these mouzas.

It can be concluded that strengthening socio-demographic profile and diversification of livelihood options can lead to better adaptation in reducing physical as well as economic vulnerability of the community. Providing trainings of pisciculture, poultry farming, dry fish preparation, artisans and crafts, making small credits and loans easily available can induce self-employment. Quantity and quality development of basic infrastructure & facilities i;e health care, education, drinking water, transport and communication is utmost required to reduce vulnerability of these migrated people.

Conclusion

This study analyzed and compared the vulnerability of lives and livelihoods of migrant and regular settlers of Gangasagar gram panchayat of Sagar Island through LVI and LVI-IPCC index scores. People of this constantly shrinking and shrinking landmass of Sundarban have been watching the ground slip away from beneath their feet. The mouzas that experience severe erosion, tidal ingression, embankment breaching, flooding scored high vulnerability index values. The climate refugees of these mouzas are more critically vulnerable with their poor socio-demographic profile, livelihood status, less social security, water and food insecurity, lower health status, higher exposure to climatic variation and environmental hazards.

The findings of this study in identifying which sector requires which special management could be helpful to the planning and development authorities to find out foolproof adaptation strategies for these climate induced migrants of Sagar Island.

Declarations

Competing interests:

The authors declare no competing interests. I had full access to all of the data in this study and I take complete responsibility for the integrity of the data and the accuracy of the data analysis.

