SUNDARBANS

A Roadmap to Resilience

Resilience Profiling
Ecosystem based Risk Reduction
Community based Action Planning
Policy Recommendations

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In Association with
South 24 Parganas District Administration
Government of West Bengal
INDIA

ABOUT THE INITIATIVE

The lower Gangetic delta or the Indian Sundarbans is a cluster of vastly populated low lying islands. The area is unique in many terms, particularly due to the present of extensive mangrove forests and associated bio-diversity. However, the region is also prone to wide range of coastal hazards due to its vulnerable geology and high developmental deficits. Consequently, its 4.37 million dwellers remain at an extraordinary risk from natural disasters such as cyclones & storm surges. This publication is a part of ongoing socio-ecological research which aims to enhance the coping capacities or 'resilience' of the communities through integrated resilience assessment framework and participatory planning. Many people and institutions have extended their support to the existing research. We extend our sincerest gratitude to all of them, especially, the South 24 Parganas District Administration for their extensive support & cooperation during data collection process.

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ACKNOWLEDGEMENT

We are immensely grateful to Mr. Santanu Basu, IAS, District Magistrate & Collector, South 24 Parganas & Smt. Lipika Roy, IFS, DFO, South 24 Parganas for their tremendous support during field visit. In this regard, we also thankfully acknowledge the help & support extended to us by the District Disaster Management Authority, South 24 Parganas and all the Block Development Officers of Sundarban Region. We also sincerely acknowledge Sumitomo Foundation, Japan for their financial assistance for publication of this document.

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ABOUT THE ORGANIZATION

International Environment and Disaster Management Research group in the environmental education laboratory of Graduate School of Global Environmental Studies, Kyoto University targets to reduce the gap between knowledge and practice through pro-active field level, community based project implementation in the field of environment and disaster risk management. The members of this laboratory work extensively in the field of disaster & climate risk reduction all over the world, especially in South & Southeast Asia. The major thematic areas of research in this laboratory are climate change adaptation, urban risk reduction, environment and disaster education.

Clock Tower, Kyoto University, Japan

FOREWORD

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The world is increasingly becoming vulnerable due to a variety of natural disasters triggered by climate change and anthropogenic alterations such as deforestation, changes in land use and unsustainable environmental practices. Particularly, the low lying coastal areas across the world, at present, remain at an un-parallel risk from natural hazards such as stronger storms & surges, tidal flooding, erosion and a wide range of other sea ward hazards. Therefore, it is highly imperative to foster disaster & climate resilience communities in the face of climate uncertainties & persisting natural calamities.

Our research group of the Graduate School of Global Environmental Studies of Kyoto University was established with the objective of constructing a new concept of promoting community resilience with appropriate scientific knowledge and policy analysis. Working closely with national and local governments, non-government organizations, United Nations, bilateral and multilateral development agencies, faculty and students develop unique process-oriented community-based approaches for disaster risk reduction and environmental sustainability across the world. We strongly believe that the key of environment and disaster management is the end-user's participation, which are the communities, and its people.

This present document is a policy advocacy report of our work carried out in Indian Sundarban delta. This fragile delta is a World Heritage Site for its magnificent natural resources, however, also globally denoted as a critically vulnerable coastal area. It is a pleasure to present the findings of the analysis of the 19 coastal blocks of the Indian Sundarbans through a multi-dimensional resilience assessment framework and further to formulate some key policy recommendation through series of consultative processes with the local communities, leaders and administrative officials. On behalf of Kyoto University, I thank each and everybody who has been associated with this research & this publication. I am particularly grateful to Mr. Santanu Basu, IAS, District Magistrate & Collector of South 24 Parganas, Government of West Bengal for his strong support & cooperation. Lastly, I sincerely believe the study will be beneficial for formulating appropriate actions in order to make the Sundarban delta region more resilient to natural disasters & climate change.

Rajib Shaw
Professor

Dated: 31st October, 2014
Kyoto, Japan

MESSAGE

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সত্যমেব জয়তে

জাভেদ আহমেদ খান
ভারপ্রাপ্ত মন্ত্রী
অগ্নি নির্বাপন ও জরুরী পরিষেবা দপ্তর ও
অসামরিক প্রতিরক্ষা দপ্তর, পশ্চিমবঙ্গ সরকার
বিকাশ ভবন, সাউথ ব্লক, ৩য় তল, সল্টলেক,
কোলকাতা - ৭০০ ০৯১
ফোন ঃ (০৩৩) ২৩৩৭-৩৭২৮/২৩৩৭-৩৭২৯
এবং
বিপর্যয় ব্যবস্থাপন দপ্তর, পশ্চিমবঙ্গ সরকার
নবান্ন ৩-য় তল, ৩২৫, শরৎ চ্যাটার্জী রোড,
শিবপুর, হাওড়া - ৭১১ ১০২
ফোনঃ(০৩৩) ২২১৪-৪০৫২/২২১৪-৪০৫১ (ফ্যাঃ)

MESSAGE

The world is increasing becoming vulnerable to a wide range of natural disasters with the onset of climate change. Over the past decade, an unprecedented set of clear priorities has emerged globally in terms of reducing underlying risks and vulnerabilities. Consequently, a paradigm shift was observed which emphasizes proactive risk reduction besides the traditional rescue centric approach. Although disasters like earthquakes, cyclones, flood etc may not be avoidable, however, its impacts can be substantially reduced by fostering resilient communities.

The Sundarban Region is characterized by several downward pulls, mainly because of poverty and difficulty generated by the adverse terrain conditions and accessibility at vital points. The rapid onset of climate change and natural disasters such as tropical cyclones has been a major concern for the local administration in this region. In 2009, the region suffered from the tropical cyclone 'Aila' as it swept across areas heavily disrupting lives and properties. Given the acute sufferings of the people, it is highly imperative that the survivors are made resilient to future disasters through proper planning & integrating disaster risk management in existing developmental activities. The Government of West Bengal has taken possible reformatory measures by strengthening the existing disaster management infrastructures and capacities of the relevant stakeholders. However, in order to sustain high levels and rates of achievements, well thought out design of multi-level planning is necessary.

I am extremely delighted that Kyoto University, Japan in association with the South 24 Parganas District Authority has come up with this relevant & contemporary report. The report summarizes a set of relevant information and action plans to foster resilient communities in the Sundarban delta. I hope that this document will serve as an important tool in planning for growth, infrastructure and reassessing our disaster management strategies. I congratulate all those are associated with this process.

03/11/14
(Javed Ahmed Khan)

MESSAGE

ডাঃ সুদর্শন ঘোষ দস্তিদার
এম. ডি.
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পরিবেশ দপ্তর
পশ্চিমবঙ্গ সরকার
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D. O. No. 268/MIC(ENV)/14. Dated the 03/11/2014.

Message

The Sundarban is the largest single tract of mangrove forest in the world. The forest was recognized as resource base about five centuries ago for its natural values and even today it is a viable resource base. Mangrove forests are now among the most threatened habitats in the world. Climate change components that affect mangroves include changes in sea-level, extreme weather events, precipitation, elevated temperature and atmospheric CO_2 concentration, and ocean circulation patterns. Predicted sea-level rise is the greatest climate change challenge for mangrove ecosystems. Sea level rise induced salinity will change the habitat pattern of the Sundarban. Changes in precipitation patterns may have a profound effect on development and growth of mangroves.

This report aims to assess the coastal communities' resilience comprehensively by adopting a multiple stakeholder approach in the eco-fragile delta of Indian Sundarbans. It contains the in depth study of all the designated 19 coastal blocks as an effort to understand the condition and capacity of the communities and local government.

I would like to express my sincere appreciation to Kyoto University, Japan and the members of the team who have worked efficiently for publishing this report. I am sure that this report will contribute in effective decision making and policy planning towards a resilient future of our coasts. Further, this will serve as important tool for decision making for proactive risk reduction and integrated management of the coastal resources.

(Dr. Sudarsan Ghosh Dastidar)

MESSAGE

মন্টুরাম পাখিরা
রাষ্ট্রমন্ত্রী
সুন্দরবন বিষয়ক (স্বাধীন দায়িত্বপ্রাপ্ত)
সেচ ও জলপথ দপ্তর, পশ্চিমবঙ্গ সরকার
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দূরভাষ ও দূরবার্তা - ২৩৩৭ ৩৫৪৪
দূরভাষ - ২৩২১ ৮২৩৮
'জলসম্পদ', বিধান নগর, কলকাতা - ৯১
দূরভাষ ও দূরবার্তা - ২৩২১ ৭৪৪০

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Message

The deltaic West Bengal or the Indian Sundarbans represents a critical area that experience several adverse consequences because of its unfavorable terrain conditions, fragile ecosystems, lack of human development and frequent natural disasters. It also shelters the largest single block mangrove forest as well as significant poor and vulnerable population which serve as major hindrance to promote sustainable development and effective conservation in this region. Additionally, the rapid onset of climate change, especially the sea level rise and changes in environmental boundary conditions clearly emerges a major threat for this low lying coastal area. Consequently, its 4.37 million inhabitants remain exceptionally vulnerable to diverse set of natural and human induced changes.

One of the critical consequences that the region is facing today is the threats of cyclonic disaster. Although the region is historically prone to storms and tidal surges, the recent impact of cyclone 'Aila' in 2009 has been particularly disastrous impounding huge loss of lives and assets. Despite of significant efforts from the Government, the area is yet to recover fully from the 'Aila' impacts. Therefore, integrating 'disaster risk reduction' in regional developmental activities is one of our immediate priorities. Consequently, the Ministry of Sundarban Affairs, Government of West Bengal established its clear interest by implementing several risk sensitive developmental projects such as strengthening the embankment network, construction of cyclone shelters, generation of alternative livelihood etc.

I am extremely delighted that Kyoto University, Japan has come up with a timely research on regional level assessment of disaster & climate resilience of the Indian Sundarbans. The report has been generated through years of participatory research involving the district authorities, local government and the communities living in this delta. Precisely, it considers both structural and non-structural issues pertaining to disaster risks that are designed to improve proper planning and reporting for environmental & human sustainability in region. I am confident that the mentioned strategies would definitely facilitate to design and implement our future plans in order toreduce the vulnerability of this eco-fragile region

03/11/14

(MANTURAM PAKHIRA)

MESSAGE

Chandan Sinha, IAS
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सत्यमेव जयते

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Message

The Sundarban delta faces several environmental challenges. These challenges evolve both from the visible trend of ecological alteration and from the rising threats from natural disasters such as tropical cyclones, storm surges & tidal flooding. Environmental & ecological degradation, new settlement patterns, livelihood choices and human behavior are all key factors that contribute to the existing vulnerability of the delta with harmful effects on human development as well as on environmental assets. These factors tend to multiply the impact of hazards and limit the ability of the region to absorb the effects, decreasing the overall resilience of the area to a wide range of coastal hazards. Therefore, an integrated coastal zone management plan encompassing the human, social and scientific dimensions is essential.

This report aims to comprehensively assess the resilience of coastal communities by adopting a multiple stakeholder approach in the eco-fragile delta of Indian Sundarbans. It comprises an in depth study of all the designated 19 coastal blocks as an effort to understand the condition and capacity of communities and the local government. The multi-dimensional resilience assessment framework addresses both structural and non-structural aspects that are vital to disaster & climate resilience. The report also makes some recommendations and offers an action plan for fostering disaster resilient communities where conservation and enhancement of ecosystem services remains central.

I express my sincere appreciation to Kyoto University, Japan and the members of the team who have worked assiduously to publish this report. The study has the potential to serve as a useful tool for decision making for proactive risk reduction and integrated management of the coastal resources. I believe that this report will contribute towards informed decision making and policy planning for a resilient future of our coasts.

(Chandan Sinha)

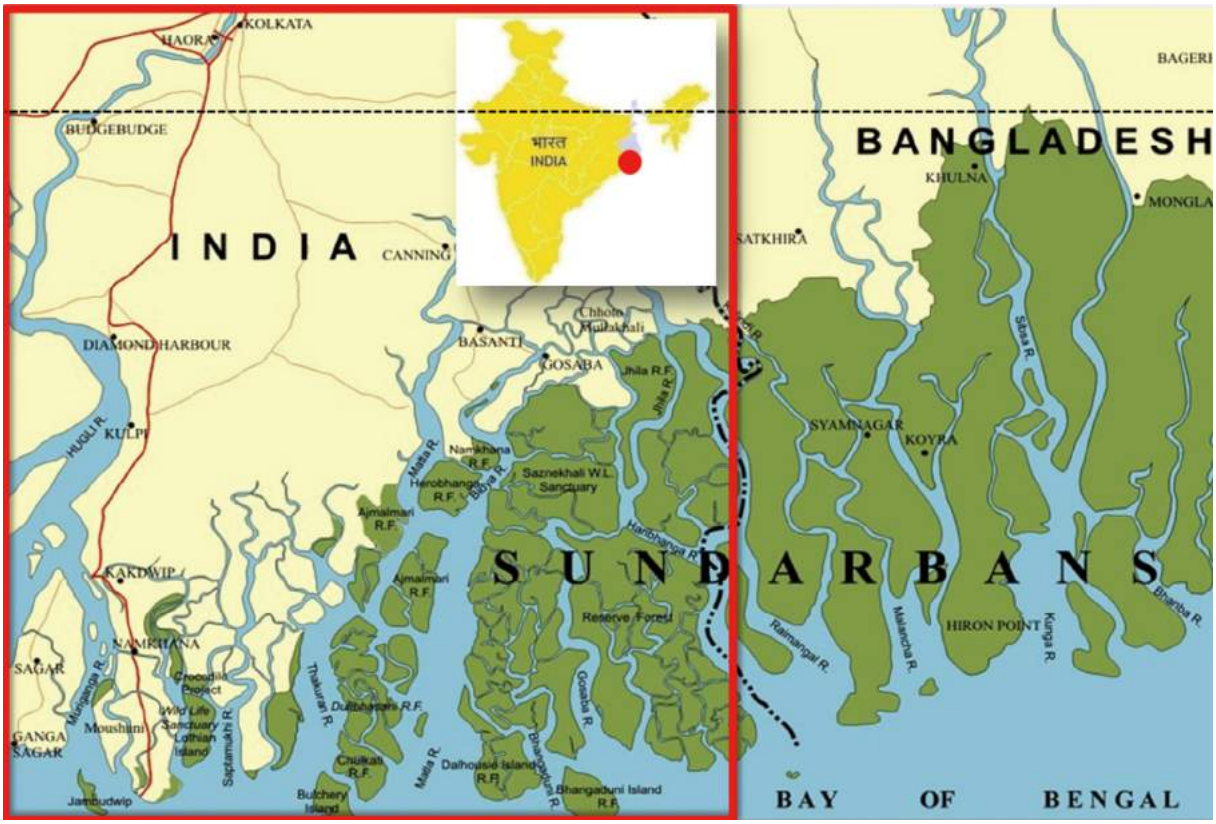
Ecosystem services of mangroves is believed to sustain more than 70 direct human activities including its remarkable habitat function for fish and crustacean production and regulating functions such as effective sediment trapping, storm and surge protection.

In association with such ecological benefits, these coastal forests also have significant cultural & aesthetics values that are intrinsically linked to social & economic well being of a vast section of coastal communities.

(In this picture: Mangrove Forests at Henry's Island, Bakkhali, Sundarbans.)

