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ActionAid Association (India)

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A study of social and ecological issues in Hingalganj Block, North 24 Parganas West Bengal

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CONTENTS

FOREWORD

The sixth assessment report of the Intergovernmental Panel on Climate Change has confirmed that vulnerable populations across the world, and especially in the Global South, are already facing the impact of climate change. What is particularly chilling is that these reports represent an international consensus and hence are an understatement of the crisis faced. The reality is considerably worse.

Already floods, storms, heat and cold waves, rising sea levels, water stress and air pollution disrupt the lives of millions of city dwellers and rural populations. The impact is felt most by the vulnerable and impoverished residents of the cities and landless agricultural labour, small farmers, pastoralists, tribal and indigenous people and other forest dwellers and coastal communities. Moreover, the increased frequency of extreme weather events increases the risk of disaster situations and severely impacts people's resilience to cope with the ongoing agrarian crisis.

In this context, we are publishing "Troubles in the Sundarbans: A study of social and ecological issues in Hingalganj Block, North 24 Parganas, West Bengal". This report presents the results of a study that ActionAid Association undertook. The Sundarbans has great significance as it is the single largest mangrove forest in the world. The area is rich and productive with plant and animal biodiversity, and the forests act as a shield to storm surges and gusty winds that often emerge in this area prone to cyclonic storms.

However, the Sundarbans is also an area where human interaction with nature has moved from subsistence activities to more commercial enterprises. For example, a coal-run power plant is under construction in the Sundarbans area in Bangladesh. Keeping this context in mind, we worked with known experts and communities to develop a deeper understanding of the threats and conservation challenges faced in the area. We focused on people and social processes, ecological processes and the stress on the Sundarbans' mangrove forests.

This research was led by a team of experts from the Professional Institute for Development and Socio-Environmental Management (PRISM), steered by Dr Aniruddha Dey, with the capable support from his colleagues Sk Tawhidul Islam, Swarnabha Bandyopadhaya, Anindita Majumder and Nandini Sanyal. The research team worked closely with the communities in the area, interacting with a broad cross-section of people. Interviews and discussions with people have been supplemented by scientific tests of water, soil and air to create a "dip-stick" data on key ecological parameters.

ActionAid Association's interest in this study is to understand how communities dependent on ecological resources can be transformed into environmental workers. This is based on our recognition that the vast majorities of landless agricultural labour, small peasants, pastoralists, tribal and other forest dwellers, small scale fish workers are the natural custodians of ecological resources. We believe that these communities can play a major role in mitigating the impact of climate change, by providing ecological services and protecting ecosystems. As a wetlands have a remarkable capacity to sequester carbon, their role in the Sundarbans can be especially crucial.

We need a pro-poor and inclusive approach to climate justice action. More than just social imagery of sustainable life, we need a participatory, decentralized, futuristic and technology-enabled action on planning, building and managing rural and urban life.

We share this report with the hope that it will contribute to conversations and discussions on the issue, as part of our ongoing efforts to advance climate justice action. Please do connect with us with your comments and suggestions.

Sandeep Chachra
Executive Director
ActionAid Association

ACKNOWLEDGMENTS

It gives us immense pleasure to share *Troubles in the Sundarbans: A study of social and ecological issues in Hingalganj Block, North 24 Parganas, West Bengal.* Particularly as the study and report preparation was accomplished during the time when all of us were reeling under the impact and uncertainties of the COVID-19 pandemic.

The report was made possible by the dedicated effort of Dr Aniruddha Dey, Team Leader and Chairperson, Professional Institute for Development and Socio-Environmental Management (PRISM) and authors from PRISM - Dr Aniruddha Dey, Sk Tawhidul Islam, Swarnabha Bandyopadhay, Anindita Majumder and Nandini Sanyal. Acknowledgements are also due to the coordination and efforts of Chittaranjan Mandal, Regional Manager (till July 2020) and Regional Manager (Officiating), West Bengal Programme Implementation, Knowledge Training, and Research Hub, ActionAid Association and Shamsher Ali, Manager, FGGII, Program-Policy-Campaign, ActionAid Bangladesh.

The completion of this project depended on the invaluable inputs and rich experiences shared by community members from the different villages in the nine-gram panchayat areas of Hingalganj block, North 24 Parganas. We are also thankful to experts and Sundarbans lovers from different disciplines and from different parts of the world, some of whom were panellists in a series of online workshops, who helped develop and enrich the insights of the study.

We would like to express our heartfelt thanks to the people working as moulis (who collect honey), fishermen and women, boat operators, home stay and resort operators, SOIL, people from the local government, women SHGs engaged in nurseries, ICDS workers, water plant operators, veterinary officers, local artisans, migratory labour, local children and youth, farmers, brick kiln workers and engine van drivers for their kind support in making us understand the ground situation with respect to threats and conservation challenges in the Sundarbans.

Thanks are also due to the research team of Dilip Banerjee (Volunteer and Advisor), Ms Nandini Sanyal (Volunteer and Advisor), Professor (Dr) Sheikh Tawhidul Islam (Climate Change and DRR Specialist), Mr Swarnabha Bandyopadhyay (Environment Specialist), Ms Anindita Majumder (Social and Gender Specialist), Mr Rangeet Mitra (Research Assistant), Mr Suryakanti Sen (Research Assistant) and Mr Prasenjit Ghosh (Research Assistant) for their expertise and hard work particularly in these difficult times to help complete the study within the specified period and the PRISM team for its support.

EXECUTIVE SUMMARY

The single largest mangrove forest in the world, Sundarbans, is spread across the mouths of the rivers Ganges, Brahmaputra and Meghna. The ecosystem in the Sundarbans is characterized as a brackish water environment as a result of the mixing of salt and fresh water. The water ecosystem is rich in nutrients and hence creates spawning grounds for a variety of fish species. The land area of the forest is also characterized by rich and productive plant and animal biodiversity. The Sundarbans' ecosystem thus becomes a supplier of a variety of food, fibre, fish, medicinal plants and wood for people/society. The Sundarbans act as a shield to protect human settlements from the impact of cyclonic disturbances such as storm surges and gusty winds. Thus, the mangrove forests provide a number of provisioning, regulatory, supportive and spiritual services (known as ecosystem services) and have attracted people to live in the forests in the adjoining areas for centuries.

The interaction between human and nature in the forest areas gradually increased from subsistence to commercial levels which eventually created a number of threats to the ecological integrity of the forest ecosystem. Due to unplanned land use alterations, establishment of industries such as wood saw mills, brick kilns, port activities as well as urban centres and unmanaged tourism activities, the Sundarbans have been exposed to a number of risks including biodiversity loss, environment pollution from upstream urban waste and industrial affluent, intentional or unintentional oil leakages and discharge from ships and vessels, emission of hazardous gases from industries and pressure by an unsustainable number of tourists.

Besides these man-made threats to the Sundarbans and its ecosystem, some natural factors too are posing threats to the forest. There has been an increase in the frequency and magnitude of cyclones which have an impact on the forest and lead to an increase in the salinity of the water and soil and shortage of fresh water supply because of climate change; these too are posing a threat to the Sundarbans.

Based on the information and analytical observations by experts and people living in the forests in the adjoining areas on the fringes of the forest, the importance of the Sundarbans in terms of ecological integrity characterized by a brackish water environment and providing economic support to local and faraway communities cannot be denied. It is also realized that the sustenance of the forest depends on the physical functions and processes of wider regions, that is, supply of fresh water and sediment from the Himalayan watershed areas. Any disturbance may push this unique mangrove ecosystem to a point of no return since changes produce a number of co-variables that generally do not allow a mirror-return of the system to the past state.

Human-nature interaction is common in the Sundarbans mangrove forests and human pressure in recent times has increased with an increase in human population in the adjoining areas to the forests and due to the development of infrastructure and industries on the fringes of the forest. In addition, development of intensive shrimp aquaculture, with shrimp ponds encroaching river beds is threatening the Sundarbans in a way that traditional shrimp farming did not. It is also imperative to mention here that unsustainable tourism masquerading as eco-tourism and promoted as such in recent times has also become a factor in the deterioration of forest quality.

This research's major focus is on three issues for developing a deeper understanding of the threats and conservation challenges in the Sundarbans – 1) people and processes, 2) ecological processes and 3) stress on the Sundarbans mangrove forests. These issues were examined in the Hingalganj area, located in the transition zones of the Sundarbans.

The study recommends that policymakers should consider micro-level differences in the level and distribution of vulnerabilities. Vulnerability assessment in a hazard-affected region depends on its social and economic conditions. The social and economic conditions of a hazard-affected region determine the degree of suffering of the population that depends on it and its economic structure due to disasters. The mangrove ecosystem is one of the essential components of the livelihood options of the forest dependent population. This study explores livelihood vulnerability and stress coping mechanisms of the local population and how NTFPs help as a 'safety net.' The collection of NTFPs is a daunting task, which involves risk from man-eater tigers. The government's initiatives to conserve these biomes will sustain only when the role of NTFPs in the livelihood and sustainable livelihood framework (SFA) is developed. Strengthening the social system with provision of economic opportunities is essential for lessening socioeconomic vulnerabilities. Among the other essential steps are providing cost-effective solutions, increasing knowledge among coastal communities, enhancing their resistance capacity, facilitating disaster response and enhancing coordination among stakeholders, communities and regional policymakers. This may help overcome policy issues and lead to an increase in adaptation and lessening of vulnerabilities in coastal areas.

Eco-tourism, which is basically Community Based Tourism (CBT) has been introduced in the Sundarbans with a view to reducing the communities' dependence on the mangrove ecosystem. This means that community members are expected to generate their livelihoods through new economic activities and gradually stop entering the forests for a living. The concept is promoting a visitor-host interaction that has meaningful participation by both the visitor and the host that generates economic and conservation benefits for local communities and the environment. This study suggests that environmental degradation/ detrimental issues due to the promotion of eco-tourism need to be addressed very carefully as ecology and economy are two sides of the same coin. In the case of the Sundarbans it is also impossible to improve the economic conditions of the people by destroying the ecology of the mangrove forests. Since large-scale industries are not possible in the Sundarbans, it is important to identify activities like involving women in natural resource based alternatives with an integrated approach to help women to take part in the development process and enable them to opt for other livelihood sources thus reducing their dependence on the forest ecosystem and promoting a green economy. Eco-development committees (EDCs), which are formed in place of joint forest management committees (JFMCs) in villages in protected areas and their buffer zones, can play an important role in checking any detrimental activities. EDCs' main role is generating awareness and mechanisms for integrating women self-help groups (WSHGs). This too needs to be thought of seriously. Communities need to be empowered, instead of treating them as beneficiaries.

Marketing is a big challenge in the Sundarbans because of its topography. Addressing this issue involves establishing linkages between the JFMCs and WSHGs. Women face more difficulties in lifting themselves out of poverty and other adversities. Women have to be free from control and violence to be able to build on their sense of self and confidence. The results that can thus be achieved include women's improved well-being.

The changes needed for this require policy and programmes targeted at improving women's access to secure livelihoods and economic resources. Their responsibilities too need to be reduced when it comes to housework. Legal impediments to their participation in public life and raising social awareness through effective programmes on education and mass communication and awareness, particularly around rights and entitlements by the government too are needed. Women's status in the family and society can only improve if programmes enhance their decision-making capacity at all levels and in all spheres of life, especially in the area of sexuality and reproduction.

Besides focussing on women, conservation in the Sundarbans has to be people-centric drawing communities to ecological practices that help them in leading decent lives and ensuring environmental conservation for the long-term health of the mangrove forests. There is no denying that women's involvement and participation will be a key component in reaching this state.

ABBREVIATIONS

AAQM	:	Ambient Air Quality Monitoring
ABT	:	Aichi Biodiversity Targets
AERMOD	:	American Meteorological Society Environmental Protection Agency Regulatory Model
AF	:	Affected Families
AGB	:	Above Ground Biomass
AP	:	Affected Person
BLCC	:	Beat Level Communication Committee
BLDO	:	Block Livestock Development Officer
BMI	:	Body Mass Index
BOD	:	Biochemical oxygen demand
BPL	:	Below Poverty Line
BSF	:	Border Security Force
CBD	:	Convention on Biological Diversity
CBMM	:	Community Based Mangrove Management
CBO	:	Community Based Organizations
CGWB	:	Central Ground Water Board
COD	:	Chemical oxygen demand
COVID-19	:	Corona Virus Disease of 2019
CPCB	:	Central Pollution Control Board
dB(A)	:	A-weighted decibel
DSH	:	Deliberate Self-Harm
DSH	:	Divine Savior Healthcare

FCA	:	The Forest Conservation Act of 1980
FGD	:	Focus Group Discussion
FPC	:	Forest Protection Committees
GBV	:	Gender-based violence
GLC	:	Ground Level Concentrations
GOI	:	Government of India
GRC	:	Grievance Redressal Committee
ha	:	Hectare
IA	:	Impact Area
IDI	:	In-Depth Interview
IFA	:	The Indian Forest Act of 1927
IGS	:	Income Generating Schemes
IIHMR	:	Indian Institute of Health Management Research
INTERPOL	:	International Criminal Police Organization
JFM	:	Joint Forest Management
JFMC	:	Joint Forest Management Committee
KII	:	Key Informant Interview
KLC	:	Kolkata Leather Complex
km	:	Kilometre
km2	:	square kilometre
KWA	:	kilowatt ampere
LEQ	:	Equivalent continuous noise level
LULC	:	Land use Land cover
m	:	Metre
MAB	:	Man and Biosphere Programme
MGNREG	:	Mahatma Gandhi National Rural Employment Guarantee
MOEF & CC	:	Ministry of Environment, Forest and Climate Change

MSL	:	Mean Sea Level
MW	:	Megawatt
NBA	:	National Biodiversity Authority
NFP	:	National Forest Policy
NGO	:	Non-Governmental Organization
NTFP	:	Non-Timber Forest Produces
OBC	:	Other Backward Class
OUV	:	Outstanding Universal Value
PAs	:	Protected Areas
PDS	:	Public Distribution System
PHE	:	Public Health and Engineering
PM	:	Particulate Matter
PM 2.5	:	Particulate Matter of 2.5 micron size
PM 10	:	Particulate Matter of 10-micron size
PMAY	:	Pradhan Mantri Awas Yojana
PPE	:	Personal protective equipment
PWD	:	Public Works Department
RF	:	Reserved Forest
RLCC	:	Range Level Communication Committee
RSPM	:	Respiratory suspended particulate matter
SAD	:	Sundarban Affairs Department
SBR	:	Sundarban Biosphere Reserve
SC	:	Scheduled Caste
SDB	:	Sundarban Development Board
SEA	:	Strategic Environmental Assessment
SeVI	:	Socioeconomic Vulnerability Index
SGBV	:	Sexual and gender-based violence

SHG	:	Self-Help Group
SLF	:	Sustainable Livelihood Framework
SLR	:	Sea-Level Rise
SOIL	:	Society Protecting Mother Nature
SPL	:	Sound Pressure Level
SPM	:	Suspended Particulate Matter
SRF	:	Sundarbans Reserved Forest
ST	:	Scheduled Tribe
STR	:	Sundarban Tiger Reserve
TDS	:	Total dissolved solids
TSS	:	Total Suspended Solids
UN	:	United Nations
UN-CBD	:	The Convention on Biological Diversity of the United Nations
UNDP	:	United Nations Development Programme
UNESCO	:	United Nations Educational, Scientific and Cultural Organization
USEPA	:	US Environmental Protection Agency
VEC	:	Valued Ecosystem Components
VO	:	Veterinary Officer
WLPA	:	The Wildlife Protection Act, 1972
WRI	:	World Resource Institute
WSHGs	:	Women Self-Help Groups
µg	:	Microgram

Chapter 1:

INTRODUCTION

Sundarbans are the single largest mangrove forest in the world, spread in the mouth of the Ganges-Brahmaputra tidal plains. Deposition of billions of tons of sediments over thousands of years from upstream Himalayan areas and the supply of huge amounts of water from large watersheds primarily caused by monsoon climatic processes has created living conditions for hundreds of floral and faunal species in these mangrove forests. The ecosystem of the Sundarbans is characterized by a tidal, brackish water and mudflat ecosystem. The water ecosystem is rich in nutrients and hence creates spawning grounds of a variety of fish species. The land area of the forests is also characterized by rich and productive plant and animal biodiversity. The Sundarbans' ecosystem is thus a supplier of a variety of food, fibre, fish, medicinal plants and wood for the people. It also harbours the world famous Royal Bengal Tiger, Gangetic dolphins and deer which uphold its strong and distinctive ecological identity and diversity. The Sundarbans act as a shield to protect human settlements from the impact of cyclonic disturbances such as storm surges and gusty winds. Thus, the mangrove forests provide a number of provisioning, regulatory, supportive and spiritual services (known as ecosystem services) which have been attracting people to live in the areas adjoining the forests for centuries.

The interaction between humankind and nature in the forest areas gradually increased from subsistence to commercial levels and eventually led to a number of threats to the ecological integrity of the forest ecosystem. People living in nearby areas altered land use unsustainably (they changed large areas from subsistence agriculture to shrimp farms), those from outside established industries such as wood saw mills, brick making where fuel generally comes from forest wood, port activities and urban centres. There have also been unsustainable tourism activities. All these have exposed the Sundarbans to a number of risks including biodiversity loss, environment pollution from upstream urban waste and industrial affluent, intentional or unintentional oil leakages and discharge from ships and vessels, emission of hazardous gases from industries and pressures by an unsustainable number of tourists.

In addition, an increase in the frequency and magnitude of cyclones and their repeated impact on the forests, increase in the salinity of the water and soil, shortage of fresh water because of diversion of river water for consumptive uses and climate change are also posing a threat to the Sundarbans. This suggests that the ecosystem in these mangrove forests is complex, the resources are diversified, interaction with humankind is complicated, disturbances by natural disasters and subtle changes happening as a result of climate change are difficult to assess and apprehend.

Objectives of the Study

The objectives of this study are:

i. Examining the pattern of the man-nature interface/ interaction in the forests to understand the impact of existing local industries on livelihood, environment and ecology in and around the surrounding areas of Hingalganj block.

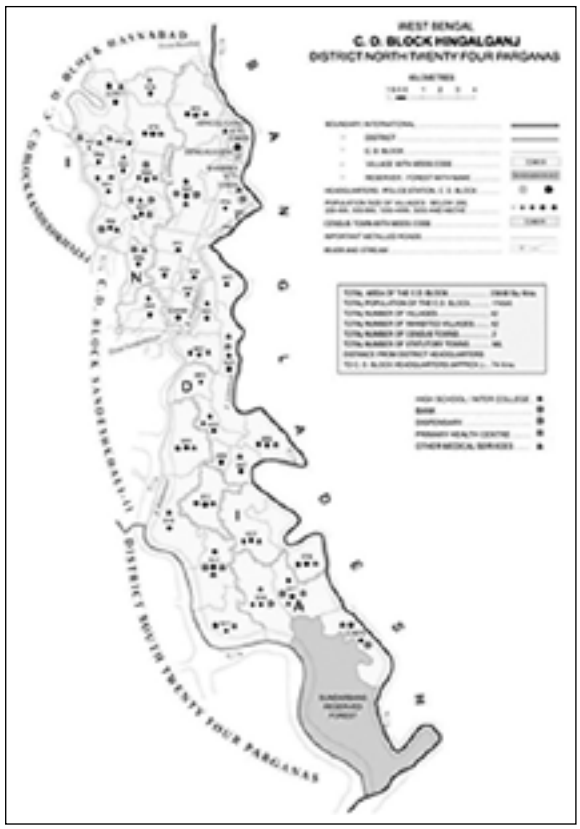
ii. Analysing government policies that support or go against the protection of the environment and ecology.

Study Area

Overview of the study area

The Hingalganj block is surrounded by Hasnabad block in the north, Kaliganj and Shyamnagar upazilas in Satkhira district of Bangladesh in the east and Sundarbans in the south. Canning II, Sandeshkhali I and Sandeshkhali II blocks of South 24 Parganas are to its west (see Annexure 2).

Figure 1.1: Administrative Map of Hingalganj



Surrounded by rivers on all sides, the small island of Hingalganj has a total area of 230.4 sq. km (GoWB, 2011a) and it consists of nine gram panchayats (Bispur, Hingalganj, Rupamari, Dulduli, Jogeshganj, Sahebkhali, Gobindakati, Kalitala and Sandeler Bil) and 124 gram sansads. It is in the south-east part of the North 24 Parganas district. The significant rivers in this region are Ichhamoti, Kalindi, Raymongal, Gaureswar, Sahebkhali, Katakhali and two small tributaries, Jhingakhali and Gomoti which flow over the eastern boundary of this block. Being a part of the Sundarbans delta, Hingalganj block is very vulnerable environmentally. The local ecology, forestry and economy of this block is adversely impacted due to both natural and anthropogenic activities.

The islands on the southern fringes are part of the active delta, being constantly configured and reconfigured by tidal movements in the rivers. The areas lying further south and surrounding the forests have mechanized boats (locally called *bhatbhati*) and non-motorized boats (dinghies) as the dominant mode of transport that connect the otherwise isolated islands.

Physical characteristics of the study area

A part of Ganges Delta, Hingalganj block is situated in the riverplain of two rivers, Ichhamati and Raimangal. Its soil is mature black or brownish loam to recent alluvium (GoWB, 2011b).

Impact due to natural disaster

Climate-related natural disasters—floods, cyclones and tornadoes—have been on the rise worldwide. It is estimated that severe cyclonic storms over the Bay of Bengal increased by 26 per cent over the last 120 years (CSE, 2012). Among the Indian states, West Bengal is on the top of the list in terms of vulnerability because of the vast low-lying mangroves in its south-eastern part. Evidence confirms that in some cases well-established forests (the mangroves) and tree plantations have offered an effective physical barrier against natural disasters and helped save both lives and property.

Sundarbans provided an effective buffer significantly reducing the impact of the storm surge. Mangroves contribute to reducing loss of life and damage to property from storms and cyclones as they reduce the impact of waves, storm surges and high winds.

Importance of Mangrove forests against natural disasters

i. Mangroves help reduce loss of life and damage to property from storms and cyclones as they reduce the impact of waves, storm surges and high winds. During relatively large storm surges, the leaves and branches of the forest canopy help reduce wave energy provided the trees are tall enough.

ii. Mangroves reduce the height and energy of the wind and swell waves passing through them, reducing their ability to erode the sediment and cause damage to structures such as dikes and sea walls.

iii. They reduce winds across the surface of the water which prevents the propagation or re-formation of waves. Mangroves with a complex structure of dense aerial roots and low branches, with various species of different ages and sizes, are most likely to be effective in reducing wave heights.

iv. Different incidents have indicated that mangroves reduced the impact of a natural disaster by reducing the destructive energy of water flowing inland. Wider mangrove forests are more effective in lowering a tsunami's height, as well as the speed of the water and the area flooded by a tsunami. Dense forest vegetation also helps reduce a tsunami's depth and area of flooding. However, massive tsunamis can damage mangroves.

v. Mangroves reduce erosion and bind the soil together. The dense roots of mangroves help bind and build soil. The above-ground roots slow down water flows, encourage deposition of sediments and reduce erosion. Complex aerial root systems help slow water flows allowing sediments to settle and lead to the sediments accreting rather than eroding.

vi. There is growing evidence that mangroves may keep up with sea-level rise (SLR). Over time mangroves can actively build soil, increasing the height of the mangroves soil surface which may be critical as SLR accelerates. However, healthy mangroves are a prerequisite for all aspects of coastal protection. Healthy mangroves require sufficient sediment and freshwater supply and connections with other ecosystems. Conversely, pollution, subsistence and unsustainable use jeopardize mangroves (Roy, 2020).

Changing pattern of cyclones in the Sundarbans

An analysis of available records of cyclones over the Bay of Bengal adjoining the Sundarbans, shows an increasing trend in their intensity while showing a decrease in the frequency of occurrence. This is a striking phenomenon from the perspective of warming trends and has a significant bearing on the extent of coastal flooding, erosion and saline water intrusion due to storm surges. In recent times, cyclones like Amphan, Aila and Bulbul have had a huge environmental and ecological impact on the Sundarbans.

Soil erosion is a major issue in the Sundarbans and in Hingalganj block as well which also has an economic impact. Mostly local people create earthen or concrete dams to prevent soil erosion. Mangrove cultivation along the seashore is another useful method of preventing soil erosion in the study area.

Sea level changes in the Sundarbans during recent times

Significant beach lowering has been observed over the erosional domains of the coastal tract. It is seen that erosion/submergence dominates in the southern part of the island system.

This points to the possibility of a relative rise in sea levels in this part of the Bay of Bengal, rather than paucity of sediment supply or other anthropogenic interventions to be the causative factors in the erosion and submergence of the island system (Hazra et al., 2002). The lower delta plain is sensitive to changes in the balance between hydrodynamics and riverine inputs

changes in relative sea levels. The islands which have a height of 3m to 8 m are partially/ often completely inundated by water during high tide.

Erratic Rainfall

According to the respondents of Ketarchak village, rain has a moderate effect on the villagers in July and November. However there is high rainfall in August, September and October which helps in *aman* paddy cultivation but the villagers also maintain that in the last few years there has been no surety of rainfall.

Table 1.1: Natural Environment of the Project Area

Eco-geography, rivers and watercourses	Seven major rivers and countless waterbodies are sources of surface water. All rivers go to the south towards the sea. Tidal effects are controlling the eco-geography of this area. It is noticed that within 24 hours, there are two flow tides and two ebb tides with a tidal range of 3-5m and up to 8m (Ghosh and Mandal, 1989; Banerjee, 1998) in normal spring tide, inundating the whole of the Sundarbans in varying depths. The tidal action deposits silt back on the channels thus raising the bed and forming new islands and creeks contributing to uncertain geomorphology (Bhattacharya, 1989). There is a great natural depression called *Swatch of No Ground* in the Bay of Bengal between 210 to 210 22' latitude where the depth of the water changes suddenly from 20m to 500m (Fergusson, 1963; Ghosh and Mandal, 1989). This mysterious depression pushes back the silt towards the south and/or further east to form new islands.
Mudflats	The Sundarbans mudflats (Banerjee, 1998) are found at the estuary and on the deltaic islands where low velocity of river and tidal currents occur. The flats are exposed in low tides and submerged in high tides, thus being changed morphologically even in one tidal cycle. The interior parts of the mudflats are a magnificent home of luxuriant mangroves. The morphology of the swamps is characterized by the occurrence of saltpans, ditches and banks with a thick mud substratum of decomposed organic matter. The Sundarbans mudflats control the food chain in the estuarine ecosystem.
Soil types	The active delta of the Sundarbans has the soil types silty clay loams, sandy clay and loams, soil with organic and peaty deposits and swampy and marshy soil, also called 'Mangrove Soil' (Ghosh and Mandal, 1989). The salinity of the surface soil and the water bodies is governed by the quantity of fresh water flow and monsoon rainfall.
Coastal dunes	Coastal dunes in the Sundarbans comprise of a system of low ridges parallel to the coast, separated by large dry and wet sand flats (Banerjee, 1998). In recent years, the coastal dunes of the western islands are being engulfed by encroaching sea waves accompanied by cyclonic storms. The rate of coastal erosion is high on the west side coasts (Bhattacharya, 1989).
Climate	The climate in the region is tropical monsoon with excess humidity. Annual average rainfall is around 1,800mm, maximum and minimum temperature in summer and winter is 400 C and 90 C. Occasionally, during the pre-monsoon period (March to May), violent thunderstorms occur while during the post-monsoon season (October to November), cyclonic storms accompanied by high sea waves and tides devastate the coastal Sundarbans areas (Bose, 2004; Ghosh and Mandal, 1989).
Local residents and their lifestyle	Out of the 102 islands in the Indian Sundarbans about 54 are inhabited and the rest are notified as reserved forests. People living on these islands are mostly migrants from other parts of West Bengal or Bangladesh. The islands lying further south (on the margins of the forests) and closer to the Bangladesh border have migrants mostly from Bangladesh, with immigrants still crossing the border and settling in the Sundarbans. These islands on the southern fringes are part of the active delta, being constantly configured and reconfigured by tidal movements in the rivers. Researchers have noticed that the quality of life is very poor in this area. Local people have built land-embankments to stop the river water from entering the villages.

Transport	• Mechanized boats, non-motorized boat, steamer boat and vessels are used for waterway transport. • On the islands, people use totos, cycles, bikes and autos. There are very few roads and vans ply as far as the roads exist. Beyond roads are mud embankments or bunds, which serve as pathways connecting one part of an island to another. • On some islands, small trucks are used for carrying goods.
Livelihood / Occupations	People's life on the southernmost islands revolves around land, water and forests. Although agriculture remains a source of livelihood for the islanders, the brackishness of rivers makes agriculture unsuitable and uncertain. Winter cultivation is virtually non-existent for want of fresh water. Poor families, especially those having very little or no land rely on rivers for marine resources such as fish, prawns and crabs. The forest is an important source of livelihood for poor families. Families frequently enter the forests in search of firewood, wood and honey. People are engaged in livelihood activities that are physically demanding and challenging. In 2010-11, those engaged in agriculture in Hingalganj CD block were classified as: *bargadars*/ share croppers 5,024 (6.68 per cent), *patta* (document) holders 26,534 (32.56 per cent), small farmers (possessing land between 1 and 2 hectares) 4,200 (5.58 per cent), marginal farmers (possessing land up to 1 hectare) 19,578 (26.01 per cent) and agricultural labourers 19,921 (26.47 per cent) (GoWB, 2011c). Total agricultural production in the block was 19,915 tons of *aman* paddy (the main winter crop) from 10,132 hectares, 1,236 tons of *boro* paddy (spring crop) from 385 hectares, 5,501 tons of aus paddy (summer crop) from 2,094 hectares, 335 tons of wheat from 124 hectares, 244 tons of jute from 12 hectares and 21 tons of potatoes from 1 hectare. It also produced pulses and oilseeds (GoWB, 2011c). The net area under effective pisciculture in Hingalganj CD block was 1,126.73 hectares and 12,243 persons were engaged in working on this land. Approximate annual production was 33,801.9 quintals (GoWB, 2011c).

Impacts due to anthropogenic activities

The total area of Hingalganj block is 230.4 sq. km2 and nearly 174,545 people live in nine gram panchayats. Nearly 90 per cent of the people are engaged either in agriculture and fishing, crab collection or honey collection. An alarming growth in population in this ecologically sensitive and fragile area has posed a major threat to its existence. Wide scale reclamation, deforestation and unsustainable resource exploitation have produced changes in the physical and biological dynamics of the coastal system.