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Figures

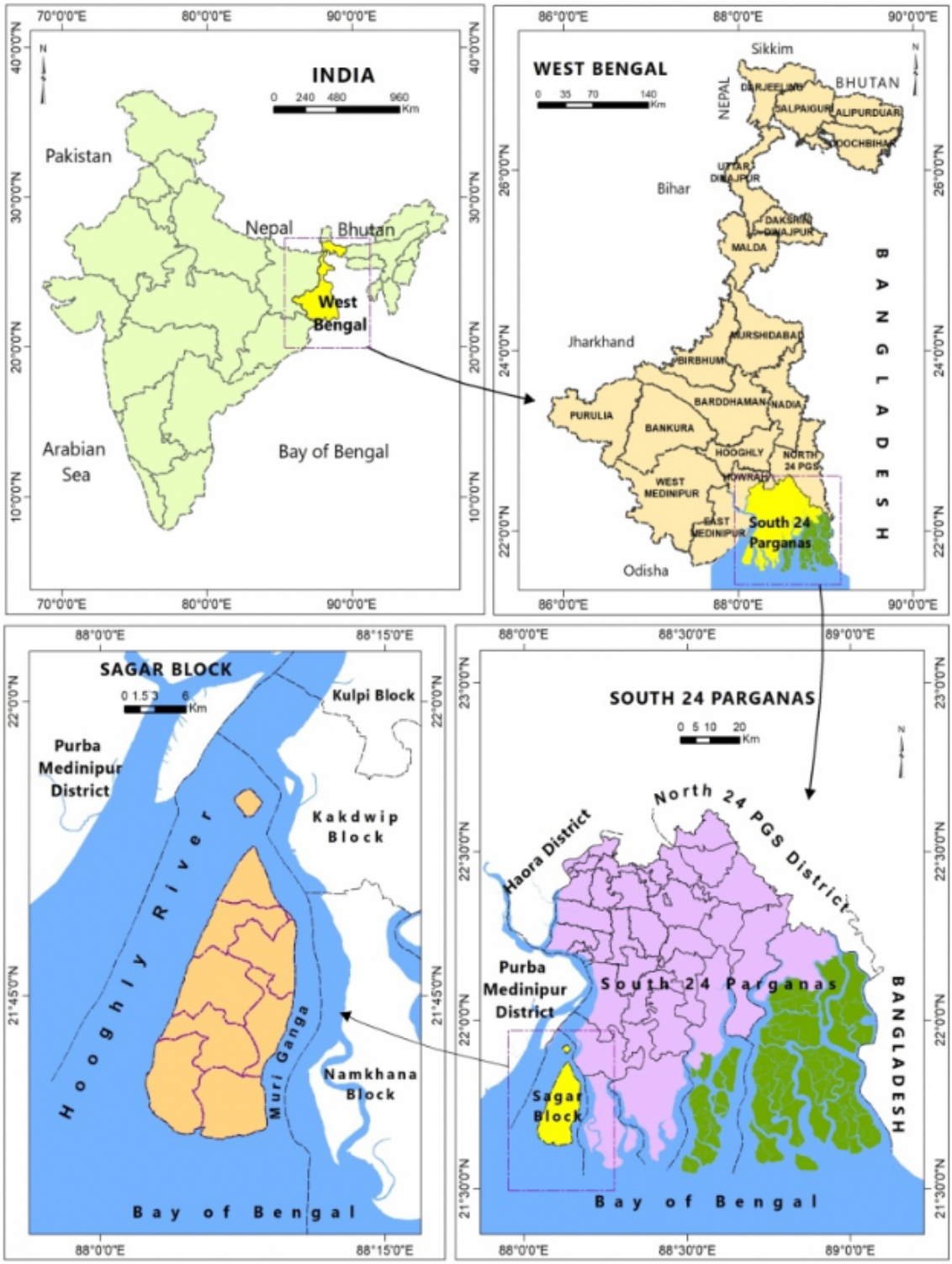

Figure 1

Study area

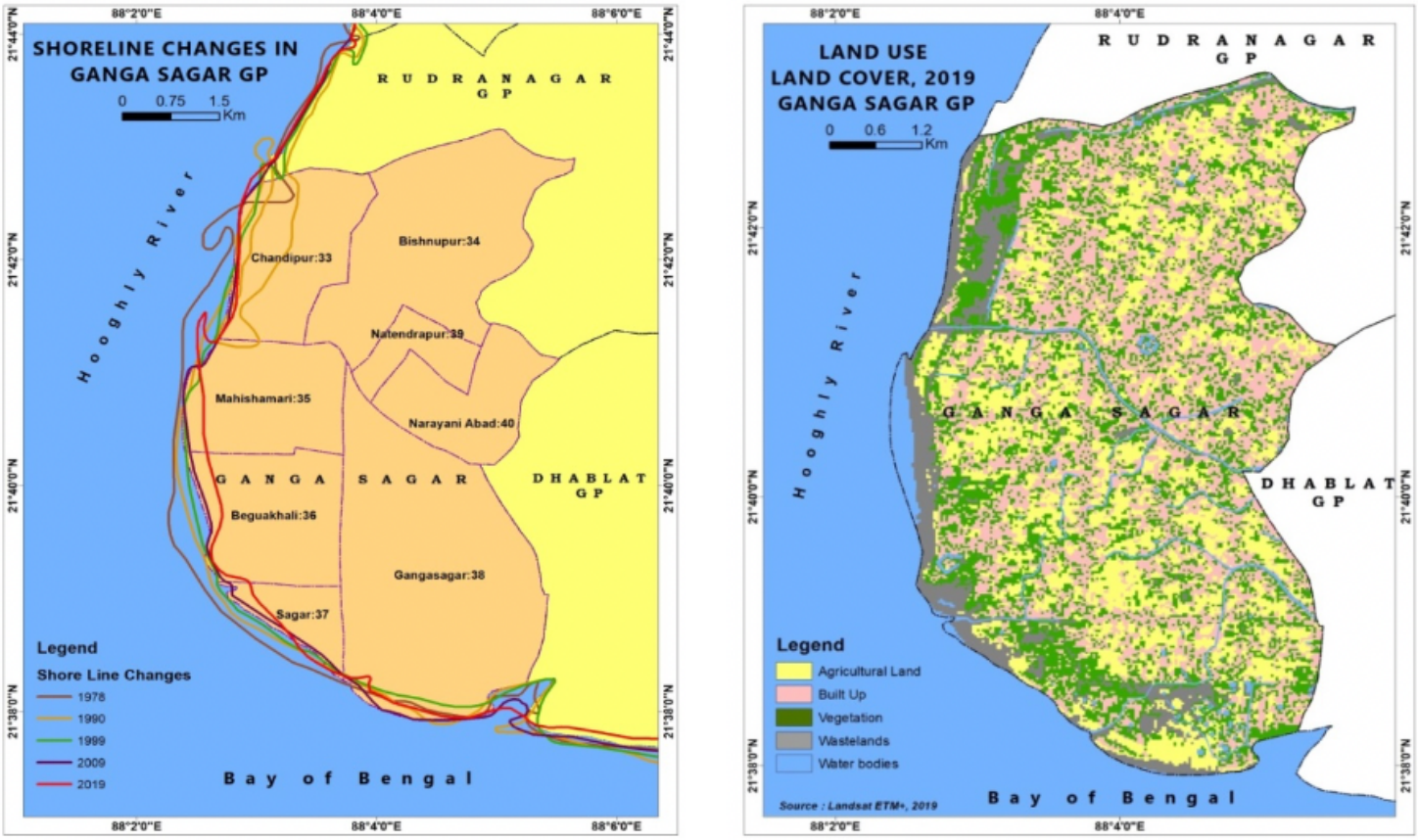

Figure 2

Shoreline Change (1978-2019) and LULC map of Ganga Sagar GP

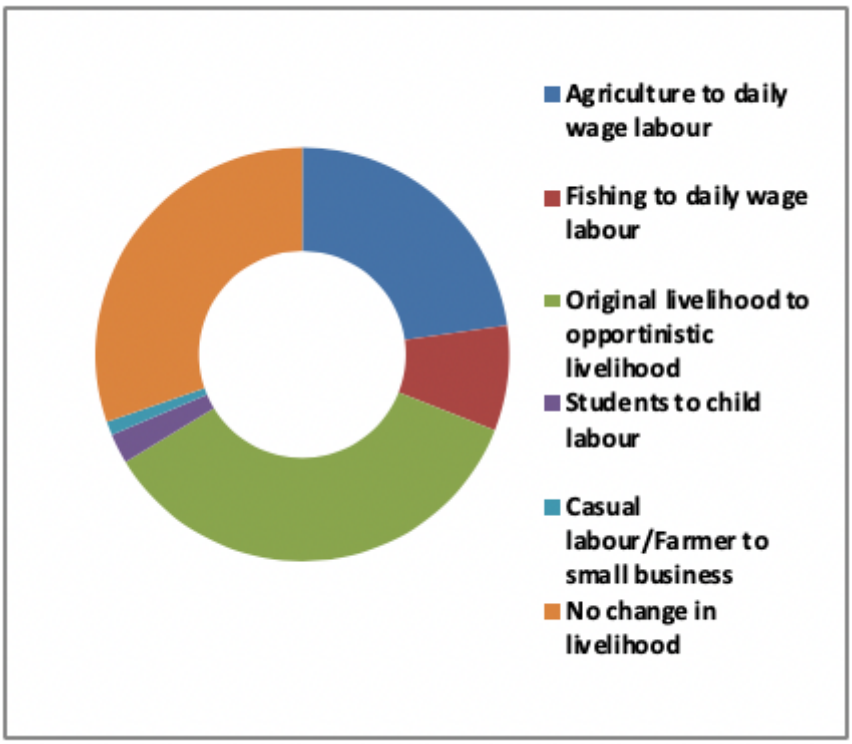

Figure 3