INTRODUCTION

Sundarbans, named after the exuberant mangrove species of *Heritiera fomes*, is the vast low lying delta situated at the confluence of the rivers Ganges, Brahmaputra, Meghna and the Bay of Bengal; extending over 25,000 sq. km in India and Bangladesh. A significant portion of the delta, measuring approximately 9630 sq. km is situated in the administrative territory of India. As per the organizational hierarchy, the region is covered within two districts of West Bengal, i.e. North and South 24 Parganas; although the majority falls within the territory of South 24 Parganas. As of 2011, the Indian Sundarbans hosts a population of 4.37 million with a staggering density of 957 people /sq.km spreading over 19 Community Development Blocks. The region also suffers from extreme poverty and lack of human development with an average of 43.5% of the population living below the nationally designated poverty line. Inaccessible and hostile terrain conditions, ecological degradation, serious developmental deficits and persisting natural calamities such as cyclones, tidal surges and floods are some of challenges that the region is facing today. Considering this, a multi-dimensional approach is required to reduce the vulnerability or in turn to enhance the resilience of the communities.



CONCEPT OF RESILIENCE

Despite of having its origin from ecological sciences, the concept of resilience has become extremely popular in the field of Disaster and Climate Risk Management, especially in the management of 'socio-ecological' systems. In a purely physical terminology, 'resilience' is considered as the capacity to absorb external shocks without significant deformation. However, in the context of disaster risk reduction, number of researchers has defined 'resilient communities' as 'systems' that can (1) absorb shocks or recurrent disturbances without significant deformation, (2) recover quickly from an altered state and further can (3) restructure and reorganize itself through adaptive processes and practices in order to minimize the impacts of expected disturbances.

SCOPE OF THE STUDY

In this publication (consultation version) results are shown from all the 19 Community Development Blocks of Indian Sundarbans. The resilience score is representative of the existing structural and non-structural components that are essential for fostering resilient communities.

BLOCK PROFILE

Name Of the CBD	Area in Sq. Km	Census (2011)	Density Person/km	Literacy Rate (%)	BPL Population (%)
Joynagar I	131.01	259980	1984	66.67	39.57
Joynagar II	186.25	246955	1326	60.09	42.60
Kultali	306.18	231855	757	60.81	46.36
Mathurapur I	147.30	194069	1318	66.00	34.43
Mathurapur II	227.45	219541	965	68.94	39.59
Kakdwip	252.74	286325	1133	71.38	34.91
Sagar	282.11	211096	748	78.92	44.46
Namkhana	370.61	181869	491	79.38	48.17
Pathar Pratima	484.47	333687	689	73.44	49.13
Canning I	187.86	297995	1586	61.23	31.05
Canning II	214.93	248521	1156	52.72	50.32
Gosaba	296.73	244721	825	69.67	38.02
Basanti	404.21	331973	821	58.12	64.89
Hingolganj	238.8	159585	668	70.07	44.50
Hasnabad	153.07	196880	1286	63.45	28.69
Sandeshkhali I	182.3	164185	901	58.45	58.29
Sandeshkhali II	197.21	160828	816	59.31	59.70
Minakhan	158.82	191908	1208	58.65	38.42
Haroa	152.73	214248	1403	62.82	33.73

METHODOLOGY

The study is based on questionnaire survey and secondary data collection covering five dimensions of coastal resilience. Each of the five dimensions was further categorized in to 5 major indicators and 25 variables. In total, the study is based on the result obtained from 125 variables. Results from the 125 variables were transformed to a resilience score by weighted mean average of the indicators and variables.

SOCIO-ECONOMIC	**Demography** Annual Average Growth Rate, Population Density, Age Dependency Ratio, % of Rural Population, % Backward/Tribal Population **Livelihood** % of Below Poverty Line population, % of population lives on Coastal resources, Enrollment in Livelihood Guarantee program, % of population lives on Eco-tourism, % of population suffered livelihood discontinuation **Health** Average Life expectancy Birth, Doctor: Population Ratio,% of population having primary health facility within regular access, General condition of Public heath, Morbidity of major diseases **Social Capital** Social cohesion, Acceptance of community leaders, Frequency of village level meetings, Occurrence of Conflicts/Riots/ Homicide incidents, Community participation in shared interests **Education & Awareness** % of Adult Literacy Rate, School dropout rate of children, Primary Schools, Existing community awareness of Disaster & climate change, Frequency of mass awareness camp run both by NGOs, CBOs etc.
PHYSICAL OR INFRASTRUCTURAL	**Transportation** % road compared to overall land use,% of all weather accessible roads, % of waterways compared to overall land use, Status of Jetties and inter island communication, Availability of emergency vehicle/boats **Residential Infrastructure** % of population with informal (slum etc) settlements, % of population in co-operative housing,% of houses living under the avg. flood line, % of population having ownership of their house, % of population living extremely close to hazardous activity (port/industry) **Electricity** % population having access to electricity, Number of hours of average disruption of electricity supply, Service quality (Frequency of dropout or distribution failure etc.),% population having alterative source of electricity in case of disruption, Implementation of renewable source of energy (Solar/wind etc) **Telecommunication** % population having mobile phone, Quality of service / network accessibility, % of population having radio/television, % of population having internet connection, Provision of fishermen tracking systems **Water & Sanitation** % population having access to safe drinking water, Quality of water, Scarcity of Drinking water and seasonal variation of water availability, % population having access to hygienic toilets, Implication of Waste water disposal and treatment facility
INSTITUTIONAL	**Laws & Policy** Integration of DRR in developmental activities, Implementation of CRZ Notification, Administrative initiatives of coastal greening, Frequency of DRR training organized by the block, % of funds allocated to DRR activities. **Coordination** Coordination among government departments, Coordination with political leaders, Coordination with NGO (Number of joint program etc), External assessment (Funding) received, Coordination with neighboring blocks **Emergency Response** Existence of early warning system, Adequacy of trained emergency response team, Availability of Evacuation centre (Number of Flood/cyclone shelter), Availability of Emergency Aids (Food, medicine, water etc),Transparency in Aid distribution process **Adaptive Action** Integration of Climate change & DRR in developmental activity, Development of forestry & Plantation at administrative initiatives, Implementation of Disaster Insurance / Statutory aids to victims, Implementation flood/erosion control technical measures only, Implementation of rainwater harvesting scheme **Governance** Implementation of developmental plans, Public Private partnerships in developmental activities, Off-disaster activities of Block Disaster Management Authority, Information sharing & risk communication with the community, Adequacy of manpower in existing block administration

METHODOLOGY

COASTAL ZONE MANAGEMENT

Embankment & Shoreline Protection % of vulnerable shoreline protected by dykes/ embankments, Average age of embankments, Strength of Material & design used for building the embankments, Frequency of maintenance of embankments, Frequency of reported overtopping incidents

Mangrove Management % of mangrove cover compared to block size, % of people directly depends mangroves, Activity of FPC in conservation of mangroves, Performance of authorities in mangrove conservation, Frequency of organized mangrove felling

Bio-Diversity Conservation Frequency of Animal Poaching incidents, Performance of FD, Activity of EDC/FPC, Reported reduction in species , Frequency of monitoring overfishing in tidal waters

Coastal Pollution Quality of water, Industrial waste discharge points, Discharge of domestic waste , Occurrence Oil spilling incidents , Frequency of monitoring of coastal water quality

Coastal Land Use % of coastal sensitive land (500m) reclaimed for agriculture (10 years), Extent of fish cultivating pond, Extent of coastal land diversion for settlements/ infrastructure, Extent of mining and other drilling activities, Extent of coastal land rehabilitation (Greenbelt etc.)

ENVIRONMENTAL OR NATURAL

Frequency of Natural Disaster Frequency of flood occurrence, Extent of cyclone damage, Extent of Coastal erosion and degree of damage, Frequency of heavy tidal inceptions, Extent of Earthquake & Tsunami vulnerability

Climate components Extent of physical impact caused by sea level rise ,Relative rate of sea level rise in the block, Reduction of availability of freshwater, Extent of rise in river water salinity, Extent of mangrove deterioration (loss of species) due to salinity, Decadal loss of shorelines/permanent inundation area

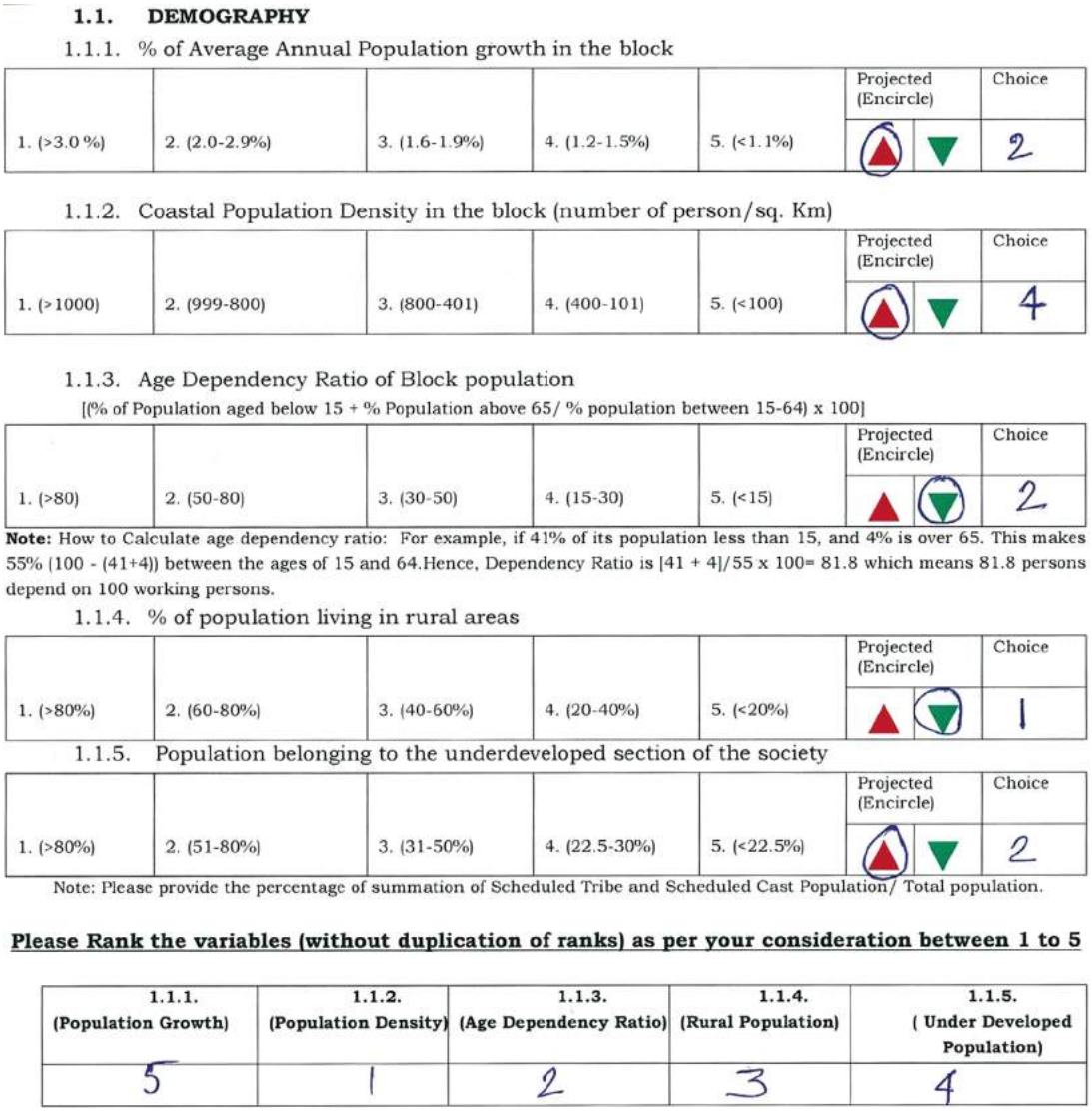
Geo-physical components Extent of change in tidal patterns leading to river piracy/damage to dykes, Extent of Natural accretion, Extent of subsidence due to compaction, Protective measures (bouldering/cementing) to control erosion

Bio-Geochemical Components Extent of arsenic contamination, % of total population exposed to arsenic contaminated water, Extent of chemical pollution, Extent of loss of soil fertility, Mitigation level of existing chemical contamination

Environmental Measures Extent of Integration of Natural hazard Maps ,Implementation of Environmental Protection Act, Extent of Control in Deep aquifer pumping, Extent of monitoring and Maintenance of environmental database, Involvement of Scientific communities in Environmental R & D

DATA COLLECTION & APPROACHES

The questionnaire survey was conducted at the Block Level and data were collected according to our pre-designed framework. The Block Developmental Officers were the major respondent; however, additional help was also sought from the other concerned officials and published data & reports. Further, the responders were requested to prioritize the variables as per their local administrative experiences.



1.1. DEMOGRAPHY

1.1.1. % of Average Annual Population growth in the block

1. (>3.0 %)	2. (2.0-2.9%)	3. (1.6-1.9%)	4. (1.2-1.5%)	5. (<1.1%)	Projected (Encircle)	Choice
					▲ ▼	2

1.1.2. Coastal Population Density in the block (number of person/sq. Km)

1. (>1000)	2. (999-800)	3. (800-401)	4. (400-101)	5. (<100)	Projected (Encircle)	Choice
					▲ ▼	4

1.1.3. Age Dependency Ratio of Block population

[(% of Population aged below 15 + % Population above 65/ % population between 15-64) x 100]

1. (>80)	2. (50-80)	3. (30-50)	4. (15-30)	5. (<15)	Projected (Encircle)	Choice
					▲ ▼	2

Note: How to Calculate age dependency ratio: For example, if 41% of its population less than 15, and 4% is over 65. This makes 55% (100 - (41+4)) between the ages of 15 and 64.Hence, Dependency Ratio is [41 + 4]/55 x 100= 81.8 which means 81.8 persons depend on 100 working persons.

1.1.4. % of population living in rural areas

1. (>80%)	2. (60-80%)	3. (40-60%)	4. (20-40%)	5. (<20%)	Projected (Encircle)	Choice
					▲ ▼	1

1.1.5. Population belonging to the underdeveloped section of the society

1. (>80%)	2. (51-80%)	3. (31-50%)	4. (22.5-30%)	5. (<22.5%)	Projected (Encircle)	Choice
					▲ ▼	2

Note: Please provide the percentage of summation of Scheduled Tribe and Scheduled Cast Population/ Total population.