Socioeconomic and cultural conditions of forest dependent people

In a land marked by uncertainty in agriculture and absence of industries, people's livelihood needs are pressing and their options are limited. But even the pursuit of these limited livelihood options is viewed as detrimental to the conservation of the wildlife of the delta. It is believed that people destroy forest resources and endanger tigers. The Sundarban Biosphere Reserve was started to strike a proper balance between the human and non- human inhabitants of what is considered a unique ecosystem, but this balance is tilted in favour of the tigers. Fishing in the river is viewed as depleting marine resources and catching tiger prawn seeds as being responsible for biodiversity loss and the erosion of the mangrove cover. Despite the overarching image of the region as a natural wilderness and the islanders' marginal status there are government departments meant to do development work for the people in the region. Two such departments are the Sundarban Development Board (as part of the Sundarban Affairs Department, SDB and SAD) and Irrigation and Waterways (Irrigation). The Sundarban Development Board was constituted in 1973 to cater to people's special needs and to undertake comprehensive development of the deltaic region. The board has mainly coordinated development activities of other government departments.

The functioning of the board did not change after it became a part of the Sundarban Affairs

Department. The board's function is mainly confined to providing infrastructure facilities like:

a) construction of brick-paved roads, culverts, jetties and bridges and sinking of tube-wells.

b) social forestry and tree planting.

c) setting up small brackish fish water ponds.

d) agricultural extension programmes (mainly rabi and kharif seed distribution to small and marginal farmers).

However, in all these domains the board is duplicating the efforts and services offered by other government departments such as the Public Works Department (PWD), the Public Health and Engineering (PHE) [for infrastructure] Department, the Forest Department (for social forestry and plantation), the Department of Fisheries (for brackish water fish and prawn cultivation) and the Department of Agriculture (for agriculture extension programmes). The board and SAD's agricultural extension programme, which consists largely of providing rabi and kharif seeds to farmers and popularizing cotton and mushroom cultivation among the farming households, remains far from being a success. The question of sustainable agriculture is deeply connected to the landscape and ecology of the delta. With people continuing to lose land and being forced to live on the edges of the embankments, agriculture remains of marginal significance. The board (now a full-fledged department) committed to addressing people's problems in the region, has not adopted any comprehensive policy or strategy to counter pressing problems of river bank erosion, flooding and people's displacement. What is even more surprising is that the department which works closely with other government departments on various other fronts (agriculture, public works, social forestry) does not collaborate with the Irrigation Department to formulate policies on issues as endemic and crucial as embankment erosion and displacement.

The embankments were built to protect these islands from daily inundations during high tides. While people live in perpetual anxiety and uncertainty about embankments collapsing, a view has gained currency in the government departments such as the Irrigation and Sundarban Affairs departments that the Sundarban embankments are unsustainable largely because people originally settled in a place primarily meant for wildlife and, more importantly, did so before the land was sufficiently elevated by the natural process of silt deposits (Kanjilal, 2000; Mondal, 1997). If people had taken time to settle down, the land could have been sufficiently elevated and they would not have needed protective embankments around their islands.

An overall analysis of socioeconomic vulnerability to climate change shows that the people of Hingalganj are highly affected by floods and cyclones. Decrease in fish production and salinization of agricultural land are major threats to the communities. Water and vector borne diseases and inadequacy of medical facilities are affecting the health of the people. A lot of agricultural land was severely affected by salinity and thus rendered unfit for cultivation in the aftermath of frequent cyclones since Aila in 2009. Moreover, due to huge losses of mangrove forests, there are several restrictions placed by the government on the collection of forest products. Consequently, large-scale migration has occurred from this coastal block. This has affected the socioeconomic condition of the people of Hingalganj to a large extent.

Changes in agriculture

Rainfall determines agricultural productivity in any region in terms of the crops to be produced, the farming system to be adopted and the nature and sequence of farming operations to be followed for achieving higher agricultural productivity. This is particularly important in a region like the Sundarbans, where other than rainfall there is no other source of irrigation. It has been reported that the pattern of rainfall in the Sundarbans has

already changed making conventional cultivation of crops difficult for farmers.

Currently total agriculture land in the Hingalganj block is 14,200 ha, of which 1,407 ha is irrigated land. Saline water stagnation leads to increased salinity of the soil. The agricultural pattern is mono-crop and only *aman* paddy is cultivated (Banerjee et al., 2017). There is scarcity of food due to mono-cropping. Scarcity of food majorly affects the villages in October and November. As the villages are mono-cropped and a majority of the villagers are primarily involved in agriculture this means unavailability of work at most times. The only time when there is work is the *aman* paddy cultivating season in June-July.

According to local people 25 per cent of the farmers do not own land. Local rice varieties such as *dash-shell, patnai, boran, gnethi* and *morichshal* are extinct in the Sundarbans. Farmers mostly cultivate the seeds given by the government. Indigenous paddy seeds are not available in this locality. *Jotai, gomoti* and *CR* are well known paddy seeds given by the government.

Conversion of agriculture land to fishing ponds (bheri)

Agriculture forms the backbone of the economy of the Sundarbans, where almost the whole area is dependent on a single crop, the rain-fed paddy *aman*. Though in 1992-93, the Sundarbans was predominantly a two-crop region where *aman* paddy was grown with wheat, in 1999-2000 it turned totally into a mono-crop region producing rain fed *aman* paddy only (Hazra et al., 2002).

During a site visit and during public consultations it was found that conversion of agriculture land to fishing ponds *(bheri)* is a serious concern in Hingalganj block. During the rainy season or during any natural disaster like a cyclone, sea water enters local agricultural land. This makes the soil unsuitable for farming because of salt. This adversely impacts the local economy. To avoid such financial losses the local people are converting their agricultural land into fishing ponds. So, loss of agricultural land in the coastal areas of Hingalganj is a major issue.

Fishing

Next to agriculture, fisheries is the dominant productive activity providing employment in the region. Nearly 42 per cent of the population belongs to the Scheduled Castes and Scheduled Tribes, most of whom are engaged in fishing. There is a 81.9 per cent fish catch during November to January while the lowest catch of 3.6 per cent is during March to June (Hazra et al., 2002). Locals maintain that the population of fish in local rivers is decreasing.

In the Sundarbans, fishing is a major source of livelihood both in the tidal water and the deep sea. However, a critical appraisal of the major catch of hilsa *(Tenulosa Ilisha)* in the Hugli-Matla estuary of the Sundarbans shows a declining trend since the 1980s (Hazra et al., 2002). Intense prawn seed collection during the 1980s and 1990s resulted in major damage to the other fish juveniles. Furthermore, nowadays big trollers are used for deep sea fishing. Sometimes local people use poison in *nallahs* during the tide to catch fish. This damages the local aquatic ecology. As a result, most of the fishermen in the project area are interested in crab catching instead of fishing. This is another major issue which will endanger the livelihoods of the fishermen community in the near future.

Collection of minor forest produce

The local economy of the study area is mainly based on the forests. Local people are involved in crab catching and honey collection. For collecting crabs and shrimp they have to go to the forests and they have observed that the number of crabs and prawns is decreasing. So, they need to enter dense forests to collect crabs, which leads to high chances of man-animal conflict. Locals informed the researchers that the population of crabs and shrimp has been decreasing. Previously, they caught limited amounts of crabs and shrimp. But in the last five years, because of increasing

demand in the urban and sub-urban markets in and outside India, they have been catching as much as possible. To meet the demand of the outside world, people have been unknowingly destroying natural resources such as crabs and shrimp. Due to devastating effects of cyclones lots of big trees have fallen down. So, collection of honey too has decreased though people are getting the desired amount of honey in deep forests.

The government gives permits to a few people to enter the forests to collect honey, crabs and prawns to reduce human dependency on the forests. But, in reality, many families go to the forests with or without licenses for their livelihood. The government has no data on non-timber forest products. However, researchers maintain that most of the permit holders live in the town.

Industrial development

Industries: Bantala Leather Complex

The Bantala Leather Complex has 400 tanneries and 60 leather goods manufacturing units, which export leather goods like footwear, wallets, bags, belts and industrial goods worth ₹5,000 crore per annum. River Bidyadhari flows through the Bantala Leather Complex and then flows to the Sundarbans region.

In the past, the main leather industries of West Bengal were developed in Tangra, Topsia and Tiljala areas of Kolkata city. But, because of a Supreme Court verdict on pollution related issues the leather industries were shifted 20 km away from Kolkata city to the Kolkata Leather Complex (KLC), Bantala as a separate tannery cluster, setting up appropriate effluent treatment plants. In KLC the Government of West Bengal has set up a state-of-the-art integrated leather complex spread over 1,100 acres.

The leather industry has been blamed for its negative impact on the environment due to the bad smell, organic waste and the disposal of different inorganic salts and heavy metal rich chemicals with waste material. According to Puntener (2001) during the processing of 1ton of wet salted hides and skins, 700 kg solid wastes, 150 kg split, and 30 m3 of liquid waste are discharged. Ozgunay et al. (2007) and Kanagaraj et al. (2006) state that for the processing of 1ton raw hides and skins more than 600 kg solid wastes of which 80 per cent, 19 per cent and 1 per cent are generated during the pre-tanning, tanning and post-tanning operations respectively. Of the liquid waste released by the leather industry, 44 per cent, 32 per cent and 24 per cent is shared by pre-tanning, tanning and post-tanning operations respectively (Rivela et al., 2004).

Thus, disposal and management of high-quality organic matter and chemical rich solid and liquid waste is very challenging as this waste has a negative impact on the environment. However, this waste also carries chemicals, which have nutrient value for the biota. Nitrogen is a major essential nutrient for all living organisms and depending on its availability the productivity of terrestrial ecosystems especially agro-ecosystems improves. Nitrate (NO3), which is a major source of nitrogen for plants, is stored in plants' vacuoles and it takes part in protein synthesis (Pal et al., 2016a). However, excess use of nitrogen rich fertilizers leads to environmental difficulties like eutrophication, biodiversity loss, stratospheric ozone depletion and global warming. Conversely, limited application leads to low productivity and an insufficient food supply. The solid and liquid waste from a tannery forms a significant amount of organic and inorganic material containing enormous amounts of nitrogen.

The coastal environment of West Bengal is recognized as the most diversified and productive ecosystem in all the maritime states in India. This area faces organic pollution from domestic sewage and toxic pollution from industrial effluents leading to a serious impact on water and sediment quality as well as on its biodiversity. An overall elevated concentration of heavy metals was observed during monsoon months. A continuous monitoring programme is

recommended to establish the studied organisms as bioindicators and for identifying future changes to conserve the 'health' of this fragile ecosystem.

Spatial distribution of heavy metals in the sediments of the estuarine environment is governed by geochemical and biogeochemical processes like sedimentation, precipitation, flocculation of particulate substances and by the basin's hydrological condition (Che et al., 2003). So, all the pollutants and heavy metals generated by the Bantala Leather Complex reach the coastal region of the Sundarbans through Bidyadhari river and result in serious damage to the environment and ecology of the region.

Brick fields

In India, fired clay bricks are produced by using traditional technologies in unorganized small-scale industries. India, which has more than 10,000 operating units, produces about 140 billion bricks annually making it the second-largest producer of bricks in the world, next only to China. Brick kilns create employment for nearly 12 million people in different areas. Availability of good quality soil is crucial for brick manufacturing in the Asian climate. In Hingalganj block there are approximately 21-23 brick fields that are operational. Average production of these brick fields is 21-22 lakh bricks in a season (six months). Mostly labour from different states works in these kilns.

Air and other Pollution due to brick fields

The combustion of coal is responsible for serious environmental pollution and health problems. Brick industries damage air quality and the health of human beings and vegetation. It has been proved that brick industries cause air pollution and land degradation besides decreasing herb density and causing nutrient disorders in plants/trees in their immediate vicinity. Besides these, they also pollute the ground and surface water. It is also known that workers in brick industries are prone to respiratory diseases such as silicosis, pneumoconiosis and musculoskeletal disorders. Brick kilns have also been shown to affect groundwater quality due to the leaching of substances (Rizwana Khan et al., 2008).

Brick kilns emit toxic fumes containing suspended particulate matter rich in carbon particles and a high concentration of carbon monoxide and oxides of sulphur (SOx) that is harmful for the eyes, lungs and throat. According to data, the primary source of SOx — a major air pollutant — is traffic vehicles (55.8 per cent), followed by the brick manufacturing industries (28.8 per cent), while the primary source of NOx (nitrogen oxides) pollutants is also traffic vehicles (54.5 per cent) and brick manufacturing industries (8.8 per cent). Also, nearly 25 to 26 per cent of the country's wood products are used for burning bricks every year, leading to deforestation.

Chapter 2:

METHODOLOGY

This study examines major threats and conservation challenges in the Sundarbans mangrove forests located in the Indian part of the forest tract. Both quantitative and qualitative methods were used to gather the necessary information. Quantitative methods were used primarily for conducting an environmental baseline monitoring of a number of environmental parameters of the forests. The qualitative methods used were Key Informant Interviews (KIIs), In-Depth Interviews (IDIs), Focus Group Discussions (FGDs) and Observations (non-participatory). In addition, nine webinars were also conducted to get the opinions of experts comprising of academicians, researchers, Forest Department officials, agriculture scientists, environmental experts, PRI members, CSO representatives, villagers and other stakeholders (see Annexures 3-5, 7). A thorough literature review was also done for understanding the relevant issues.

Challenges faced and addressed

At the outset, it should be mentioned that two major issues overwhelmed the research team. First, ample literature is available on threats and conservation challenges of the Sundarbans and therefore locating a niche for this research within existing knowledge was challenging.

Second, the COVID-19 pandemic made the data collection process difficult because of maintaining social distancing guidelines as well as of the agency of 'do no harm.'

In addition, as per the Indian government's guidelines, it was not possible to start the collection of environmental data for specific parameters before October every year.

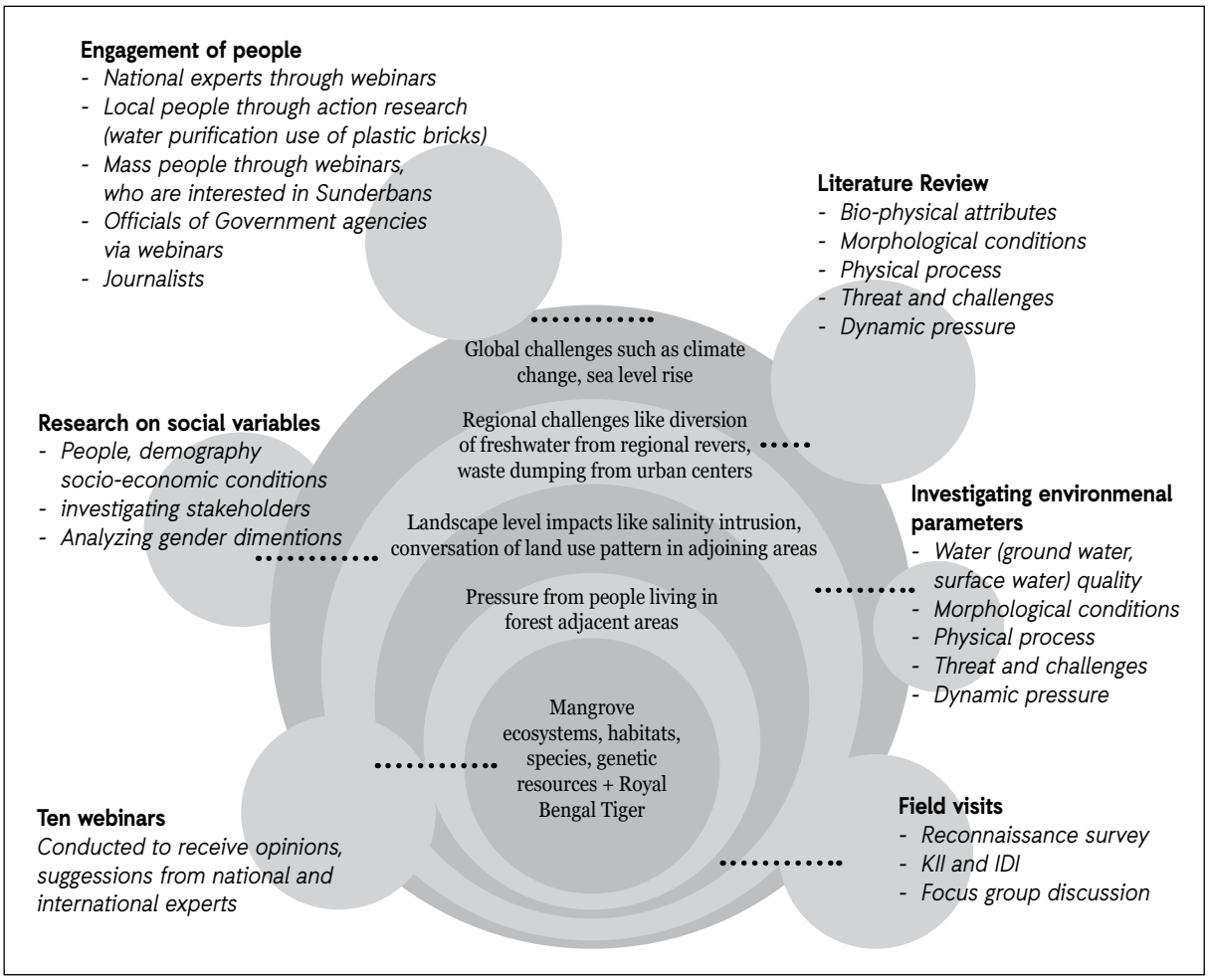
Three of the research team members were affected by COVID-19 starting from August 2020 that jeopardized the research activity and its momentum.

The first challenge was addressed by adopting strategies including (i) reviewing a range of studies for a thematic understanding of the issue at hand, and (ii) identifying the factors because of which the conditions of the forests are not improving despite a number of conservation and protection programmes being implemented in the forest areas.

The challenges of the COVID-19 pandemic were addressed by adopting research methods that fit the 'neo-normal' situation for gathering necessary information primarily by using online techniques such as Google forms and by conducting theme-based webinars in which experts from different fields participated and provided valuable insights. People from different backgrounds both from India and Bangladesh participated in the webinars. The strategies discussed significantly contributed in overcoming the hindrances and gaining support in gathering the data.

Using technology: Two groups in social media -- a WhatsApp group and a Telegram group -- were set up for discussing the issues pertinent to the research. Regular discussions on different issues are going on on these groups with people connected with the Sundarbans.

Figure 2.1: Threats and challenges to the Sundarbans at different scales



Note: Scale-specific threats and challenges were investigated by using a number of tools and methods and by engaging with a number of stakeholders.

The threats and challenges of the Sundarbans are wide-ranging and heterogeneous (Figure 2.1), some cover local areas (for example, tree felling and unsustainable harvesting of resources) while others originate at the regional and global levels (for example, climate change induced sea-level rise). It is also important to note that scale-specific challenges need actions that are appropriate for a particular challenge. The research methods were tuned for developing a proper understanding of these issues.

Literature review

A thorough literature review was conducted which suggested that existing studies have a limited scope and pay less attention to developing a holistic understanding of the threats and challenges of the Sundarbans. Authors have different opinions, suggestions and recommendations. However, this research attempted to develop a 'fairly full' understanding of the threats and challenges to mangrove forests by focusing on the following main aspects:

i. Developing an understanding of the physical, biological, fluvial and metrological attributes of the ecosystem. This understanding will help us to know the ecosystem's health, integrity and services. Attention was also paid to understanding the demographic and socioeconomic conditions of the people living in the adjoining areas.

ii. Historical legacies and evolution of the current approach by examining the policies and temporal dimensions of forest management.

iii. Surveying the negotiated space by local people, forest managers and NGOs and their struggles to attain diverse objectives at the cost of forest quality.

iv. External factors that are beyond the present geographical extent of the forests.

This 'fairly-full' understanding was developed by connecting small anecdotes and making inter-scale connections of processes and functions so that both big and small, local and global, spatial and temporal, event-specific and episodic threats could be properly understood. The literature review helped in this. This understanding also helped identify appropriate sets of questions and checklists for data collection and identifying the key personnel and stakeholders who could provide useful information for identifying threats and challenges and at the same time give suggestions for improving the mangroves' ecosystem.

Primary Data Collection

The research used both quantitative and qualitative methods for collecting primary data. Quantitative methods were mainly used for gathering information about a number of environmental parameters. The qualitative methods include Key Informant Interviews (KIIs), In-depth Interviews (IDIs), Focus Group Discussions (FGDs) and non-participatory observations. These methods were used in Hingalganj, the study area where the fieldwork was done for primary data collection. At the beginning, a reconnaissance survey was conducted to understand the contextual setting of the area and to identify the key persons, professional groups, local representatives and environmental activists. A discussion checklist was developed based on the literature review along with a scope of the task which was used as a guiding tool for conducting the qualitative survey. People provided useful information about the current management practices of mangrove forests including identifying gaps. FGDs were also conducted with different professional groups such as fishermen, small business holders and women's groups in the area.

Stakeholder consultations and survey

Information, opinions, suggestions and recommendations from five groups of people and stakeholders were received: (i) local people who are the users of forest resources and also play a role as the forests' protectors, (ii) people's representatives like panchayat members and other local leaders, (iii) professional experts working in universities, think-tanks and other organizations, (iv) government officials who are responsible for safeguarding the forests, (v) common people who are interested in the Sundarbans mangrove forests and their well-being and sustenance. The checklists and key questions on people's perceptions related to (i) people and processes, (ii) ecological functions, and (iii) stresses (threats and challenges).

Questionnaire Survey - Google Form

Focusing on these three major thematic areas, two Google Forms were designed for gathering primary data from the people. The first Google Form had nine technical questions for academicians, researchers, experts and administrators. The second Google Form for local people was comprehensive and the questions were organized in seven sections (Section A – G):

Section A: Asset holding and poverty conditions.

Section B: Daily activities, economic opportunities and income generation.

Section C: Food security, nutrition and social well-being.

Section D: Ecosystem services of mangrove forests for local communities and gender equality.

Section E: Local perceptions about the pressures on the Sundarbans mangrove forests.

Section F: Perceptions about the environment, disaster impact, climate change and sea-level rise on the sustenance of mangrove forests.

Section G: Engagement of local people/ stakeholders in Sundarbans' resource management.

Webinars

The discussions during the webinars were a substitute for face-to-face conversations and formed an added dimension of this research during the COVID-19 pandemic. Webinars enabled the team to consult a range of experts, academicians, forest administrators, researchers, people from government agencies and local village representatives. The webinars were very effective in gathering information as they connected and brought together concerned people to the table virtually. The steps taken for conducting the webinars include:

i. Selection of professionals having thematic expertise.

ii. Background preparation for the sessions for information gathering.

iii. Steering the webinar sessions including question and answer sessions.

iv. Systematically recording the information.

v. Classifying the information under the themes.

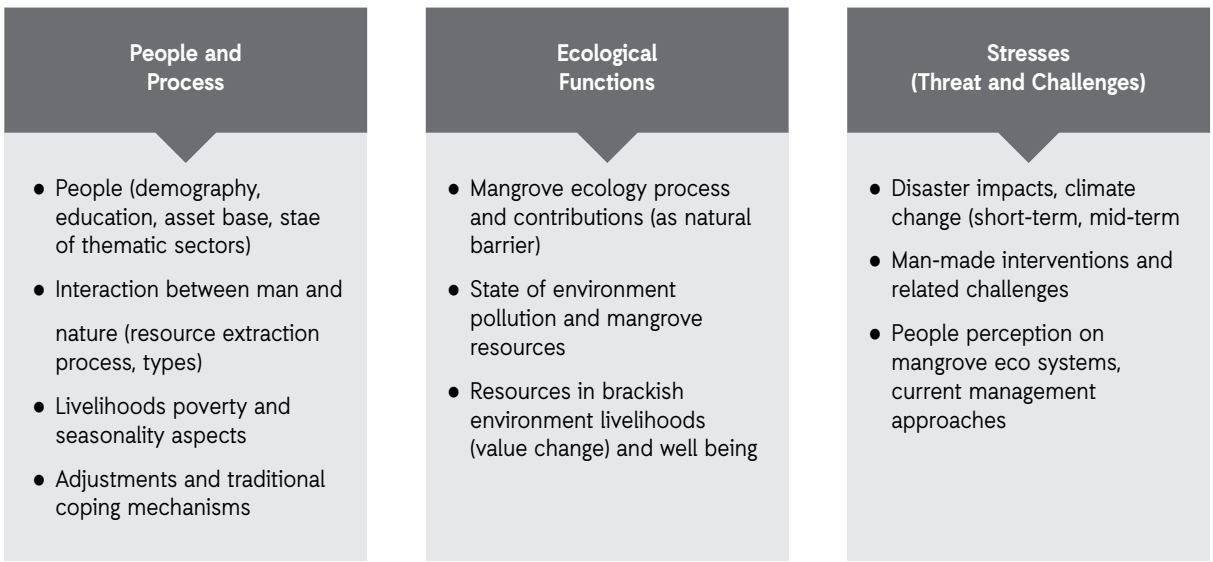
vi. Reporting the observations, suggestions and recommendations in the research report.

The data collected from people and stakeholders helped this research in three ways. First, it helped in developing a comprehensive understanding of the threats and challenges to the Sundarbans. Second, the diverse opinions helped in developing recommendations based on common consensus. Third, opportunities created by triangulating the information gathered from different sources for generating trustworthy results (Figure 2.2).

The research also faced many challenges. These were addressed by adopting strategies that include (i) a literature review for a thematic understanding, and (ii) identifying the factors which are preventing the forests from improving despite a number of conservation and protection programmes being implemented in the forest areas.

An assessment of environmental quality and modelling <b level heading>

Figure 2.2: Thematic areas based on which questions/ checklists were developed



An environmental assessment study was carried out for identifying critical issues and the areas that needed to be studied in detail for an impact assessment. This report was prepared based mainly on a field reconnaissance survey, public consultations, stakeholder meetings and secondary data. This report details the scope of activities for assessing environmental and social impacts due to developments in Hingalganj block, Sundarbans.

Data was also collected from secondary published sources. The following information was collected from secondary sources:

- Climatic conditions and meteorological data from government websites and international meteorological websites.
- Geology, seismicity, soil, groundwater and topography from various government websites and district groundwater brochures of the Central Ground Water Board (CGWB).
- Land use from Google Earth and other satellite imagery.

Primary data formed a part of appreciating the environmental conditions in and around the mangrove forests. The parameters of the environment assessed in the research include physico-chemical and biological properties of land, soil and water. Terrestrial and aquatic flora and fauna and their communities were assessed as biological parameters. Dissolved oxygen, pH, conductivity and temperature were measured for water quality. For soil parameters such as soil organic carbon, pH and salinity were determined. For air quality monitoring, parameters like PM 10, PM 2.5, Sulphur Dioxide (SO_2), Oxides of Nitrogen (NOx) and Carbon Monoxide (CO) were measured. The sampling of PM 10, PM 2.5, SO_2, NOx was done on a 24-hour basis while 8-hourly samples were collected for CO. Daytime noise levels were monitored during 6 am to 9 pm and night-time noise levels during 9 pm to 6 am.

Site survey

Field surveys were done during August-November 2020 to identify the Valued Ecosystem Components (VECs) within the project area and quantifying their impact on the Sundarbans. A detailed survey was carried out to identify all environmental baseline locations. The environmental baseline conditions in the area were prepared based on investigations, field visits and consultations with local people. The main objective of these visits was identifying important environmental and social components through a scoping process.

Identifying monitoring locations

The environmental baseline data comprises of the features of the project area. It includes environmental features such as forest area, conservation area, water bodies (rivers, lakes, ponds and reservoirs), cultural properties, industries and places of historical importance and tourism. To establish a baseline status of air quality, noise quality, soil quality, water (surface and ground) quality and the ecology, information was also collected from the field. The sampling locations were selected after the field reconnaissance and a review of the project influence area.

The baseline status of the ambient air quality was assessed in terms of receptor sensitivity. The criteria used for selecting the monitoring locations was based on:

- Access to power and security of instrument.
- Meteorological conditions.
- The assumed regional influences on background air quality.
- Present land use.

Conducting environmental baseline monitoring

Baseline information includes physico-chemical, biological and human aspects of the Sundarbans. i) Physico-chemical includes information on land, soil quality, surface water and ground water. ii) Biological information includes information on the terrestrial and aquatic flora and fauna and their communities; iii) Information on human aspects includes health and safety and socioeconomics. Additional data was collected through primary sources which included:

a) Field monitoring.

b) Field survey.

Water

At each water body site, a composite sample was collected with a 1-litre bottle from each of the locations. Field parameters included dissolved oxygen, pH, conductivity and temperature measured at each water quality sampling site near the water body. Water samples were collected, preserved, stored and shipped in accordance with established technical procedures for water quality sample collection that are consistent with standard methods.

Soil

A soil profile of the mangroves in the lower Gangetic delta is important for regulating floral and faunal distribution. Soil organic carbon, pH and salinity were monitored in the mangrove ecosystem of the Indian Sundarbans. Samples of soil were collected and are being tested for physical and chemical properties.

Air

To establish the baseline ambient air quality, an Ambient Air Quality Monitoring (AAQM) station was set up at one location. At this location monitoring was undertaken as per the new notifications issued by MoEF on 16 November 2009. Data was collected on the following parameters:

- PM 10
- PM 2.5
- Sulphur Dioxide (SO2)
- Oxides of Nitrogen (NOx)
- Carbon Monoxide (CO)

The sampling of PM10, PM2.5, SO2 and NOx was done on a 24-hourly basis while 8- hourly samples were collected for CO.

Noise

At one location, the sound pressure level (SPL) was measured at an interval of 1 minute. At all these locations, daytime noise levels were monitored during 6 am to 9 pm and night-time noise levels during 9 pm to 6am. Noise readings, with setting at 'A' response - slow mode -- were recorded. The readings were tabulated and a frequency distribution table prepared from which 24 hourly, hourly, and average Leq noise levels were calculated.

Air Dispersion Modelling

To assess the impact of industries and other anthropogenic activities, the ambient air environment along with typical emission rates were used as an input in the air dispersion model, for example, AERMOD.

Air dispersion modelling is of particular concern where educational institutes, healthcare facilities or cultural/ religious structures are in close proximity to the industries.

Identifying and Evaluating Potential Impacts

This section presents the likely potential impact on various environmental components of the study area based on the visits and primary surveys as well as secondary data. Secondary data related to the study area (Hingalganj block in Sundarbans) was collected, collated and analysed to support the data collected through field monitoring.

Meteorological data for the project area was collected from secondary sources.

Model selection

Model selection depends on the complexity and geomorphology of the study area (for example, mountainous terrain, urban or rural area). Gaussian-plume models are best used for near-field applications where the steady-state meteorology assumption is most likely to apply.

Modelling methodology

The intention of an air quality impact assessment is limited to predicting potential ground level concentrations (GLCs) of CO2 due to emissions from brickfields within the study area and assessing the potential impact on the receiving environment at identified sensitive receptors.

Satellite imagery was accessed and assessed to determine the impact on land use/ land cover and soil erosion.