Loss of original livelihood

Figure 4

Migration map of Study area

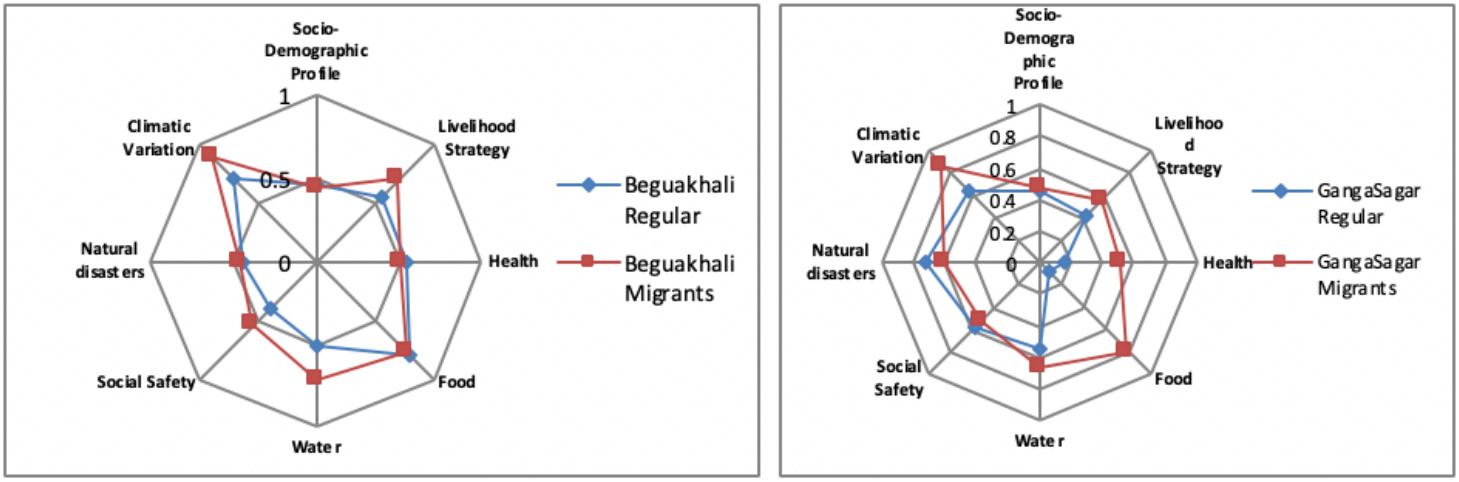

Figure 5

the vulnerability spider diagram ranges between 0 (least vulnerable) to 1 (extremely vulnerable) of the major components of the LVI for Beguyakhali and Gangasagar mouza.