Please Rank the variables (without duplication of ranks) as per your consideration between 1 to 5

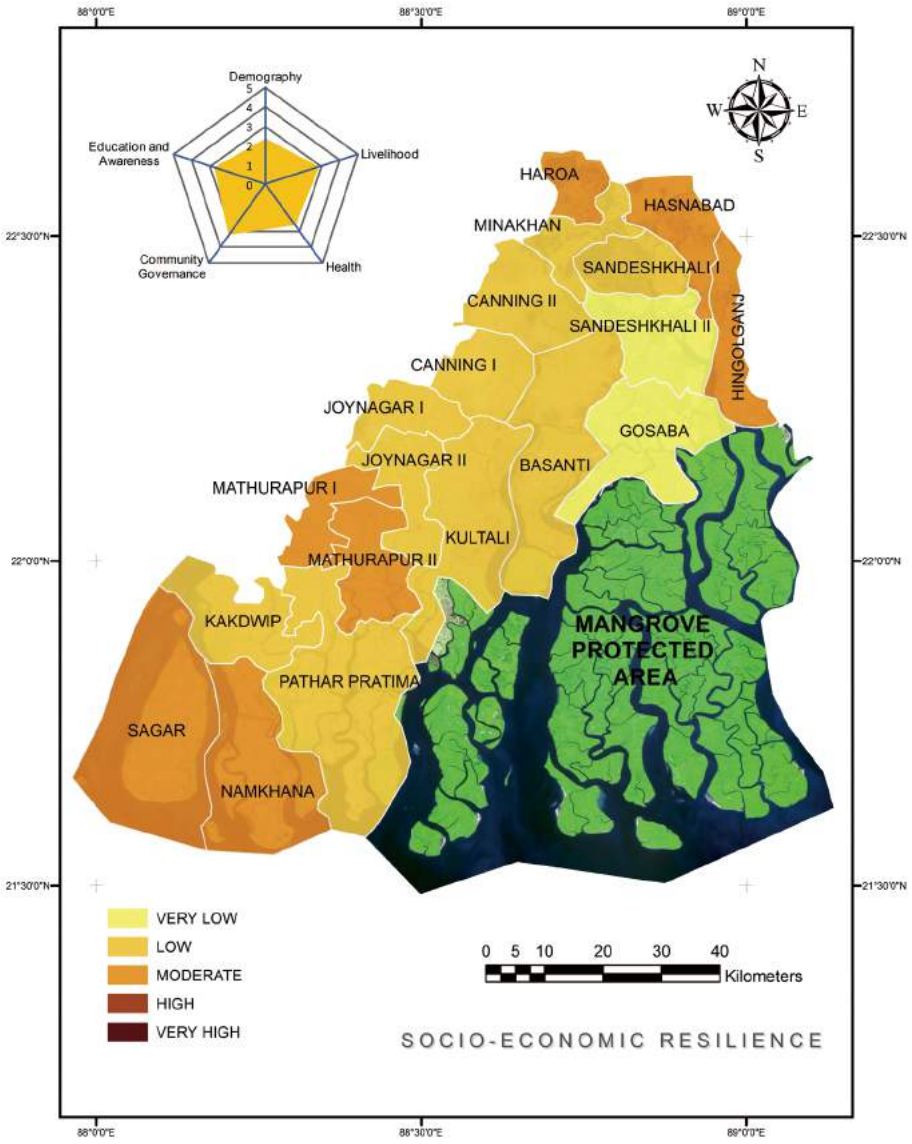
1.1.1. (Population Growth)	1.1.2. (Population Density)	1.1.3. (Age Dependency Ratio)	1.1.4. (Rural Population)	1.1.5. (Under Developed Population)
5	1	2	3	4

Figure 1: Filling Out the Questionnaire and Prioritization of Variables under Demography Component (from Canning I Block)

RESULTS

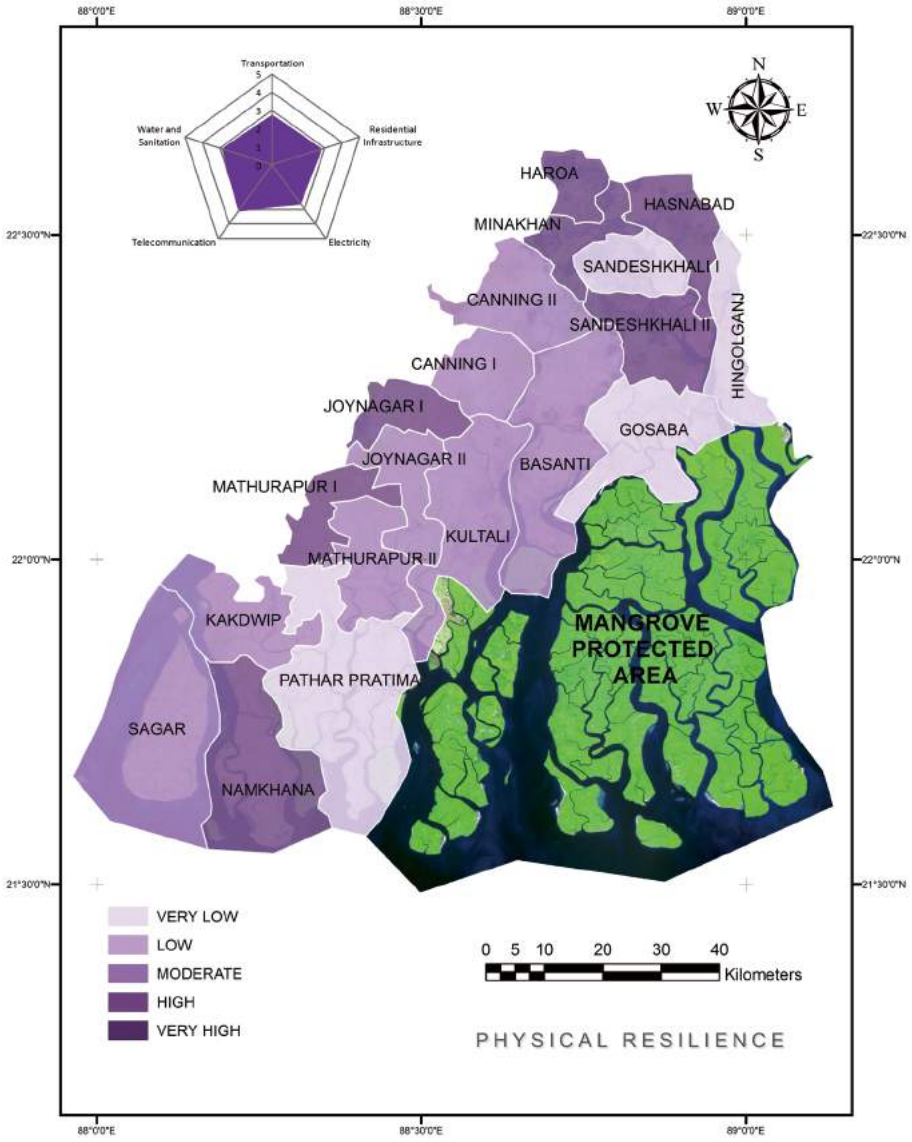
The following pages show and discuss the results for the overall resilience of the region with the help of spider diagrams and spatial maps for better visual understanding. This is important to mention that results approaching 5 depicts high resilience and vice versa.

SOCIO-ECONOMIC RESILIENCE



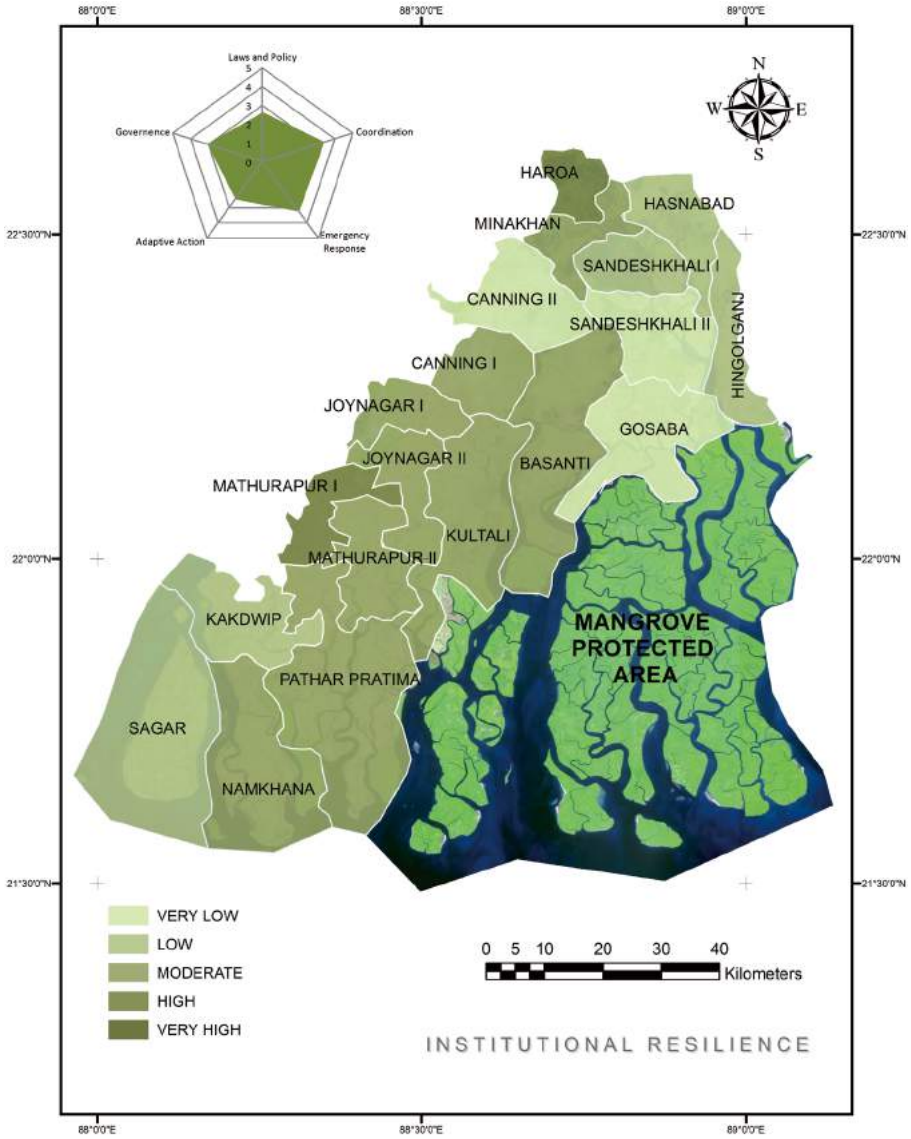
Overall socio-economic resilience is observed to be uniformly poor and can be generally assigned between 'very low' to 'low' category. Out of the five components, demography and livelihood resilience seems to be critical for all the blocks. For example, the average population density is close to 987/sq.km; extremely high compared to any other coastal rural areas in the country. Population density in blocks such as Joynagar I (1984/sq. km), Canning I (1586/sq. km) are alarming. Similarly, average annual growth for blocks of Kultali, Canning I & Canning II crosses 2% per year. On the other hand, excluding some of the interior blocks, livelihood scenario of the communities remains extremely vulnerable. Extreme coastal blocks such as Gosaba, Basanti, Kultali (> 40% of population) heavily survive on the coastal resources. Particularly, the study coincides aftermath the cyclone 'Aila' where majority of the extreme coastal blocks suffered heavily from livelihood discontinuation due to saline water flooding of the agricultural lands. However, in statistical term, Socio-economic factors (r =0.48) has moderate influence in the overall resilience of the region.

PHYSCIAL RESILIENCE



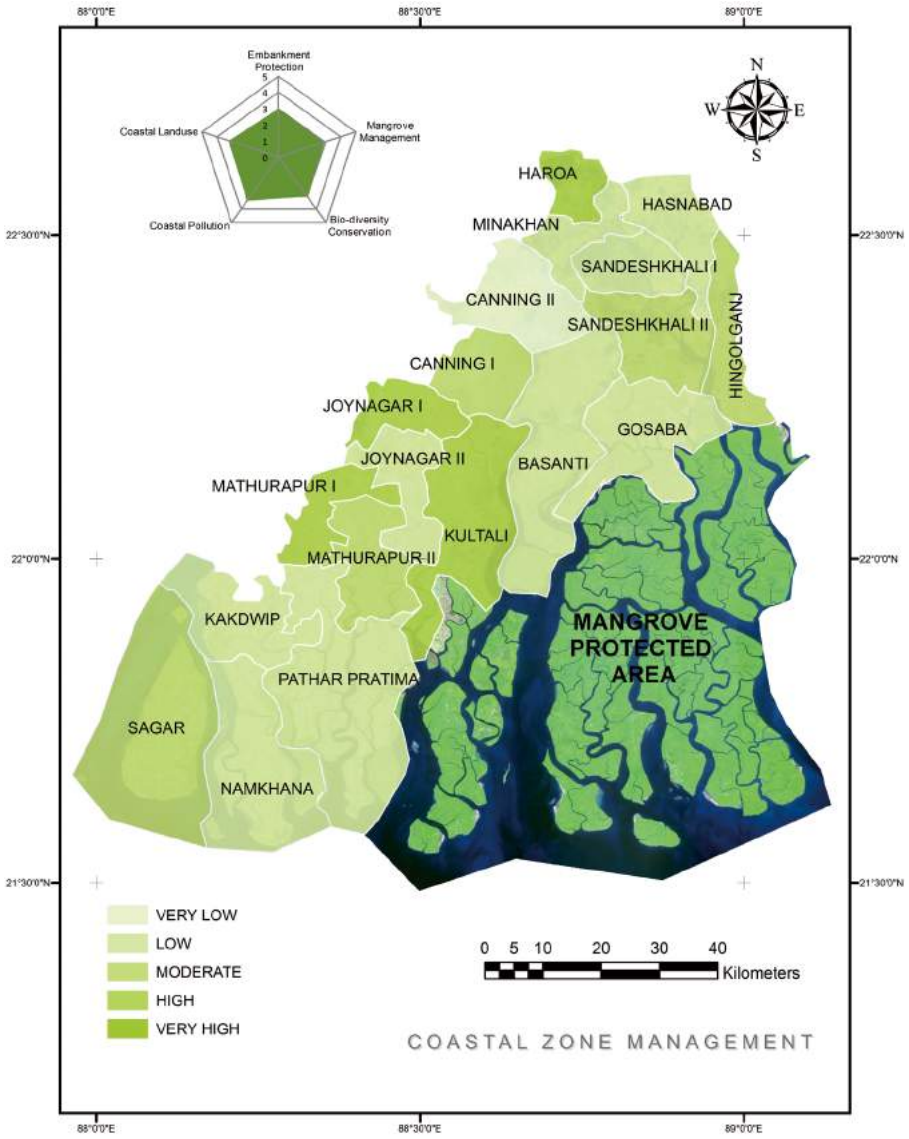
Physical resilience profile of the 19 coastal blocks follows the similar trends of socio-economic resilience and in general, can be categorized between poor to moderate. This is mostly because of earthen housing structures, non-availability of potable water, rural electrification and primitive transportation. However, on the other hand, cyclone 'Aila' in 2009 has triggered some positive changes with 14 new projects of building 'emergency cyclone shelters' in the delta is currently being undertaken. Out of the five components, transportation & electricity has wide spread variation. While at one hand, blocks such as Joynagar I, Mathurapur I, Canning I, Hasnabad, Haroa and well connected by railways and formal public transportation network, blocks such as Sandeshkhali I, Sandeshkhali II, Goasaba remain physically isolated due to lack of well developed transportation network. The same observation holds true for electricity, although the situation has improved over the past few years. In general, physical factors have been indentified to have significant correlation (r=0.68) with the overall resilience.