Geospatial Assessment

Examining the locational attributes of the Sundarbans in terms of changes in its geographical extent over the years, spatial distributions of its ecosystem and habitats and topographical characteristics of the forest terrain are important for understanding the interplay between tidal actions and the accretion-erosion process of the forest. It is important to note that the geospatial assessment of the Sundarbans started in the 1800s although such assessments were conducted through physical surveys and manual mapping exercises at that time. The commercial exploitation of forest resources was the sole aim of the then forest management and thus related policies were introduced by the British (East India Company) administration in the beginning of the 1800s and such practices were formally started with the establishment of the zamindari system in the Indian subcontinent through the enactment of the Permanent Settlement Act of 1793. The British administration undertook a thorough topographic survey to produce large scale (1:63360) topographic maps (between 1908-42) and medium scale topographic maps (1924) which were revised through a planimetry survey using air borne remote sensing (aerial photographic survey from 1943 to 1945). These survey activities helped in retrieving information about the distribution of forest resources and map out canals, creeks, rivers and land tracts in the Sundarbans. These historical maps are still supplying useful information on different bio-physical variables with locational tagging. The use of geospatial information is pivotal in understanding the coastal geomorphological characteristics where the Sundarbans are located within the wider geographical context of the surrounding region. For instance, presence of an elevated terrain in the west and northern parts that supplies freshwater towards the Sundarbans through rivers and canals and the occurrence of Swatch of No Grounds in the immediate southern parts of the forests heavily influence a determination of the characteristics of the terrain conditions vis-à-vis the forest's bio-physical attributes. Understanding these externalities was extremely important for developing comprehensive policies for protecting the forests and geospatial data and methods hugely contributed in this regard.

Additional points in research methodology

Engagement of people from diverse backgrounds

This research used video conferencing facilities in which people from various backgrounds and various geographical locations got the opportunity to participate in the opinion sharing processes.

International connections

People from India, Bangladesh, United Kingdom, Austria, Vietnam, Indonesia and the United States provided their expert opinions in what was an excellent opportunity to get connected internationally in the COVID-19 pandemic situation.

Gathering information using a democratic process

The webinars were theme based in which different people from diverse backgrounds and interests participated and arguments and counter-arguments were given which led diverse opinions on the theme. In a normal situation, experts are generally interviewed separately and a direct cross-examination of their opinions does not happen. In that sense, the webinars helped in getting on-board experts with different interests in the same session and the information emerged/gathered was shared and mutually approved. Moreover, this was an opportunity for the experts vis-à-vis the community members and CSO facilitators to interact with each other, which helped in cross learning as well as knowledge sharing. This unique opportunity is an outcome of this innovative research methodology.

Recording and archiving facility

This helped in getting a digital recording of the discussions that helped the research team to retrieve useful and pertinent information after the meetings which they classified and analysed.

Wider (expert, non-expert) participation

The approach used for collecting information facilitated the participants to share their ideas, views, comments and suggestions through a chat box which enriched the information base.

Use of online facilities

Online facilities for data collection helped save money, energy and time and contributed in managing the data collection processes. In normal times, researchers have to pay huge attention to arranging logistics and other related activities for data collection and those processes do not allow researchers to adequately focus on research questions and thus divert their attention to non-research actions. In comparison this innovative research methodology was more effective and productive.

Validation of the findings <c level heading>

The research also adopted other methodologies such as a literature review, in-person data collection through KIIs and FGDs and assessing the environmental parameters. The online discussion provided opportunities to cross-examine the facts received using the other methods thus triangulating the data collection process and validating the findings.

Chapter 3:

THE SUNDARBANS MANGROVE FORESTS IN LITERATURE

The Sundarbans lie in the lower southern part of Ganges-Brahmaputra delta along the coast of Bay of Bengal. Approximately 10,200 sq. km of Sundarbans is divided between Bangladesh (60 per cent) and India (40 per cent). These mangrove forests are nationally and internationally recognized for their rich biological diversity with almost 350 species of vascular plants, 250 fish, 58 reptiles, 42 mammals, 8 amphibians and 300 birds along with various species of phytoplankton, fungi, bacteria, zoo-plankton, benthic invertebrates and molluscs. This forest ecosystem is a safe home for many rare and endangered animals like the Royal Bengal Tiger, several species of dolphins, river terrapin, Indian flap-shelled turtle, peacock soft-shelled turtle, estuarine crocodile while Javan rhino, wild buffalo, hog deer and barking deer; these are already extinct in the area (Gopal and Chauhan, 2006). In addition to its abundance of biological resources, Sundarbans as a unique single patch of mangrove forests, also play a significant role in restoring and preserving the ecological balance, maintaining environmental sustainability and providing economic support to the dependent community living in and around it (Lee et al., 2014; Srikanth et al., 2016). Considering the richness of both floral and faunal species and its services (Chaudhuri et al., 2015; Tallis and Kareiva, 2005), this unique ecosystem was declared a 'Ramsar site' under the Ramsar Convention in 1992 and a 'World Heritage Site' by UNESCO in 1999.

State policies and management approaches for protecting the Sundarbans and its ecosystem

During the last few decades, the biodiversity of the Sundarbans was brought under protection and conservation by creating several sanctuaries for protecting wildlife, especially its tiger population and it was declared the Sundarban Biosphere Reserve (SBR) by the state Forest Department. Key policies for the management of the Sundarbans have been updated from time to time and many new policies have been adopted with a view to finding out more effective management strategies.

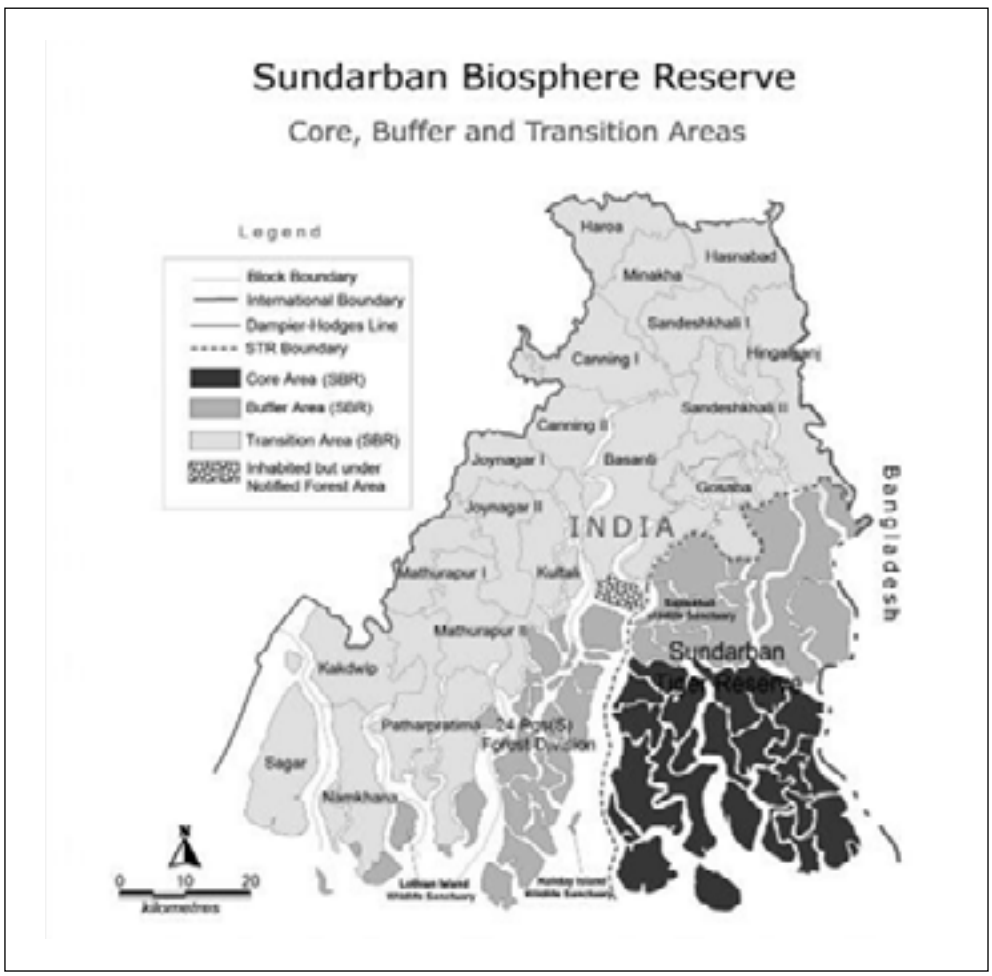
Giri et al. (2007) examined the extent of Sundarbans in both India and Bangladesh using satellite remote sensing between the 1970s and 2000. Their study concluded that its net spatial extent has not changed much since the 1970s. The reasons behind this could be that the Sundarbans were under strict protection and conservation and afforestation/forest regeneration policies were adopted. Historically forest management practices and patterns of forest resource use have played key roles in both the existence and destruction of mangrove forests. The huge destruction and failure of state agencies to protect the valuable mangrove ecosystem gradually influenced government agencies to adopt diversified policy prescriptions targeting restoration and conservation of this important ecosystem (Dasgupta and Shaw, 2013).

A number of state policies and legislative documents are helping in safeguarding ecosystems including those of mangrove forests in India. The major policies include the Forest Act (1927) that made provisions for declaring a Reserved Forest (RF) within the Sundarbans. It prohibited clearing forest land for cultivation and imposed restrictions on felling of trees, starting fires and collecting timber and other produce from the reserved forest. The Forest Conservation Act (1980, amended in 1988) is another key legislative document which explicitly focuses on the necessity of conserving forests for their effective management. This law prohibits the use of forest land for other non-forest purposes.

Enactment of this act had an impact on curtailing illegal encroachments of forest land and preventing the conversion of forest land for other land uses (Dey, 2006). The Wildlife Protection Act (1972 amended in 2003) provides protection to wild fauna and flora and has provisions for setting up of protected areas (PAs) and has categorized wildlife species into six schedules with variable degrees of punishment for possessing and/or transporting them.

The Sundarbans were brought under discrete zonation to protect and conserve its biodiversity and wildlife and to prohibit different development activities including actions that undermine its biodiversity and the wildlife conservation efforts. For example, the Coastal Regulation Zone declaration in 1991 and the declaration of the Sundarban Biosphere Reserve (SBR) in 1989 as part of UNESCO's Man and Biosphere programme established a more formal arrangement for coordinating and

Figure 3.1: Divisions within the Sundarban Biosphere Reserve



integrating diverse activities of conservation and research and training for improving harmony between man and the environment (http://www.sundarbanbiosphere.org). After declaring the Sundarbans, a Biosphere Reserve, it was declared a fully restricted area and designated areas within the Sundarbans could not be entered without prior permission. The Sundarbans, due to their unique ecosystem, were declared a World Heritage site in 1989 and wildlife sanctuaries for conservation and management of wildlife were also put in place through key policies. The total area of the SBR was divided into core, buffer and transition zones. The buffer and transition zones known as multiple use zones have four forest blocks - Jhilla, Arbesi, Harinbhanga and Khatuajhuri under the Basirhat Range (STR Management Plan 2000–2010 as cited in Ghosh and Ghosh, 2019). Public entry to the core area is strictly prohibited by the Forest Department to preserve its diverse floral and faunal species (Ghosh, 2015). It is important to note that the core and buffer areas are in the forested area while the transition area is densely populated and follows mono-culture for tree plantation which is a common practice in the area.

The National Conservation Strategy and Policy Statement for Environment and Sustainable Development (1992), the Biological Diversity Act (2002), the Biological Diversity Rules (2004), the National Environment Policy (2006) and Guidelines on Access to Biological Resources and Associated Knowledge and Benefit Sharing Regulations (Guidelines, 2014) are some other noteworthy legal documents that provide safeguards to the Sundarbans. Some legislative documents such as the National Forest Policy (1988) originated in the Forest Policy that was introduced in 1927, while some policies, legislations and guidelines were developed to align with global guidelines to protect the environment and ecosystems such as the Biodiversity Act (2002), Biological Diversity Rules (2004) and the Indian Wildlife Protection Act (1972). These documents are heavily influenced by the (UN) CBD (Convention on Biological Diversity) principles endorsed in the Earth Summit (1992) and the five-point Aichi Goals that include 20 targets.[1] However, these legal documents formed the basis for integrating and mainstreaming environmental considerations in other sectoral policies and programmes and at the same time also providing guidelines for taking action for the conservation, promotion and sustainable use of environmental resources. The UN-CBD (the Convention on Biological Diversity of the United Nations originated in the Earth Summit held in 1992 in Rio). This is the prime source that has influenced policy framing in India for environmental conservation and management. The Government of India has taken a range of initiatives (see 6th Assessment Report submitted to UNCBD) to provide safeguards for the environment by upholding 12 CBD targets and 20 Aichi Biodiversity targets (ABTs). Major thematic areas where commitments have been made include awareness and integration of biodiversity values, principles for the use of natural resources and managing ecosystems by declaring protected areas, reducing the loss of habitat and ensuring thriving ecosystem services, control of pollution and Invasive Alien Species, biodiversity knowledge management by promoting traditional knowledge and resource mobilization for environmental protection.

Till recently, all the policies and legislative guidelines followed a top-down approach for forest management, where the major responsibilities of agencies (civil administration, the Forest Department and law and order

1. Strategic Goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society.
   Strategic Goal B: Reduce direct pressures on biodiversity and promote sustainable use.
   Strategic Goal C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity.
   Strategic Goal D: Enhance the benefits to all of biodiversity and ecosystem services.
   Strategic Goal E: Enhance implementation through participatory planning, knowledge management and capacity building.
   See more Aichi Biodiversity Targets at: <https://www.cbd.int/sp/targets/>

enforcement agencies) were centralized and governed by state and national policies. Dasgupta and Shaw have argued that sustainable forest management originates from the key concept of co-management of forest resources and essentially involves multiple stakeholders. In South and Southeast Asian countries, mangrove-dwelling communities have long been ignored in the centralized mangrove management policies. As a consequence, conservation initiatives could not achieve the desired results. Community-based mangrove management has tremendous potential, especially in countries where loss of livelihood due to mangrove deterioration adversely affected the coastal communities. (Das Gupta and Shaw, 2013).

This has often created tension and mistrust between the Forest Department and local people; it also has harmful effects on conservation efforts and indirectly creates conditions for illegal logging and unsustainable use of forest resources (Zorini et al., 2004). Consequently, Community Based Mangrove Management (CBMM) was introduced in the Sundarbans in 1990 with a view to achieving a balance between the effectiveness of conservation strategies and generating livelihood opportunities for the socio-economically disadvantaged local people. Hence, the Indian Forest Policy was revised to include involving people's participation in forest management under the Joint Forest Management (JFM) programme. In addition, Sundarbans Forest Protection Committees were created by involving the local government in the buffer zones and Eco Development Committees for the protection of wildlife sanctuaries were formulated in 1996. It is important to note that the nature of CBMM activities in the Sundarbans is different from Joint Forest Management practices in other parts of India as conservation lies at the heart of the approach in CBMM. CBMM reduces local people's access to forest resources.

Dutta et al., (2012) indicate that the contribution of local communities with their traditional knowledge is crucial for forest management which may impact the sustenance and well-being of forest resources as well as of the forest dependent communities.

The question that still remains unaddressed is the issue of livelihood security for the local people and preventing forest degradation. This still remains a challenge. The expansion of eco-tourism has been advocated by involving tourists, investors, government officials and local communities to give local people options through eco-tourism for livelihood security and at the same time protecting the ecosystem and promoting biodiversity conservation. But our literature review suggests that experts and authorities are sceptical about the real benefits of eco-tourism in the Sundarbans as the benefits and control over actions by the local community are minimal. In addition, tourists show little respect for the forest and the biosphere system and its processes. Ghosh and Ghosh (2019) found that eco-tourism in the Sundarbans brought unequal and skewed economic benefits and failed to bring real benefits to the poorest and most marginal communities. In addition, eco-tourism in the Sundarbans is found to be leading to increased pollution and harming the health of the ecosystem.

Threats and challenges faced by the Sundarbans

Sundarbans have been ravaged by anthropogenic pressures for many decades (Sievers, 2020). Till recently the high population growth posed major threats to this ecologically sensitive ecosystem and its existence. The inhabitants do not possess adequate agricultural land to ensure food and livelihood security which compels them to harvest resources unsustainably from the forests leading to the degradation of mangrove forests as forest biophysical properties (felling trees, fragmentation of habitats) are destroyed. At the same time, there is also over fishing, a reduction in the forest area, degradation of the environmental quality and extraction of other non-timber forest products (NTFPs) such as fuelwood, *golpata* leaves (Nypa) and Goran sticks (Chakraborty,

2011). In addition, animal poaching, especially for deer and the Royal Bengal Tiger, poisoning canals and creeks for over-fishing are reported to be major threats in the Sundarbans. Table 3.1 identifies the major threats to the Sundarbans (also see Annexure 8).

Gender issues

Women and Livelihood

A discussion on livelihoods in the Sundarbans is incomplete without a discussion on fishing.

Table 3.1: Major threats to the Sundarbans

No.	Threats	Attributes of threats	References
1.	**Human induced pressures**		
	1.1 Over-extraction for various reasons	Breakdown of ecosystem integrity at an alarming rate. From 1986 to 2002, about 5 per cent of the forest in the Indian part of the Sundarbans was lost.	Singh et al. (2017) Ghosh et al.(2015)
		High population growth in the forest adjoining areas has posed threats to Sundarbans' resources.	Chowdhury and Brahma (2019)
		Population increase as a result of natural growth and new human habitations has a negative impact on the local economy and make the poverty situation worse, leading to competition among groups of people over resource extraction from the forest and also triggers human- animal conflict.	Das et al. (2016) Hazra et al. (2014)
		Around 34 per cent of the people living around the Sundarbans in India have extreme poverty.	
	1.2 Land use changes in the areas adjoining the Sundarbans	Conversion of mangrove forests into agricultural land and shrimp farming and aquaculture. On a regional scale, coastal agricultural land development and shrimp farming were identified as major factors accounting for 90 per cent of the reported losses.	Gopal and Chauhan (2006) Hazara et al. (2002)
		Weak enforcement of legal measures and improper monitoring are major drawbacks in the conservation and restoration initiatives.	Dasgupta and Shaw (2013)
	1.3 Environmental pollution (local oil spillage from the boats, ships, local industries, and use of castoff fuels)	Sundarbans have huge pollution loads from anthropogenic sources such as industrial, domestic and shipping activities in recent times with a higher rate of heavy metal contamination.	Banerjee et al. (2011) Chowdhury and Maiti (2016)
		Due to fuel operated transportation, a higher concentration of lead (Pb, 27.79 –47.07 mg/kg) and cadmium (Cd 0.8 – 3.3 mg/kg) was found in the forest areas.	
	1.4 Environmental pollution (regional discharges from urban centres in the region and large industries)	Untreated effluents from a number of small and large factories are dumped into Kulti river which mix with the waters of the Sundarbans which is approximately 35 km south-east of Kolkata.	Maiti and Chowdhuri (2013) Chowdhury and Brahma (2019)
		Use of chemical fertilizers, pesticides and insecticides in the nearby areas and the consequential discharge of residue in the Sundarbans' wetlands have eco- toxicological effects and change the ecosystem's biochemistry that is detrimental to its flora and fauna.	

No.	Threats	Attributes of threats	References
	1.5 Reduction in freshwater supply	Decrease in water transparency leading to a reduction of phytoplankton communities resulting in a reduction of fish that depends on phytoplankton.	Raha et al. (2012), Mitra et al. (2009)
		The steady rise in riverine water salinity is impacting the local ecology.	Mitra and Banerjee (2011)
		Freshwater flow from the Ganges into the Sundarbans has reduced from 3,700 to 364 cubic metres per second since the construction of the Farakka Dam in India in 1974 and led to an approximately 60 per cent reduction in freshwater supply. Increased sediment depositions due to a reduction in the freshwater flow has resulted in the closure of tidal creeks which is another reason for the degradation of the mangrove forests.	Sarker et al. (2016); Aziz and Paul (2015)
2. Natural pressures			
	2.1 Impact of salinity	Sundarbans have poorer forest formation than the Bangladesh mangroves due to higher salinity and biotic interactions in India.	Naskar and Mandal (1999) Gopal and Chauhan (2006)
		Increased salinity conditions posing threats to fauna species like *Avicennia alba* and *Exocoecaria agallocha* and also threaten floral species like *Heritiera fomes* and *Sonneratia casoelaris*. These floral species require regular supply of freshwater for their growth.	
		Increased salinity conditions are associated with modifications in soil-chemical processes with Sulphate reduction by Sulphate reducing bacteria, resulting in the accumulation of Sulphides that are potentially toxic for plants.	Nickerson and Thibodeau (1985); Chowdhury et al. (2019)
		Less salinity tolerant species such as *Heritiera fomes, Xylocarpus spp.,* and *Phoenix paludosa* are gradually decaying.	Mukhopadhay et al. (2019)
		Salinity induced migration in the near future.	
	2.2 Impact of cyclonic disturbances and flooding	Cyclonic disturbances (especially during 1987–88, 1991, 2007 and 2009) are threatening the Sundarbans mangrove forests.	DasGupta and Shaw (2013) Ghosh et al. (2015)
	2.3 Coastal erosion resulting in increased water turbidity caused by an increase in suspended sediments	High water turbidity leads to a reduction in sunlight and oxygen in the water and the aquatic environment becomes less tolerant of aquatic communities; major erosion takes place in the western parts of the Sundarbans and comparatively less in the eastern parts.	Raha et al. (2012)

No.	Threats	Attributes of threats	References
3. Climate change induced threats			
	3.1 Sea level rise	Sea level rise is happening at an average rate of 3.14 mm per year in the Sundarbans forest areas. But Ericson et al. (2006) reported sea level rise in the Bay of Bengal at more than 10 mm/year, which is the world's highest rate of sea level rise. Rise of sea level and reduction in freshwater flows are considered major factors for the continuous annihilation of the mangroves.	Hazra et al. (2002); Danda (2010); Eriscson et al. (2006); DasGupta and Shaw (2013); Lara et al. (2011) Mitra et al. (2009); Gupta (2018)
	3.2 Increase in temperature	Rise in temperature affects the biology of mangrove species at the molecular, physiological and biochemical levels thereby altering distribution patterns as well as community interactions.	Perry et al. (2005); Neogi et al. (2014)
	3.3 Salinity intrusion and impact on the aquatic environment and soil	Less saline conditions in estuaries on the western side of the Sundarbans (Hooghly and Muriganga river dominated areas) due to melting of Himalayan glaciers; increased salinity seen in the central part (Matla and Thakuran river areas).	Banerjee et al. (2017); Mitra et al. (2009).
		Concentration of organic carbon, ammonia–nitrogen and plant-available phosphorus and microbial enzyme activities for decomposition and nutrient cycling in sediments are critical decisive factors in controlling the density and	Reef et al. (2010), Krauss et al. (2008); Sams-Uddin et al. (2013)
		development of mangrove forests in terms of tree structure, species distribution and growth patterns. The deficiency of Fe, N and P limit the growth of mangrove ecosystems and this condition is reported in the Sundarbans. Decrease in plant-available P, ammonia-N and plant-available N has been revealed with a decrease in forests which means that the local soil quality is degrading either because of salinity intrusion or other stressors. This poor soil quality, in turn, limits the development of new plant colonies.	Chowdhury and Brahma (2019)
	3.4 Increased climate change related extreme events	Inundation of the islands, coastal flooding, coastal erosions, severe cyclones in the Sundarbans as a result of climate change. Displacement of the inhabitants leading to increased vulnerabilities, food shortages and making people more dependent on forest resources resulting in the forest's degradation.	Chaudhury et al. (2015) Guha and Roy (2016)

Fishing has perhaps been the most common livelihood option for the people of the Sundarbans ever since they inhabited the area. It has not only provided livelihood to but also provided protein in the islanders' diet. The people of the Sundarbans have traditionally been fishers in terms of their skills and culture. One of the traditional inland fishing techniques, *meendhar* (prawn seed collection) was synonymously associated with women fishers of the Sundarbans. Most of the fishers are now opting for crab catching which is physically more strenuous and is also riskier because these crabs are mostly found in the interiors around tiger reserve forests (Kanjilal, 2010).

Options like kitchen-gardens and livestock rearing are also facing uncertainties. Repeated loss of land and salinity ingression is making kitchen gardens almost impossible to sustain. According to the respondents, previously the islands were self-sufficient in producing their own food and even quite famous for producing vegetables like gourds, pumpkins, okra, chilli and tomatoes. Recent climate changes had an impact on this viable option and has made people dependent on the market for their vegetables. The nearby vegetable markets are also facing losses due to shortage in production, leading to a significant increase in vegetable prices which are beyond the reach of most of the respondents. According to the respondents this has limited their food choices (Kanjilal, 2010).

Livelihood restoration through male migration is one of the most significant factors behind such changes. Those who have moved out of the state reported that they left because of better paid employment than in their own state, though there is evidence that they are being exploited. Large sections of the migrated population depend on traditional means of sending money back through their peers. The supply of money is therefore often erratic. Not all migrants are willing or able to send money home regularly leading to the women, now de facto heads of their families, falling prey to moneylenders. In the aftermath of cyclone Aila the respondents stated that there was a proliferation of moneylenders, who charged a high rate of interest (Kanjilal, 2010).

Mothers with migrant husbands are facing moderate to severe financial and human resource challenges while seeking care. Additionally, they have to take part in their households' livelihood restoration processes which was not mandatory or time consuming earlier. Women islanders now have three burdens: livelihood, household chores and child and elderly care (Kanjilal, 2010).

Women are also becoming part of the marginal workforce as unskilled labour in the handicraft sector, the domestic help sector and also becoming part of risky options like crab catching. While migration is a strategy for adapting to climate change for both the sexes most women migrate in response to indirect impacts, primarily in response to the overall depressed economy, which leads to critical losses in their incomes. Low participation of women in agriculture is also a reason for women migrating (Ghosh, 2018).

As a coping strategy, farmers borrow money from local moneylenders in an attempt to regain their losses. This attempt sometimes pushes them into a vicious cycle of indebtedness which in turn could make them more vulnerable to any further climatic or non- climatic shocks like health or education (Ghosh, 2018).

Women and health

Research on the healthcare system in the Indian Sundarbans conducted by the Indian Institute of Health Management Research (IIHMR) in West Bengal in 2010 found that in general women in the age group of 15-59 years reported a larger proportion of general ailments as compared to men. They were more vulnerable to health problems like asthma, arthritis and vision-related issues. Data on the body mass index (BMI) of selected mothers showed that a little less than one-third of the women (31.5 per cent) were underweight (BMI) (Kanjilal, 2010).

Women were also found to be disproportionately affected by mental health problems as compared to men. A study conducted on the clinical records of patients admitted for deliberate self-harm (attempted suicide) in six government hospitals in the Sundarbans found that women accounted for 65 per cent of the Divine Saviour Healthcare (DSH) admissions and 67 per cent of the deaths due to deliberate self-harm. Women's vulnerability to mental disorders in particular and to other health problems in general has its roots in their highly fragile status in the Sundarbans, chronically perpetrated by poverty, destitution, domestic violence and society's indifference to their problems (Kanjilal, 2010).

Water and Women

Poor rural families are dependent on the environment for their food, water, shelter, farming and grazing of animals. More than 90 per cent of the world's 1.1 billion poor rely on the environment for sustenance (WRI, 2005). Fruit and root gathering are commonly among the duties ascribed to women and children, while men do the hunting and trapping of mammals, reptiles, birds and fish.

Women, particularly poor women in the Sundarbans, are disproportionately vulnerable due to their dependence on water and bio-fuels, their responsibility for fetching water for household use, their role in securing food and fuel, their predominant presence in low technology rain-fed agriculture and greater exposure to the risks of climate hazards.

Poor rural women are most affected by environmental degradation and the effects of climate change which are caused by a lack of or insufficient water resources particularly after cyclones like Amphan. They are deprived of locally available, sustainable and renewable life sustenance. As natural resources deplete, they are forced to travel longer distances to collect these necessities, and often face dangers of sexual assaults and increased economic and social stress. Pre-existing gender inequalities are deepened by economic crises, particularly due to the under-representation of women at all levels of economic decision making starting with the family to the community and local governance.

Women in communities like the Sundarbans that are vulnerable to climate change are more likely than men to lose their lives during natural disasters due to lack of basic skills like swimming or difficulties in swimming in a sari or cultural factors that restrict their mobility. Women and children are more at-risk during floods. UNDP (2011) did an inventory of 140 disasters between 2005 and 2009 and found that four times more women than men died due to these disasters. Many women can't swim, stay at home and can't flee with their children and have no means of transport for themselves, apart from cultural barriers of leaving the house.

Chapter 4:

KEY FINDINGS ON THREATS AND CHALLENGES FACED BY COMMUNITIES IN THE SUNDARBANS

Understanding poverty and climate change in the context of the Sundarbans is complex and layered and it cannot be fully understood without a gendered lens. A person's social status, power, poverty and access to and control over resources go a long way in determining how that person will be able to cope and manage the impact of climate change and/or a natural disaster. Women are more vulnerable to climate change since they make up a bulk of the world's poor and are more dependent on natural resources and men for their sustenance. Overall patriarchal control, gender stereotypes and expectations promote unequal access to and control over resources, the net result being further marginalization of women.

The FGDs bring out clearly how women of Hingalganj (Shamshernagar) experienced more persistent and longer-term vulnerabilities than men as they lacked choices and opportunities and a denial of their basic rights like safety, respect and dignity within homes and outside. Hence, any effort to change the situation needs to be long drawn and focused on personal, relational and societal aspects of women's empowerment.

Women and Livelihood

"We pursue a livelihood by putting our lives at stake every day; our lives have no value," – this was the single defining statement made by a woman respondent in one of the FGDs that resonated with most of the women that this study reached out to.

Livelihood of all the women and their families in the Sundarbans is primarily dependent on crab catching, however none of them had government permits to enter the forests for fishing or catching crabs. Crab catching is completely dependent on the tidal clock. On most days women with their male partners leave the house well before the first light of dawn and return after dusk. 67.74 per cent of the women participants in the FGDs accompanied their husbands daily to the forest for crab collection. Only 32.25 per cent stayed at home. However, if any family can afford it then newlyweds and women with small children are spared from going to the forest. The mothers-in-law take it upon themselves to train the younger ones in the art of crab catching and surviving in the forest. On good days, they are able to catch 2-5 kg of crab. Only the big crabs are sold. On 'bad' days, a full day of labour can provide only 500 gm of crabs. The income from crabs ranges between ₹2,000 to ₹5,000 depending on the nature and quantity of the catch.

All families have taken up small animal farming like goats, chicken, ducks and geese. Some families also have cows. The produce is mainly used for consumption and only the surplus is sold. Two to three women also spoke about growing turmeric on their land and a few spoke of having nutrition gardens and vermicompost pits in their backyards.

The land is essentially used for mono-paddy cultivation. Almost all the participants said that the produce falls short of their annual requirements, and hence they had to fall back on forest resources.

However, it was quite clear that all families were not engaged in forest resource collection. Families that caught crabs, did not collect honey and so

on. But sighting of a full honeycomb prompted them to cut a portion and take it with them. Men were mainly engaged in honey collection.