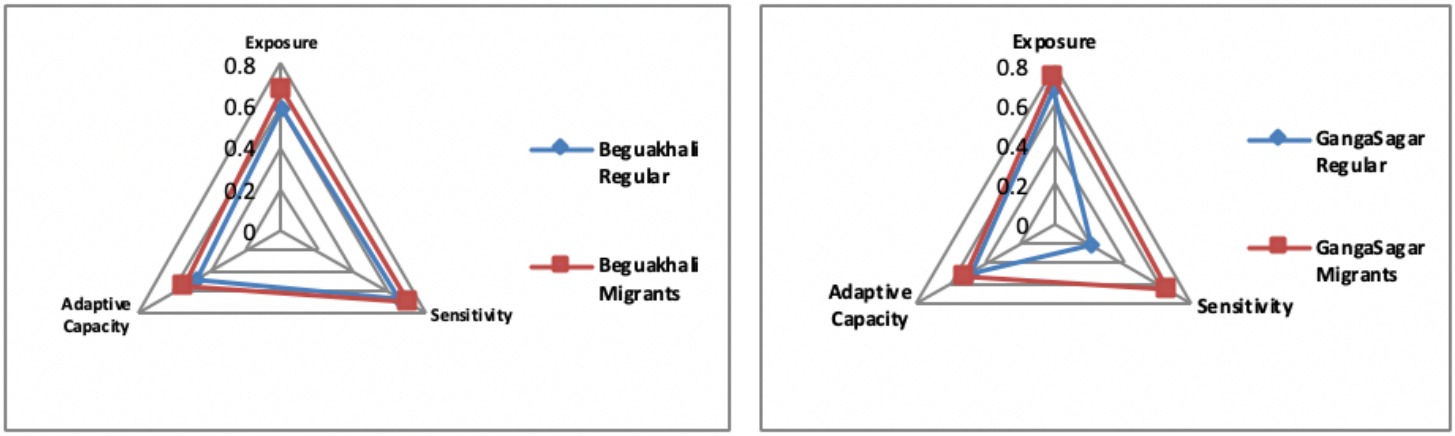

Figure 6

Vulnerability Triangle Diagram of LVI-IPCC for Beguyakhali and Gangasagar mouza

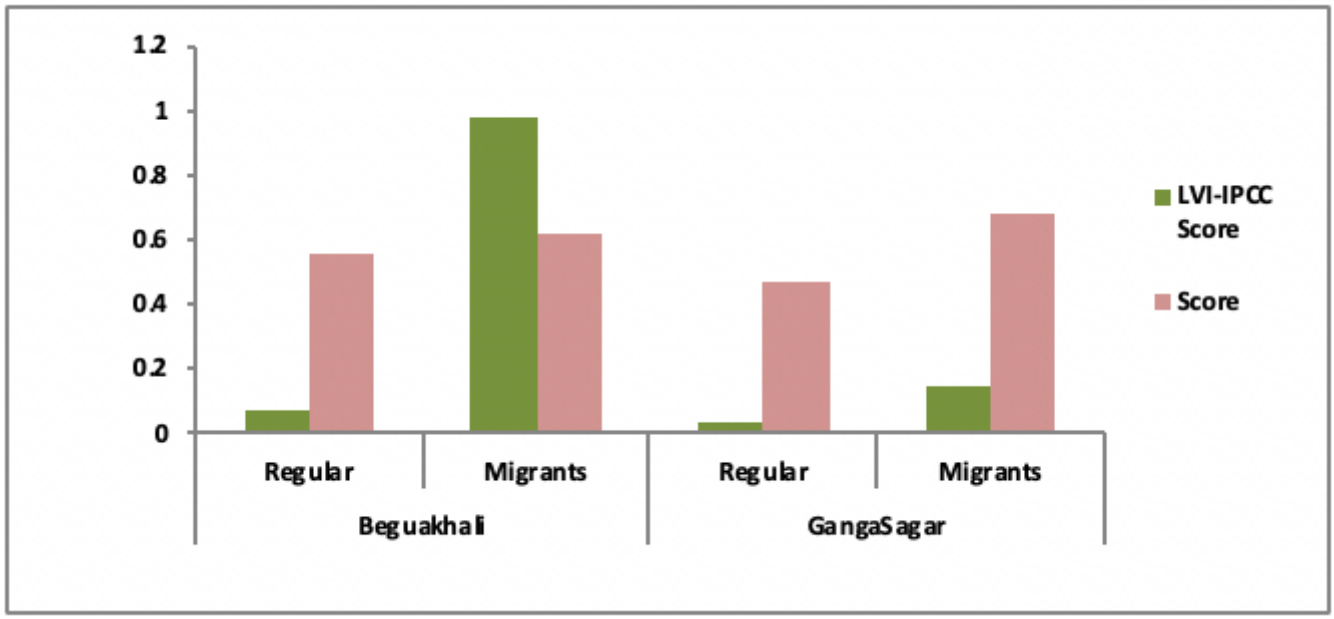

Figure 7

Comparison of LVI & LVI-IPCC Scores