INSTITUTIONAL RESILEINCE



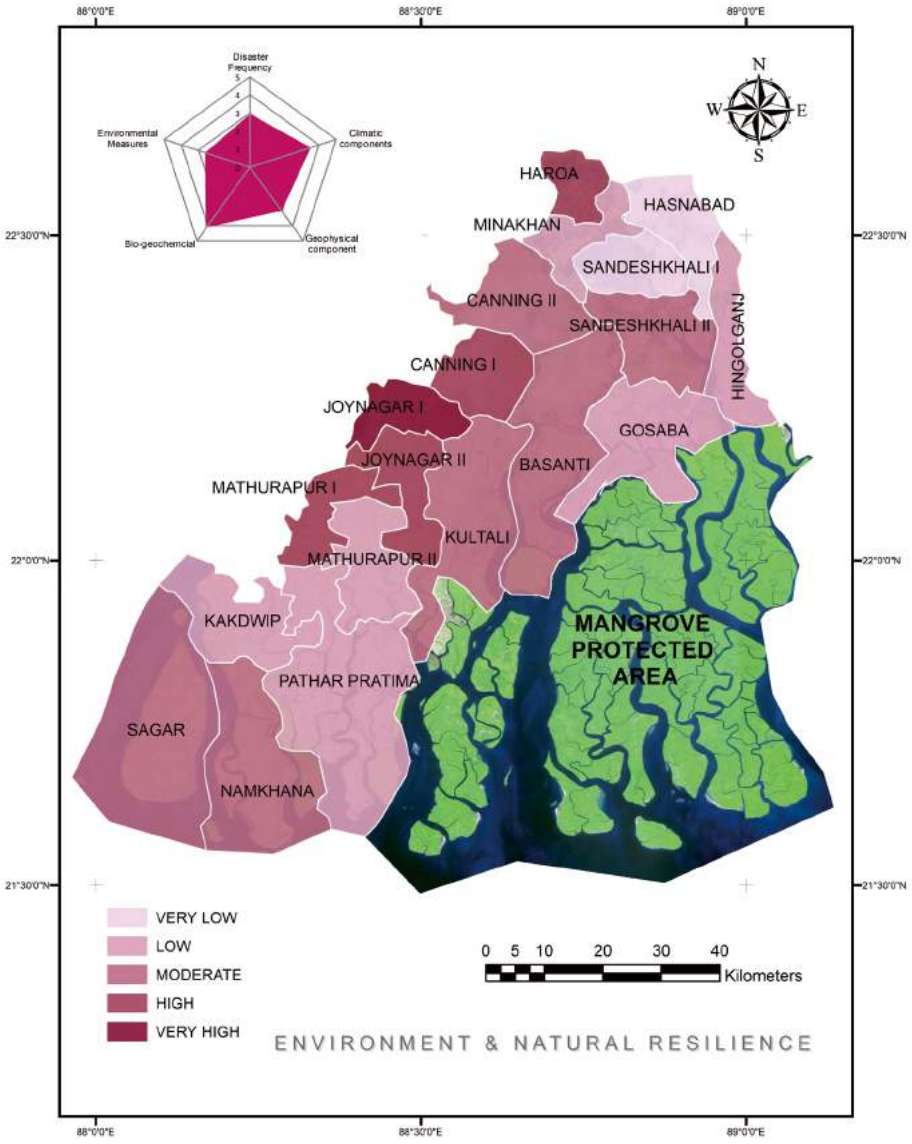
The institutional resilience also varies significantly and can be generally defined as low to moderate. Out of the five components, 'adaptive actions' and 'laws & policy' are the specific areas that require adequate attention. This is precisely important for the extreme coastal blocks such as Gosaba, Patharpratima, Sandeshkhali I & II. In cases of these blocks there is an acute need for adaptation in the sectors such as livelihood, water management etc. Although, there is a plethora of preventive environmental laws and policies exist, implementation of these policies is not satisfactory. However, since the Cyclone 'Aila', in general, emergency management has improved considerably with all the blocks having a Disaster Management Plan to deal with emergencies. Notably, one of the significant achievements since the cyclone 'Aila' is that the local government undertook a community based mangrove plantation program named as "Green Sundarbans". Pathapratima, Namkhana are presently under going mangrove plantation under this project. Institutional factors also remain statistically significant (r=0.8) in the overall resilience of the region.

COASTAL ZONE MANAGEMENT



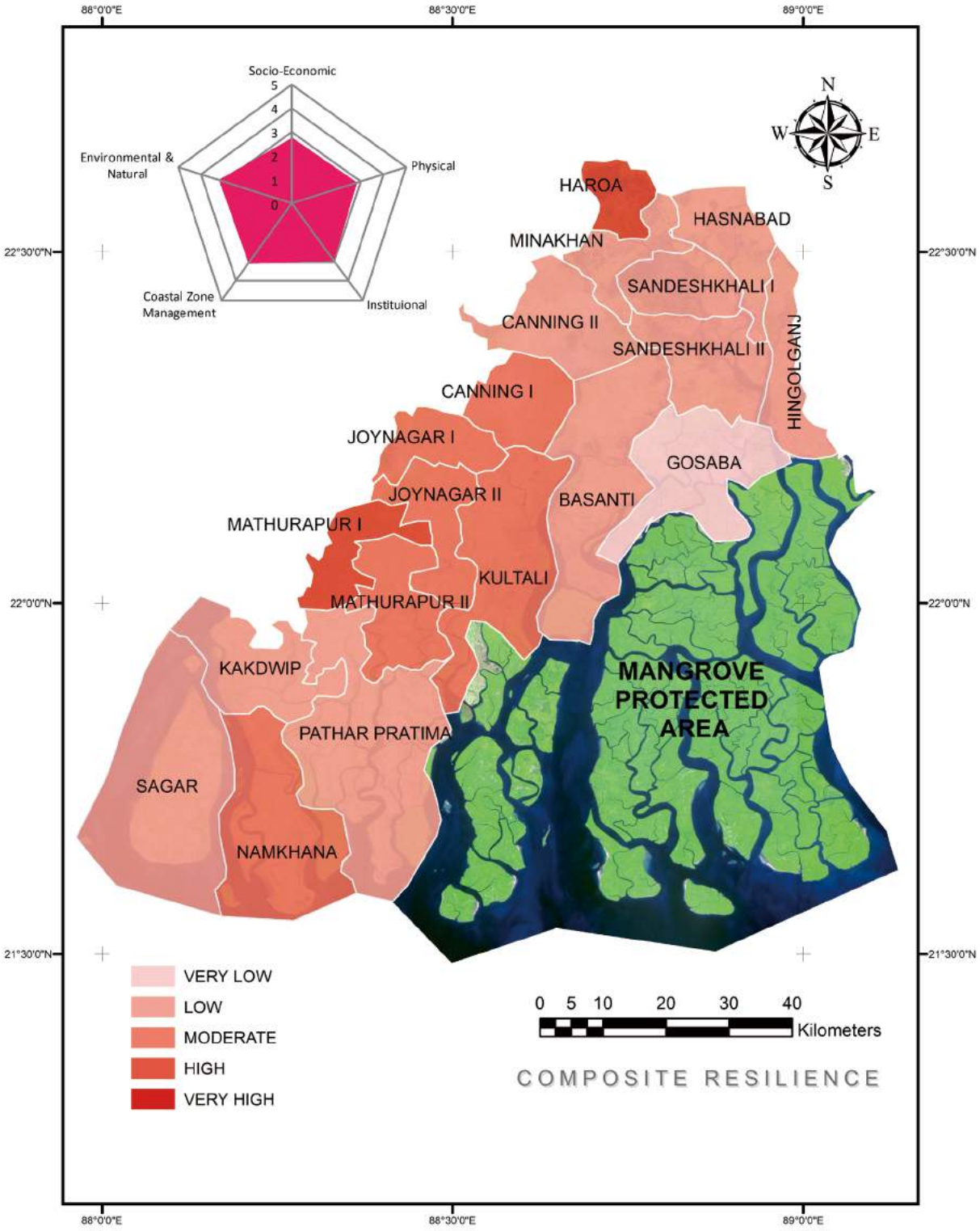
Resilience due to effective coastal zone management (CZM) is a measure of local level ecosystem conservation, implementation of CZM guidelines and structural competency (earthen embankments). Interior blocks such as Mathurapur I, Joynagar I are found to highly resilient since the length of coast lines is limited. Despite of the fact that all these areas were reclaimed from dense mangrove several years ago, there has been no major alteration of coastal land since the last 10 years. On the other hand, the observed resilience scores of the extreme coastal blocks are significantly low compared to the interior blocks (e.g. Gosaba, Sandeshkhali I & II, Namkhana, Kakdwip). One particular reason is the existence of extensive embankment networks in these blocks, majority of which are semi-engineered earthen structures that were constructed over a century ago.These blocks are also challenged with mangrove degradation, heavy violation of forest rule etc. As a component, CZM has strong correlation (r=0.78) with the composite score of the blocks.

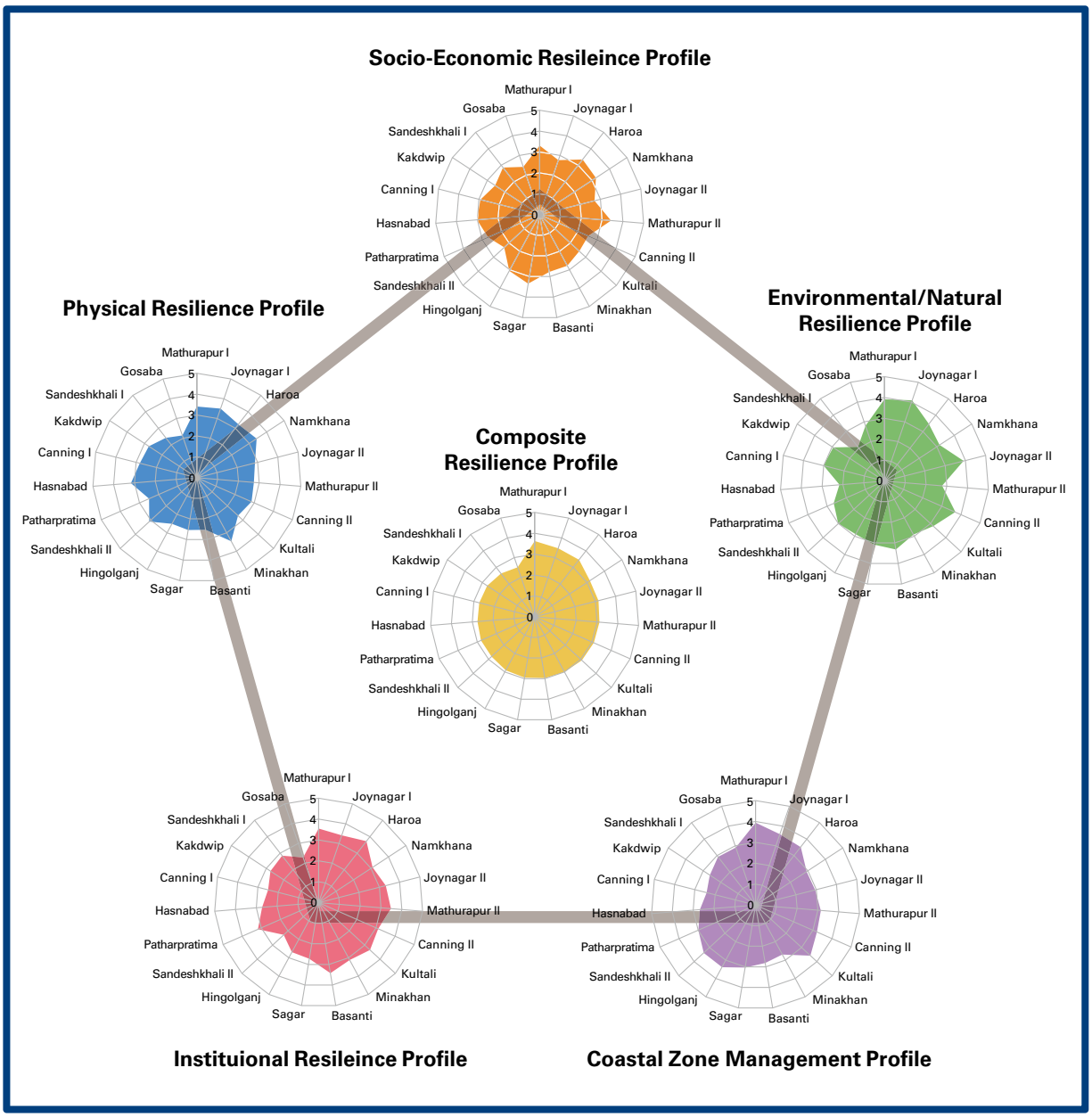
ENVIRONMENTAL OR NATURAL RESILEINCE



Environmental/Natural Resilience is a measure of the local level variation of natural exposure from coastal disasters. Consequently, all the extreme coastal blocks show moderate to low resilience score and almost uniformly exposed to coastal disasters such as cyclones and storm surges. Likewise, interior blocks are observed to somewhat more resilient compared to the extreme coastal blocks. However, the eastern coastal blocks such as Gosaba, Sandeshkhali I & II are further exposed to high soil salinity while the western blocks such as Sagar, Kakdwip are exposed to severe coastal erosion. Apart from that, significant portion of tube wells in Hasnabad, Hingolganj used for drinking water purposes have been found arsenic contaminated, although, the other coastal blocks are found to be safe in this regard. In general, environmental resilience (or Exposure) has very strong correlation (r=0.78) in the overall resilience.

COMPOSITE RESILIENCE





The study used the weighted mean average to calculate the composite resilience score of the 19 community development blocks. All the obtained resilience scores range from 2.07 and to 4.09. Using these values as lower and upper limit, the resilience scores were further segregated into five categories, i.e. Very High (5.0 > 4.0), High (4.0 > 3.5), Moderate (3.5>3.00), Low (3.0>2.5) and Very Low (2.5>2.0). Consequently, out of the 19 blocks, only one (Mathurapur I) can be classified as High resilient block, while 7 blocks are classified as moderate resilient and rest of the 11 blocks are classified into low resilient blocks. As discussed, majority of the low resilience blocks are extreme coastal blocks. Therefore, in general, it can be concluded, community resilience follows an inversely proportional relationship with the exposure, i.e. communities with low in Environmental & natural resilience (i.e. high exposure) are less resilient and more prone towards disaster loss. However, as discussed earlier there are significant contributions of other factors, especially coastal zone management and involvement of local institutions.

PLANNING FOR COASTAL RESILEINCE

The overall resilience profile of the Indian Sundarbans demands an urgent and immediate attention in order to cope with future disasters as well as the climatic abruption that the regions will probably face in near future. This has also been figured in the revised coastal zone management notification of 2011 by the Government of India which declares the Indian Sundarbans as 'Critically Vulnerable Coastal Area.' The notification has urged the local government to develop a comprehensive plan to manage the region; however, it requires a participatory planning approach that emphasizes involving the local community in the strategic and management processes of region. In view to harmonize different approaches and challenges, the study conducted several focus group discussions & participatory planning with the local communities in order to understand the intrinsic vulnerability of the communities, their existing coping abilities and further to plan for actions that would facilitate the coping abilities of the communities. Consequently, the study comes up with a set of policy recommendation based on the field observations and interaction with a huge number of community members, occupational groups, NGO activist and local leaders. The report specially emphasizes three sectoral areas, i.e. enhancing the efficiency of the existing participatory mangrove management, integrated livelihood planning & proactive risk reduction through integrated coastal zone management.

POLICY RECOMMENDATION

Enhancing Participatory Mangrove Management

BACKGROUND

The name Sundarban is synonymous to its heritage mangrove forests. Any regional plan for Sundarbans, therefore, should provide adequate priority to the mangrove forests. These mangroves are particularly important from the risk reduction point of view since it serves as an effective buffer between the land and the water. Mangrove ecosystem services are vital for the region to arrest soil erosion & promote natural accretion, providing rich breeding ground of estuarine fishes and to support a number of local livelihoods. Although, there has not been significant degradation of mangroves since the last three decades, considering the region's vulnerability, forest cover still need to be increased, especially along the shorelines. The region has long adopted participatory mangrove management as a tool to promote community based mangrove management. At present around 65 Joint Forest Management Committee (JFMC) consisting approximately 35,000 members are responsible for the management of nearly 64000 ha of mangrove forests. However, this arrangement has been partly successful to motivate the communities to effectively involve in the participatory management. The study therefore undertook a systematic survey of the JFMCs to understand the existing conflicts and probable measures to motivate the communities towards effective participation in the JFM approach. The following sections provide some of the key policy recommendations.

COORDINATION

The sole agenda of the participatory forest management in Indian Sundarbans revolves around the conservation of the existing mangroves & associated bio-diversity through community 'policing'. Notably, this approach has been fairly successful since illegal poaching & logging have reduced significantly. However, under the existing scenario, it requires a more proactive approach, i.e. from conservation to restoration and development of new mangrove areas, especially in the tidal mudflats and along the embankments. The study observed that such initiatives have been undertaken by the local government, several NGOs and voluntary groups mostly in an adhoc basis which needs to governed and categorized by the forest department. Also, a technical wing needs to be formed to assist such groups. Similarly the 'Green Sundarban' Initiative needs to be closely monitored by the forest department and adequate technical assistance should be extended in this regard.