Honey bee farming as a livelihood option was not pursued directly by the residents of the village. It is pursued seasonally (for three months) by outsiders who bring boxes and catch the local bees for honey. Families with land and space allow these boxes to be placed for three months against a paltry payment and 1 litre of honey per box when they leave. Each box produces about 16 litres of honey. The honey thus obtained is sold in the market in used plastic water bottles for ₹250 to ₹500.

Women along with men are actively involved in MGNREGS work. According to the Pradhan, Kalitala gram panchayat, 30-40 per cent women are engaged in MGNREGS work.

The local women participants said in the FGDs that the government had failed to understand the real reasons for the depletion of the forests as well as the loss of biodiversity in the mangrove ecosystem. Unless there is a mechanism which involves the participation of the communities in maintaining the forest ecosystem and the communities start owning the forest it will be difficult to prevent its degeneration. As of now, it is clear that only the Forest Department's personnel are the owners of the forest and responsible for saving it from strangers. However, the communities feel that they are not strangers as they understand the importance of the forest. Unless this is considered seriously by the Forest Department and there are some policy level changes, it will be difficult to stop invasions and maintain an equilibrium. Ultimately empowering people with knowledge is essential as only then will people start thinking of alternatives and their dependency on the forest ecosystem will slowly reduce.

Research participants felt that the increasing trend of girls marrying boys from other states, linguistic groups and castes is slowly disturbing social cohesion.

- During an in-depth interview with shrimp collector Debabrata Mandal the researchers came to know that the total cost for collecting crabs and prawns ranged between ₹6,000 and ₹10,000 and for honey collection, the cost varied between ₹20,000 and ₹25,000. Only pass holders can claim compensation for any injuries or deaths while collecting these in the forest.

  As per the information given by farmer Sanjib Mandal average expenses per visit are approximately ₹2,500 and 80 to 90 kg of crabs can be collected per visit. The price of the crabs varies between ₹70,000 and ₹ 80,000 per quintal.

  Local resident Kalpana Mandal complained that as a condition for getting a permit, they have to sell half the collected honey to the forest officials at ₹120 per kg, which is very low in comparison to the existing market rate.

  There are a few legal permits holders who do not enter the forest but they earn by selling their legal permits to interested people for around ₹50,000. There are people who pay the price and enter the forest maintaining a quasi-legal system for collecting NTFPs. The official permit costs ₹500. However, the FGDs revealed that since the government has stopped issuing new permits, a few permit holders feel encouraged to continue with the malpractices and those who invest huge sums for buying a permit try to exploit the forest resources as much as they can.

  The researchers were told that after Aila, most of the families lost their domestic animals. Actually, because of the impact of cyclone Aila, the socio-environmental condition changed and effected domestic animals adversely. Thereafter, due to frequent cyclones and extreme weather conditions people couldn't rear livestock in the unfriendly environment.

- The government is promoting artificial insemination, which will ultimately lead to hybridization, which according to the

informants will not be suitable for them, as neither are they accustomed to rearing those animals, nor can they afford to feed the animals. Moreover, they were apprehensive about the climate being conducive for those hybrid varieties. They were worried that a day will come when there will be no indigenous animals. These types of animals are not suitable for the local weather conditions. As a result, the mortality rate among cross breed animals is higher than that in normal livestock.

- *Moulis* (honey collectors) informed the researchers that they often risked their lives in the peak season to collect honey armed with nothing but a prayer to Bon Bibi (the forest goddess). They go deep into the forest as the wild bee colonies have mostly shifted to the core areas, hence honey collection has also decreased.

- People said that agricultural production was not enough. Without any irrigation facilities, they are dependent on rainfed agriculture only, which is paddy, and now in the absence of local rice varieties such as *dash-shell, patnai, boran, gnethi* and *morichshal* the farmers are mostly cultivating the seeds given by the government, like *jotai, gomoti* and *CR*.

- Two decades ago, many villagers shifted from agriculture to fish farming. After some time when they realized that it was not a profitable business, a large number of people associated with fish farming returned to agriculture. Because of unknown viruses, prawn production has been destroyed in particular. Locals have understood that it is an expensive business for them. The locals are also assuming that fish farming may also be impacted by air pollution. During the field visits, researchers observed some activities related to aquaculture.

Access to and control over assets

On average the families owned 1-1.5 bighas of land. The average family size was 5-7 members. Women identified their livestock, the forest and their husbands as the resources and assets that they possessed. Most women said that the frequent cyclones had long ago forced them to sell their jewellery and other valuables that they had to survive. While every family had some land, it was not in the woman's name. When it was enquired whether they felt it was important for women to own some assets in their names, the women said that for them it was something to aspire for as assets always help in a crisis particularly to pawn for cash. After some prodding, some women pointed out that it was important for women to have some assets as these gave them some security in their old age. A couple of stories cropped up on how elderly widowed women had to face neglect and isolation for lack of assets and also how elderly women are pressurized by their sons to pass on the ownership of movable assets to the next of kin. In one group, women also said that they felt unwelcome in their parental homes as they are a burden on their brothers even though they went visiting. In three groups, it came out clearly how difficult it was for women to take a break and visit their parental homes as their absence meant a loss of income and hardships for the men and other family members.

As far as women's role and participation in decision-making is concerned, the tribal women seemed to be better off as they said that their opinions were sought in financial decisions. While it was clear that there existed considerable transparency among tribal couples on income and expenditure, however, in discussions women acknowledged that although their opinions were sought, they did not have control over the earnings and that they could not consider a specific share of the earnings as their own. When asked whether they could spend a part of the income (their share of labour) with full autonomy, the women said

that without permission or knowledge of their husbands, they would not be able to do so.

Savings and Debt

All the women participants in the FGDs were members of WSHGs. They all had bank accounts and following the norms of WSHGs, all of them saved ₹20 per month. All the members said that they had exhausted their abilities to seek loans as members of SHGs. They pointed out that apart from the inter-lending activities of the groups, the SHGs did not provide them with any economic vision or opportunity. In fact, the women who were also group members were unaware of rules and regulations regarding grading, bank linkages and subsidies that the very concept of a SHG brings with it. Holding regular meetings was a challenge because of their lives that left them with hardly any time. Because of apathy towards the banking system and how it can benefit them, the women were dependent on the local rich for loans against a very high rate of interest – 33 per cent or Re 1 for every ₹3.

Additional vulnerabilities as women

Managing the double burden

The burden of a livelihood and nurturing the family emerged as a primary issue for women that made them angry and feeling hopeless. The idea of rest for these women was a luxury as the only time when they thought of resting was when they slept. The average hours of sleep were 4-5 hours per day. After a full day of physical and emotional hardships, they were on extended household duties - cleaning and cooking, taking care of the animals and meeting their husbands' needs. One woman said it was humiliating for women if they were "unable to place a plate of rice in front of his (the male partner's) tired mouth."

Women had a lot to say about what they thought and felt about shared domestic responsibilities. Some felt that the notion of shared domestic responsibility can only be applicable to those families where women 'earn' or are able to manage help. When it was pointed out that they contribute equally (if not more) to their families' monthly incomes, they said that it was practically impossible to expect the men to contribute to household chores after their backbreaking day's work. Some others felt that men were not skilled enough to do household chores.

While on the one hand the women were angered by the unfair burden thrust on them by society, they were also unable to imagine the possibilities of an equal partnership.

Security and Safety

While the fear of tigers, crocodiles, snakes and wild boar are predominant in their minds when women venture out to the forest, fear of dacoits and pirates too adds to their woes. Prasanta Mukherjee, a resident social activist of the area was of the opinion that there had been a number of cases where these people venturing into the forest illegally were captured by pirates and let off for a ransom. While BSF patrols the borders and the Forest Security Guards the forest, lack of coordination between them and no involvement of the locals fails to prevent animal poaching and illegal felling of trees in the forest and trafficking of animals across the India-Bangladesh border.

Women were subjected to taunting and accusations of being poachers and traffickers of animals by the BSF.

Domestic violence was reported by women as a regular occurrence. The women made it sound as if it was a 'normal' part of their lives that did not warrant much discussion. The feeling of powerlessness and humiliation in such cases was shared but interestingly the initial discussion around domestic violence was met with uncomfortable laughter and banter. Physical as well as emotional abuse was reported.

It was quite clear that while talking about their fears, the issue of safety was seen as being external. Safety within marriage was something that they did not consider their right, but a matter of fate.

Local women said that they were more vulnerable than men and more victimised.

Son preference

The women said that the general norm in the community was that if the firstborn was a male child, depending on the financial status of the family the decision for having a second child was consciously taken. However, if the first born was a girl, women had to go through repeated pregnancies till they produced a son. Women's desires and decisions hardly mattered in such a situation.

Freedom of Mobility

Although women went out every day with their partners for work, it was clear from the discussions that they did not enjoy free mobility. "If you want to maintain a family life, as a woman you have no choice but to accept the pressures," a respondent said in an FGD. Visits to parents' homes or elsewhere required permission from the men. Although some women expressed their willingness to go for residential skill building programmes, for most this would be possible if their male family members (husbands or fathers-in-law) consented or 'passed an order.' For a couple of women, while going out of the village for skill upgradation was permissible during day time it was absolutely imperative that they returned home by the evening.

Plight of 'tiger widows'

One woman retold the horrors of losing her husband to a tiger attack. She had to fight the tiger to bring back her dead husband's mauled body. As her entering the forest was illegal, she had to keep his death hidden. The incident forced her sons to migrate in search of work. In another case, the widow had to continue going to the forest in search of crabs.

Early marriages and human trafficking

Education for girls is considered important till the time an eligible match is found for them. If a girl is unable to do well in her studies, immediate marriage is the only solution. Girls are not allowed to be outside their homes after evening. Even if girls get jobs, they are allowed to work if their 'husbands to be' agree.

Average age of marriage for girls in the area is 15 years. Cases of underage girls eloping are rampant. Social pressure can prompt families to halt girls' education and push them into early marriages. A couple of incidents were shared by women where a romantic relationship and even talking to a boy resulted in preventing a girl from pursuing her studies and forcing her to accept marriage. In another instance, the local club forcefully made a boy and a girl (who was less than 18 years by a few months) marry despite pleas from the girl's family that they would marry them in a couple of months when the girl turned 18 because the community felt that an unmarried boy staying at the girl's house without marriage, but with the consent of her parents, was a dangerous example for the community. While a crime was legitimized and condoned by the community, the girl lost access to Kanyashree funds.

Women retorted that people were aware of the legal marriageable age for girls and they were also aware about the rules and norms of the Kanyashree scheme. When asked how the Kanyashree funds are used once girls can access them, most women said that they were used for taking care of marriage expenses. One woman said that her daughter had forbidden anyone to use the money as she considered it to be her future security. On the question of dowry, the women said that there was no longer any direct cash demand. However, demands were made about the nature and quantity of jewellery and

other items. The items that were indispensable in a marriage were jewellery for the bride (as per the demands of the groom's family), a gold ring and watch for the groom, a bed and other things.

Discussions also revealed that while the community played a very vigilant role when it came to who a young girl was meeting or talking to, the same enthusiasm was not seen when it came to women asking for help when abused by their partners.

A large number of cases of human trafficking have been reported from North 24 Parganas but the women respondents and some men in the locality could not remember any case in the recent past. However, Pradhan, Kalitala gram panchayat reported 2-3 cases of human trafficking in recent times.

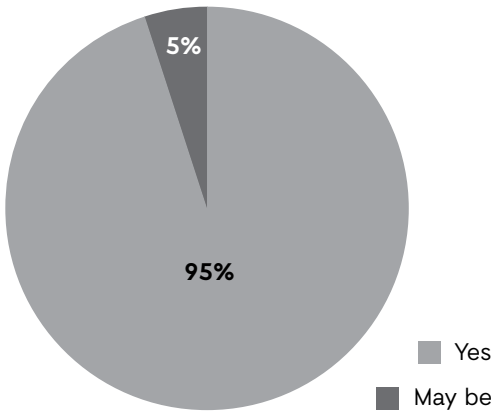
Education and Health

Although the participants in the FGDs had little to basic school education they were serious about educating their children. Women's education levels are low in the area. They pass school but due to social norms they are unable to go to college. For higher studies, they have to travel more than 2km to reach a high school. Pre- schools don't function properly.

The ICDS centres or the anganwadi centres are focussed on providing meals to children. The women were not aware of the services that the centres were supposed to provide. Mothers' meetings did not take place and the women were not aware of the provisions for such meetings. The women complained that the ICDS workers did not come to the centres regularly.

Tribal children went to the Adivasi school for primary education. The high school is far away. Teachers were not regular and the school did not provide students with multiple choices when it came to subjects for higher secondary courses.

Drinking Water



- The Drinking water problem is still unresolved.

  1) Salinity of the water in the tube-wells is very high.

  2) Drinking water projects are not enough to meet the requirements.

- Local people talked about water scarcity in the locality. They said that the government had installed two solar ultra-filtration units (one for purifying pond water and another for groundwater) to provide quality water to the local people. Stakeholders complained about the selection of the sites as two units are in the same place. But due to lack of competencies and other related reasons, the units were not operating at the desired level. The filters were not functioning properly because of technical issues such as poor battery backup, placement of solar panels and delayed supply of the required reagents.

  There are other sources of drinking water such as tube-wells and drinking water supply by the government through VATs. The participants also highlighted that natural gas comes with the water in some tube-wells. During discussions with the local people, we identified a tube-well where natural gas was emitting with the water.

  Participants in the FGDs said that local communities take water for their household

needs from the unit which purifies the pond water. On the other hand, for drinking water they depend on the plant treating groundwater. But not more than 5 per cent of the population has access to treated water from this unit.

- Participants added that the water table in the area is as deep as 1600 ft.

Knowledge about climate change and impact

The members of the groups identified some major changes that have taken place over the last few years due to climate change. A decade ago, the primary livelihood of the people was fish catching. Crabs were caught for a meal or two and essentially as a delicacy. This practice got completely reversed over the years and crab catching has become the main livelihood while fish are caught for eating at home. All the members agreed that excessive crab catching will adversely impact the ecosystem and when that happens, they will have to migrate to cities for survival. As a way of ensuring that the number of crabs does not reduce drastically, they pointed out that small crabs were set free or kept in chambers for crab farming till they grew to a certain length and weight when they were sold.

The women also pointed out that they had heard and seen less tigers swimming across the river and entering their villages which was a regular thing 10 years ago. Infrastructure was identified as a reason for this change.

It seemed that women were not very aware of the impact of climate change and excessive use of forest resources on the Sundarbans' biodiversity and ecosystem.

Rights and Entitlements

Women identified access to safe drinking water as a major issue affecting the entire area. The main source of drinking water is tube-wells, though limited quantities of filtered water are also provided by the administration. Ponds are used for domestic requirements.

Women were of the opinion that access to safe drinking water was difficult particularly for those who accompanied their husbands to the forest. Before leaving for the forest, women had to stand in line and keep their water containers in the queue for water.

The tube-well water had a dark brown colour that one might mistake for mustard oil. The water is saline and has a high chemical content (methane). In the absence of clean water, the residents had no choice but to consume this water.

PDS services were provided once a month. On that day women and children stood in long queues starting early morning in front of the ration shop. In families where both parents had to go to the forest, it was left to the children to collect the dry rations. These children gave school a miss as they had to travel far and bring provisions for the month.

Eco-Tourism and its relation with Conservation of Biodiversity

Eco-tourism is nature-based tourism, which means protection of nature as well as enjoying it. The International Ecotourism Society (2006) defines eco-tourism as 'responsible travel to natural areas that conserves the environment and improves the well-being of local people.'[1] To minimize dependence on the mangrove ecosystem, government agencies have introduced eco-tourism, which is basically Community Based Tourism (CBT) that involves the application of

1. International Ecotourism Society, 2006, "Definition of Ecotourism" http://www.ecotourism.org

tourism as a tool to strengthen the abilities of rural community organizations. The concept is promoting visitor-host interactions that have meaningful participation of both the visitor and the host and help in generating economic and conservation benefits for local communities and the environment. Community-based eco-tourism is supposed to be more environment friendly with a sustainable tourism approach and is regarded as a tool for natural and cultural resource conservation and community development. An important characteristic of eco-tourism is its linkage to, or emphasis on environmental conservation – tourists' enjoyment combined with preservation of the local environment. Actually, under this community-based eco-tourism approach it is expected that the local community will plan, develop and manage CBT to maximize its benefits and minimize the negative impact of tourism. Eco-tourism has been introduced in the Sundarbans with a view to reducing the communities' dependence on the mangrove ecosystem and means that the community will generate its own livelihood options with new economic activities and gradually stop entering the forest for their living.

As a result, homestays have started coming up in the Sundarbans to promote eco-tourism and from the discussions with the owners it can be concluded that they were not aware of the differences between mass tourism, which aims at maximizing profits for the investors and community based eco-tourism, which is more concerned with the impact of tourism on the community and environmental resources and is a result of a community development strategy.

> *In the name of eco-tourism lots of homestays were sponsored, which led to destructive forms of tourism.*
>
> *These are the places where any tourist can come and often, they cause disruption to the local economy and lead to seasonal unemployment and the degradation of the natural and cultural environment. The owners only understand the economic benefits of tourism as it provides alternative economic opportunities and fail to use tourism as a tool for strengthening the rural community organizations' that manage tourism resources with the participation of local people.*
>
> ~ Arobindu Sardar, a tour operator in the Sundarbans

> *The concept was floated by the government a couple of years back and at the time people who were already involved in the tourism business developed a network. That helped in supporting each other in business. But after 2-3 years slowly the network started becoming defunct as large businessmen, mostly from the cities, who were investors in the tourism business, withdrew from small scale tour operations. Now it's the Forest Department and other government departments that are trying to sponsor a few people to set up homestays, but this is not community-based tourism. In the tourist seasons a few tourists come to the villages with DJ sets, make a lot of noise and pollute the environment in the name of tourism.*
>
> ~ Biswarup Mondal, Homestay owner, Samshernagar, Hingalganj

Hence, existing tourism cannot be termed eco-tourism, as the carbon footprint from this activity is very large. Although it's a good alternative but we need to be very cautious and vigilant about environmental degradation/ detrimental issues due to the promotion of eco-tourism. It needs to be remembered that ecology and economy are two sides of the same coin in the Sundarbans and it's impossible to improve the economic conditions of the people by destroying the ecology of the Sundarbans.

The Sundarbans have scenic beauty, biodiversity and rivers, as well as festivals, local cultural art forms and places of religious interest. There are locations for scenic views for tourists. These offer huge potential for developing activities for community-based eco-tourism, as well as allied services and infrastructure facilities in the surrounding areas. One major limitation is lack of accommodation in the areas surrounding the Sundarbans, hence the main eco-tourism activities undertaken by the local community are establishing homestay facilities. Producing and selling local handicrafts, cultural shows and amusement and tour guides are also part of eco-tourism activities. All of them are community based. However, the number of tourists is relatively small, and those who can afford it have taken it as a secondary occupation for supplementing their incomes. The relatively low income from homestays is also indicative of large tour operators not being interested in involving the local community in their business.

When asked about the problems that they saw in community-based eco-tourism in their locality, most of the respondents said the small number of tourists, difficulty in communicating with the tourists due to differences in language and robberies in the case of fishermen. Specific help for promoting eco-tourism mentioned by them includes a conducive administrative climate, law and security enforcement, loan facility for investments in eco-tourism activities, musical instruments for cultural activities, training in English language and improving handicrafts. As the members of local community involved in eco-tourism in the Sundarbans are ordinary people, their capacity building in eco-tourism activities should be considered an important step in the promotion of community-based eco-tourism.

Some action plans that were discussed during the discussions, can be initiated for the promotion of community-based eco-tourism in the Sundarbans. These include:

(i) Improving infrastructure facilities for tourism, especially for tourists in the locality such as building cottages.

(ii) As the local people have to be involved in community-based eco-tourism, they should be trained to enhance their capacity in dealing with tourists such as skills in communication and cultural performances.

(iii) Tour operators, whether government or non-government, should be encouraged to involve the local people in the tourism business.

(iv) Local handicraft products should be promoted and their quality and variety improved.

> *Life in the Sundarbans must be considered a school, where learning is an endless journey. I developed a passion for the Sundarbans after my stay there with my children.*
>
> *The journey begins...*
>
> ~ Prashanto Mukherje, from SOIL (CBO) working in Shamshernagar

(v) Action needs to be taken to reduce mismanagement by the Forest Department through increased awareness building, monitoring and accountability.

(vi) Local people should be made aware of the prospects of alternative job opportunities in community-based eco-tourism which will not only increase their earnings but also reduce their dependence on the Sundarbans thus helping environmental conservation.

Cultural practices and Conservation of Biodiversity

Bon Bibi Johuranama, which narrates the story of Bon Bibi, is chanted in the villages on the fringes of the Sundarbans, before honey collectors and fish workers enter the forest. The only protection that they have is the sacred blessing of the forest goddess Bon Bibi.

The imagination of Bon Bibi as a forest goddess and the 'religion of the forest' is manifested in the everyday lives of the people. It underscores local ecological knowledge, customary rights and a deep-seated belief system. At the core of such a place-based religious framing is a unique perspective highlighting sustainable practices and ecological resilience. Villagers dependent on the mangrove ecosystem for their livelihoods typically follow norms of access to forest areas and do not extract more than they need. These norms include entering the forest during certain hours and refraining from entering at night so as not to agitate the wildlife, refraining from defecating and smoking in the forest and entering the forest without any arms. Although the villagers depend on the forest ecosystem for their living, they do not catch fish during certain breeding seasons and do not extract wood or honey from small flowering trees.

What appears representative of the regional folk tales regarding Bon Bibi is an intrinsic adaptive capacity of the local people in the form of their traditional ecological knowledge and their adaptability to the inhospitable forest.

People in the area seem to be aware of the growing degradation of the mangroves. People such as woodcutters, fishermen, *moulis* (honey collectors) and *bawalies* (golpatta collectors) around the Sundarbans who directly depend on the forest for their livelihood, do not do much harm to the forest. It is the people who indulge in illegal activities such as smuggling wood and hunting wild animals who destroy the natural conservation system of the forest. The local musclemen, corrupt political leaders, forest officers and the police, robbers and greedy buyers of forest wood are mainly responsible for the destruction of the forest. The local people are generally engaged as labour in these activities. As they do not find sufficient job opportunities throughout the year, they are forced to work as labourers in the destruction of the Sundarbans for their livelihood. Almost all the respondents stated this as the main reason for the involvement of the local people in the environmental degradation of the Sundarbans.

Further, extended commercial shrimp farming in the whole coastal area has increased the salinity of the soil, which has decreased the natural fertility of land and led to a decline in farmers' incomes over the years. This has led many people to be more dependent on the Sundarbans for their livelihood. As a result, the Sundarbans are gradually losing their natural biodiversity leading to its destruction. However, it needs to be noted that environmental degradation of the Sundarbans is a result of human interventions largely for commercial reasons and to a lesser degree for livelihood and tourism purposes.

Bon Bibi worship might not have transcended the local barriers of the Sundarbans' islands to reach the domains of popular religious practices in mainland cities but it preaches virtues of forest conservation. Therefore, conservation norms safeguarding these largest coastal mangrove forests must recognize place-based customary norms, since an isolated body of scientific conservation policies will be inadequate in addressing the challenges posed

to the vulnerable ecology. Bon Bibi worship is significant in underscoring place-based framings on environmental consciousness in specific conservation landscapes, where the dominant conservation ethic is rooted in state-led legal provisions.

Environment quality monitoring

Air Quality

Air pollution is caused due to both natural and man-made processes. The main source of air pollution is human induced/man-made, which includes industrialization and its by-products, burning of timber, rapid urbanization, vehicular pollution, plastics, burning of polymers, processing of various materials emitting obnoxious gases, generation of smoke, dust and fine particles due to construction activity and rapid burning. The air quality parameters considered for this study include PM10, PM2.5, Nitrogen Oxides (NOx) Sulphur Dioxide (SO2) and Carbon Monoxide (CO) (see Annexure 9).

Comparison of Air quality in the last 20 years

As per Central Pollution Control Board (CPCB) report in 2001-02, NO2 concentrations in the rural Sundarbans were below the prescribed limit for National Ambient Air Quality whereas they were at par at Kaikhali and Pakhiralaya (31 µg/m3). The Suspended Particulate Matter (SPM) level crossed, though marginally, the sensitive zone standards in the core area of the Sundarbans at Pakhiralaya probably due to the atmospheric transportation/dispersion of the land based particulate matter in addition to local inputs like air-borne pollen grains/spores of mangroves. SO2 levels in the Sundarbans along the peripheral locations of the rural Sundarbans as well as in the core area were less as compared to NO2 concentrations. The recent ambient air quality has improved compared to 2001-02. NOx value is much less (16.6 µg/m3) than in 2001- 02.

Air dispersion modelling of emissions during fuel combustion in brick fields in the study area

To assess the impact of air emission, air dispersion modelling was done for a brick field located at latitude 22.4813637 N and longitude 88.9745206 E. The inputs, assumptions and output of this dispersion modelling exercise are:

Inputs

The following details were obtained from brick manufacturers located in the project area:

- 24 tons of coal required for every 1 lakh bricks.
- Production of bricks in 6 months is approximately 21 lakhs.
- Stack height 125 – 130m.

One year hourly meteorological data for 2018 from Alipur Meteorological Station, Kolkata.

Assumptions

- Continuous operations for 6 months.
- Stack diameter ~ 2m.
- Flue gas exit temperature ~ 100 OC.
- Heating value of coal ~ 24.33 MJ/kg.
- Sulphur content in coal ~ 1 per cent.

Pollutant Emission Rates

Based on these inputs and assumptions, emissions rates of criteria pollutants were estimated as:

- PM10 emission rate - 0.093 gram/ sec.
- NOx emission rate - 0.137 gram/sec.
- CO emission rate - 4.157 gram/sec.
- SO2 emission rate - 0.468 gram/sec.

Outputs

The air dispersion modelling using AERMOD was done for PM10, SO2 and NOx. Since the

emission rate of CO is much less compared to its ambient limit, modelling was not done for it.

Analysis of Results

Based on the results presented earlier, following inferences can be drawn:

- Due to the operation of brick fields in Hingalganj block, ambient air pollutant concentrations are not expected to exceed permissible limits.
- The impact zone of air emissions due to operation of brick fields is limited within 300m of their locations.
- The predominant wind direction being towards north and north-west, the emitted air pollutants are expected to disperse away from Hingalganj block.

Noise

High noise levels are a concern for sensitive receptors like hospitals and educational institutions. A silence zone is defined as an area up to 100 metres around premises such as hospitals, educational institutions and courts. The silence zones are to be declared by the competent authority.

The Central Pollution Control Board (CPCB) has specified ambient noise levels for different land uses for day and night time (Table 4.1).

Silence zone is an area up to 100 m around premises such as hospitals, educational institutions and courts.

Locations for noise monitoring were selected in a commercial market place (the Shamshernagar market area). The noise levels were monitored with Integrated Noise Level Meters.

The noise monitoring survey showed that noise levels were within the permissible limits. The permissible limits for commercial areas prescribed by CPCB standards is 65 dB(A) and 55 dB(A) for day time and night time respectively. The average day time noise level was 59.4 dB(A), whereas average night time noise level was 48.3dB(A).

Surface Water Quality

Surface water includes drainage channels (rivers, streams, canals) and stagnant water bodies (for example, lakes, ponds, tanks and other impounded water bodies). It was essential to identify and examine a few of the surface water resources and their characteristics in the study area. To understand surface water characteristics in the study area, two locations were selected for surface water sampling. Both ponds are used for domestic purposes. The sampling locations are shown in 4.1.

The pH of the sampled water in the region was well within permissible limits (7.0 – 7.75). Total hardness as CaCO3 in the water sample from Shamshernagar (pond) was 506 mg/l which is the highest in all the samples but very less than the limit (300mg/l) prescribed for drinking water. Biological Oxygen Demand (BOD) level for all analysed water samples was higher than the permissible standards. Salinity level was 0.5-1.9 in both the locations.

Table 4.1: Ambient of noise levels

Area Code	Category	Limits in Decibels (dB A)	
		Day time	Night time
A	Industrial	75	70
B	Commercial	65	55
C	Residential	55	45
D	Silence Zones	50	40

Surce: Central Pollution Control Board, New Delhi

Note: Day-time: 6 am to 10 pm, Night-time: 10 pm to 6 am;

Figure 4.1: Surface water sampling

Surface water sampling in Shamshernagar

Surface water sampling in Kalitala

Groundwater Quality

For establishing baseline quality, ground water samples were drawn from two locations in the project area and analysed as per IS 10500. Sampling was done at Shamshernagar and Kalitala. The bore well at Kalitala was adjacent to the public toilet. So, there were high chances of

Figure 4.2: Groundwater sampling

Surface water sampling in Kalitala

Groundwater sampling in Kalitala

sewage water mixing with fresh water sources for the local aquifer.

In the groundwater samples collected from bore wells in Kalitala and Shamshernagar very high values of total dissolved solids of 10500 mg/l and 3960 mg/l were found; these are very high and more than the permissible limits. Total alkalinity ($CaCO_3$), total hardness and BOD were also very high and exceeded permissible limits. E. coli and total Coliform were found in both the samples. The groundwater at both the locations was saline whereas salinity in the groundwater at Kalitala was 9.3. Therefore, groundwater at Kalitala was of very poor quality and not safe for drinking. This bore well is located adjacent to the public toilet. After checking the monitoring data of Kalitala's groundwater it can be assumed that there may be chances of cross-contamination of the sewage water in the local aquifer. This is leading to polluted groundwater in that region. Groundwater containing heavy metals above the maximum permissible limits pose potential risks to human health. Groundwater in this area poses a big threat due to high levels of heavy metals and it is necessary to avoid this water for drinking due to potential health hazards. Arsenic, lead, nickel, cadmium and chromium largely contributed to health hazards.

Soil quality

To understand the soil characteristics in the study area, four locations in the study area were

Figure 4.3: Soil sampling in the study area

Soil sampling in Shamshernagar

Soil sampling in Kalitala

selected for soil sampling. The soil sampling locations are shown in Figure 4.3.

In general, the soil is medium textured, sandy loam, silt loam or clay loam. The grain size distribution is highly variable. In this area the pH levels range from 7.33 to 7.45. Available potassium (as K) content is high which varies from 241.5 to 313 mg/kg whereas the nitrogen content is very low.

Chapter 5:

COMMUNITIES AND LOCAL GOVERNANCE

It is important to develop a clear understanding on the framework of regulatory governance in India. Developing this understanding is needed as people's institutions are proposed and created and are not spontaneous. People in the Sundarbans' fringe villages have failed to think about themselves as 'ecosystem people' and are very much a part of the mangrove ecosystem of the Sundarbans. Although most of the policy papers use phrases like, 'human capital development as well as improvement in livelihood opportunities' to improve the dismal living conditions of the people still dependent on the mangrove ecosystem for their living, ultimately they work with an exclusivist approach even as the mangrove ecosystem and wildlife conservation have become a priority for the government. Community participation has become a sub-clause only in policy documents as neither the community people nor personnel from different departments responsible for executing the policies understand the processes to be followed to ensure the involvement of community members. Here it is worth mentioning that the people of the transition zone consider themselves intruders in the forest. They are at the mercy of the Forest Department's officials if caught without a valid permit. There are Forest Protection Committees (FPCs) in the villages, but the members proudly say that they have the power to negotiate with the forest officials for releasing an intruder caught while trespassing. But the same people cannot say a single word to the BSF personnel when they see them disposing kerosene in the river. Nor can they protest when the tourists enjoy loud music in areas just across the core zone.

However, the Sundarbans region is an example of the coexistence of man-animal- mangroves and other creatures and this symbiotic relationship has existed for centuries.

The current institutional context of the Sundarbans is characterized by the existence of:

a) Inter-related instruments regulating the types of activities that can take place in different parts of the ecosystem; and

b) multiple national and state-level agencies and local governments, most of which operate based on a traditional sectoral approach that does not explicitly recognize the unique and changing conditions of the Sundarbans (The World Bank, 2014).[1]

The framework design is with respect to:

a) Biosphere conservation;

b) Coastal zone management; and

c) Climate change.

Currently, multiple government agencies from all three levels of government – central, state and local – operate in the Sundarbans region, each having its own set of incentives, goals and resources.

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1. The World Bank (2014). Building Resilience for the Sustainable Development of Sundarbans. Strategy Report, Washington DC: World Bank (available at: https://mpp.nls.ac.in/blog/institutional-approaches-for-addressing-priority- challenges-in-the-sundarbans/)

The Government of West Bengal's (GoWB) Forest Department and the Government of India's (GoI) Ministry of Environment, Forest and Climate Change (MoEF) play crucial roles in the management of protected areas. The Forest Department is also responsible for the reserve forests in the two districts of North and South 24 Parganas; its duties include managing the lease and permit system through which authorizations for forest exploitation are awarded.[2]

The Regulatory Context of the Sundarbans

In December 1878, the colonial administration notified the Sundarbans forest as a 'Protected Forest.'

By May 1943, all the remaining parts of the 'Protected' forest were reclassified as a 'Reserved' forest to forestall any further reclamation/ conversion.

This forested part of the Indian Sundarbans Delta (ISD) as we see it today is overseen by the Director of the Sundarban Biosphere Reserve (SBR) through the Divisional Forest Officer of 24 Parganas (South) Forest Division and the Field Director of the Sundarban Tiger Reserve which came into being through a notification in December 1973.

The Sundarban National Park within the Tiger Reserve was declared a World Heritage Site in 1987 and is provided with the highest level of official protection, classified as a Category Ia (Strict Nature Reserve) Protected Area under the IUCN classification system.

To improve an understanding of environmental sustainability issues, conservation, and social and economic values of forests, the National Forest Policy was redrafted in 1988, which subsequently led to the Joint Forest Management Resolution of 1990.

All of the ISD was declared a Biosphere Reserve in March 1989 but the human inhabited part is de jure and not under the jurisdiction of the Director of the Biosphere Reserve.

The Government of West Bengal issued two specific guidelines in 1991 and 1996, both of which have a bearing on the management of Sundarbans forests. These are (1) Mangrove forest areas of Sundarbans, and (2) National parks and sanctuaries in the state.

Based on these notifications, community-based committees were devised to increase community involvement in ecosystem management as well as redistributing the benefits of appropriate management more fairly were developed. Accordingly, 51 Forest Protection Committees (FPCs) and 14 Eco-Development Committees (EDCs) associated more specifically with National Parks and Sanctuaries, were constituted in the Sundarban Biosphere Reserve between 1993 and 1998 in 46 forest fringe villages across seven Community Development (CD) Blocks.

In 1994, the Sundarban Affairs Department (SAD) was developed as a dedicated department in which SDB was subsumed.

India's National Environmental Policy, 2006, recognizes that mangroves and coral reefs are important coastal environmental resources.

The Coastal Zone Management Authority (CZMA) is positioned to enforce and oversee national regulations in the Sundarbans, which are established through MoEF and are to be enforced nationally and through the state coastal zone management authorities.

The West Bengal State Action Plan on Climate Change has identified the Sundarbans as a priority region. However, in the National Action Plan on Climate Change the Sundarbans are not included as one of the priority areas under

2. https://mpp.nls.ac.in/blog/institutional-approaches-for-addressing-priority-challenges-in-the-sundarbans/

the eight national-level missions to develop plans for climate change adaptation in several priority areas.

Government programmes for the region's development are driven largely by agencies in the Government of West Bengal. The Department of Sundarban Affairs (DSA) and the Forest Department have the broadest administrative influence over the Sundarbans. When the Department of Sundarban Affairs was created in 1994, it subsumed the Sundarban Development Board (SDB), which had been created to address the socioeconomic challenges in the region. A report by the World Wildlife Fund clarifies the political challenges faced in planning for the region.

Department of Sundarban Affairs is the only agency that explicitly recognizes the region's terrain, poverty and accessibility challenges and has special mandate to address the region's challenges (2019).

The Sundarban Development Board which was created to look into 'the planning and co-ordination of development activities in the backward region,' it's scope of work, as well as DSAs, has been limited to the socioeconomic development of the inhabited parts in the Sundarbans.

SDB's original mandate was coordinating the activities of the various sectoral departments operating in the eco-region. However, SDB has since morphed into a parallel implementation agency with a range of divisions mirroring the departmental mandates of different state departments, for example, Agriculture, Fisheries, Social Forestry and Civil Engineering (Danda et al., 2011). [3]

Although a broad range of governmental organizations operate in the region which can address the issues of the region, evidence and experience indicates lack of coordination, inadequate data to guide policy efforts and poor monitoring and evaluation programmes. All of these have hindered progress. At the state level, around 20 different GoWB agencies implement one or more programmes, or have a formal mandate to intervene in the Sundarbans but most of these have a sectoral focus and implement state-wide policies and programmes. Consequently, the system fails to recognize the state's diverse ecological, social and economic conditions, which results in similar efforts, both in the state's hills in the North and the Sundarbans in the south.[4]

Additionally, other departments with the responsibility for forests, irrigation and waterways, health and education, continue to function independently, which defeats the purpose of creating DSA as a coordination agency. Therefore, the presence of numerous governmental organizations with overlapping authority and responsibilities often results in duplication of efforts.

A different problem arising from lack of inter-agency coordination relates to the number of agencies whose responsibilities are overlooked for compliance or safeguards. For instance, environmental impact assessments, which are supposed to be mandatory for significant projects anywhere in India, are not done for such projects in the Sundarbans.

The number of poorly adapted initiatives that have been used in the Sundarbans over the past decades make it clear that there are no effective incentives for government agencies to cooperate or coordinate their programmes in the region. For instance, aquaculture development has contributed to tidal creek erosion that undermines embankment stability. Another example is the complete ban on mangrove cutting,

3. A.A. Danda, S.A. Gayathri, J. Ghosh, Bandyopadhaya, S. Hazra (2011). Indian Sundarbans Delta: A Vision. New Delhi: World Wide Fund for Nature-India.
4. https://mpp.nls.ac.in/blog/institutional-approaches-for-addressing-priority-challenges-in-the-sundarbans/

which reduces the incentives for communities to manage them well and has in fact turned the pursuit of some potentially sustainable uses of the forest into a crime.

Although the Department of Sundarban Affairs is intended to coordinate all efforts in the region, tackling high-priority issues can be improved by enhancing cooperation and coordination between selected pairs of responsible departments of the Government of West Bengal. For example, cooperation between the Forest Department and the Irrigation and Waterways Department is essential given current and future needs to encourage mangrove growth along areas that become available for restoration as a result of embankment realignment. There is a need to ensure that areas created by the retreat of embankments are immediately planted with appropriate mangrove species and these are maintained. This requires the Irrigation and Waterways Department to (a) plan and implement embankment realignment activities sequentially and engage in mangrove planting at the time that the embankments retreat; and (b) hand over jurisdiction of the land vacated as the embankments are realigned to the Forest Department without any opportunity for other land uses for that land. The Department of Panchayat and Rural Development should also be a part of enhanced coordination efforts, given its capacity to improve community efforts in social forestry.

Another example involves coordination between the Irrigation and Waterways Department and the Department of Fisheries and Aquaculture. Much of the current embankment erosion in the eastern delta is related to the location of aquaculture ponds and the timing of pond refilling activities. The Department of Fisheries and Aquaculture should promote aquaculture practices that do not negatively impact embankment investments by the Irrigation and Waterways Department. Enhanced cooperation and communication between these two departments can reduce the undesirable effects associated with the location and operation of aquaculture activities. For example, both departments should take steps to stop pond operators from operating their sluices at the same time to let water in to flush the ponds during high spring tides because there is a major discharge at that time.

The EDCs, which were formed in villages adjoining the sanctuaries, are entitled to 25 per cent of the tourism receipts. However, due to the discontinuation of coupe operations in the ISD's forest in accordance with a Supreme Court directive in 1996, the share of forestry revenue that FPCs would have ordinarily received is no longer available.

This has created an unequal situation among the committees in forest fringe villages which not only leads to difficulties while seeking community cooperation for managing the forested region in ISD but also leaves scope for corruption.

The situation is under review so as to bring EDCs and FPCs at par in terms of entitlements to tourism revenue.

Nevertheless, despite these difficulties, through positive engagement with the local population through EDCs and FPCs, the Forest Department, has since 2001 been able to achieve zero mortality of strayed tigers due to retaliation by villagers.

ISD's 19 CD blocks fall within two separate districts of North 24 Parganas and 24 Parganas (South). The highest unit of elected local self-government at the district level is the zila parishad followed by the panchayat samiti at the block level and the gram panchayat at the village cluster level. Parallel to this is the civil administration headed by civil servants (Block Development Officers and others); direct governance by the state government ends at the block level. Up to the block level, administration of different spheres of governance is overseen by various departments assigned sectoral responsibilities.

Table 5.1 List Of Forest Protection And Ecodevelopment Committees[5]

Range	Beat/Station	Name of EDC/FPC	Registration No. & Date	No. of Families				Protected Forest Area (Ha)
				GC/OBC	SC	ST	Total	
Basirhat	Jhingekhali Stn.	Samernagar	2/FPC/FD/STR, dt. 6-5-98	32	203	38	273	2584
Basirhat	Jhingekhali Stn.	Kalitala-Pargumti	8/FPC/FD/STR, dt. 6-5-98	74	331	12	417	1544
Basirhat	Jhingekhali Stn.	Hemnagar	10/FPC/FD/STR, dt. 6-5-98	11	235	20	266	4174
Basirhat	Bagna Stn	Gobindapur	11/FPC/FD/STR, dt. 10-12-02	-	195	5	200	860
1	2	4	-	117 (10.12%)	964 (83.39%)	75 (6.49%)	1156	9162 = 91.52 km sq.

Study Findings

In the Hingalganj CD block there are 4 Forest Protection and Eco-Development Committees. In the 4 FPCs there are 10.12 per cent families from the General/ Other Backward Communities, 83.39 per cent families from Scheduled Caste communities and 6.49 per cent families from the Scheduled Tribe communities, who are responsible for Jhingekhali and Bagna stations, covering a 9,162 hectare area.

The discussions showed that:

- Local people engage in many beneficial purposes to save the forest.
- The FPC solves many local issues.
- There is a committee working with the department which has suggested many safeguarding proposals in times of need.
- The committee takes important decisions if 'intruders' are found in the forest without permission.
- Local people are careful in protecting their environment as per their knowledge and skills through:
  1. Assisting the Forest Department in saving wildlife
  2. Providing timely information about poachers to the concerned officials
  3. Alerting people in case of a forest fire
  4. Protecting the forests from illegal hunting and poaching
  5. Assisting the Forest Department in conserving the forest land
  6. In case a wild animal enters in the village, immediately informing the Forest Department's officials for its rescue and proper rehabilitation

Some people working in the area are confident and skilled enough to carry out the tasks of saving wildlife along with the other people so they need to be appreciated.

5. http://www.sundarbanbiosphere.org/html_files/eco-development_committees.htm

In response to the functioning of JFMCs in the Sundarbans, one of the Forest Department officials said that the most important issue is facilitating the villagers and motivating them to adopt government schemes. He also urged the financial institutions to chip in to help with better economic rehabilitation/ opportunities through livelihood development plans for income augmentation, which will be more beneficial for the communities dependent primarily on forest resources and also in saving the forests.

He added that under the Joint Forest Management schemes the Forest Department supports the digging of ponds in the fringe villages. In every financial year this is done in 2-3 villages. Generally, villagers use these ponds for bathing, washing utensils and washing clothes but if encouraged people can use the infrastructure for pisciculture. The Forest Department can provide them seeds/ spawns with an agreement that the community will be involved in the economic activity and once they produce fish with marketable quality they will sell and earn the profits.

In response to a question on the challenges in implementing the Forest Department's ideas the official said that the first thing is departmental policies and financial crisis. Secondly, inadequate number of staff to manage everything. Very soon a few van-sahayaks will be recruited but this will not be enough. It becomes difficult for the Forest Department's people to reach interior areas as they remain busy with paperwork.

Are there any specific livelihood generating options that the government departments provide? What are the joint activities that the government is doing under JFM in the Sundarbans? The official said that there are 3 ranges – Raidighi, Ramganga and Matla in the Tiger Zone of the Sundarban South division. In Ramganga there are 5 JFMCs (jurisdiction 730 km sq. area, of which 560 km sq. is sanctuary area), in Raidighi there are 9 JFMCs and in Matla there are 3 JFMCs.

Role of Non-Government Organisations and Self-Help Groups

The study found one NGO, SOIL Society for Protection of Nature (SOIL) working in Shamshernagar which is focussing on meeting the educational needs of the youth by providing tuitions and encouraging the older boys to teach the younger ones. SOIL is also developing a group of young boys and girls as environment warriors. One of the achievements of this group is that it has been able to make the village plastic free.

Apart from SOIL there is the Adivasi Bikash Parisahd which is playing an important role in promoting tribal culture and heritage but lacks structured development programmes for the tribal community.

The women were aware of some NGOs working in the area and remembered that they had provided relief material post Bulbul and Amphan cyclones, but could not point out any long-term service or programme being run in the area.

The Pradhan, Kalitala gram panchayat reported that the panchayat has been able to mobilize women into 1,000 WSHGs. He added that the gram panchayat has also encouraged economic empowerment of women through distribution of chicks, ducks and goats to encourage women to take up small animal farming to augment their incomes. The Pradhan identified fear for their safety, lack of education and lack of income as the three key issues faced by women in his locality.

Government policies for controlling the biosphere reserve and their impact

Because of government interventions and also due to brick construction and houses allotted under the Pradhan Mantri Awas Yojana (PMAY) the requirement for wooden poles has reduced very significantly, which has had a positive impact on forest resources and uprooting of trees has been decreasing.

The communication system has improved under the Panchayati Raj System thanks to which people are getting sufficient food items from the government supported free food distribution centres such as authorized ration shops through PDS. So, people have stopped cutting the trees in the forest for their sustenance.

During the group discussions, the locals discussed Forest Protection Committees (FPCs) established for the benefit of the forest and its residents. Major duties of FPCs are informing the Forest Department about tiger infiltration in the villages and helping it to force the tigers to return to the forest. These committees have five members each, including one elected person from the local panchayat and two women and two men. Of these four one works as the convenor. The convenor circulates concerned information related to the forest and its wildlife. FPCs also negotiate between the Forest Department and convicted people who illegally enter the forest. For legal entry, there is a specific process to get permission from the Forest Department. FPCs protect both the villagers and the forest.

The research team was informed that a few villagers are not satisfied with FPCs' work.

Dependence on natural resources is increasing. The laws and procedures enforced by the Forest Department without taking into account the concerns of the villagers, are not making the interventions effective and at many times these are difficult to enforce. No strategies have been developed to transfer the ownership and control of forest resources to the local communities, except the formation of a few statutory FPCs as per government orders. People are forced to enter the forest without a license for collecting honey. They are forced to sell the that honey they collect at throw away prices. This impacts negatively on the local economy. Imbalances in the ecosystem, have led to both the forest and its inhabitants being victimized. No meaningful awareness campaigns and capacity building drives have been initiated by the Forest Department.

Role of the Forest and Border Security Force (BSF) Personnel <b level heading>

The participants said that the personnel deputed by the Border Security Force (BSF) neither understood their language nor were they respectful of their cultural norms and practices. Although the local communities do not dare to get into any conflicting situation with the armed forces they try and maintain a distance to avoid any conflicts.

According to local communities there are some unusual and unscientific practices adopted by the BSF personnel and throwing kerosene in the river is degrading the aquatic biodiversity. This, according to the informants is very frequent and a common practice as BSF personnel cannot stock unconsumed kerosene in their camps because if they do there will be decline in their quota.

According to the participants, even the forest officials deputed in the area do not have adequate knowledge about the mangrove ecosystem, the area and the people. It has been found that even with common villagers who are not intruders and always follow the norms, the BSF and forest personnel behave with a superiority complex.

However, some of the informants were considerate about the cultural differences with the personnel deputed either by the Forest Department or by BSF. They believed that maintaining a good relationship with the outsiders will ultimately save their forest from degeneration.

Initiatives taken by the Forest Department

In one of the webinars the Forest Range Officer, Ramganga Range, 24 Parganas South Division, in-charge of the West Sundarbans Wildlife Sanctuary discussed the problems of executing BLC (Boat License) rules. People did not listen and there was huge pressure mainly by the fish and the crab collectors. The Forest Department was trying to advocate to the fishing communities

to renew their boat licences, but people did not think that it was important to do so.

There were problems of environmental pollution and biotic pollution due to the entry of mechanized boats in the forest area. Poaching and felling had also increased with the entry of mechanized boats. The department has been trying to restrict the entry of mechanized boats mainly in the sanctuary areas. He also said that the policy does not allow mechanized boats so in the last 5-6 years the Forest Department had stopped almost 80-90 per cent of the poaching and felling too had significantly reduced.

The mangrove ecosystem is acting like a kidney and the Forest Department has taken up programmes to make the common people aware of these issues. After the devastation due to cyclone Amphan people have started realizing the importance of mangrove forests.

Even COVID-19 helped them understand the feeling of helplessness when the tourism industry completely collapsed and fishing was impossible during the lockdown and they had no alternative livelihood opportunities.

Forest Department officials are trying to convince the people to assess the risks associated with entering the forest areas for catching crabs and shrimp.

The Forest Department is trying to improve the livelihoods of the local people and rehabilitating them based on their limited capacities; the block administration is also involved and supportive. The Forest Department is working closely with the panchayat samiti and the respective gram panchayats on this.

Forest Department officials are trying to facilitate the local communities and motivating them to adopt government schemes and also urging others to help them financially for their better economic rehabilitation/ opportunities through livelihood development plans for income augmentation, which will be more beneficial for the communities dependent primarily on forest resources and also help in saving the forest.

Prasanta Mukherjee, a resident social activist in the area suggested two options – strict enforcement, which he said was not feasible and economic rehabilitation through alternative livelihoods. He said crabs need brackish water and inside the villages there are lots of brackish water ponds. The villagers are bringing Vannamei shrimp (Penaeus vannamei) seeds from outside and this, if taken as an example, makes it possible for the Forest Department and other civil society organizations to motivate villagers to opt for an in-situ crab culture, so that quality is maintained. This will help overcome conservation challenges.

The youth are not interested in collecting honey as moulis. They can be motivated through apiaries. The Sundarbans South division has introduced this and by placing bee hives it has collected honey, which has been branded BANAFUL and is sold in the open market. In the Tiger Zone there are some cooperatives which if supported with bee hives can motivate and encourage the youth by extending financial support to apiculture.

Under the Joint Forest Management schemes, the Forest Department provides support for digging ponds in the fringe villages. In every financial year this is done in 2-3 villages. Generally, villagers use these ponds for bathing, washing utensils and washing clothes but people can be encouraged to utilize that infrastructure for pisciculture. The Forest Department can provide them seeds/ spawns with an agreement that the community will be involved in the economic activity, and once it produces fish of a marketable quality, they will be able to sell it and earn money.

At present in the tiger zone in the Sundarbans South division there are three ranges – Raidighi, Ramganga and Matla. In Ramganga there are 5 JFMCs (jurisdiction 730 sq. km area, of which 560 sq. km is sanctuary area), in Raidighi there

are 9 JFMCs and in Matla there are 3 JFMCs. Every year there are annual general meetings. The members are the sabhapatis and saha sabhapatis of each block, pradhans of the concerned GPs and karmadhyakshas. Beat officers are Member Secretaries of the JFMCs, who are directly dealing with the JFMCs' activities. There are mandates for Beat Officers like they need to conduct 2-3 meetings every month. Generally, the jurisdictions are based on the gram panchayats. But sometimes more than one GP may be included in one JFMC. There are also BLCCs (Beat Level Communication Committees) and RLCCs (Range Level Communication Committees). Meetings for BLCCs are normally held every month and for RLCCs once in three months. There is a provision of taking young JFMC members for patrolling. As already mentioned, they have limited staff members and to overcome this they are communicating with JFMC members, which helps them in getting information about the entry of scheduled animals in the villages, as well as in taking measures to rescue them. Sometimes controlling mobs is very essential, and effective communication with the JFMC helps them address these challenges.

The Forest Department extends support to JFMC members in terms of providing training on kneading, organic farming and vermicompost production. It also helps in constructing flood relief centres, community halls, jetties, excavating ponds and commissioned water treatment plants.

Although, the Wildlife Protection Act 1972 is the main tool there is an order at the state level that there should be no felling of mangroves, and if it is done, it has to be taken very seriously. This has already been communicated to the civil administration, the police administration and the forest administration.

Chapter 6:

CONCLUSIONS AND RECOMMENDATIONS

Ecological changes in the Sundarbans are having a profound impact on people's livelihoods, social relations and deepening their vulnerabilities due to climate change. Based on our findings and the multiple conversations we had with affected communities, researchers and representatives of local governments, we think that urgent action needs to be taken to understand and respond to the vulnerabilities of local populations while ensuring the ecological sustenance of the Sundarbans.

The webinars we conducted for the study showed that having a holistic vulnerability framework, inclusion of coastal communities in suggesting adaptive measures and having an effective coastal zone management plan will be helpful in lessening the impact of vulnerabilities on the Sundarbans. Strengthening the social system with provision of economic opportunities is essential for *lessening socioeconomic* vulnerabilities of the people dependent on the forests.

Cost-effective solutions, increasing knowledge among coastal communities, enhancing resistance capacity, facilitating disaster response and enhancing coordination among stakeholders, communities and regional policymakers will *help overcome policy* issues, increase adaptation and lessen vulnerabilities in coastal areas.

A consolidated infrastructural set-up, proper early warning systems, disaster monitoring centres, better transport connectivity in remote islands, better livelihood opportunities, education and awareness will help in improving the socioeconomic conditions of the communities.

Recommendations

Vulnerability mapping

Consider micro-level differences in the level and distribution of vulnerabilities. Frequent climate change-induced disasters have always been detrimental for the local community. Thus, a social and economic vulnerability assessment is imperative for understanding the impact of the disasters which will help in designing efficient management strategies. Since there is very little scientific data on vulnerability demand assessments and policy measures, scholars have used various indicators to quantify the degree of vulnerability (Abuodha and Woodroffe, 2010; Hahn et al., 2009; Orencio, 2014; Sam et al., 2017; Szlafsztein and Sterr, 2007). Vulnerability assessment in a hazard-affected region depends on its social and economic conditions (Malakar and Mishra, 2017). Such an assessment is very essential for determining the degree of suffering of the population and economic structures due to disasters. This can be done using both primary data (Challinor et al., 2010) and secondary data (Sahana and Sajjad, 2019).

A composite socioeconomic index has to be constructed as a function of exposure, sensitivity and adaptation. Average storm surge height, slope amount, flood inundation, drainage proximity and drainage density need to be used for assessing exposure. Flood inundation layers need to be prepared using a shuttle radar topographic mission digital elevation model (SRTM DEM-1 arc second) through spatial modelling. Proximity to the drainage layer to be prepared by digitizing the rivers from topographical sheets and Google Earth and using a buffer analysis in ArcGIS.

Euclidean distance function in ArcGIS can be used for preparing the drainage density layer. The slope needs to be calculated from SRTM DEM data using the spatial analysis tool in ArcGIS, while data for average storm surge height can be got from the Indian Meteorological Department (IMD) and converted into raster format using the IDW function in ArcGIS. Data on indicators of sensitivity and adaptation collected at the household level using multi-stage cluster sampling method should be used.

Hingalganj block was found to have low adaptation (Sahana et al., 2019). Even the current study found that this block had registered a high degree of exposure and sensitivity with negligible adaptation. The block had low levels of higher education, lack of amenities and facilities and prevalence of muddy structures. Effective adaptation measures are required to increase the level of adaptation in the block. A SeVI analysis showed that the block with its adjacent areas requires immediate attention to minimize the level of vulnerability. The area has been experiencing huge devastation due to disasters. Thus, efforts should be made to increase the adaptive capacity in this block through improving the early warning system, disaster preparedness, infrastructural development, provision of basic health facilities and improvements in infrastructure to reduce people's socioeconomic vulnerabilities.

Monitoring the spatial pattern of physical changes to the landscape and adopting a sustainable approach (ecological, social and economic components) may be effective in planning and managing the critical natural resources in vulnerable hotspots.

Public investments in infrastructure

Education and awareness among local communities may help in an understanding of the magnitude and implications of biodiversity loss and the importance of adopting resilient behaviour.

Improvements in healthcare facilities, indurate embankments along the rivers and villages located along coastal areas, providing livelihood opportunities, lessening population pressure on the resources, mangrove conservation and disaster risk management are other measures which if adopted will improve the physical and social structure of the area.

Climate change mitigation and policies

It is important that more stringent laws are put in place for controlling the access issue but at the same time translating policy into practice is equally important. There are many policies but due to poor implementation it is difficult to see the results. What we need is disseminating policies in people friendly ways and trying to change people's behaviour. Community institutions like JFMCs and EDCs can play a very important role in this. So, if a policy formulation integrates the community, acceptance will be more and there will adherence to the norms by the communities.

The main goal of the JFMCs and EDCs, linking the well-being of the forest and the communities is yet to be achieved. The communities need to be empowered, instead of treating them as beneficiaries. If they are empowered to take decisions on management issues and access to the forest it will be beneficial for maintaining the equilibrium between the ecology and economy.

Linkages can be established for financial management like how to regulate the share and repayment between the JFMCs/EDCs and the WSHGs which will address many investment issues. Since marketing is a big challenge in the Sundarbans because of its topography it is important to take decisions on the products to be promoted as livelihood options and their shelf life so that people do not get demotivated.

If JFMCs/EDCs are not allowed overarching roles it will be difficult to maintain a balance between the ecology and economy. Moreover, there are very big JFMCs/EDCs like one JFMC or EDC

with 1,400 members, which indicates that these have been formed as a formality. It is known to everyone that one group cannot be functional with so many people. For making those JFMCs/ EDCs meaningful and active it is important to decide the size of a group, have clarity on the roles of the group, empowering the members and giving them controlling powers. Otherwise, they will remain JFMCs only in name and receive some benefits as passive beneficiaries, which can be beneficial for a few but overall benefits of striking a balance between the Sundarbans' ecology and economy will not be achieved.

The Ranger of the Ramganga Forest Range said in one of the webinars that there is one JFMC for a 730 sq. km area, which is not only inadequate but has been formed as a formality. The sabhapati of the block panchayat samiti and the pradhans of the concerned gram panchayats are members and the Beat Officer is the Member Secretary, which clearly shows the power equations where the common people cannot raise their issues. Although there are governing bodies and representatives of tribal communities as per the provisions but this is not enough and tribal communities' voices are not heard. Their dependence on the forest is more and at the same time their access to information and skills is less than other communities.

Since unlike others the tribals still maintain their cultural norms, predominantly with animism and animatism, they should have their own livelihood plans. Since tribals generally live in clusters, separate JFMCs can be formed for them if we seriously want JFMCs to work meaningfully. Cultural appropriateness is a factor and it has been experienced that the tribals include piggery in their alternative livelihood development plans but general communities don't want this activity to be included.

Livelihoods

Management of natural resources and increasing adaptation among farmers will help reduce the vulnerability of the Sundarbans. Moreover, enhancing traditional activities may have a trustworthy and constructive impact than proceeding with new ideas.

Non-Timber Forest Produce

The mangrove ecosystem is being used for subsistence and commercial purposes by the local inhabitants. It is an essential component of the livelihood of the forest dependent population in the area. From the discussions it was found that a gamut of NTFPs are being collected from the Sundarbans which are contributing to people's livelihoods. The study also tried to assess the livelihood assets of the people and how much of these could be attributed to NTFPs. It explored the livelihood vulnerability and stress coping mechanisms of the local population and how NTFPs helped as a 'safety net.' Of course, not every family goes in for NTFP collection but the number of those who do is significant. The major NTFPs collected include firewood, prawns, fish, crabs, honey and bee wax. The collection of NTFPs is a difficult task, which involves risk from man-eater tigers. High livelihood vulnerability was also observed with little help from the government. If these biomes are to be conserved it is necessary that the government must consider the role of NTFPs in the livelihood of the people and develop the Sustainable Livelihood Framework (SFA) accordingly so that the biomes as well as people's needs can be sustained.

Community based tourism

To minimize dependence on the mangrove ecosystem government agencies have introduced eco-tourism, or Community Based Tourism (CBT) that involves using tourism as a tool for strengthening the abilities of rural community organizations. The concept is promoting visitor-host interaction that has meaningful participation by both the visitors and hosts and generates economic and conservation benefits for local communities and the environment. Under this approach it is expected that the local community will plan, develop and manage CBT to maximize their benefits and minimize the negative impacts of tourism already taking place

within their societies. CBT is regarded as a tool for natural and cultural resource conservation and community development. Eco-tourism has been introduced in the Sundarbans with a view to reducing the communities' dependence on the mangrove ecosystem. This means that the communities will generate their livelihoods through this new economic activity and gradually they will stop entering the forests for their livelihood. However, it is important to point out that the present form of tourism cannot be termed eco-tourism, as the carbon footprint from this activity is excessive. Although it is a good alternative but we need to be very cautious and vigilant about environmental degradation/ detrimental issues due to the promotion of eco-tourism. It needs to be remembered that the ecology and economy are two sides of the same coin in the Sundarbans and it is impossible to improve the economic conditions of the people by destroying the Sundarbans' ecology.

Green economy

Since Aila we have seen outmigration of male members increasing and women taking over the responsibilities of running their homes. Hence, livelihood options should be decided based on their comfort and convenience. If we can promote a green economy, like involving women in natural resource-based alternatives which with an integrated approach will help women directly take part in the development process and will also strengthen their families so they can reduce their dependence on the forest ecosystem. Since large scale industries are not possible in the Sundarbans, activities based on women's abilities should be planned for a green economy. Integrated agriculture and livestock development programmes are feasible. Rainwater is a big resource in the Sundarbans, hence it should be harvested and used for integrated farming systems like digging ponds, checking the intrusion of extra water by raised embankments, vegetable cultivation, growing horticultural plants, rearing livestock, fishing, reviving organic farming techniques and growing indigenous salt tolerant varieties which will help in promoting a green economy.