AWARENESS

The study observed a growing mutual distrust between the Forest officials and the local fishermen group due to the restriction of access in the core and restricted areas. Of late, there have been several cases of forest crimes, particularly due to the illegal access in the restricted areas. Several fishermen group mentioned that they are not aware of the demarcation and has been victimized under the circumstances. Consequently, growing mutual distrust has been a major concern pertaining to effective involvement of the fishing communities which forms the largest forest user group. Therefore, it is strongly recommended that a detailed map of 'go and no go' areas should be provided along with the fishing licenses. Proper campaigning should also be made in order to aware the communities of the possible legal and ecological consequences.

BENEFIT SHARING

The existing benefit sharing mechanism between the JFMC and the FD needs a major restructuring. For example, The Eco-Development Committees (EDCs) now get a revenue sharing of 25% from the ecotourism which is considered to be on the lower side. On the other hand, the FPCs do not get any benefits from the eco-tourism. Similarly, there are persisting issues of the Non timber Forest product prices, especially honey. Honey collectors are compelled to sell their products to the West Bengal Forest Development Corporation with a stipulated price (INR 100/kg). Communities claim that the prices are not competitive with the local markets. Although, such issues are not pertaining to other forest products such as wax etc, the local forest department needs to provide adequate attention to market competitiveness of the forest products.

INSTITUTIONAL MODIFICATIONS

On an institutional dimension, the JFMCs perform under the co-management guidelines stipulated by the Forest Departments, i.e. the State Forest Department and the Sundarban Tiger Reserve. However, political interferences have been a major concern for the selection and performance of the JFMCs. Some of the committees could not be formed or remain non-functional due to political reasons. Therefore, strict regulation and code of conduct should be initiated to restrict the undesired political intervention into the functioning of JFMCs. On the other hand, the focus group discussion with the JFMC members revealed that they are not necessarily aware of the detailed plans since they were not involved in the micro-planning process. The forest department, therefore, need to effectively include the local communities in decision making process.

HUMAN RESOURCES

The mangroves of Sundarban represent a structurally complex ecosystem that is highly prone to changes in environmental boundary conditions. It requires close monitoring of environmental & ecological parameters. However, considering the extremely difficult terrain conditions, monitoring of this ecosystem requires high amount of vigor and capacity. Therefore, the forest department require adequate human resources which at present it is lacking. Interviews with higher officials reveal that aging of the local forest staffs clearly emerging as a threat to constant surveillance. Therefore, it is highly imperative that the Forest department is properly staffed with compatible human resources. On the other hand, many organizations and local universities work of several ecological aspects of the Indian Sundarbans. A possible collaboration and sharing of information would deeply facilitate quick decision making process.

POLICY RECOMMENDATION

Participatory Planning for livelihood Resilience

BACKGROUND

Sundarban region is exceptionally vulnerable in terms of its existing livelihood scenario of the local communities. On an average, 43.5% of the populations of this region live under the designated poverty line. Mono crop agriculture, primarily rice, form the major form of livelihood of the communities (approximately 60%), however, saline water flooding in the cyclone 'Aila' has drastically reduced the productivity of the coastal agricultural land. On the other hand, approximately 30% of the local communities depend on estuarine and on-shore fishing. Fishing is one of the traditional livelihoods of the communities. However, of late, fishing activities is also simultaneously challenged with drastic reduction (30-50%) of fish catch. Another section of the communities, precisely, economically marginalized women group take part in prawn seed collection. The process is poorly rewarding and ecologically destructive that is believed to be primarily responsible for reduction of aquatic bio-diversity. The study primarily interacted with these three occupational groups in order to understand the existing threats and coping mechanism. The following recommendations are based on the FGDs conducted with these groups.

ADAPTATION

Both the existing form of agriculture and fishing requires substantial amount of adaptive measures to cope with climate extremity. Therefore, planning for agricultural adaptation (e.g. cultivation of salinity tolerant species, crop diversification etc) is extremely necessary. However, this process will require substantial amount of external assistance, capacity development and training of the vulnerable groups. Further, adaptation measures will largely vary depending on the socio-economic and individual capacity of the farmers as well as fishermen. Therefore, prioritization of adaptive actions needs to be integrated in the regional agricultural and fisheries action plan. There is also a need for creation of separate adaptation fund in the distirct level.

ALTERNATIVE LIVELIHOOD

At present, over 50% of the total agricultural workers are landless labors. Similarly, approximately 3-5% of the communities are involved in eco-sensitive livelihood such as prawn seed collection. Several researchers has already urged about development of alternative livelihood for these vulnerable communities. However, these need to reflect in the regional development plan as a priority. Further, small scale rural initiatives needs to be supported by the local government through small loans, infrastructural assistance and subsidies.

MARKET

Focus Group Discussion with the local fishermen also revealed problem of non-availability of markets and high transportation cost involved to reach the distantly located commercial facilities. Therefore, development of wholesale markets for large scale transaction of goods needs to be developed within the extreme coastal blocks. Improvement of the local transportation facilities is also very important in this regard.

FACILITIES

Interaction with several occupational groups revealed that a number of physical facilities could positively influence the local livelihood scenario. For example, agricultural communities revealed that irrigation facilities, seed collection and soil testing laboratories are extremely important in view of developing their potentials. Similarly, there is also a need for developing local hatcheries & breeding centers to support local fishermen. These facilities can be planned through the effective involvement of NGOs & NPOs or strengthening block offices with adequate human resources and facilities.

Embankment & Vulnerable Area Management

BACKGROUND

Sundarban is crisscrossed with several tidal rivers, channels and creeks making it topographically complex and inaccessible. There are approximately 4000 km of embankments of which 672 km of embankment was fully or partially destructed by the cyclone 'Aila' in 2009. Understandably, the entire network of embankment remain at the central of attention in the management of this low lying delta area. The Government of West Bengal has launched the 'Aila damaged embankment reconstruction project which aims to reconstruct approximately 800 km of vulnerable embankments. This project is crucial in view of abating future disaster impacts. However, the project is severely challenged due to non-availability of land. Over the last 5 years, less than 40% of the requisite land has been acquired. The study provides following policy recommendations which emerge from the interview of the project officials and the local communities.

LEGAL ISSUES

In view of the vulnerability of the delta, acquisition of the land is extremely crucial. However, there have been several issues with the existing process of land acquisition. The study proposes a separate sub-section of the existing land acquisition & rehabilitation policies to deal with urgent and immediate land acquisition in highly vulnerable (naturally) areas for larger public interest. Public Hearing & other legal formalities in this regard should be dealt with immediate priority.

RESEARCH

Considering the extreme fragile hydro-geological settings of the delta, a close monitoring mechanism should be established to govern the hydrological changes that the delta is facing today. River course changes, coastal erosion and accretion need to be documented on regular intervals. Academic and research institutes need to be involved in the overall delta area management and a strict 'Lab to Land' policy need to be adopted.

GREENBELT

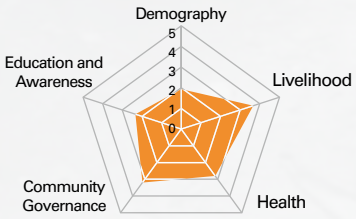
As the embankments provide protection to the island, maintenance of the embankment should be given the first priority. Responsibility of maintaining the embankment can be shared with the local people. The maintenance procedure should also include the development and monitoring of coastal greenbelt as proposed the 'Aila Dam reconstruction project.'

STRUCTURAL ISSUES

Majority of the existing embankments are earthen and made from the locally available soil, however, considering the eco-fragility of the region changing of the structural component is not recommended. In some cases height of the embankments need to be increased above the existing heights under the clogging of the river beds. Importantly, embankments are also used as major arterial roads for many islands. Therefore, surface protection and erosion control of embankments should be dealt with priority. Surface protection to embankment can be provided in many forms –grass turf, vetiver grass hedges, stone riprap, concrete slabs, etc.

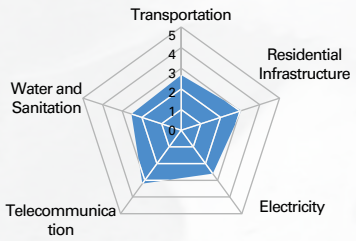
CANNING-I

Socio-Economic



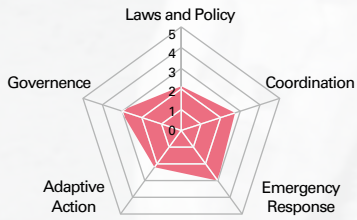
Canning I block consists of 11 Gram Panchayets and the Sub-divisional headquarters. The existing demographic settings, i.e. high population density (1586 person/sq. km) and decadal growth rate of 21.82% is the major concern for the block. Since the block also host the administrative facilities of the Canning sub-division, in general, the livelihood scenario of the blocks is better compared to other blocks with around 12% people are involved in organized sectors. Dependency on coastal resources are also comparatively less. The block also consist a sub-divisional hospital and some private health care facilities.

Physcial



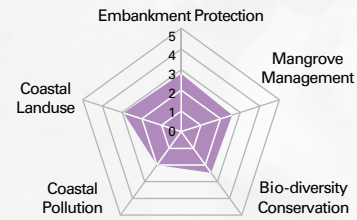
Although the block is connected by rail and road network, transportation remains a challenge, especially in the interior villages. Approximately, 15% of the household has formal electricity connection and 80% of the residential infrastructure is primitive. However, the in spite of that, tele-communication has majorly improved over the years, almost 70% of the communities have mobile phone connection.

Institutional



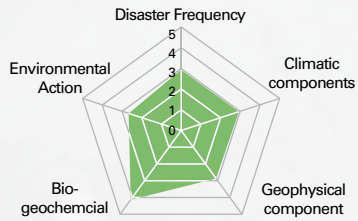
Since the block is centrally located and also hosts the sub-divisional headquarters, in general, the emergency response set up & coordination with the other blocks is better that the rest. However, the block is yet to implement any substantial adaptation actions to cope with its vulnerability.

Coastal Zone Management



Canning I block is located in the transitional zone of the Sundarban mangroves. Majority of the mangrove area in this block is unprotected open forest. Over the past few years, some of the transitional mangroves were lost in this block, although relatively small. The block has an extended stretch of embankment across the river Malta in the South east region, part of which is being upgraded after the Cyclone 'Aila'.

Environmental/Natural

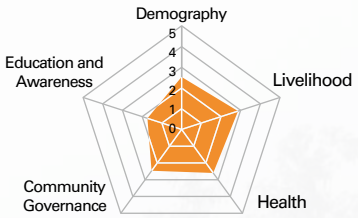


Canning I block is mainly prone of tidal flooding. The main water areas of the block are now challenged with excessive sedimentation and clogging of riverbed. This has resulted in poor navigability and emerged as major threat to tidal flooding. Overtopping of tidal embankments has become more frequent in recent years. Neither of the domestic tube wells has so far been reported of Arsenic or other heavy metal contamination.

CANNING-II

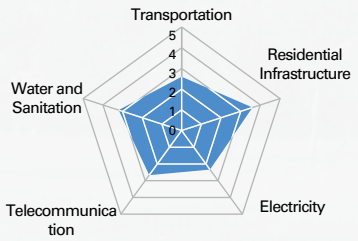
Canning II block consists of 9 Gram Panchayets and is located in the North-east of the Canning town, the sub-divisional headquarters. The existing demographic settings, i.e. high population density (1156 person/sq. km) and decadal growth rate of 26.82% results in poor demographic resilience of the block. In terms of livelihood, approximately 70% of the communities depend on mono-crop agriculture and half of the population lives under the designated poverty line. Around 52% of the population is literate. In terms of health facilities, it has a block health centre, however, the doctor: population ration is very poor.

Socio-Economic



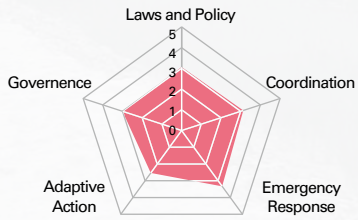
The block is poorly connected and the existing transportation facility in poor. The length of surfaced road compared to the block size is about 0.26 km/sq. km. Almost 100% of the population can be designated as rural population and suffers from poor residential infrastructure. Only 3 to 5% of the local households are having formal electricity collection.

Physcial



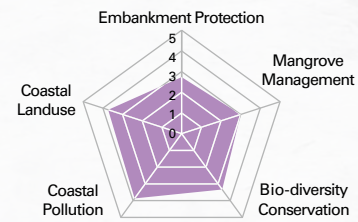
The location proximity to the sub-divisional head quarters is a major cause behind it moderate institutional resilience. Emergency response and cordination among the communities are also satisfactory. However, no intuitional adaptation actions have been initiated by the local government or the village institutions.

Institutional



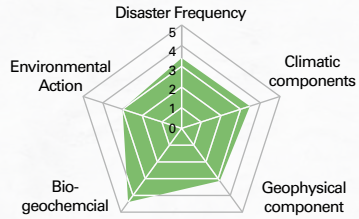
Coastal exposure of Canning II Block is relatively low since it only faces a small stretch of the river Matla in the South-west region. Therefore, no significant interventions into the coastal ecosystems were observed in this block. Relatively small stretch of embankment exists in this block and these embankments were not identified as vulnerable. However, structurally this is over a century old which has been repaired on demand basis.

Coastal Zone Management



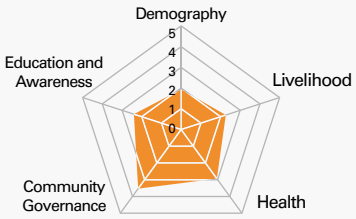
Canning II block is primarily exposed to cyclonic storms. Particularly the rural setting is prone to high winds. The land is stable and there has not been major subsidence and erosion incidents occurred in past few years. The ground water is also relatively contamination free. Overall, the natural resilience is significantly high compared to its neighboring blocks.

Environmental/Natural



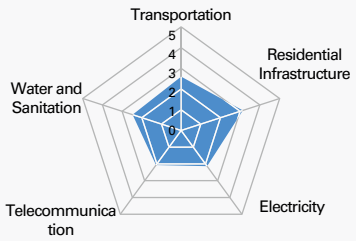
BASANTI

Socio-Economic



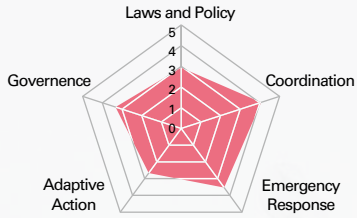
Basanti Block consists of 13 Gram Panchayets and is located in the South east of the Canning town, the sub-divisional headquarters. This is also designated as extreme coastal blocks located in the mangrove buffer areas. The population density (821person/sq. km) and decadal growth rate of 19.16% is quite high. Almost the entire population is rural. In terms of livelihood, over 70% of the communities are involved in agriculture. This block is also characterized by a huge number (approximately 65%) of BPL population leading to very poor socio-economic resilience.

Physcial



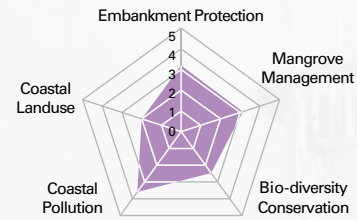
The block is poorly connected and void of formal transportation network. Approximately 80% of the housing structures are made of earthen structures. In terms of road area, the block has only 0.46 km/sq. km of the total area. Less than 1% of people are having electricity connection. Drinking water facilities are also not adequate. In general, physical resilience of the block is poor.

Institutional



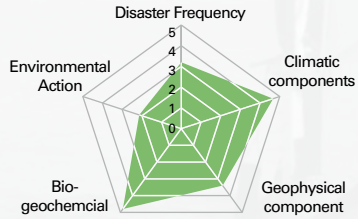
Since the cyclone 'Aila' the block has experienced some sort of institutional strengthening and received good amount of aid and attention. However, despite of that institutional intervention in promoting adaptive action is not experienced.

Coastal Zone Management



Coastal exposure to Basnati Block is very high since the block is surrounded by two major channels, i.e. Matla River and Bidya River. The main problem it has experienced is the land use alteration & land encroachment in the highly eco-sensitive areas, although the length of potentially vulnerable embankment is relatively small. The block has several Forest Protection Committees performing under the local forest department. This has made substantial contribution in conservation of the mangrove forests.

Environmental/Natural

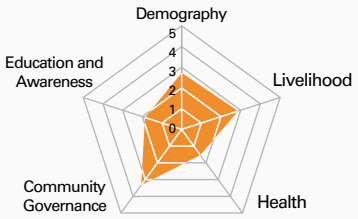


Basanti Block is primarily exposed to coastal flooding and storm surges. Rising of inland water salinity is also a potential concern for the local fishermen. However, the ground water of the block is void of arsenic and heavy metal contamination. Also, the majority area of this block is not prone to natural subsidence.

GOSABA

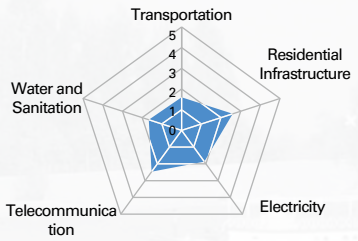
Gosaba block is located at the fringe of the Sundarban mangrove forest and also a significant part of this block is covered under the mangroves. The Block consists of 15 Gram Panchayets. Population density (825 person/sq. km) and decadal growth rate of 9.83% is high and moderate respectively. The entire population is rural. In terms of livelihood, the block is exceptionally vulnerable. Over, 70% of the population is dependent on agriculture and rests are involved in fishing and prawn seed collection. The block lives in isolation and livelihood opportunities are very limited. Overall, the socio-economic resilience is observed to be poor.

Socio-Economic



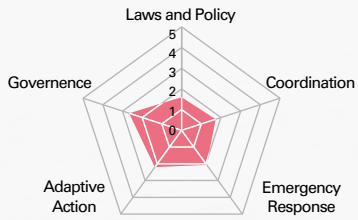
The block is very poorly connected through semi-mechanized boats. In the islands, no formal motorized public transportation is unavailable. Less than 1% of the communities have formal electricity connection and the islands are yet to be connected to the main supply grids. Over 80% of the housing is vulnerable to storms and flooding. Although, approximately 65% of the communities have access to mobile phones, telecommunication facilities are not up to the satisfactory limit.

Physcial



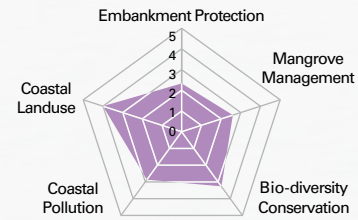
Physical isolation plays also an important role in Gosaba's poor institutional resilience. Implementation of laws and policies are also another critical issue under the depleting resources and poor socio-economic condition.

Institutional



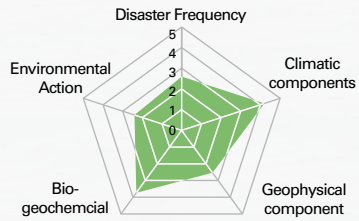
Gosaba is one of the extreme coastal blocks and coastal exposure is very high. The block is entirely surrounded by earthen embankments which posses a formidable challenge. Many of its embankments were destroyed during the past cyclone leading to prolonger flooding. Gosaba has several Eco-Development Committees for bio-diversity conservation, especially tigers. The problem of man animal conflict in this block is acute.

Coastal Zone Management



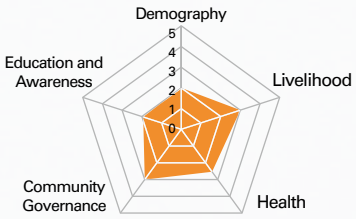
Gosaba block is exposed to all sort of coastal hazards. The primary concern is the tidal and surge flooding. However, existence of the great Sundarban mangroves provides a strong buffer to the wind hazards. It is also experiencing severe coastal erosion and changes of river courses. Salinity has become a major problem in recent years. Ground water is, in general, free from heavy metal or arsenic contamination.

Environmental/Natural



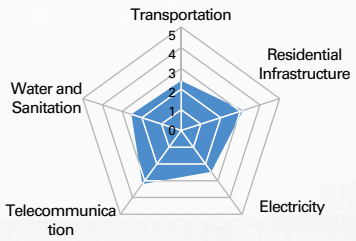
KAKDWIP

Socio-Economic



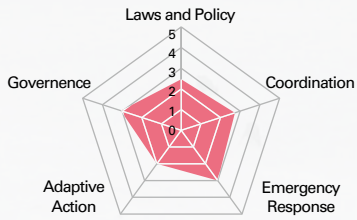
Kakdwip block is located in the South western part of Indian Sundarban in the bank of Hooghly River. The block consists 11 Gram Panchayets and the Kakdwip sub-divisional township. The block experiences high population density (1133 person/ sq. km) with a decadal growth rate of close to 19.64%. Approximately, 53% of the population is dependent on agriculture. It also hosts a good amount of fishing communities. Apart from the Kakdwip Township which also serves as the head quarter of Kakdwip sub-division, the entire population is rural.

Physcial



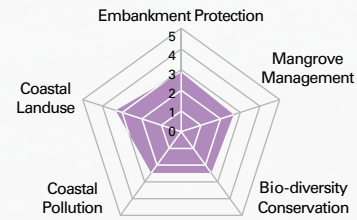
The block is connected through roads and railways. The amount of available road is 1.21 km/sq, km of the block area which is significantly high compared to other blocks. However, the interior rural areas are not very well connected. Approximately 12 % of the population, mainly residing in the township is having access to electricity. Most of the communities are having mobile phones and formal communication medium such as television and radio.

Institutional



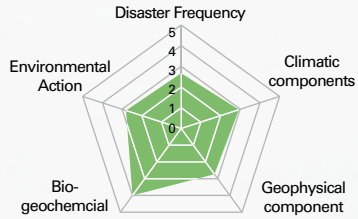
The observed institutional resilience for this block can be categorized between poor to moderate. Part of this evolves from the ineffective implementation of laws and policies. Similar to the other blocks in the region, emergency response mechanism has improved since Cyclone "Aila'.

Coastal Zone Management



Kakdwip has significant coastal exposure since it has long strength of embankments across the river Hooghly in the west and Saptamukhi in the South. The embankment scenario is comparatively better to other blocks and also only a small stretch was breached during Aila. Despite of an entry point to the Sundarbans, mangrove cover of this area is significantly low. The Kakdwip Township also causes substantial water pollution in the adjoining rivers since it does not possess any waste water treatment plant. Also, some of the villges are dangerously close to the river.

Environmental/Natural

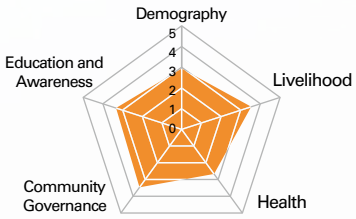


Kakdwip is primarily exposed to coastal erosion and has high flooding potential. River bank erosion is also an identified as a major threat for the block under the changing hydrological scenario of the river Hooghly. However, the block does not suffer from ground water contamination with arsenic or other heavy metals.

SAGAR

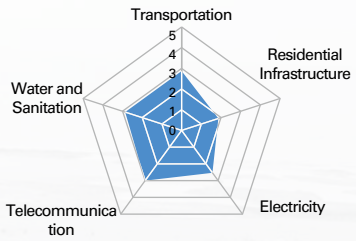
Sagar is an extreme coastal block situated in the western part of the delta. The population density of the block is 748 person/sq km and the decadal growth rate is 13.71%. Approximately, 75% of the communities are involved in mono crop agriculture. However, religious tourism has substantial positive impact in the local economy. Sagar has one of the highest literacy rates in the delta. In general, the socio-economic scenario is comparatively better than the other extreme coastal blocks.

Socio-Economic



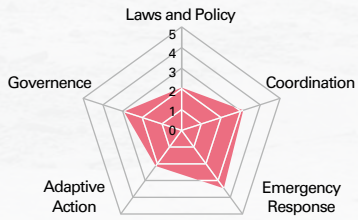
The entire block of Sagar represents islands communities and suffers from geographical isolation. The only way to enter the block is through waterways and the transportation is not well developed. However, the block has a well developed arterial road with formal transportation such as bus, car etc. The road density is 0.59 km/sq/km. Close to 2% of the people have electricity connection, however, the situation is expected to improve as the island have been recently connected to the main power grids. Rural infrastructure such as mud houses is the major concern for this block.

Physcial



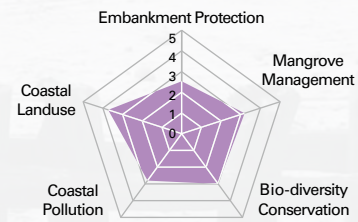
Sagar has a well established emergency response and coordination mechanism, presumably due to the annual religious event that it hosts. However, in general, implementation of CZM notification and other environmental regulations are poor. Despite of the blocks vulnerability, adaptation mechanism are also not in place.

Institutional



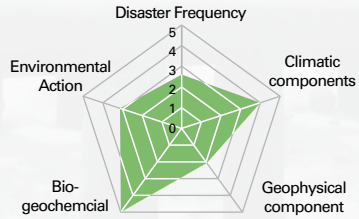
Sagar is surrounded by rivers (Gabtala River in the west and Muriganga River in the east) and faces the Bay of Bengal in the south. The main island of Sagar is protected by sea and river dykes and maintenance of these facilities is of major concern. Some of the embankments were damaged during the cyclone 'Aila' and presently being reconstructed.

Coastal Zone Management



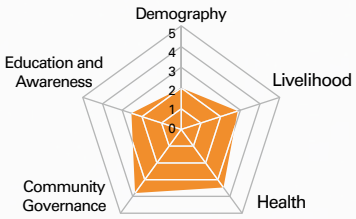
Sagar is primarily exposed to severe coastal erosion and the projected sea level rise implies a grave concern for the block. It is also equally exposed to coastal flooding and storm surges as well as high wind events. The main islands and some other nearby small islands are probably undergoing a geological subsidence leading to a rapid coastal erosion and loss of land. However, the block is free from bio-geochemical hazards such as arsenic contamination etc.

Environmental/Natural



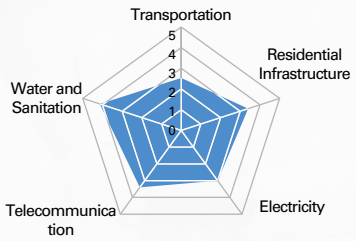
NAMKHANA

Socio-Economic



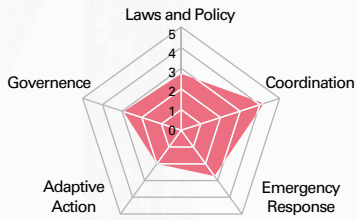
Namkhana is an extreme coastal block in the Kakdwip sub-division. The block consists of 7 Gram Panchayets with a population density of 491 person/sq. km. The decadal growth rate is also moderate 13.22%. Approximately, 65% of the communities are involved in agriculture and rests are involved in estuarine fishing. The block is predominantly rural, however, part of this block such as Namkhana and Bakkhali are now being developed as small townships. The block is characterized by high amount of poverty with approximately half of the population is living below the poverty line. .

Physcial



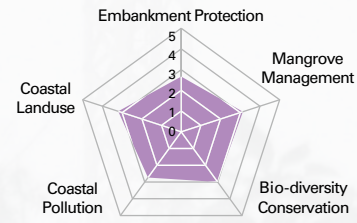
Namkhana is connected by road and water ways; however, it is difficult to reach some of the remote islands such as Mousuni. Approximately 6% of the population has formal electricity connection. In general, the population has safe drinking water supply in terms of availability of tube wells. The block is covered through both private and government telecommunication network and over 70% of the population has access to mobile phones.

Institutional



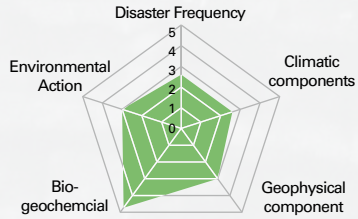
The institutional resilience of this block is moderate. Similar to the neighboring blocks, it requires substantial institutional intervention to promote adaptive actions. In general, coordination mechanism among the adjacent blocks and higher level of government is well established.

Coastal Zone Management



Namkhana block is surrounded by several creeks and river channels and faces the sea in the south. The Henry's island in the southern tip of the block maintains a thick greenbelt of mangroves which undoubtedly increases its resilience from storm surges. The block also host several protected areas of mangroves. However, similar to other coastal blocks, maintenance of extensive embankment network remain as a crucial challenge.

Environmental/Natural

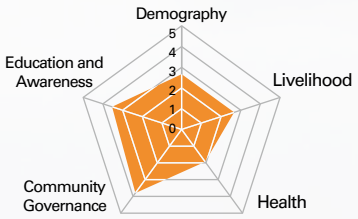


Namkhana is located at the central tip of the delta and exposed to severe cyclones and tidal flooding. This is also one of the extremely affected blocks in the cyclone Aila. The area is further prone to erosion and rising salinity of the inland waters. However, the region is not exposed to acute bio-geochemical hazards such as arsenic or heavy metal contamination in ground water.

PATHARPRATIMA

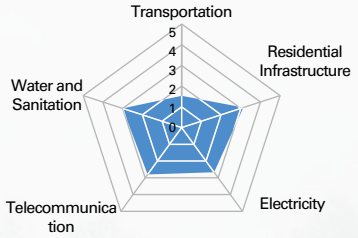
Pathar Pratima block is located in south central region of the Indian Sundarbans. The block consists 15 Gram Panchayets. The existing density of population is about 689 person/sq. km. The decadal growth rate is 15.71, considerable high for a rural coastal area. Close to 65% of the communities are involved in agriculture and almost half of the population survive below the designated poverty line. However, close to 74% of the people are literate and well aware of their existing vulnerability.

Socio-Economic



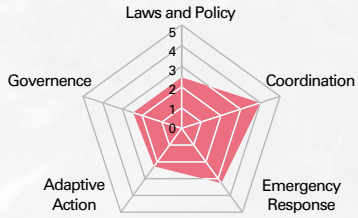
The block is connected through roads and waterways. The amount of available road is 0.23 km/sq, km of the block area which is significantly poor compared to other coastal blocks. Informal semi-motorized vehicles & boats are the lifeline for local people. Particularly, G-spot and other extreme coastal areas are highly inaccessible. The block has less than 1% of house hold electricity connection, however, localized solar power are extensively used by the communities.

Physcial



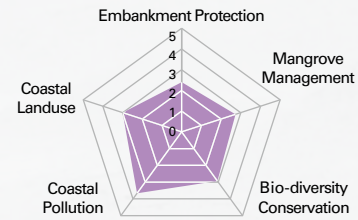
The observed institutional resilience for this block can be categorized between poor to moderate. Part of this evolves from the effective implementation of laws and policies. However, similar to the other blocks in the region, emergency response mechanism has improved since Cyclone "Aila'.

Institutional



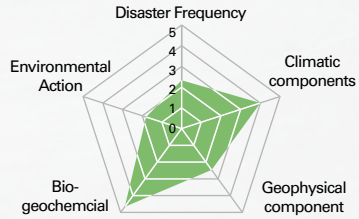
Similar to the other coastal blocks, Pathar Prratima block has high coastal exposure. The block is surrounded by Takhurani River in the east and Saptamukhi River in the west. The Southern part of the block consists of small deltaic islands crisscrossed by several tidal creeks. Therefore, embankments are the lifeline of this blocks. However, following the cyclone Aila, the majority of the embankment need to be reconstructed and require improvement. The block has significant mangrove forests in its southern tip which is being protected by the forest department.