Run-off from the agricultural fields mixed with chemical fertilizers and pesticides and the increase of *bheri*s and their management systems are detrimental to the Sundarbans' ecology. JFMCs and EDCs can play an important role to check such detrimental activities. Their main role is generating awareness and we need to think of mechanisms of integrating WSHGs with JFMCs and EDCs. There are provisions for issuing licenses, which is inadequate. However, those who are doing a good job with responsive behaviour can be incentivized by reviewing this licensing policy.

Women's inclusion in decision-making

The FGDs provided enough evidence that women face a greater depth or severity of vulnerabilities emanating from poverty, lack of capabilities and gender biases present in both the society and government. Women are likely to experience more persistent and longer-term vulnerabilities than men as lack of choices and opportunities coupled with denial of enjoyment of basic rights like freedom, respect and dignity keep increasing women's irregular burden of powerlessness relative to men. Hence, women face more difficulties in lifting themselves out of poverty and other adversities. The issue of women's greater vulnerabilities or conversely women's empowerment can be understood from four aspects: a) agency; b) resources; c) freedom from violence and control and; d) achievements. Agency is the ability to set goals and exercise individual choice to achieve these goals which is based on three inter-related elements – self-awareness and efficacy; a woman has to be aware of her abilities and her capacity to decide actions and she should believe that she will be able to act on them; critical consciousness- a concept formulated by Brazilian educationist Paulo Freire in relation to social oppression. It means that an individual gains an insight or awareness about his/her status and position in society and tries to change that reality. Ultimately this leads to a deeper understanding of the four folds of power (over, to, with and within). Resources

means material, human and social expectations and allocations and therefore access and control over them determines who is empowered and who is marginalized. Women have to be free from control and violence to be able to build on their sense of self and confidence and access the resources. Achievements include a variety of outcomes ranging from improved well-being to achieving equal representation for women in politics. All these four aspects are intricately linked with one another and complement one another. Empowerment is therefore a process and is difficult to measure.

The study found unequal power relations in families and society impeding women's attainment of healthy and fulfilling lives. Women's situation cannot be improved and their vulnerabilities reduced unless one is serious about challenging gender stereotypes and working to eliminate all practices that discriminate against women including violence against them and assisting them in promoting their agency and voice and attaining their rights.

The study also found that while sexual and gender-based violence (SGBV) and women's safety are identified by the government and the communities as the most pressing issue affecting women, interventions are not planned and funds rarely disbursed or used effectively for addressing this problem.

Achieving this change will require policy and programmes targeted at improving women's access to secure livelihoods and economic resources, reducing and alleviating their extreme responsibilities with regard to housework, removing legal impediments to their participation in public life and raising social awareness through effective education programmes and mass communication and awareness, particularly around rights and entitlements from the government. Women's status in their families and society can only improve if programmes aim to enhance their decision-making capacity at all levels and in all spheres of life, especially in the area of sexuality and reproduction.

The study also found that the community, especially women were not actively participating in the conservation of the Sundarbans. The long-term sustenance of the Sundarbans is based on the people owning an economic stake in their conservation and even this cannot be achieved without women's participation and involvement. A balance needs to be attained between a people-centric and a pure environment conservation approach for the long-term health of the Sundarbans. There is no denying that women's involvement and participation will be a key component in reaching this balance.

ANNEXURES

Annexure 1: The Research Team

Team Leader: Dr Aniruddha Dey

Aniruddha Dey has over 35 years of experience as a development practitioner as well as a professional. He is now the Founder Chairperson of the Professional Institute for Development and Socio Environmental Management (PRISM), West Bengal, India. Lead and managed the organization including policy development, volunteers' development, strategic planning and direct technical support especially in the areas of Participatory Research, Innovation and promotion of locally appropriate and Climate Smart Models, Urban Climate Change Resilience Strategy Development, Women's Empowerment through Self-Help Groups, Sustainable Agriculture/ Livelihood, Emergency Response, Community Based Disaster Risk Reduction, Environmental Education for Children and Youth, Safe Drinking Water and Hygiene, Networking and Partnership Management.

Recipient of two International Awards -- The International Cultural Diploma of Honor for achieving prominent positions in society because of exceptional contributions to professions and communities and the 1998 ERM Excellence Award in the category of GLOBAL PROJECTS for Social Assessment of Infrastructure Projects: Project Gopalpur – R & R Monitoring and Evaluation by ERM International.

Climate Change & DRR Specialist: Prof (Dr) Sheikh Tawhidul Islam

Sheikh Tawhidul Islam is Professor in the Department of Geography and Environment and Director, Institute of Remote Sensing, Jahangirnagar University, Dhaka, Bangladesh. He has been working in the areas of environment, disaster management and climate change for the last two decades. He obtained his PhD from Durham University under the Commonwealth Scholarship Programme (2006). He has published 35 scholarly articles in peer reviewed journals and books, written /edited 3 books and led more than 60 research projects and gained valuable experience on the environment and the development of Bangladesh and the region. World leading publishing house Routledge from Taylor and Francis Group has recently released a book titled *Geography in Bangladesh: Concepts Methods and Applications* edited by Dr Islam

(https://www.routledge.com/Geography-in-Bangladesh-Concepts-Methods-and-Applications-1st- Edition/Tawhidul-Islam-Paul/p/book/9781138570610).

Environment Specialist: Mr Swarnabha Bandyopadhyay

Swarnabha Bandyopadhyay has over 22 years of experience in environmental assessment and management. He has worked as EIA specialist for the World Bank, the Asian Development Bank as well as for Petroleum Development Oman (a Shell company), ADNOC Group of Companies and Dow Chemicals, to name a few. He has undertaken numerous due diligence studies in accordance with IFC/ World Bank Performance

Standards. Further, being an alumnus of the World Bank Graduate Scholarship Programme he has a wide professional network and access to various World Bank resources. Swarnabha's work experience spans the Indian subcontinent, Middle East & North Africa and Europe. Swarnabha has been working at the capacity of Corporate Focal Point at Abu Dhabi Gas Industries Ltd (GASCO), ADNOC; Environmental Safeguard Specialist for RasGas Operation and commissioning of Barzan; Environmental Specialist for IFC/ World Bank's Equator Principles Audit of Yanbu Petrochemical Plant, Saudi Arabia, Secretary, Environment Committee of Abu Dhabi National Oil Company; Advisor, Chhattisgarh Environmental Conservation Board, Govt. of Chhattisgarh, India; Air Quality Specialist for FAIHAA-2 Drilling Programme in Basrah for Marine & Environmental Consulting Bureau, University of Basrah, Iraq; Served as Lead Verifier for GHG Emission Inventory developed by Pepsico International's subsidiary at Amman, Jordan; Environmental Specialist for World Bank-funded power project at Batam, Indonesia for PT Medco. Authored environmental and social guidelines for small hydropower projects in India under SARI (USAID).

Social and Gender Specialist: Ms Anindita Majumder

Anindita Majumdar is the Founder and Managing Trustee of Equidiversity Foundation. She is a gender activist with 19 years of experience, an Ashoka Fellow and an IVLP alumni. She has worked under the appointment of the Danish funding agency India Group Funen (IGF) as the programme lead on developing capacities of panchayats and voters for planning and implementation of 4 MDG goals, Project under Full Partnership Fund, US Department of State to strengthen women's political participation and voice in rural local governance, West Bengal. She has served as the Assistant Director of Swayam, a leading NGO in Kolkata working against violence on women and on gender issues. She has been engaged in training of field level staff; community women; activists; lawyers and other officials. She is also a certified trainer on self-defence for women (WENLIDO) and has imparted training to young activists in West Bengal and Bangladesh.

Apart from managing the trust (since its inception in 2016), she has been working as a Consultant with various organizations like Swayam, a feminist organization working against violence on women; Jeevika Development Society, a NGO working on women's rights; Indo-Global Social Service Society (IGSSS) on gender and masculinity.

Advisor: Ms Nandini Sanyal

Nandini Sanyal has been working as a professional geographer for 20 years. She has obtained a Professional Master's Degree from ITC, The Netherlands and a Master's Degree in Geography from University of Durham, UK. Her professional interests of working lie within the areas where human societies interact with nature and vice-versa. In doing so, she is conversant to a number of social theories and conceptual framework like Political Ecology including its sub-domain Feminist Political Ecology (to understand the situated gender inequality experienced by women), Common Property Resource Theory, and Poststructuralism etc. In addition, she has professional experience of using geospatial technologies (GIS, Remote Sensing, GPS) in areas like environmental processes and systems, natural resource assessment/management, disaster management and impact evaluations of development interventions etc. She has published an article in a peer reviewed journal and a book chapter published by Rutledge publisher. In summary, putting together her training on qualitative methods, expertise on quantitative techniques especially on geospatial applications, experience in conducting research works for different agencies and strong field orientation as a geographer made her a professional with required skills to contribute in developing high quality knowledge products.

Research Assistant: Mr Rangeet Mitra

Rangeet Mitra has been working for more than 7 years in the field of livelihood and sustainable development. He has completed B-Tech in chemical engineering and also finished his MBA – Public systems (Environment Specialization) from IISWBM.

He has in-depth experience in all the branches of livelihood development. He has worked in many reputed organizations such as PwC, Cygni Energy, etc. As a national project coordinator, he has installed and monitored pan India rural dc 48v solar electrification drive on behalf of Cygni energy (Incubated by IIT – M). Also, he has done several capacity-building and awareness programs in Manipur, Rajasthan, Assam, J&K and MP. Project Management, Client Handling, and documentation are his key skills.

He is now working as a senior consultant in Prayukti International which is a consultancy firm working globally in the field of environment and sustainability. During his working period in Prayukti, he has been managing various projects such as the Livelihood development-related program, Impact Analysis, Environmental studies and capacity building (ITI in Uttarakhand, Funded by World Bank), etc. Also, he was worked as a consultant of the Chhattisgarh Environment Conservation Board, Raipur.

Research Assistant: Mr Surya Kanti Sen

A competent environmental professional with 5 years of experience in Online Emission System, EIA, EMP, Waste inventorisation, TSDF (Treatment, Storage and Disposal Facility), Ambient Air Quality Monitoring and Noise Monitoring. He was appointed as an advisory consultant in state pollution control board and handles different Air Modelling projects in Middle East countries. He did Masters in water, waste and environmental engineering from University College Dublin, Ireland and received UCD Engineering and Architecture Global Graduate Scholarship.

Research Assistant: Mr Prasenjit Ghosh

Mr Ghosh has dedicated towards environmental activities such as EIA, EMP and Environmental Modelling. He deals with top leaders such as the World Bank, IFC, ADB and E&Y. He has been successfully managing sustainable development related activities in India, Bangladesh and Arabian countries.

Researcher: Mr Gouranga Nandi

Mr Nandi is a mainstream media professional and ecology and human rights activist. He is an Executive Member of many independent national level civil society organizations like Life and Nature Safeguard Platform (LNSP), Right to Food Network (KHANI), Paribesh Surakhha Manch (PSM). Mr Nandi is working at a National Bengali daily print media named KalerKantho as Khulna Bureau Chief. He is also a contributor BBC Bangla. He is the author of twelve books on environment, liberation war 1971, water justice, land rights and impact of shrimp farming issues. Mr Nandi has led and contributed to a number of research and publication about ecology and human rights aspects. He has written a number of articles and published in mainstream news media, focusing on human rights, Sundarbans mangrove forest, impact of commercial shrimp farming, land litigation, climate change and coastal zone of Bangladesh. He has been interviewed by a number of electronic and print media. Besides this, he has provided advisory services to many development organizations and training institutes.

Annexure 2:
Geographical Area and Demography

Table A2.1: Geographical Area (in hectares)

Sl. No.	Name of the Gram Panchayat	Total Land (ha)	Total Agricultural Land (ha)	High (%)	Medium (%)	Low (%)
01	Bispur	3189.73	1833	10 (%)	30 (%)	60 (%)
02	Rupmari	2258.77	1376	05 (%)	15 (%)	80 (%)
03	Dulduli	3277.77	1489	03 (%)	07 (%)	90 (%)
04	Sandeler Bill	2676.31	1404	08 (%)	12 (%)	80 (%)
05	Sahebkhali	3235.51	1943	03 (%)	07 (%)	90 (%)
06	Gobindakati	2111.93	1278	03 (%)	07 (%)	90 (%)
07	Jogeshganj	3500.85	2096	03 (%)	07 (%)	90 (%)
08	Hingalganj	1637.87	1051	05 (%)	20 (%)	75 (%)
09	Kalitala	2430.49	1440	03 (%)	07 (%)	90 (%)
Total		**24319.23**	**14200**	**4.78 (%)**	**12.44 (%)**	**82.78 (%)**

Table A2.2: Land Holding Pattern in Percentage

Sl. No.	Name of the Gram Panchayat	Big Farmers (%)	Marginal farmers (%)	Small Farmers (%)
01	Bispur	01 (%)	59 (%)	40 (%)
02	Rupmari		0 60 (%)	40 (%)
03	Dulduli		0 60 (%)	40 (%)
04	Sandeler Bill		0 60 (%)	40 (%)
05	Sahebkhali		0 60 (%)	40 (%)
06	Gobindakati		0 60 (%)	40 (%)
07	Jogeshganj		0 60 (%)	40 (%)
08	Hingalganj		0 60 (%)	40 (%)
09	Kalitala		0 60 (%)	40 (%)

Table A2.3: List of Embankments in Hingalganj

Sl. No.	Name of the Embankments	Length
01	Ichhamati	9 km
02	Kalindi	70 km.
03	Raymongal	29 km (Left side of Hingalganj block)
04	Sahebkhali	37.6 km
05	Katakhali	14 km
06	Gaureswar	46.6 km
07	Gomati	No

Table 2.4: Drinking Water Sources

Sl. No.	Name of the GP	Tube well	Well	PHE Stand/VAT	Remarks
1	Bispur	Yes	No	Yes	Total Tube Well -1940 (approx.). Functional – 1545 & Dysfunctional- 395
2	Rupmari	Yes	No	Yes	
3	Dulduli	Yes	No	No	
4	Sandeler Bill	Yes	No	Yes	
5	Sahebkhali	Yes	No	Yes	
6	Gobindakati	Yes	No	Yes	
7	Jogeshganj	Yes	No	Yes	
8	Hingalganj	Yes	No	Yes	
9	Kalitala	Yes	No	Yes	

Table 2.5: Population details of Hingalganj

Population	**174,545** M: 88,937 (51%), F: 85,608 (49%)
Scheduled Castes	115,227 (66.02%) M: 59,011, F: 56,216
Scheduled Tribes	**12,743 (7.30%)** M: 6,414, F: 6,329
Others	**46,525 (26.68%)**
Decadal growth of population in 2001-2011	**11.60%**
Population below 6 years	**18,880** M: 9,567, F: 9,313
Sex Ratio	**963**
Child Sex Ratio	**973**
Rural	**159,469**
Urban	**15,076**
Literacy	**76.85%** M-75.17%, F-61.64%

Table A2.6: Gram Panchayat-wise population details of Hingalganj

Sl. No	Name of the Gram Panchayat	Total Number of HH	Population		
			Male	Female	Total
01	Bispur	5411	10955	10405	21360
02	Rupmari	3641	7583	7221	14804
03	Dulduli	5332	10082	9707	19789
04	Sandeler Bill	4368	8483	8251	16734
05	Sahebkhali	5770	11052	10377	21439

Sl. No	Name of the Gram Panchayat	Total Number of HH	Population		
			Male	Female	Total
06	Gobindakati	4444	8699	8334	17033
07	Jogeshganj	5767	11136	10481	21616
08	Hingalganj	6270	12092	11938	24031
09	Kalitala	4689	8938	8647	17585

Annexure 3:
List of Participants in Research

Table A3.1: List of Key Informant Interviewees

Date	Place	Name of the person	Age	Sex	Occupation	Information Collected (SECTOR)
12/8/20	Hingalganj	Mr Tapan Mondal	-	M	NGO worker	Brief Details of the Project Area, Poverty Condition
12/8/20	Hingalganj	Mr Suvankar Mondal	-	M	NGO worker	Brief Details of the Project Area, Poverty Condition
12/8/20	Hingalganj	Mr Gouranga Mridha	-	M	NGO worker	Brief Details of the Project Area, Poverty Condition
2/9/20	Kalitala	Mr Subhas Biswas	-	M	Bank officer	Daily activities economic opportunities and income generation
2/9/20	Kalitala	Mr Sourav Mani	-	M	Folk artist	Details Cultural heritage
2/9/20	Kalitala	Mr Gouranga Mandal	60	M	Crab collector	Daily Activities, Source of Drinking Water, Food Security
10/9/20	Samser Nagar	Mr Samir Mandal	25	M	Manager of local hotel	Eco-Tourism, Ecosystem
11/9/20	Samser Nagar	Mr Ajit Millar	22	M	Boat man	Livelihood, Source of Water, Ecosystem
2/9/20	Kalitala	Mr Pradut Mandal	32	M	Mangrove farmer	Livelihood, Mangrove, Ecosystem, perception of Sundarbans
12/9/20	Soddar Para Ghat	Mr Debdas Gayen	-	M	Honey collector	Livelihood, idea on environment and Climate Change, Ecosystem, perception of Sundarbans
10/9/20	Samser Nagar	Mr Nityanada Mandal	-	M	Shrimp collector	Livelihood, Daily Activities, Ecosystem, perception of Sundarbans

Table A3.2: List of in depth interviewees

Date	Place	Name of the person	Age	Sex	Occupation	Information Collected (SECTOR)
12/08/20	Hingalganj	Mr Saiful Islam	-	M	Veterinary Officer, Hingalganj Block	Information about the Livestock
12/08/20	Hingalganj	Dr Barun KantiHalder	-	M	BLDO, Hingalganj	Information about the Livestock
12/08/20	Hingalganj	Mr Ajay Mistry		M	Peon, Fishery Department	Sharing Information about Fish Firming
10/09/20	Samser Nagar	Prasanta Mukharjee (NGO)	-	M	NGO Worker (Soil)	Asset holding and poverty conditions, daily activities economic opportunities and income generation , sources of drinking water, food security, Ecosystem Services, Cultural Heritage, Perceptions on Sundarbans, Perception of people about the environment, local water, air quality, disaster impacts, climate change, sea level rise etc
11/09/20	Samsher Nagar	Biswarup Mandal	65	M	NGO Activist	Sources of drinking water, food security, ecosystem services of mangrove forests, characterizing communities, Local perception on the pressure on Sundarbans, Perception of people about the environment, local water, air quality, disaster impacts, climate change, sea level rise etc., ecosystem
12/09/20	Samser Nagar	Krishna Pada Mandal	50	M	Honey Collector	Ecosystem, Perception of people about the environment, local water, air quality, disaster impacts, climate change, sea level rise etc, perception on the pressure on Sundarbans, Ecosystem services of mangrove forests, food security, sources of drinking water, daily activities economic opportunities and income generation & poverty conditions)
13/09/20	Samser Nagar	Namita Munda	-	F	House Wife	Situation & Status of Women, Source of Water
14/09/20	Samser Nagar	Sudeb Majhi	-	M	Boat Man	Livelihoods, Tourism, Perception on pressure on Sundarbans

Date	Place	Name of the person	Age	Sex	Occupation	Information Collected (SECTOR)
15/09/20	Samser Nagar	Sanib Mandal	-	M	Artist	poverty conditions, daily activities, economic opportunities and income generation)
16/09/20	Samser Nagar	Haripada Mandal	27	M	Honey collector	poverty conditions, daily activities, economic opportunities and income generation)
17/09/20	Samser Nagar	Debabrata Mandal	32	M	Shrimp collector	Ecosystem services of mangrove forests, Local perception on the pressure on Sundarbans

Table A3.3 Participants in Focus Group Discussion I

Date	Place	Name of the person	Age	Sex	Occupation	Information Collected (SECTOR)
02/9/20	Kalitala	Dipankar Gayen	32	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
02/9/20		Pranab Sarkar	35	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
02/9/20		Raji Barman	-	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Biswajit Gayen	29	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Santash Taraphdar	37	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Anand Mistri	39	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Smarajit Mandal	41	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		SuvenduBaidya	43	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Sanjay Biswas	-	M	Artisan	Cultural Heritage, Ecosystem Livelihoods
2/9/20		Bacchu Taraphdar	-	M	Artisan	Cultural Heritage, Ecosystem Livelihoods
2/9/20		Sudip Mandal	37	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Ajit Mistri	45	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Joyanta Biswas	-	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Sujit Mandal	40	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Pinki Mandal	-	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Pappu Mandal	-	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods

Date	Place	Name of the person	Age	Sex	Occupation	Information Collected (SECTOR)
Date	Place	Name of the person	Age	Sex	Occupation	Information Collected (SECTOR)
02/9/20	Kalitala	Dipankar Gayen	32	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
02/9/20		Pranab Sarkar	35	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
02/9/20		Raji Barman	-	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Biswajit Gayen	29	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Santash Taraphdar	37	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Anand Mistri	39	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Smarajit Mandal	41	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		SuvenduBaidya	43	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Sanjay Biswas	-	M	Artisan	Cultural Heritage, Ecosystem Livelihoods
2/9/20		Bacchu Taraphdar	-	M	Artisan	Cultural Heritage, Ecosystem Livelihoods
2/9/20		Sudip Mandal	37	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Ajit Mistri	45	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Joyanta Biswas	-	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Sujit Mandal	40	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Pinki Mandal	-	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20		Pappu Mandal	-	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods

Table A3.4: Participants in Focus Group Discussion II

Date	Place	Name of the person	Age	Sex	Occupation	Information Collected (SECTOR)
2/9/20		Pappu Mandal	-	M	Artisan	Cultural Heritage, Ecosystem, Livelihoods
2/9/20	Kalitala	Sanjib Mandal	35	M	Mangrove Farmer	Mangrove, Livelihoods, Perception of people about Sundarbans
2/9/20		Ajit Mistri	45	M	Mangrove Farmer	Mangrove, Livelihoods, Perception of people about Sundarbans

Date	Place	Name of the person	Age	Sex	Occupation	Information Collected (SECTOR)
2/9/20		Pradyat Mandal	30	M	Mangrove Farmer	Mangrove, Livelihoods, Perception of people about Sundarbans
2/9/20		Sudip Mandal	-	M	Mangrove Farmer	Mangrove, Livelihoods, Perception of people about Sundarbans
2/9/20		Suresh Mandal	32	M	Mangrove Farmer	Mangrove, Livelihoods, Perception of people about Sundarbans
2/9/20		Subal Mistri	43	M	Mangrove Farmer	Mangrove, Livelihoods, Perception of people about Sundarbans
2/9/20		Subhas Mandal		M	Mangrove Farmer	Mangrove, Livelihoods, Perception of people about Sundarbans

Table A3.5 Participants in Focus Group Discussion III

Date	Place	Name of the person	Age	Sex	Occupation	Information Collected (SECTOR)
10/9/20	Samser Nagar	Gouranga Mandal	55	M	Shrimp, Crab catcher	Perception of people about Sundarbans, Ecosystem, Mangrove, Daily Economic Activity
		Romapada Mandal	45	M	Honey Collector	Perception of people Sundarbans, Ecosystem, Mangrove, Daily Economic Activity
		Haripada Mandal	-	M	Shrimp, Crab catcher	Perception of people Sundarbans, Ecosystem, Mangrove, Daily Economic Activity
		Rabindragnathi Das	37	M	Migratory Labour	Perception of people Sundarbans, Ecosystem, Mangrove, Daily Economic Activity
		Dinabandhu Mandal	36	M	Shrimp, Crab catcher	Perception of people Sundarbans, Ecosystem, Mangrove, Daily Economic Activity
		Nityanada Mandal	-	M	Honey Collector	Perception of people Sundarbans, Ecosystem, Mangrove, Daily Economic Activity
		Hazari Mandal	40	M	Farmer	Perception of people Sundarbans, Ecosystem, Mangrove, Daily Economic Activity
		Kartikpada Mandal	-	M	Honey Collector	Perception of people Sundarbans, Ecosystem, Mangrove, Daily Economic Activity

Table A3.6: Participants in Focus Group Discussion IV

Date	Place	Name of the person	Age	Sex	Occupation	Information Collected (SECTOR)
10/9/20	Samser Nagar	Ramapada Gayen	-	M	Honey Collector	Livelihood, Idea about Sundarbans
		Pramad Gayen	-	M	Honey Collector	Livelihood, Idea about Sundarbans
		Prasanta Gayen	-	M	Farmer	Livelihood, Idea about Sundarbans
		Asit Gayen	-	M	Shrimp Catcher	Livelihood, Idea about Sundarbans
		Sunit Gayen	-	M	Crab Catcher	Livelihood, Idea about Sundarbans
		Basu Majhi	-	M	Fishery Owner	Livelihood, Idea about Sundarbans
		Surajit Mandal	-	M	Migratory Labour	Livelihood, Idea about Sundarbans

Table A3.7: Participants in Focus Group Discussion V

Date	Place	Name of the person	Age	Sex	Occupation	Information Collected (SECTOR)
11/9/20	Samser Nagar	Debabrata Mandal	-	M	Crab Catcher	Livelihoods, Ecosystem services sources of drinking water
		Malina Raptan	-	F	Student	Livelihoods, Ecosystem services sources of drinking water
		Biswajit Bouliya	-	M	Student	Livelihoods, Ecosystem services sources of drinking water
		Koilash Mandal	-	M	Student	Livelihoods, Ecosystem services sources of drinking water
		Debabrata Mandal	-	M	Crab Catcher	Livelihoods, Ecosystem services sources of drinking water
		Debabrata Mandal	-	M	Crab Catcher	Livelihoods, Ecosystem services sources of drinking water
		Sunil Mandal	-	M	Student	

Table A3.8: Participants in Focus Group Discussion VI

Date	Place	Name of the person	Age	Sex	Occupation	Information Collected (SECTOR)
11/9/20	Samser Nagar	Debabrata Mandal	_	M	Crab Catcher	Livelihoods, Ecosystem services sources of drinking water
		Malina Raptan	-	F	Student	Livelihoods, Ecosystem services sources of drinking water
		Biswajit Bouliya	-	M	Student	Livelihoods, Ecosystem services sources of drinking water
		Koilash Mandal	-	M	Student	Livelihoods, Ecosystem services sources of drinking water
		Debabrata Mandal	-	M	Crab Catcher	Livelihoods, Ecosystem services sources of drinking water
		Debabrata Mandal	-	M	Crab Catcher	Livelihoods, Ecosystem services sources of drinking water
		Sunil Mandal	-	M	Student	

Table A3.9: Participants in Focus Group Discussion VII

Date	Place	Name of the person	Age	Sex	Occupation	Information Collected (SECTOR)
21/9/20	Samser Nagar	Surjabati Mandal	-	F	-	Daily activities economic opportunities and income generation, especially for women
		Purnima Baidya	-	F	-	Daily activities economic opportunities and income generation, especially for women
		Santirani Mandal	-	F	-	Daily activities economic opportunities and income generation, especially for women
		Biswarup Mandal	-	F	-	Daily activities economic opportunities and income generation, especially for women
		Sunetra Mandal	-	F	-	Daily activities economic opportunities and income generation, especially for women
		Haridasi Mandal	-	F	-	Daily activities economic opportunities and income generation, especially for women
		Malina Mandal		F		Daily activities economic opportunities and income generation, especially for women

Table A3.10: Participants in Focus Group Discussion VIII

Date	Place	Name of the person	Age	Sex	Occupation	Information Collected (SECTOR)
22/9/20	-	Suhasini Mandal	-	F		Situation of Women, Ecosystem Services, Conservation need
	-	Kanti Mandal	-	F		Situation of Women, Ecosystem Services, Conservation need
	-	Usha Mandal	-	F		Situation of Women, Ecosystem Services, Conservation need
	-	Madhabi Mandal	-	F		Situation of Women, Ecosystem Services, Conservation need
	-	Lakhi Mandal	-	F		Situation of Women, Ecosystem Services, Conservation need

Table A3.11: Participants in Focus Group Discussion IX

Date	Place	Name of the person	Age	Sex	Occupation	Information Collected (SECTOR)
22/9/20	Samser Nagar	Nirmala Munda	-	F	ICDS Employee	Situation of Women, Ecosystem Services, Conservation need
		Subarna Munda	-	F	Labour	Situation of Women, Ecosystem Services, Conservation need
		Jomuna Munda	-	F	Crab Catcher	Situation of Women, Ecosystem Services, Conservation need
		Rina Munda	-	F	Crab Catcher	Situation of Women, Ecosystem Services, Conservation need
		Namita Munda	-	F	Shrimp Catcher	Situation of Women, Ecosystem Services, Conservation need
		Chandana Munda	-	F	Crab Catcher	Situation of Women, Ecosystem Services, Conservation need
		Kalidasi Munda	-	F	Shrimp Catcher	Situation of Women, Ecosystem Services, Conservation need
		Sujata Murmu	-	F	Crab Catcher	Situation of Women, Ecosystem Services, Conservation need

Table A3.12: Participants in Focus Group Discussion X

Date	Place	Name of the person	Age	Sex	Occupation	Information Collected (SECTOR)
22/9/20	Samser Nagar	Prabhati Raptan	-	F	House Wife	Asset holding and poverty conditions, daily activities economic opportunities and income generation, especially for women
		Ekadashi Raptan	-	F	Shrimp Collector	Asset holding and poverty conditions, daily activities economic opportunities and income generation, especially for women
		Mana Raptan	-	F	Larvae catcher	Asset holding and poverty conditions, daily activities economic opportunities and income generation, especially for women

Table A3.13: Webinars on different themes for gathering opinions and recommendations

Webinar	Panellists
WB – 01 (12th November, 2020 at 5 pm)	Mr Razzak, Sabhapati, Patharpratima Panchyat Samiti; Mr Dilip Banerjee, Ashoka Fellow and Mr Sougata Mukharjee from the Sundarban Biosphere Reserve
WB – 02 (12th November, 2020 at 7pm)	Mr Dinanandhu Das, Secretary, YDC, Sandeshkhsli 2; Mr Sanjib Kumar Mondal, Pradhan, Gobindokati GP, Hingalganj & Mr Aurobindu Sardar, Snake Rescuer and Tourism Business, Joynagar
WB – 03 (14th November 2020 at 11 am)	Dr Saswati Sen, Director, WWF INDIA (WBSO); Dr Raktima Mukhopadhaya, ED, IBRAD & Mr DEBAJYOTI Chakraborty, Coordinator, State IAG West Bengal.
WB – 04 (15th November 2020 at 7 pm)	Prof Ashis Sarkar, Former HoD, Geography, Presidency University; Dr Ashim Goswami, former scientist, NATMO & Dr Arati Nandi, TA Consultant, ADB.
WB – 05 (17th November, 2020 at 05:30 Pm)	Mr Saroj Dash, Environment Specialist, Dr Md Golam Mahabub Sarwar, Researcher, Climate Change in South Asia Project and Md Mahmudun Nabi Khan, US Agency for International Development.
WB – 06 (18th November, 2020 at 11 am)	Prof L N Satpathy, Climate Change Expert and Prof Calcutta University, Dr Ashok Kanti Sanyal, Chairman, Biodiversity Board, GoWB and Prof Subhas Santra, Former HoD, School of Environmental Sciences, Kalyani University.
WB – 07 (20th November 2020, at 7 pm)	Prof Sugata Hazra, Climate change expert & Prof, Oceanography department, Jadavpur university, Dr Anurag Danda, Climate change expert, and Papiya Majumder, Research scholar, York University, UK.
WB – 08 (25th November 2020, at 7 pm)	Professor Md. Abdul Aziz, PhD, Department of Zoology, Faculty of Biological Sciences Jahangirnagar University, Savar, Dhaka, Bangladesh; Mr Tapas Ranjan Chakraborty, Disaster Risk Financing Coordinator, Oxfam in Bangladesh.
WB – 09 (27th November 2020, at 7 pm)	Mr Jitendra Roy, Joint Secretary, Department of Agriculture, Govt. of West Bengal; Dr Manas Ghosh, Director, State Agricultural Management & Extension Training Institute, WB (SAMETI), Ram Krishna Mission, Narendrapur; Mr Anupam Paul, Deputy Director, Department of Agriculture, Govt. of West Bengal

Table A3.14: Links to Webinars conducted in the course of the research

WEBINAR 1	12 Nov 2020, 05- 06:30 pm	https://drive.google.com/file/d/13JwelYIgSZkkr6XAx4RgAYxezh4pZ3UP/view?usp=sharing
WEBINAR 2	12 Nov 2020, 07-08:30 pm	https://drive.google.com/file/d/1da7lRnplt-M3FGdlXHI3fqnN9F7rK7jM/view?usp=sharing
WEBINAR 3	14 Nov 2020, 11 am -12:30 pm	https://drive.google.com/file/d/1JmoRfgc5sLRGRQKKNmYoritYMrNx47MS/view?usp=sharing
WEBINAR 4	15 Nov 2020, 07-09 pm	https://drive.google.com/file/d/1Kd8B54Vkb8qo685DPHviDcQJvZ18Ho9x/view?usp=sharing
WEBINAR 5	17 Nov 2020, 07-09 pm	https://drive.google.com/file/d/1qwkTGg5UGZSyTJbNu5lvW45l7Ql8yvGC/view?usp=sharing
WEBINAR 6	18 Nov 2020, 11 am -12:30 pm	https://drive.google.com/file/d/1XhLNf92Uvqmp3ihAGLw-j8sTGj0PGRD_/view?usp=sharing
WEBINAR 7	20 Nov 2020, 07-09 pm	https://drive.google.com/file/d/1xhB6s9p7yVukncFziRMSqRCbwNLj73k-/view?usp=sharing
WEBINAR 8	25 Nov 2020, 07-09 pm	https://drive.google.com/file/d/1sEEi8ZTNe5TIpsfvnyihIB5agXkzPoqR/view?usp=sharing
WEBINAR 9	27 Nov 2020, 07-09 pm	https://drive.google.com/file/d/1sEEi8ZTNe5TIpsfvnyihIB5agXkzPoqR/view?usp=sharing

Annexure 4: Guidelines for Conducting Interviews, FGDs & Observations Methodologies: PRISM

1. How to introduce your agency: a need-to-know checklist

This checklist can be used to help make sure field staff know the answers to questions they are likely to be asked by the stakeholders, government officials, and others.