Coastal Zone Management



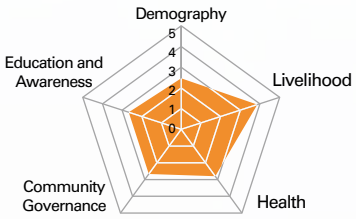
Due to its geographical location, this block is severely exposed to coastal& surge flooding. Tidal flooding is also a mjor concern for this block. Part of this block is also experiencing coastal erosions. The projected consequences of climate change may have significant adverse impact of this block. However, the block is free of bio-geochemical contamination.

Environmental/Natural



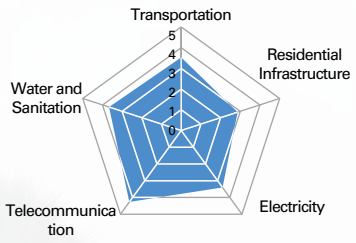
JOYNAGAR-I

Socio-Economic



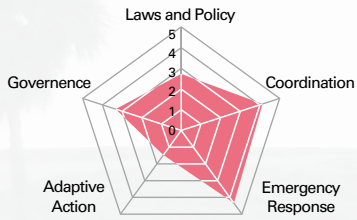
Joynagar I block is located in the middle mature delta and consists of 12 Gram Panchayet. The block is under the Baruipur Sub-division and represents a mixed population of rural and semi-urban settlements. Joynagar I has the highest population density (1984 person/sq.km) with a decadal growth rate of 18.66. Approximately, 33% of the communities are involved in agricultural sector. Joynagar has a relatively better health facilities compared to the other blocks.

Physcial



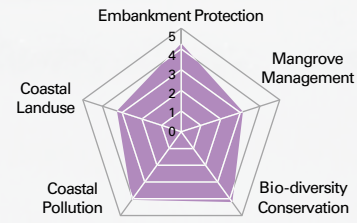
Joynagar I block is well connected via rail and road networks. Formal transportation facilities exist in almost every corner of the block. Although, some of the interior villages are difficult to reach by formal mean of transportation. Approximately 15.21% of the local populations have access to electricity. Joynagar I is also the highest amount of people having access to supplied drinking water. Over 80% of the communities have access to mobile phones, radio or television.

Institutional



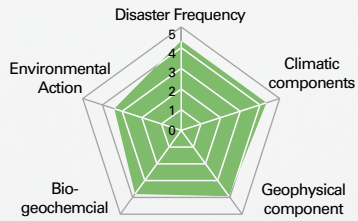
Due to the close proximity to the state capital, both the coordination and emergency response mechanism are satisfactory. However, implementation of laws and policies is identified as a major challenge.

Coastal Zone Management



Joynagar I block has significantly less coastal exposure. The Hobka Cannel flows through the north of the block. There is only a small stretch of embankment. Particularly, the embankments of this block did not suffer much damage in the Cyclone 'Aila". The block has a small patch of unprotected mangroves in the south east, however, significant conservation imitative exists at present.

Environmental/Natural



Due to its interior location in the middle mature delta, the block is relatively less exposed to coastal hazards. The block is primarily get affected by wind hazards. However, block is partially contaminated by arsenic in some of the tube wells. There is no major observed or predicted impact of climate change on this block.

JOYNAGAR-II

Joynagar II block is located in the south of the middle mature delta under the Baruipur sub-division. The block consists of 10 Gram Panchayets. Almost the entire population is rural excluding the sub-urban areas of Joynagar. The block is densely populated (1326 person/sq.km) and experiences a decadal growth rate of 18.06%. The choice of livelihood is limited. More than half of the existing population lives on agriculture. Approximately, 42.6% people live under the designated poverty line.

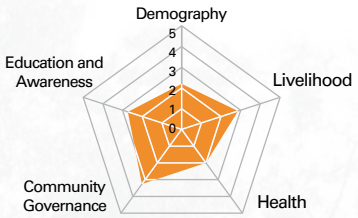
In general, Joynagar II block is well connected via road and railways. The Joynagar-Majilpur station on the Seladah Lakshmikantapur railway serves the gateway of the block. Over 90% of the population lives in rural areas and live in earthen or semi structured houses. Only 5.80% of the population has formal electricity connection, although many of the communities use personalized solar electricity facilities. Similar to other blocks, majority of the communities have access to mobile phones, TV or radio.

In general, these blocks show similar institutional resilience to Joynagar I block and take the advantage of being at close proximity to the district and sub-divisional head quarters. Coordination with NGOs & research organization such as ICAR is also very satisfactory. The Nimpeeth Krishi Vigyan Kendra, an NGO & technical consutant has worked extensively with the block administration in promoting agricultural adaptation.

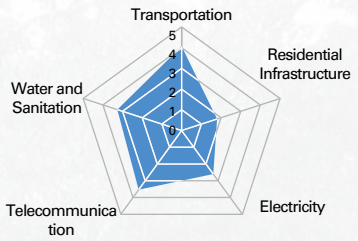
Joynagar II is surrounded by creeks and small channels, especially Moni River and Hobka Khal in the west and east respectively. The eastern side of the block is entirely covered by earthen embankments; part of which has been demarcated as vulnerable. There has also a bit of sparse mangrove vegetation which remains unprotected.

Exposure to Coastal Hazards is significantly low, primarily due to its location in the middle mature delta. However, southern part of the block was heavily impacted by river flooding due to the cyclone 'Aila'. The block is void of major heavy metal or arsenic contamination.

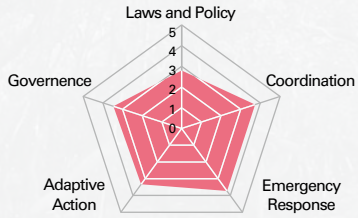
Socio-Economic



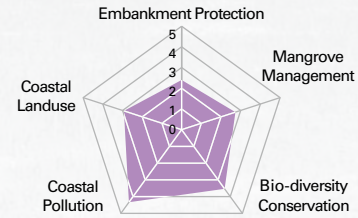
Physcial



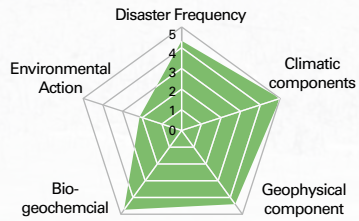
Institutional



Coastal Zone Management

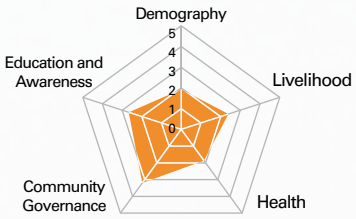


Environmental/Natural



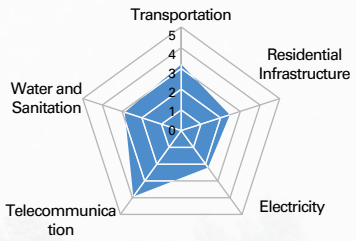
KULTALI

Socio-Economic



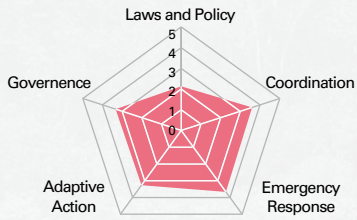
The block Kultali stretches from middle mature delta to the active delta area and consists of 11 Gram Panchayets. Kultali block has predominantly rural communities with a population density of 757 person/sq. km. The decadal growth rate is 23.33%; significantly high compared to the other coastal blocks. More than 70% of the communities are involved in mono crop agriculture. Close to 46.36% of the population lives under the poverty line. The block has been infamous for law & order problem creating conflicts among the communities.

Physcial



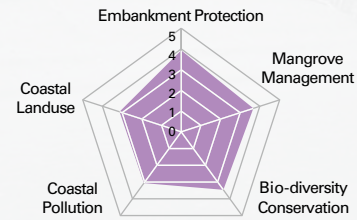
Kultali block is connected through a major arterial road; however, formal public transportation in this road is rare. Almost half of the population has access over drinking water facilities, however, only <1% has access to electricity. Over 70% of the communities have access to mobile phones, TV or radios. The majority of the local houses are semi-engineered earthen structures.

Institutional



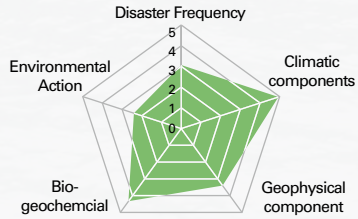
Implementation of laws and policies is a substantial challenge for the local administration. However, emergency response has substantially improved since the cyclone 'Aila'. The block is yet to implement any formal structured adaptation measures. Lack of human capacity in the block administration is also a major challenge.

Coastal Zone Management



Kultali block is surrounded by rivers. Matla River flows south to the block. It has a long stretch of embankments facing the Matla River, part of which has been restored after cyclone 'Aila'. The block also has several Forest Protection Committees in order to protect and conserve the mangrove forests. In general, the functions of FPCs are satisfactory, however, in some cases the forest cover has marginally reduced. There are some problems with illegal settlement across the river embankments.

Environmental/Natural

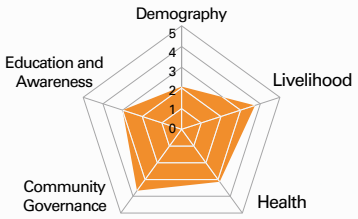


Kultali block is primarily exposed to coastal flooding. The southern tip of the block was inundated during the cyclone Aila and a large portion of the coastal land was eroded. The changing river track of Matla near Kaikhali is also an identified phenomenon. There is no reported arsenic contamination in this block.

MATHURAPUR-I

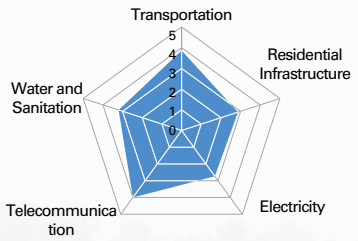
Mathurapur I block is located in the middle mature delta under the Diamond Harbor sub-division. The block consists of 10 Gram Panchayets. Population density of this block is 1318 person/sq km. The block also experiences a decadal population growth 17.87%. Approximately 46% of the populations are involved in agriculture. 34% people live under the designated poverty line which is significantly low compared to the other blocks of Sundarbans.

Socio-Economic



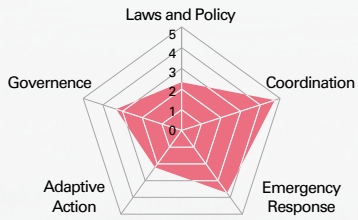
The block is well connected by road and railways. The available road length/sq. km of land area is approximately 2.06. Nearly 12% of the people have formal electricity connection while more than 50% of the population has access to drinking water supply. Almost the entire community has access to television, radio or mobile phones.

Physcial



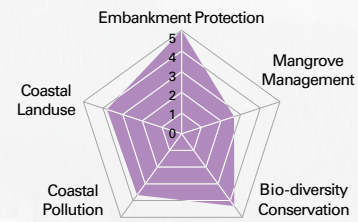
Coordination between the blocks and with other implementing agencies is substantially good for this block. This is primarily due to close proximity to the head quarters and land connectivity. The block has an emergency management plan in place. However, similar to the local administrative scenario, implementation of laws and policies remain significant challenge.

Institutional



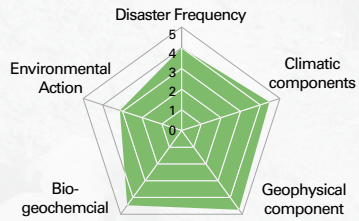
Mathurapur I has only a small stretch of embankment in the south of the block. These embankments are not classified as vulnerable; also it did not suffer major damage in the cyclone 'Aila'. The block does not possess significant amount of mangroves or designated forest land. However, there are scope for mangrove plantation.

Coastal Zone Management



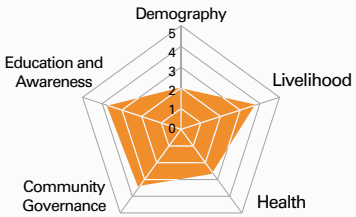
Although it is a designated block under the Sundarban region, the block is relatively less exposed that any other blocks in the region. It only faces significant wind hazards and some occasional flooding. No major incidents of land erosion or land subsidence were recorded in this block.

Environmental/Natural



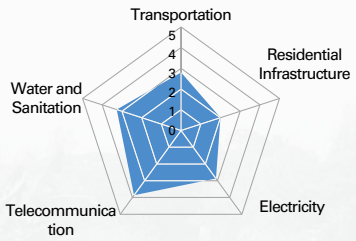
MATHURAPUR-II

Socio-Economic



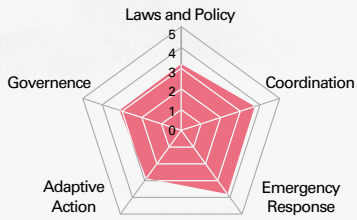
Mathurapur II block is located under the Diamond Harbor sub-division. The block has a population density of close to 1000 person/sq km. The decadal population growth has been 10.72%, relatively low compared to the other blocks. Approximately 40% of the population lives under the poverty line. Agricultural community consist amount 63% of the local population.

Physcial



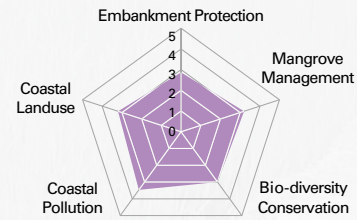
Mathurapur II is connected by roadways; however, connectivity to the interior blocks is poor. The length of surfaced road/sq km is only 0.60. Approximately 6% of the communities have household electricity connection while more than 50% of the population has access to safe drinking water.

Institutional



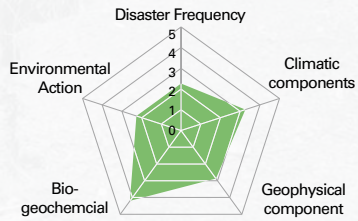
Institutional resilience profile of the block is similar to the neighboring blocks. The block has an emergency management plan in place. The existing coordination mechanism is also good due to its proximity and land connectivity to the administrative headquarters.

Coastal Zone Management



Mathurapur II has moderate coastal exposure. There is a long stretch of embankment across the Raidighi River located in the South of the Block. These stretches of embankment are relatively safe and did not suffer much in the cyclone 'Aila'. However, the block does not possess significant mangrove or forest cover and there is scope of mangrove plantation.

Environmental/Natural

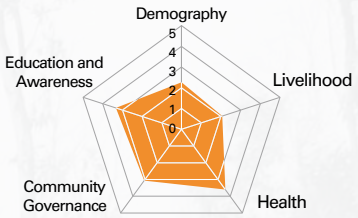


The block is relative less exposed to coastal hazards with moderate frequency of flooding. The immediate threat comes from high wind event. However, the block is experiencing river bank erosion in the south. The block is free of bio-geochemical hazards.

SANDESHKHALI-I

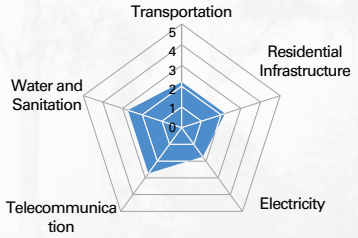
Sandeshkhali I block is located in the Bashirhat Subdivision under the North 24 Parganas. This riparian block has a population density of 901 perosn/sq. km with a decadal population growth of 16.88%. Close to 60% of the population live under the designated poverty line. Approximately, 63% of the population lives on agriculture. Approximately 59% of the communities are literate. Sandehkhali I has extremely limited health facilities.

Socio-Economic



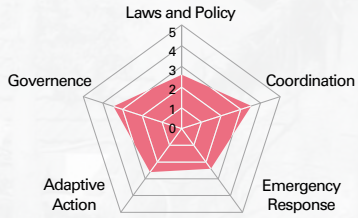
Sandeshkhali I is connected by road and waterways, although the interior villages are only connected through waterways. The block has the road density of 1.14 km/sq km. Domestic electrify connection is rare; however, many uses personalized solar facilities .The existing residential and housing facilities are mostly earthen, making it highly vulnerable to coastal hazards.

Physcial



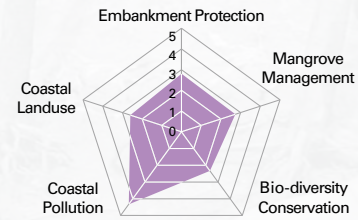
The inaccessible location of the block has been a major drawback in the emergency response mechanism adopted by the block administration. However, the block prepared a disaster management plan after the cyclone Aila.

Institutional



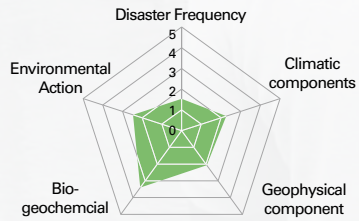
The block has significant coastal exposure. The block is surrounded by rivers and creeks and survives on a peripheral embankment. The eastern part of the block has experienced embankment failure during the cyclone 'Aila'. Majority of those is yet to be properly reconstructed. The block has several altered land for coastal shrimp cultivations adding to its vulnerability. Despite of significant mangrove cover, majority of it are not protected.

Coastal Zone Management



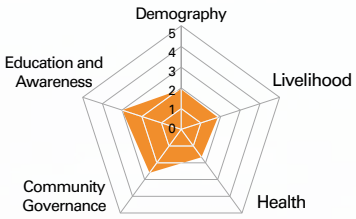
Sandehkhali I has high coastal exposure and primarily exposed to coastal flooding, storm surges and high wind events. The block is also among the most impacted blocks in cyclone Aila. River bank erosion and changing of river courses are of primary concern for this block, especially near Dhamakhali, the entry point and commercial centre of the block. Apart from that, approximately 0.6% of the existing tube wells have arsenic contamination leading to bio-geochemical hazards.

Environmental/Natural



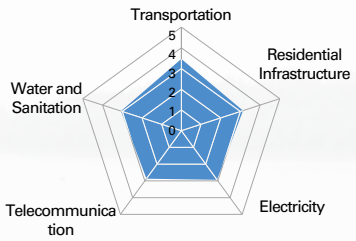
SANDESHKHALI-II

Socio-Economic



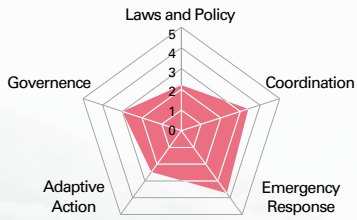
Sandeshkhali II is located in the Bashirhat sub-division and to the north of the Gosaba block. The block consists 8 Gram Panchayets. The block has a population density of 816 person/sq. km and the decadal population growth in 17.98%. Close to 60% of the existing population live below the designated poverty line. Nearly 65% of the populations live on agriculture. Sandeshkhali II has also extremely limited health care facilities making this block exceptionally vulnerable on socio-economic front.

Physcial



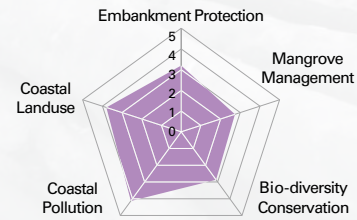
Sandehkhali II is connected by roads and waterways. Most of the locations under this block can only be reached by semi-motorized boats. The block consists road areas of nearly 0.14 km/sq km. Similar to the adjacent blocks, the existing residential infrastructure are high vulnerable and made of semi-engineered earthen houses. However, more than 60% of the population have mobile phone and have access to radio.

Institutional



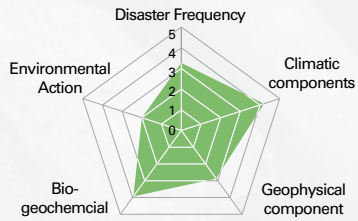
Sandeshkhali II is among the most impacted blocks in the Cyclone Aila. Since then, the institutional mechanism has vastly improved. The block maintains an emergency action plan. However, similar to the regional scenario, efforts for institutional adaptation are yet to be initiated.

Coastal Zone Management



Sandehskhali II is surrounded by rivers and creeks. It faces the Bidya River in the South. The eastern part of the block has a huge stretch of vulnerable embankment which was destructed during the cyclone 'Aila'. Sandehkhali II also has substantial amount of mangrove forest. Especially in the southern villages of the blocks have several patches of mangrove. In general, the mangroves are well conserved.

Environmental/Natural

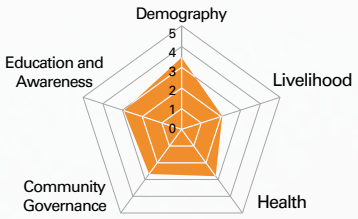


Sandeshkhali II receives very high exposure from all sorts of coastal hazards. The block was affected by storm and floods during the cyclone 'Aila'. Change of land use in terms of development of shrimp & aquaculture ponds further adds to its vulnerability. A small number of shallow tubewells are arsenic contaminated, however, they are well segregated.

MINAKHAN

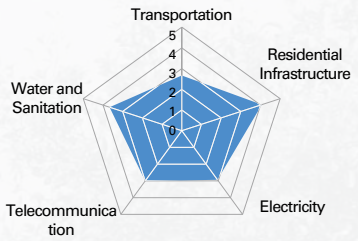
Minakhan is located in the eastern part of the Sundarban delta under the Bashirhat sub-division. The block has a staggering density of 1208person/sq km and experiences a decadal population growth of 13.58%. Close to 55% of the local communities are engaged in agriculture. The block also has significant amount of BPL population. In general, the observed socio-economic resilience can be defined as poor.

Socio-Economic



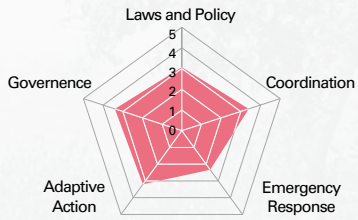
Minakhan is connected by roads & waterways. However, the interior areas are difficult to reach in absence of formal road network. The average road area is about 0.38 km/sq km. Close to 27% of the local communities has access to electricity. Compared to the other blocks, the residential infrastructure is slightly better. Majority of the community members have access to mobile phones and radio or TV.

Physcial



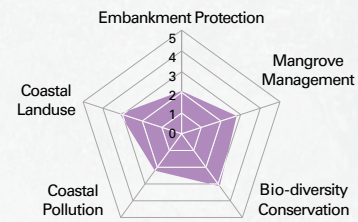
The administrative headquarter of this block is well connected to the district headquarters by an all weather road ensuring good coordination. In general, the observed institutional resilience is comparable to its neighboring blocks.

Institutional



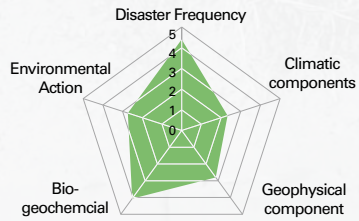
The block is crisscrossed by several small tidal creeks. Bidyadhari Khal marks the western border to the block while Netia Khal marks the boundary in the east. The block has long stretches of embankment; approximately 30% of them are vulnerable and were damaged during the Aila. Particularly, the block experiences severe alteration of land use due to the creation of aquaculture ponds. Similarly discharge of untreated Kolkata city sewage severely pollutes the tidal water bodies.

Coastal Zone Management



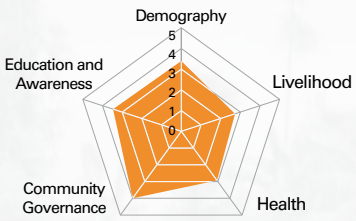
Majority of the existing block area is not exposed to coastal hazards. However, the southern parts of the block, especially, along the river are prone to erosion and river flooding. The transitional salinity is a major issue for the local fishing communities which have also been considered as a major treat under climate change.

Environmental/Natural



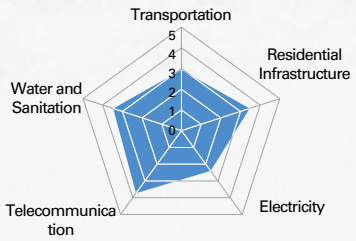
HAROA

Socio-Economic



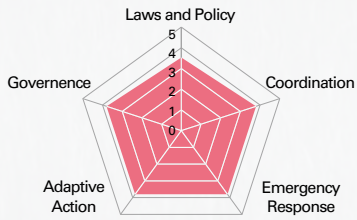
Haroa block is located in the north of Minakhan under the Bashirhat Sub-division. The block consists of 9 Gram Panchayets and has a population density of 1403 person/sq. km. It also experiences a decadal growth rate of 17.38%. Close to 50% of the communities are involved in agriculture. Haroa has significantly low BPL population (nearly 33%) compared to the adjacent blocks.

Physcial



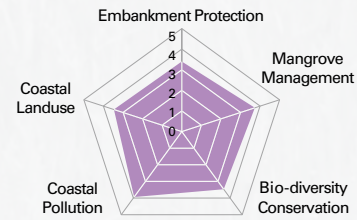
Haroa is well connected by rail and road networks. The block has one of the highest road densities (nearly 2.11 km/sq km of the total area) in Sundarban area. Approximately 60% of the communities have access to electricity. Most of community members have access to mobile phones, radio and TVs. Also, the residential infrastructure is significantly better compared to the other blocks.

Institutional



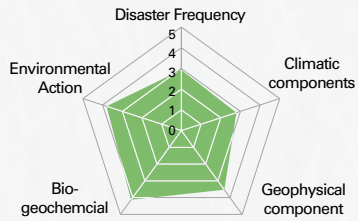
Due to close proximity of the district headquarters (Barsat) and sub-visional headquarters (Bashirhat), the block is good in terms of coordination and governance. In general, the observed institutional resilience is comparable to the interior blocks.

Coastal Zone Management



Haroa has relative small coastal exposure. The Bidyadhari Khal (canal) flows through the western part of the block. There is a little stretch of vulnerable embankments. Although the block does not have significant amount of mangrove forests, in general, no further degradation has been reported in recent years. In also has relatively small areas designated to shrimp farming activities.

Environmental/Natural

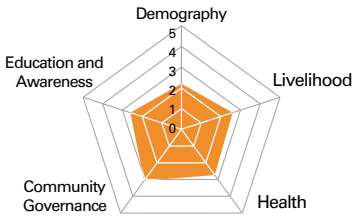


In general, the environmental and natural resilience of Haroa is significantly high compared to other blocks in this region. The block is moderately exposed to flood and high winds. However, the block has some problem with the ground water arsenic contamination.

HASNABAD

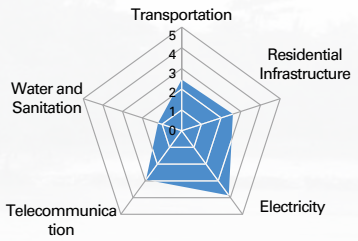
Hasnabad block is located in the northeastern corner of Indian Sundarbans bordering Bangladesh. It consists of 10 Gram Panchayets and also hosts the Hasnabad Township; the sub-divisional headquarters of Bashirhat. The block has a high population density (1286 person/sq. km) and 36% of the local communities are involved in agriculture. The block is located in the border area. Several issues such as trans-boundary migration, illegal settlements are majorly responsible for poor community participation in developmental agendas.

Socio-Economic



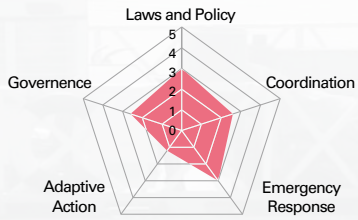
Hasnabad town is well connected by road and railways. However, interior villages are isolated and the formal road coverage is only about 0.37 km/sq.km. Close to 65% of the local households have formal electricity connections. However, residential infrastructures are vulnerable as majority of the communities live in earthen housing. Almost 75% of the communities have access to mobile phone, radio or TV.

Physcial



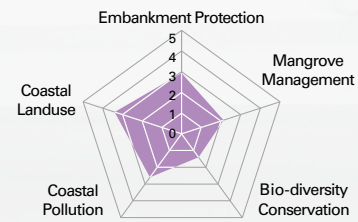
Hasnabad being a border area, constantly faces law and order problems. The local administration is poised of several challenges, particularly conflicts among the communities.

Institutional



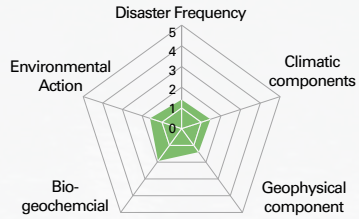
Hasnabad has high coastal exposure, particularly in the eastern part of the block. The river zone also faces the problem of industrial pollution and forcible occupation of land by people. This has resulted in several adverse consequences in the local bio-diversity. The existing small patches of mangroves and other coastal forests are highly vulnerable under the human encroachment. Hasnabad has also had substantial amount of lands diverted to aquaculture ponds.

Coastal Zone Management



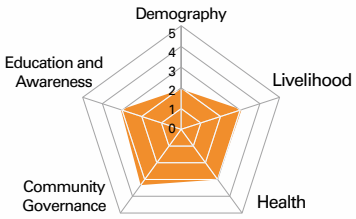
The river Icchamati marks the eastern boundary of the block. This transboundary river has undergone severe siltation which exerts significant risk of riparian flooding. The river is also undergoing natural course changes along with changes in water quality. Hasnabad is also a designated arsenic contaminated block.

Environmental/Natural



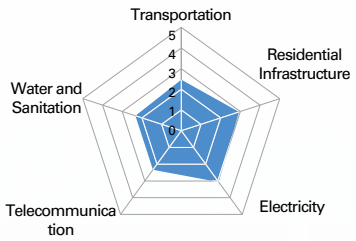
HINGOLGANJ

Socio-Economic



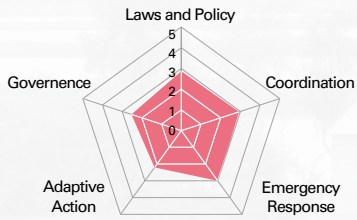
Hingolganj block is located the eastern corner of Indian Sundarbans bordering Bangladesh. The block has a moderate population density of 668 person/sq. km. Close to 60% of the communities are involved in agriculture while 45% of the local communities live under the designated poverty line. The health conditions are also not satisfactory. However, on a positive note, more than 70% of the communities are literate.

Physcial



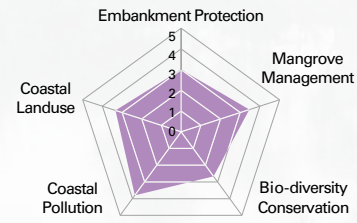
Hingolganj is connected through roads and waterways. The majority of the block is extremely difficult to reach. The road density of Hingolganj is 0.21km/sq km. approximately 25% of the local population has domestic electricity connection and the residential infrastructure is in general poor. Approximately 50% of the communities have access to mobile phones, radio or TV.

Institutional



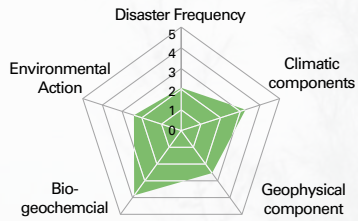
The observed institutional resilience is comparable to the neighboring blocks. As a bordering block, enforcement of laws and policies remain the major challenge of the local administration.

Coastal Zone Management



Hingolganj is surrounded by river and creeks in its four sides. Icchamati River marks the eastern boundary of the block. The block survives due to long stretches of earthen embankments, significant length of which was breached during cyclone 'Aila' in the Southern corner of the block. Presently, the embankments are being reconstructed. The block does not host significant amount of mangrove or other coastal forests, however, anthropogenic interventions of forests is relatively less.

Environmental/Natural



Hingolganj is severely exposed to storms and river flooding. It is also one of the worst affected blocks in Cyclone Aila. Similar to the neighboring Bashirhat Block, heavy siltation in the riverbed of Icchamati also exerts similar risk of riparian flooding, coastal erosion and increment in soil salinity.