You can use it at the start of a project or in conjunction with Tool 11 to brief new staff.

2. Who are we?

What is PRISM? Professional Institute for Development and Socio Environmental Management – PRISM is a not-for-profit, non-governmental organization aims to develop and implement solutions that balance the need for food, shelter, income and environmental quality prescribed for all. It was registered under The West Bengal Societies Registration Act 1961. Our work is guided by our objectives for long term development. The key sectors of interventions are Environment, WASH, Livelihood and Women & Children's Development. Gender issues are given priority. The central theme of the strategies is capacity building and a process of empowerment to enable people to manage the activities by themselves, during and after our intervention. As a facilitator PRISM views its intervention as tool for capacity building and focuses on organization building and human resource development. Groups and organizations of the neediest and the marginalized are supported to increase their participation and enable them plan, prioritize and implement actions at their own pace. PRISM is primarily aiming at developing a sustainable, integrated and people-centred development strategy generated through field experiences. PRISM is now a well-structured organization having a dedicated and motivated professionals and volunteers of developmental planning, implementation and application of scientific knowledge. PRISM takes up research and consultancy jobs through which resources pulled together and implementation works at the field supported. We provide only Technical support such as capacity building of the workers of other grassroots organization, transfer of rural technologies, consulting services to the government and other agencies in terms of evaluation, research, training, developing IEC materials, documentations, etc.

What is ActionAid Association? ActionAid Association is an organisation working for social and ecological justice. ActionAid has been engaged with the most marginalised communities in India since 1972. In 2006, ActionAid Association was registered as an Indian organisation, governed by an independent General Assembly and a Governing Board. Together with supporters, communities, institutions and governments, we strive for equality, fraternity and liberty for all. ActionAid Association works in 24 states and two union territories, with several partners and allied organisations.

ActionAid Association is part of a global federation and a full affiliate of ActionAid International, that has presence in over 40 countries worldwide.

3. What is our mandate?

To undertake various research and action programmes for integrated development of the poorer and weaker sections of the society in both rural and urban areas so as to empower them for a better standard of life.

To create awareness among the people about developmental activities, social change and various forces acting in the process and to enable them to participate in these activities to their best advantage.

To help initiate activities/impart skills for strengthening institutional/organizational development.

To work towards a just and egalitarian social order.

4. Why is our agency here?

To understand the threats and conservation challenges in Sundarbans through a case study from Hingalganj Block of North 24 Parganas.

5. Where do we get the money?

Through ActionAid Association ActionAid Association (hereinafter referred to as AAA), represented by the Regional Manager, Kolkata Regional Office, 3A Dr S. N. Roy Road, Kolkata - 700029

6. Our aim. What we are planning to do?

Examine the pattern of Human-Nature interface/ interaction in the forests to understand impact of existing local industries on livelihood, environment and ecology in or surrounding areas or Hingalganj block.

Analysis of government a policy that support or goes against protection of environment and ecology.

Assess the extent of physical, in particular the quantifiable impacts of Rampal project in the India part of Geographies - potential releases from RPP on livelihood, environment and ecology in or surrounding areas of Hingalganj block as well as on the India part of geographies.

7. Why do we do this rather than other things?

Conducting research to learn about issues being faced by communities and to make necessary policy recommendations.

8. The project and the community. What is our project area?

HINGALGANJ Block, North 24 Parganas, West Bengal, India.

9. Who decided?

The ActionAid Association & PRISM

10. Who was involved in deciding project activities?

Project Affected People of Rampal Power Plant in Bangladesh, several National and international research agencies, UNESCO, humanitarian agencies

11. What is the plan for the whole project?

To understand the threats and conservation challenges in Sundarbans.

12. How long will it last?

Till 31 December 2020.

13. Who are the partners?

ActionAid Association, PRISM, People of Hingalganj

14. Why were some people chosen and not others?

Because of COVID-19 it was difficult to move around the field. The research team adopted a strategy to disseminate the information through some known people in the area and from those discussions some other people's contact details were obtained and this way the people chosen.

15. How does the project work?

Basically, through some literature review, observation and through using some other PRA tools, which are feasible in the present Corona lock down situation.

16. How are the people of Hingalganj involved?

The people of Hingalganj are considered as informants during the primary data collection.

17. What is the progress this month?

We are in the verge of completing literature review, collected contact details of many villagers and resource persons for interview, finalising the questioners to be administered,

18. What is the plan for next month?

Initiate primary survey and complete literature review.

19. What are the main challenges for technical staff this month?

Revision of the Research Methodology – due to COVID-19 conventional research methodologies need modification, the

20. What are technical staff doing to address these challenges?

The technical staff will collect the information a) from literature, b) from different individuals and groups c) use the collected information for perception analysis d) to do the analysis and test their hypothesis, e) collect air & water quality data of the area d) collect GPS data and prepare geospatial database and maps of impact zones, f) prepare technical report and g) use the information and report as a tool for lobbying & advocacy to minimise the threats & conservation challenge in Sundarbans

21. How to conduct KII

How to conduct an individual interview - Individual interviews can be used during assessments or surveys. An individual interview can mean a ten-minute conversation during an informal visit or a longer and more structured discussion, using a series of questions on a particular topic. Whatever the case, focus on essential information and build your interview around current concerns, for example, profiling and needs assessment, tracking changes, or seeking feedback.

Aim to interview people at times that are safe and convenient for both staff and interviewees.

The time your interviewee has available should determine how long your interview lasts.

Make sure that people understand why you wish to talk to them and what you will do with the information they share.

Never use people's names when using information without their express permission or that of their guardian.

Start with questions that are factual and relatively straightforward to answer.

Move on to more sensitive issues, if necessary, only when the person you are interviewing is more at ease.

Make sure people know that you value their time and participation.

Don't end the interview too abruptly.

Take responsibility for the effect on your interviewee if sensitive issues are discussed.

Record, store, and use information safely.

22. Some 'Do's' for interviews [1]

Do try to make sure you have a good translator.

Do locate elders/leaders first, explain who you are and what you are doing, and ask their permission to interview.

Do ask individuals' permission to interview them; for example, 'Is it OK if I ask you a few questions about the conditions here?' Thank them afterwards.

Do try to prioritise discussions with women and children, and other people likely to be experiencing particular difficulty.

Do try and interview at least three families in each location in order to cross- check the information you are receiving.

1. Schofield (2003). From S. Burns and S. Cupitt (2003). 'Managing outcomes: a guide for homelessness organisations', Charities Evaluation Services (adapted); R. Schofield, Medair (internal, adapted).

Do make sure that you include people at the edge of a camp or site where you may find the poorest families living, quite literally, on the margins.

Do avoid large crowds following you around if possible, since this is likely to intimidate interviewees and interviewers.

23. FGD Guideline

A FOCUS GROUP DISCUSSION (FGD) is a group discussion of approximately 6 - 12 persons guided by a facilitator, during which group members talk freely and spontaneously about a certain topic. A FGD is a qualitative method. Its purpose is to obtain in-depth information on concepts, perceptions and ideas of a group. A FGD aims to be more than a question-answer interaction. The idea is that group members discuss the topic among themselves, with guidance from the facilitator.

a. How to conduct a focus group[2]

If possible, conduct a few focus groups and compare the information you are collecting from these and other sources.

b. What is a focus group?

Six to twelve people are invited to discuss specific topics in detail. The focus group can bring together people who have something in common. They may share a particular problem, or be unable to speak up at larger meetings (for example, younger people, women, or minority groups), or are people only peripherally involved in the community, such as nomads. It is best not to have leaders or people in authority present – interview them separately.

c. Why only six to twelve people?

In a larger group: Speaking time will be restricted and dominant people will speak most

The facilitator will have to play more of a controlling role

Some members of the group will become frustrated if they cannot speak

Participants will start talking to one other rather than to the group as a whole

The group may stop focusing and start talking about something else

d. What do you need?

An experienced facilitator: a native speaker who can lead, draw out the people who are not talking, and stop others from talking too much

Time to prepare open-ended questions and select focus-group members

One, sometimes two, people to note in writing what is said

A common language

A quiet place where the group will not be overheard or interrupted

To sit in a circle and be comfortable

Shared understanding and agreement about the purpose of the discussion

Ground rules, for example: everyone has a right to speak; no one has the right answer; please don't interrupt

Permission from the group to take notes (or maybe use a tape recorder)

About one to one-and-a-half hours and some refreshments

e. What happens?

The facilitator makes sure everyone has a chance to speak and that the discussion stays focused

2. From V. M. Walden (no date) 'Focus group discussion', Oxfam (internal. adapted); L. Gosling and M. Edwards (2003) Toolkits: a practical guide to planning, monitoring, evaluation and impact measurement, Save the Children (adapted); USAID (1996). Performance Monitoring and Evaluation TIPS No. 10, USAID Centre for Development Information and Evaluation (adapted).

The note-taker writes notes

At the end of the session, the facilitator gives a brief summing up of what has been said in case someone has something to add

The facilitator checks that the written record has captured the main points and reflected the level of participants' involvement in the discussion.

f. Preparing for the Session (Responsibility of the Facilitator or Moderator)

Identify the major objective of the meeting.

Carefully develop five to six questions.

Plan our session.

To call potential members (to invite them to the meeting)

g. Developing Questions

Develop five to six questions - Session should last one to 1.5 hours

Always first ask yourself what problem or need will be addressed by the information gathered during the session. Always we have to be positive while asking y questions.

Focus groups are basically multiple interviews. Therefore, many of the same guidelines for conducting focus groups are similar to conducting interviews.

h. FGD Guidelines

How do they perceive / What do they heard about Environmental Impact (with examples from the past and present)

What are the major/significant changes and/ or impacts of Environment in their area?

What do they feel are the reasons?

What are the coping strategies?

What do they feel are the solutions?

What are the specific suggestions they would like to make to address the issues?

i. How to observe[3]

In some situations, informal observation may be all you can do and 'good enough' when making an assessment or tracking changes. 'I look to see if people are moving into houses. I ask if they feel safe. Are they smiling? Are they happy? I look to see if children are going back to school.' (John Watt)

Observing people:

Some tips and possible problems.

Tips

- Explain why you want to observe people at the site, and how the information you collect will be used. Request permission from the people living there.
- Invite people living there to observe the site with you.
- Give observers brief training and support. Agree the information you want to collect through observation.
- Afterwards, compare notes and pool observations as soon as you can. Record your findings in writing and use them.

Possible problems

- Observing people may affect their normal behaviour and routines.
- If an observer knows the people being observed well, this may make it hard for him/ her to be unbiased.
- Involving many observers can result in many different opinions and interpretations.
- Findings that are not recorded immediately will be less reliable.

Note: *Due to COVID-19 pandemic PRISM is intended to provide guidance to staffs/ volunteers and partners on the impacts of COVID-19, and recommendations for these implications may be addressed in programs and operations.*

3. From Partners in Evaluation: Evaluating Development and Community Programmes with Participants, © Marie- Thérèse Feuerstein 1986. Reproduced by permission of Macmillan Publishers Ltd.

24. Principles for COVID-19 related guidelines

In undertaking programming activities, staffs/ volunteers and partners should consider:

Assess risk of transmission: At this stage in the pandemic, testing remains limited. This means that data on positive cases is unreliable. PRISM recommends that staffs/ volunteers and partners assume wide community spread and adjust programming accordingly. Keep in mind that PRISM programs should operate under the assumption that anyone they encounter is a suspected COVID-19 case.

Ask ourselves how critical it is to carry out the activity against risk of staffs/ volunteers and partners, and weigh the risk to project participants of not carrying out the activity. Life-saving (e.g., emergency food distributions, clinical care for emergency conditions) and life sustaining (e.g., prevention and treatment of vector borne diseases like malaria, dengue, etc., vaccinations) activities should be prioritized.

Adopt a 'Do No Harm' approach: should understand how COVID-19 is transmitted and implement general basic preventive measures to both protect themselves and reduce the risk of spreading the virus during program implementation (See Guidance at WHO – COVID-19). These measures include the following for all people with whom we work, including staff, volunteers, program participants and community members, service providers, vendors, etc.

Do not participate in program activities when feeling unwell; stay home and seek medical advice.

Maintain physical distancing protocols

Follow recommended hygiene practices

Wear non-medical masks (3-layred cloth masks) when in line with Government and/or WHO guidance

Make special considerations for **populations who are most at-risk** of developing severe illness (e.g., elderly, immunocompromised, those with existing health conditions, pregnant women)

Those who have come into contact with someone exhibiting or reporting COVID-19 symptoms should self-quarantine and monitor for onset of symptoms. Those experiencing symptoms should self-isolate and seek medical support/ advice as per Ministry of Health & Family Welfare protocols (e.g., calling before seeking medical care).

Consider protection of the most vulnerable and include safeguarding measures

Maintain constant and transparent communication with communities about activities, changes, and the community's comfort level and needs related to the health implications of continued programming.

Keep up-to-date on and follow WHO and Government protocols and messaging around COVID-19:

Follow Government restrictions and request authorization for carrying out essential services/ activities, as needed

Work with local health actors/cluster to ensure health messaging related to COVID-19 is consistent and contextualised

Stay updated and inform staffs/ volunteers and partners how to refer to appropriate national or local COVID-19response services or hotlines.

Adapt programming guidance to your context and be ready to further adjust as the situation evolves: Elements of the guidance ay need to be monitored based upon community risk levels, types of programming activities undertaken, social norms and perceptions, local capacities, operating environment, new WHO guidance, and

feedback from donors in each program we work in. For assistance, please contact the COVID-19 focal point of the organisation.

This document provides additional recommendations to be used in conjunction with and to supplement guidance provided by WHO and MoH&FW as relevant.

[Disclaimer: PRISM COVID-19 program resources and guidance are developed after consideration of international guidance from relevant international organizations such as the World Health Organization (WHO), Inter-Agency Standing Committee (IASC), and other humanitarian bodies. PRISM COVID-19

program resources and guidelines are updated regularly as new information becomes available. staffs/ volunteers and partners wishing to refer to and use PRISM resources and guidance should ensure that they are also referring to the latest information available from WHO and IASC.][4]

Annexure 5: Questions/Checkpoints

Section 2.2 (characterizing communities)

Name and address (GPS coordinates):

Occupation (primary/major) and related process (breakdown of activity into number of items and taking seasonality issues, resources use e.g. soil, water, biological, human labour etc. into account):

Occupation (secondary) and how that provides support (explanation identical to primary occupation):

Asset base (tangible: land, household amenities, livestock, poultry, machines and ornaments etc. Intangible assets: skills, traditional knowledge, networks and partnerships)

Education (respondent's and also children's):

Composition of family and their age:

Disease pattern (common disease and factors of illness):

Nearest health care centre (including who is the first point of consultation):

State of emergency situation management:
Income (they may talk about daily/weekly/ monthly, by have to make a monthly average):

Attachment with and local agencies (SHG, CBOs, NGOs etc.)

Benefits received from the government of non-government sources (what are those and how communities use that resources)

Section 2.3 (Asset holding and poverty conditions)

State of poverty condition in the community (in addition to household):

Title/ownership over resources (especially for women), savings and debt/mortgage issues. Loan repayment process.

Factors of persisting nature of poverty conditions in the area (why people don't be able to come out of poverty; local attributes and systemic weakness/development gap)

What was the conditions in the past? Good – why? Bad – why?

Safety net benefits received from government and/or non-government sources and use.

Use of savings (purpose, process).

Section 2.4 (daily activities economic opportunities and income generation, especially for women)

What kind of work do you engage in daily? Economic activities engaged in - Earnings from this activity.

4. SAFETY AND SECURITY STRATEGY FOR COVID-19 – Policy Document of PRISM

Household level agricultural activities (farming, animal husbandry, nutrition garden, compost making, collection of honey, fish farming, others)

How much time (average hours) do you allocate to your daily activities? Which activities do you consider to be most important? Issues to consider – cooking, harvesting of resources, value addition to agricultural products (mori, bori making etc.), care giving, leisure time, resting time/sleep, community work.

What do you do with your income? (make savings, education of the children, health, dress purchase, others).

Do you think you can freely decide what to do with your earnings?

What kind of trainings have you gone through for economic activities?

Do you think that livelihood activities in the area have changed in the last 5 years?

If yes, how?

How has this change impacted women?

Do you think there is any change in the climate in the last 5 years?

If yes, what kind of changes?

Do you see any link between these changes and changes in livelihoods?

Issues related to VAW (Violence against Women). What are the risks women in your village face?

What are the new risks and opportunities brought to women due to climate change?

How have men's and women's access to resources (for example water, land and social

networks) changed and how these have helped in coping with the effects of climate change?

Section 2.6 (sources of drinking water)

Water sources/options (tap, well, tube well, pond). Seasonality concerns.

Water access (especially women cases) issues (time spent, distance, energy).

Water use for domestic and external purposes.

Local water management issues.

Water quality issues.

Section 2.7 (food security)

Sources of food (cultivation homestead and fields; purchase, collection from common properties e.g. river, forests, received as relief items)

Pattern of food intake at household level (cereals, vegetables, protein, fruits, fat; quantity, quality and nutrition issues)

Food shortage conditions (time, impacts, coping strategies. Food storage issues)

Section 2.8 (Ecosystem services of mangrove forests)

Supporting services (Nutrient cycling, biologically mediated habitats, primary productions)

Provisioning services (product supply such as fish, crab, shrimp, wood, honey etc., raw materials, genetic resources)

Regulating services (climate regulation, waste treatment and disease regulation, Buffer zones)

Cultural services (Inspirational, recreation and tourism, science and education)

Major occupation groups in the area who collects/ harvests resources from the mangrove forest ecosystems (such as honey collectors, golpata harvesters, fishermen communities, shrimp fry collectors, crab collects etc.). How much money they generate against their investments (describe the processes)? Do they need any formal permits to enter into forests, is there any ban imposed in specific times of the year etc. that controls access?

Is there any SME developed in the area based on the available resources where local people including women take part?

Based on these harvests/collections how local economy (also taking support services like small business, providing transport facilities into account) functions and communities make their living and ensure well-being?

Is there any seasonality concerns that impact on resources availability and eventually impact on income generation of occupational groups?

Are there any tourism facilities in the area? Can the local communities generate economic benefits out of the tourism?

Is there any group of people in the area who gathers medicinal ingredients from the mangrove forests? What are those and related processes?

Section 2.10 (Local perception on the pressure on Sundarbans)

What is the present condition of forests (description of major factors of deforestation) compared to the past conditions?

Perception about population pressure and resource use of Sundarbans ecosystem

Description on illegal removal of trees?

Perception about biodiversity in Sundarbans and also in adjacent river systems

Illegal saw mills operation in Hingalganj are threats to the adjacent forest

Perception about local people on the protection of mangroves.

What is the role of government sector in resource management of Sundarbans

Role of government sector in protecting Sundarbans

Is there any change in forest condition in terms of area and forest quality?

If there is any change what is the impact on women and man of that change

Section 2.11 (Perception of people about the environment, local water, air quality, disaster impacts, climate change, sea level rise etc.)

Presence of brick fields as major sources of Air pollution

Presence of any other kinds of polluting industries

Erosion in the local rivers as a threat

Impact of increasing salinity intrusion in surface water and ground water and its impact on agricultural and local fishery business

Unscientific collection processes of Larvae of fishes, crab from local rivers and its impact on biodiversity

Use of lower quality oil as fuel and its impact on environmental degradation.

Man-animal conflicts are also reasons of the poor living standard of local people.

What is the disaster scenario of the locality? Is there any flood, cyclone happened during the last 5 years?

Have they heard about Rampal project in Bangladesh?

Outbreak of COVID-19 has increased the rate of unemployment in Hingalganj block. Also, presence of large numbers of migrant labours has downed the economic growth

Common people are not aware of the Rampal Power Plant related issues.

People are not concerned about hygiene and cleanliness

Section 4.4 (ecosystem)

We may ask for people's opinion on local/forest biodiversity (ecosystem diversity, species

diversity e.g. flora/fauna, genetic diversity)

The ecosystems not only support local communities, it rather provides support to national food security

Section 4.5 (spatial modelling)

1. Overlaying physical coordinates with social coordinates

Section 5.2 (negotiations)

Do they discuss among themselves about the challenges related to forests and their wellbeing? With whom they talk and outcomes? Any environmental movement took place in the area?

How to safeguard Sundarbans and local people?

Annexure 6: Biodiversity in the Sundarbans

Before doing a detailed analysis, it is important to have a clear understanding about the types, importance, uses and threats to the conservation of biodiversity. Actually, biodiversity may be seen as the variety and variability of living organisms and the ecological complexes in which they exist. In other words, biodiversity is the occurrence of different types of ecosystems and different species of organisms with the whole range of their variants and genes adapted to different climates and environments along with their interactions and processes. There are three inter-related hierarchical levels of biodiversity:

Genetic Diversity – describes the numbers and types of genes as well as chromosomes present in different species. The magnitude of variations in the genes of a species increases with increase in size and environmental parameters of the habitat.

Species Diversity – describes the number and richness of the species within a region, which depends largely on climatic conditions.

Ecosystem Diversity - describes the interaction of species living together and the physical environment of a given area. It relates varieties of habitats, biotic communities' ecological processes in the biosphere and also talks about the diversity within the ecosystem. It is also referred to as Landscape Diversity because it includes placement and size of various ecosystems. The importance of biodiversity can be seen in terms of a) productive value, b) consumptive value, c) social value, d) aesthetic value, e) legal value, f) ethical value, g) ecological value, and h) economic value. Biodiversity is considered a reservoir of resources to be used for the manufacture of food, medicines and industrial products. Biodiversity is being depleted by the loss of habitat, fragmentation of habitat, over exploitation of resources, human sponsored ecosystems, climatic changes, pollution invasive exotic spices, diseases, shifting cultivation and poaching of wildlife. Conservation of biodiversity ensures protection, upliftment and scientific management of biodiversity for maintaining it at its threshold level and deriving sustainable benefits for the present and future generations. The conservation of biodiversity has three basic objectives a) maintaining essential ecological processes and life supporting systems, b) preserving the diversity of species, and c) sustainable utilization of species and ecosystems.

There are two types of conservation methods:

In-situ conservation - The conservation of species in their natural habitat or natural ecosystem is known. In this process, the natural surroundings or ecosystem are protected and maintained so that all the constituent species (known or unknown) are conserved and benefited. The factors which are detrimental to the existence of species are eliminated by suitable mechanisms.

Ex-situ conservation - involves maintaining and breeding endangered plants and animals under partially or wholly control-led conditions in specific areas like zoo, gardens and nurseries, that is, the conservation of selected plants and animals in selected areas outside their natural habitat.

It is widely accepted that biodiversity loss and poverty are linked and that conservation and poverty reduction should be tackled together. Clear conceptual frameworks are needed if policies on the social impact of conservation programmes and the success of community-based approaches to conservation are combined (Adams et. al., 2004).[5]

5. Adams, M. William, Ros Aveling, Dan Brockington, Barney Dickson, Jo Elliott, Jon Hutton, Dilys Roe, Bhaskar Vira and William Wolmer (2004). "Biodiversity Conservation and the Eradication of Poverty," Science, 306 (5699), 1146-1149.

The Indian Sundarbans have become increasingly hazardous and high levels of material poverty have been evident for generations. For centuries, large parts of the forest have been extensively exploited for timber, fish and shrimp seeds or converted to agriculture and aquaculture. Upstream water diversions and other anthropogenic activities have changed the land forms in the delta and the structural integrity of the embankments. The region's population growth has led to degradation of the mangrove forest, unsustainable extraction of natural resources and an increase in the number of people exposed to significant and recurring floods. Pollution from nearby cities has increased. In addition, the absence of adequate physical infrastructure in the region contributes to low standards of living. Increased salinity and waterlogging have impacted agriculture and shrimp farming practices have been ecologically unsustainable. Moreover, the frequency of human–animal conflicts has increased because of habitat loss.

The Sundarbans are used for subsistence and commercial purposes by the local inhabitants. It is one of the essential components of the livelihood of the forest dependant population of the area. However, the mangrove ecosystem and wildlife conservation have become a priority for the government. Hence, the government imposes restrictions on catching fish in the core and buffer areas of the biosphere reserve, which intensify fishermen's everyday resource-access struggles in the mangrove forests and the conflict between local fishermen and conservation needs, broadening an understanding of human-environment relationships in the Sundarbans region of India. One study shows that NTFPs contribute almost 79 per cent (Rs 80,000) on average to the annual income of the collector's family. NTFPs also help as a 'safety net' for the local population as these are used for reducing high livelihood vulnerability and stress coping mechanisms. The major NTFPs that are collected include firewood, prawns, fish, crabs, honey and bee wax. The collection of NTFPs is a daunting task, which involves risks from man-eating tigers. If, these biomes are to be conserved it is necessary that the Sundarbans Development Authority consider the role of NTFPs in the livelihood and develop the Sustainable Livelihood Framework accordingly so that the biomes as well as people's need can be sustained (Singh et. al., 2017).

The study area, Hingalganj block, where residents face particularly high risks and hardships, referred to as the 'transition zone,' is between the part of the Sundarbans on the mainland (the 'stable zone') and the 'core zone.' The people in this area suffer from a shortage of livelihood opportunities. They also lack the economic, human and social capital to make permanent out-migration to urban job centres successful in the short term.

One World Bank technical-assistance study suggests biodiversity conservation activities by involving mangrove restoration in new land areas created by realigning existing embankments to prevent embankment failure due to tidal creek erosions (Sánchez-Triana et. al., 2016).[6] Other measures aimed at conserving biodiversity involve generating revenues to benefit local residents and giving them a stake in forest conservation (Biller and Sanchez-Triana, 2013).[7] One approach to revenue generation involves paying for ecosystem services (Pattanayak et al., 2010).[8] Services provided could include the use of the forest as a bio-shield to protect Kolkata and other inland areas from damaging winds. Also, an innovative revenue-generation approach that can be further explored involves creating

6. Sánchez-Triana, E., Leonard Ortolano and Tapas Paul (2018). "Managing water-related risks in the West Bengal Sundarbans: policy alternatives and institutions," *International Journal of Water Resources Development,* 34 (1).

7. Biller, D. and E. Sanchez-Triana (2013). "Enlisting markets in the conservation and sustainable use of biodiversity in South Asia's Sundarbans." *International Journal of Social Ecology and Sustainable Development,* 4, 71–86.10.4018/IJSESD [Crossref], [Google Scholar].

8. Pattanayak, S. K., S. Wunder and P. J. Ferraro (2010). "Show me the money: Do payments supply environmental services in developing countries?" *Review of Environmental Economics and Policy,* 4, 254–274.

property rights on NTFPS such as honey, fruits and other extracted products and non-extractive use functions (for example, tiger viewing). Moreover, by preserving the mangroves it will be possible to access revenue streams that have been (and will be) created as part of carbon financing programmes intended to manage greenhouse gas emissions. New revenues generated in these ways could provide benefits for the communities such as programmes to provide transition-zone residents the training needed to access jobs in the stable zone and outside the Sundarbans.

Another biodiversity-conservation measure involves establishing privately funded hatcheries for use in shrimp aquaculture and improving shrimp seed collection methods while the hatcheries are being developed. Aquaculture in the Sundarbans could be made more sustainable if state-of-the-art hatcheries are promoted and if the Food and Agricultural Organization's Code of Conduct for Responsible Fisheries are adopted.

The following information was collected through FGDs and IDIs and through observations made by the team at Shamshernagar, Kalitala panchayat, Block-Hingalganj, District North-24 Parganas on 28 and 29 December 2020:

Honey and Bees

Honey is collected from forest from 15 March. April is the best time for honey collection. This continues till 30 June. The collectors depend on gathering tons of honey and beeswax from the hives of wild honey bees during this time of the year. For the rest of the year, they depend on fishing and catching crabs in the rivers and creeks - an equally risky business. Permits to enter the forest were not issued this year because of the COVID-19 lockdown and it was a huge loss as the *moulis* depend on honey collection for their financial needs.

Honey in the Sundarbans is a unique geographical indicator. Some of the dwellers called *moulis* traditionally depend on forest honey and wax which are collected from the world's largest mangrove forest as their livelihood. Honey collection starts from the Bengali month *Chaitrya* (second half of March) and during this season, every forest dependent community collects a single pass for honey collection and a BLC (Boat License Certificate) pass for a boat to enter into the Sundarbans by a group consisting of 7/9 members from the local office of the Forest Department. For becoming eligible to get an entry pass and a BLC pass, the forest dependent community has to submit a photocopy of their Photo ID cards. Generally, BLC passes are provided to the owners of boats or chiefs of the groups who are locally called *sajunis*. Each group collects honey from the Sundarbans in a specific time and from specific parts of the forest under the local administration and the time and division of the forest are identified, approved and set by the Forest Department. After collection, 50 per cent of the honey is sold to the Forest Department at a fixed price and the rest goes to the moneylenders, who supported them financially. Those who did not seek any financial support sell their collected honey in the local open market. The *moulis* practice historical rules and regulations in honey collection.

> *"We enter the forest for collecting honey knowing how risky it is. I have escaped twice from tigers' attacks but have witnessed how other team members being killed by the tigers. Still, we enter the forest to collect honey around this time as it is a lucrative business and we depend on it. Every year, thousands of people enter the forest to collect honey and catch fish, crabs and prawns - legally and illegally - and get attacked by tigers and crocodiles. Many cases go unreported. Permit holders need to deposit 50 per cent of their collection to the Forest Department at the rate of Rs 120 per kg and the rest they sell in the local market at the a of Rs 250-300 per kg."*
>
> ~ Kartick Mondal (62), Shamshernagar

Women observe some rules and rituals when male members of the forest dependent community go to collect honey in the Sundarbans. Generally, when women accompany the men, they don't go to the faraway places; do not use oil on their hair and soap during their baths. During honey collection, the moulis do not fight with each other, they do not tell lies and do not misbehave with others.

The male members also follow some rules and rituals during honey collection. The group members always follow the instructions of their chief. Every group has a division of labour.

During honey collection, they observe the movement of bees using their previous experience and anchoring their boats besides the bank of the river. After finding the beehives, they make a broom like bouquet for making smoke which drives away the bees in the beehives. At that time, all of them cover their mouths with cloth to protect them from the bees. The moulis cut only that part of the hive that contains honey and the other parts where bees and their larvae stay are left away. The collected honey is kept in baskets made from cane. Earlier they preserved honey in earthen pots or glass jars, but these days they use used plastic water bottles to store honey, because of which their honey gets contaminated soon.

According to the informants, if honey is not collected on time, it gets accumulated as food for bees inside the hives and for having food, the bees spend times uselessly. This leads to less pollination in the Sundarbans resulting in less availability of flowers. This also causes problems for the honey collectors because the less availability of flowers has an impact on the availability of honey. If the amount of honey production reduces, it has a negative impact on the lives and livelihoods of the moulis. The moulis urge the Forest Department not to issue passes for catching fish and crabs in falgun (February-March) and if passes are issued, the Forest Department has to be very careful so that no one is allowed to collect honey.

Bees play a significant role in pollination and regeneration of mangroves. Most of the moulis think that if honey is collected in a proper way, it will not be harmful for the Sundarbans. Rather it contributes to biodiversity flourishing and the natural management of the Sundarbans. They opine that if honey is not collected at the proper time and season the pollination process gets disturbed, causing various problems to the ecosystem of the forest. But some of the honey collectors do not follow the rules of honey collection. They cut the whole hives when they collect honey and some light a fire inside the hives which leads to the death to the bee larvae and some in the name of honey collection cut down the trees of the Sundarbans. They also sometimes cut the leaning branches of trees which has a negative impact on the hive making by bees as well as on the livelihood security of the moulis.

Informants also said that the fruits of the mangroves are consumed by the fish. If pollination gets disturbed, it will affect the fruiting stage, reduce fruit production and fish production will be impacted. The deer in the Sundarbans depend on the fruits for food so they will suffer due to unavailability of flowers. The scarcity of deer will affect food availability for tigers. Ultimately, this will go against conservation and lead to biodiversity loss.

Birds

Even 20 years back, lots of birds could be seen in the Sundarbans. Migratory birds came in the winter and the area was popularly known as *Pakhiralaya* (the nest of birds). People said due to disturbances created by viewers from outside (mostly from the nearby villages and tourists during the tourist season) the birds flew away and most probably shifted to the dense forest areas.

Some of the senior informants recalled and described the details of various patterns of the birds' food habits. According to them, in earlier days aquatic birds were mostly found in the

area. The food for the birds were fish and shrimp which was in plenty. But over a period of time due to overfishing and continuous disturbance of their habitat the birds left. Aquatic birds are now in danger if they are at all available.

Although it has decreased today, a participant said that he has seen almost 35 species of birds in the village. He saw a Pond Heron *(Ardeola grayii)* tied with a rope in someone's yard. After enquiring he was informed that there was a common practice among the villagers to kill these birds and eat them. This has reduced with education and awareness, but has not completely stopped.

Presence of honey eater and insect eater birds are also seen in the area.

> *Historical data shows that the harvest of this block was often looted by pirates, which led the British administration to establish a paddy-trading centre at Hingalganj in 1790. This is important to remember about the richness of agricultural practices in the block, which no more exists.*
>
> ~ Biswarup Mondal, villager and one of the informants. Fish, Crabs and other aquatic species

Fish like Shankar fish (Ray fish), Joanbodhi (locally pronounced and English/ Scientific name could not be traced), Kamot (Shark) are less in numbers.

Snails, turtles and leeches have died due to excessive saline water intrusion in the river.

Snakes

Snake bites are common in the Sundarbans due to several venomous and non- venomous snakes. This problem gets magnified due to lack of awareness and infrastructure in Sundarbans added to a lack of understanding of modern medicine and dependence on local faith healers.

Presently snakes are declining in the Sundarbans due to habitat loss caused by tremendous population pressure. Out of fear villagers kill snakes indiscriminately which is another important reason for the reducing snake diversity and density. From the discussions it can be concluded that, as compared to earlier times, venomous snakes are very few in number. Aila has a severe impact on slow-moving reptiles as the saline water damaged and destroyed their habitats.

Snakes are also dying because they are being trapped in nylon nets while passing paddy fields. Nylon nets are regularly used by the farmers. Most of them are dumped in the field after use. Abundant use of Glyphosate (weed killer) and other pesticides also pose a threat.

Agriculture

Agriculture is completely rainfed. The indigenous rice varieties cultivated in recent years are:

Lilabati, Dudherswar, Gobindobhog, Dasshan, Begunbichi (Flavoured), Kalomota, Hamon, Bayerbat, Gerimukhi, Hogla, Khejurchori, Kumragor, Tal Mugur, Nona Bogra, Patnai, Sadamota, Gentu, Koijuri, Ghunshi, Holde Batali, Hamai Muri, Begunbichi and Sadagetu, Lalgetu.

Over the years farmers have imported many varieties of paddy seeds, like 23 number Patnai, Jhingeshal, Rupshal, Gopalbhog, Bhunri, Darishal, Morishal, Morichbot, Rani Aakando, Lilaboti etc.

In 2020 *Sadagetu* and *Lalgetu* were cultivated on 27 per cent of the high land. *Dudheswar* and was cultivated on 11 per cent of the medium land while *Tal Mugur* and *Nona Bogra* were cultivated on 62 per cent of the low land.

In July 2010, WWF-India was informed about the possibility of accessing seeds of 'Hamilton' paddy from the Department of Agricultural Sciences, University of Calcutta. Only 25 grains of Hamilton paddy could be obtained from the Calcutta University farm in Baruipur, a little south of Kolkata. While 15 of these grains were passed on to noted rice scientist Dr Debal Deb the other 10 grains were passed on to Umapati Sarkar, a farmer from Sandeshkhali II CD Block for further propagation. Both Dr Deb and Mr Sarkar were successful in multiplying the number of seeds. Dr Deb said that the tests showed that Hamilton can withstand 14 ppt salinity. If ultimately re-introduced in the region, it could significantly enhance farmers' adaptive capacity against recurrent salt water inundation.

After cyclone Aila the vulnerability of freshwater paddy agriculture in the delta was exposed. Hence, researches were initiated to revive the salt-tolerant paddy.

The farmers commonly use high yielding varieties like *Swarna*, Mini-kit, *Masuri,* IR8 and IET1444 (century).

We were informed that due to water scarcity and unavailability of irrigation facilities in most of the areas of Hingalganj block farmers cannot cultivate the Rabi crop.

Medicinal Plants

Medicinal plants that grow only in salty climates have been seen in the Sundarbans. Among them the most commonly found medicinal plants are:

Hargoza A gregarious shrub, commonly found with mangroves along the coastal regions of India. It is used as a medicine for asthma and rheumatism. Applied topically, the leaves are used as a poultice on wounds. In the Sundarbans, however, the leaves of the plant are used for treating tiger-bites.

Garjan *Rhizophora apiculata* is often found in the mid–lower estuary in larger riverine estuaries and embankments and *Rhizophora mucronata* is mostly found in areas that have regular freshwater flows. Its bark is reportedly used to treat angina, boils and fungal infections. The leaves and bark are used as an antiseptic and to treat diarrhoea, dysentery, fever, malaria and leprosy. The bark is also used for treating fractures.

Gang Jhapa A mangrove associate species, a perennial, much branched, fast growing, evergreen shrub that grows up to 6 m in height. The juice of the leaves is known to bring down fever.

Kankra An evergreen mangrove that grows up to 30 m in height. It may grow as a single-stemmed tree or a multi-stemmed shrub. The astringent fruit is used as a treatment for shingles. The roots and leaves are used for burns and the bark is used for treating minor cuts.

Keora This is an exclusive mangrove species. It is an evergreen, fast growing, pioneer tree that grows up to 20 m in height. Its flowers are a good source of honey and the fruits are used as vegetables and pickled. The extract of the plant parts possesses significant anti-oxidant, anti-fungal, anti-microbial, antidiarrheal, anti-bacterial, analgesic and cytotoxic activities. Its juice is used to treat bleeding piles.

Gewa A deciduous, much branched shrub to small tree that grows up to 5-15 m in height with an irregular crown. It shows coppicing ability and grows well in the non-saline to moderate saline areas with full sunlight. It is traditionally used in the treatment of ulcers, sores and stings of poisonous marine creatures, and also functions as an emetic and purgative. Its bark oil is used for treating rheumatism, leprosy and paralysis. It is also used traditionally in the treatment of conjunctivitis, dermatitis and haematuria. The latex exuded from this plant is used as an abortifacient and as a purgative, and also used in treating ulcers. The roots of the plant are used for toothache and swellings as well as used as an ingredient of embrocation.

Khalsi It is an evergreen, pioneer, single or multi-stemmed shrub or small tree. Its flowers are bisexual, rich in nectar and fragrant. Extracts have shown remarkable effect as an anti-arthritic and anti- inflammatory agent to combat chronic inflammatory diseases. It has been used for years in the treatment of many inflammatory and autoimmune diseases like atherosclerosis, rheumatoid arthritis and asthma.

Goran It is an evergreen, medium-sized, slow growing perennial shrub that grows up to 4 m in height. This species is found to tolerate moderate to strong saline conditions; grows well on the raised areas with infrequent tidal inundations. Its bark is astringent. A decoction is used to treat haemorrhages.

Sundri This is a non-exclusive mangrove species. It is an evergreen tree that grows up to 25 m in height. It can tolerate moderate saline conditions, but grows well in the well-drained soil in non-saline areas. *H. fomes* is an important mangrove species having ethnomedicinal uses in traditional medicines. It is used for gastrointestinal disorders including diarrhoea, dysentery, constipation, indigestion and stomach-ache. It is also recommended for skin diseases including dermatitis, rashes, eczema, boils, itching, scabies, sores, infections and hepatic disorders including jaundice and hepatitis. It is also useful in treating diabetes and goitre. It is a good insect repellent and has wound healing abilities.

Golpata It is an evergreen, fast growing, clumping stemless, versatile palm that grows up to 9 m in height. This species has a horizontal creeping stem that grows under the ground level. Various parts of the tree are used such as leaves for thatching, roofing and Nypa sap for making sugar. The young inflorescence before flower opening is tapped to yield a copious sap to make sugar, alcohol or vinegar, molasses or treacle. The juice extracted from shoots is mixed with coconut milk to treat herpes, the ash of burnt leaves and roots is used for headaches and toothaches. The leaves decoction is used as a lotion for indolent ulcers.

Karanj This is a mangrove associate species. The seed oil is used in the treatment of dyspepsia and for a sluggish liver. It is used externally for skin diseases and rheumatic joints, is effective in enhancing the pigmentation of skin affected by leukoderma or scabies while its powdered seeds are used as an expectorant in treating bronchitis and whooping cough. A paste made from the powdered seeds is spread on sores and rheumatic joints, an infusion of the leaves is used to relieve rheumatism and the decoction is used as a cough remedy. Its leaves are crushed and applied as a poultice for the treatment of parasitic skin diseases and to relieve bleeding haemorrhoids. Its juice is used for herpes and itches while its flowers are claimed to have anti-diabetic action, fresh stem bark is astringent and is taken internally to relieve bleeding haemorrhoids, applied to reduce the enlargement of the spleen. Its root bark is used as an abortifacient and the antiseptic root juice is put on sores and ulcers and used to clean teeth.

Dhundal This is an exclusive mangrove species. It is a medium- sized, less branched, evergreen tree. It is a medicinal mangrove plant, traditionally used for treating diarrhoea, cholera, fever, dyslipidaemia and inflammation.

Geomorphology and Biodiversity

The biodiversity of Sundarbans is at great risk today due to rising salinity and flooding in rivers. As a result, the character of the sedimentation is getting changed.

According to the local people high saline water is the result of infiltration though trees are being planted by the Forest Department.

Deforestation

Deforestation to fulfil the consumption needs (mainly for house construction) has completely stopped these days as people are trying to build their houses with bricks and mortar. Wood is no

longer considered a building material since the government introduced some housing schemes.

Water Pollution and Biodiversity

The possibility of oil contamination increases when oil falls into the water while a ship is leaving. The participants pointed out several issues: A) Ship repairing done midway is a reason of oil spillage. B) Some of the participants have seen the BSF personnel pour kerosene in the river, as they have a weekly quota, which is not consumed needs to be disposed to empty the containers. The adjacent river is the best place to dispose it as they are afraid they will lose their quota of kerosene oil. C) Sundarbans is only accessible by water transportation (engine boats, ships and ferryboats). Most of the tourists visit Sundarbans using different water vessels, with very limited safety and security measures available. Spillages, although not on a large scale, have been noticed.

> *Common people have little knowledge about venomous and non-venomous snakes. Out of fear, villagers kill snakes indiscriminately which is reducing snake diversity and density.*
>
> *There is a huge knowledge gap in preparedness and response for snake bites which leads to death of snake bite victims.*
>
> ~ Ajit Kumar Gain Barefoot Doctor, Samshernagar

Climate Change

Climate change, extreme weather conditions, frequent cyclones like Aila, Bulbul, Fani and Amphan led to devastation. There is excess salty water and the risk of water resources being endangered is increasing.

Annexure 7

Table A7.1: Ambient Air Quality in the Project Corridor

Location: Shamshernagar Village		Date of sampling: 07-08.11.2020			
Sampling Done by: A. Mandal / S. Ghosh		Sampling done as per: CPCB Guidelines (Volume-1)			
Environmental Condition: Clear & Sunny		Average Temperature: 32°C			
GPS Coordinate: N 220 11′ 26.7″, E 89o 03′36.5″					
Sl. No.		**POLLUTANT**	**RESULT**	**LIMIT**	**METHOD OF TEST REFERENCE**
1		Particulate matter (<10µm) in µg/m3	57	100	IS: 5182 (Part-23)- (RA- 2017)
2		Particulate matter (<2.5µm) in µg/m3	16	60	USEPA CFR-40, Part-50. Appendix-L
3		Sulphur dioxide (SO2) in µg/m3	<4.0	80	IS: 5182 (Part-2)-2001, (RA-2017)
4		Nitrogen dioxide (NO2) in µg/m3	16.6	80	IS: 5182 (Part- 6)-2001, (RA-2017)
5		Carbon Monoxide (CO) in mg/m3	0.217	2	IS: 5182 (Part-10) :1999, (RA-2014)

NOTE: Limit as per CPCB notifications, New Delhi, 18 November 2009 for ambient air quality.

Figure A7.1: Air Pollutant Concentration in Ambient Air along the Project Area

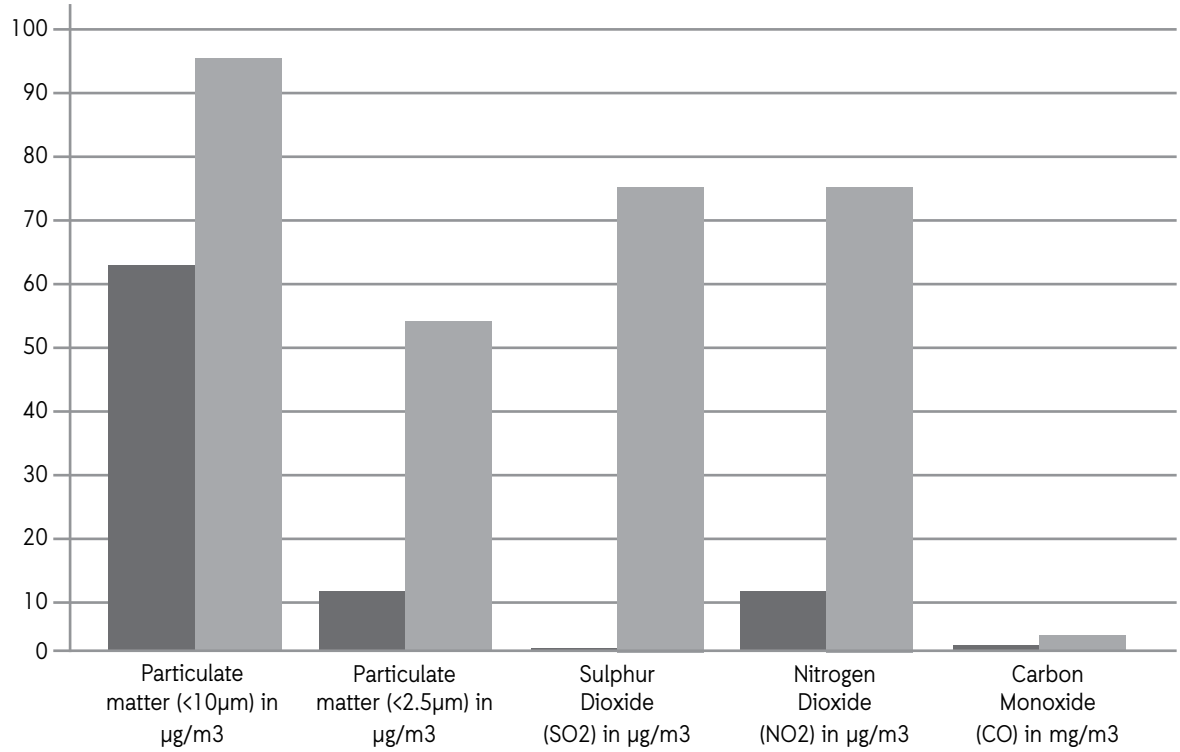

Figure A7.2: Windrose diagram

WIND ROSE PLOT: Windrose Diagram Kolkata, West Bengal, India	**DISPLAY: Wind Speed Direction (blowing from)**		
NORTH 20% 16% 12% 8% 4% WEST WIND SPEED (m/s) >= 11.1 SOUTH 8.8 - 11.1 5.7 - 8.8 3.6 - 5.7 2.1 - 3.6 0.5 - 2.1 Calms: 50.49%	EAST		
COMMENTS: Meteorological data from Alipur, Kolkata, India	DATA PERIOD: 2018 Jan 1 - Dec 31 00:00 - 23:00	CLIENT: Bongs Prayukti International Pvt. Ltd.	
		MODELER: Swarnabha Bandyopadhyay	
	CALM WINDS: 50.49%	TOTAL COUNT: 7695 hrs.	
	AVG. WIND SPEED: 0.66 m/s	DATE: 01-01-2021	PROJECT NO.: PI/2020/15

Table A7.2: Predicted Ground Level Concentration of Pollutants (in µg/m3)

Averaging Period	PM10	SO2	NOx
1-hour	10.3	51.8	15.2
24-hour	1.6	8.0	2.3
Annual	0.02	0.09	0.03

The graphical output of the dispersion modelling for SO2 for 1-hour averaging period is given in Figure 9.3.

Figure A7.3: Dispersion modelling for SO2 for 1-hour averaging period

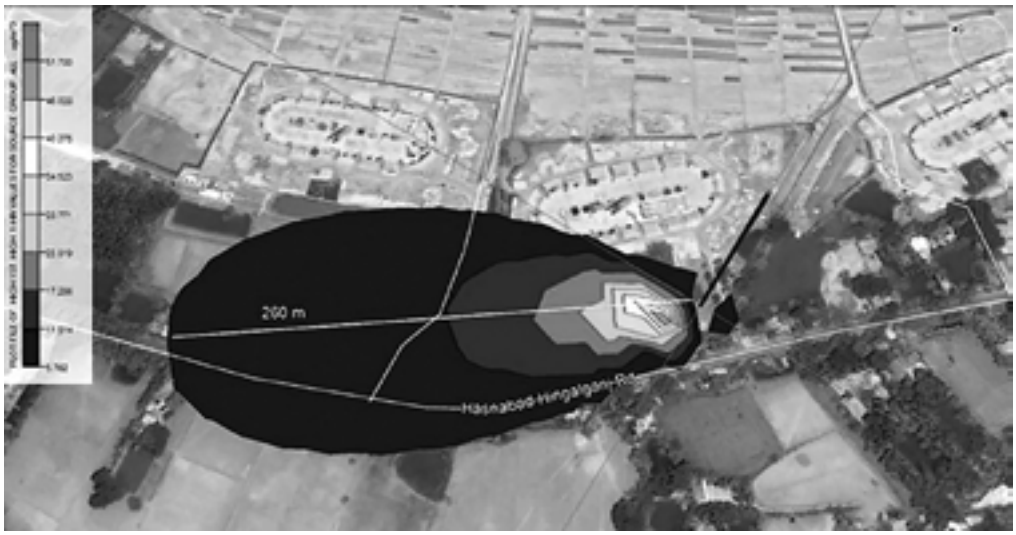

Table A7.4: Ambient Noise Level in decibels (A)

Sampling Done By: A. Mandal / S. Ghosh				
Sampling Guideline: As per IS: 9876: 1981 (RA-2001)				
Date of Monitoring	GPS Coordinate	Location	Leq dB (A) Day Time	Leq dB (A) Night Time
07/08.11.2020	N 220 11' 35.1", E 89o 03'43.8"	Shamshernagar Auto Stand	59.4	48.3

Table A7.5: Water Quality Characteristics in the Project Area

Sl. No.	Test Parameter	Test Method	Tolerance Limit as per IS:2296, Class B	RESULT	
				Samsher Nagar (Pond)	Kalitala (Pond)
1.	Colour in Hazen Units	IS 3025 (Part 4): 1983 (RA2012)	300 (Max.)	<1.0	<1.0
2.	Odour	IS 3025 (Part 5): 1983 (RA2012)	----	Agreeable	Agreeable
3.	pH Value at 250C	IS 3025 (Part 11): 1984(RA 2012)	6.5-8.5	7.0	7.75
4.	Total Dissolved Solids (as TDS) in mg/l	IS 3025 (Part 16): 1984(RA 2012)	----	2350	690

Sl. No.	Test Parameter	Test Method	Tolerance Limit as per IS:2296, Class B	RESULT	
				Samsher Nagar (Pond)	Kalitala (Pond)
5.	Ammonia as NH3 in mg/l	IS 3025 (Part 34): 1988(RA2014)	----	4.21	2.34
6.	Boron (as B) in mg/l	IS 13428-2005(Annex L)	----	<0.5	<0.5
7.	Calcium (as Ca) in mg/l	IS 3025 (Part 40): 1991(RA2014)	----	158.4	88.0
8.	Chloride (as Cl) in mg/l	IS 3025 (Part 32): 1988(RA 2014)	----	733.8	195.6
9.	Copper (as Cu) in mg/l	IS 3025 (Part 42): 1992(RA2014)	----	2.90	1.84
10.	Fluoride (as F) in mg/l	IS 3025 (Part 60): 2008(RA 2013)	1.5 (Max.)	1.74	1.30
11.	Free Residual Chlorine in mg/l	IS 3025 (Part 26): 1986(RA 2014)	----	0.2	0.2
12.	Iron (as Fe) in mg/l	IS 3025 (Part 53): 1988(RA 2014)	----	<0.05	0.93
13.	Magnesium (as Mg) in mg/l	IS 3025 (Part 46): 1994(RA 2014)	----	26.4	15.84
14.	Manganese (as Mn) in mg/l	IS 3025 (Part 59): 2006 (RA 2014)	----	14.61	18.9
15.	Nitrate (as NO3) in mg/l	IS 3025 (Part 34): 1988(RA 2014)	----	12.8	9.64
16.	Phenolic Compounds (as C6H5OH) in mg/l	IS 3025 (Part 43): 1992(RA 2014)	0.005 (Max.)	<0.001	<0.001
17.	Sulphate (as SO4) in mg/l	IS 3025 (Part 24): 1986 (RA 2014)	----	130.1	39.96
18.	Salinity in PSU	APHA 23rd Edition-2017, 2520B	---	1.9	0.5
19.	Alkalinity (as CaCO3) in mg/l	IS 3025 (Part 23): 1986(RA 2014)	----	128	140
20.	Total Hardness (as CaCO3) in mg/l	IS 3025 (Part 21): 2013	----	506	286
21.	Cadmium (as Cd) in mg/l	IS 3025 (Part 41): 1992(RA 2014)	----	7.41	6.21
22.	Cyanide (as CN) in mg/l	IS 3025 (Part 27): 1986(RA 2014)	0.05 (Max.)	<0.02	<0.02
23.	Lead (as Pb) in mg/l	IS 3025 (Part 47): 1994 (RA 2014)	----	1.28	0.84
24.	Mercury (as Hg) in mg/l	IS 3025 (Part 48): 1994(RA 2014)	----	<0.001	<0.001
25.	Arsenic (as As) in mg/l	IS 3025 (Part 37): 1988 (RA 2014)	0.2 (Max.)	0.06	0.17
26.	Zinc (as Zn) in mg/l	IS 3025 (Part 49): 1994 (RA 2014)	----	1.42	1.56
27.	Total Chromium (as Cr) in mg/l	IS 3025 (Part 52): 2014(RA 2014)	----	0.98	0.78
28.	Biochemical Oxygen Demand (as BOD) mg/l	IS 3025 (Part 44)-1993, RA:2014	3.0 (Max.)	62.4	83.2

Sl. No.	Test Parameter	Test Method	Tolerance Limit as per IS:2296, Class B	RESULT	
				Samsher Nagar (Pond)	Kalitala (Pond)
29.	Dissolved Oxygen in mg/l	APHA 23rd Edition-2017, 4500-O-C	5.0 (Max.)	6.4	6.7
30	Total Coliform MPN/100ml	IS: 1622-1981(RA 2019)	500	30	55

Table A7.6: Water Quality Characteristics

SN.	Test Parameter	Test Method	IS 10500:2012 Amd. 1 & 2		Result	
			Acceptable Limit	Permissible Limit	Near Kalitala	Shamsher Nagar
1	Colour in Hazen Units	IS 3025 (Part 4):1983 (RA 2012)	5	15	5.6	3.8
2	Odour	IS 3025 (Part 5):1983 (RA 2012)	Agreeable	Agreeable	Agreeable	Agreeable
3	pH Value at 250C	IS 3025 (Part 11):1984 (RA 2012)	6.5-8.5	No Relaxation	7.6	8.4
4	Turbidity in NTU	IS 3025 (Part 10):1984 (RA 2012)	1	5	20.4	8.8
5	Total Dissolved	IS 3025 (Part 16):1984 (RA 2012) Solids (as TDS) in mg/l	500	2000	10500	3960
6	Ammonia (asNH3) in mg/l	IS 3025 (Part 34):1988(RA 2014)	0.5	No Relaxation	<0.5	<0.5
7	Boron (as B) in mg/l	IS 13428-2005(Annex L)	0.5	2.4	<0.5	<0.5
8	Calcium (as Ca) in mg/l	IS 3025 (Part 40):1991(RA 2014)	75	200	1100	308
9	Chloride (as Cl) in mg/l	IS 3025 (Part 32):1988 (RA 2014)	250	1000	66.53	1908
10	Copper (as Cu) in mg/l	IS 3025 (Part 42):1992(RA 2014)	0.05	1.5	1.31	1.04
11	Fluoride (asF) in mg/l	IS 3025 (Part 60):2008(RA 2013)	1	1.5	1.22	1.33
12	Free Residual Chlorine inmg/l	IS 3025 (Part 26):1986(RA 2014)	0.2 (min.)	1.0 (min.)	0.2	0.2
13	Iron (as Fe) in mg/l	IS 3025 (Part 53):1988(RA 2014)	1	No Relaxation	1.74	0.96
14	Magnesium(as Mg) in mg/l	IS 3025 (Part 46):1994(RA 2014)	30	100	448.8	211.2
15	Manganese (as Mn) in mg/l	IS 3025 (Part 59):2006 (RA 2014)	0.1	0.3	4.62	0.09
16	Nitrate (asNO3) in mg/l	IS 3025 (Part 34):1988(RA 2014)	45	No Relaxation	8.97	16.8
17	Phenolic Compounds (as C6H5OH)in mg/l	IS 3025 (Part 43):1992(RA 2014)	0.001	0.002	<0.001	<0.001
18	Sulphate (asSO4) in mg/l	IS 3025 (Part 24):1986 (RA 2014)	200	400	48	14.85
19	Salinity in PSU	APHA 23rdEdition-2017, 2520B	---	---	9.3	3.9

SN.	Test Parameter	Test Method	IS 10500:2012 Amd. 1 & 2		Result	
			Acceptable Limit	Permissible Limit	Near Kalitala	Shamsher Nagar
20	Total Alkalinity (asCaCO3) in mg/l	IS 3025 (Part 23):1986(RA 2014)	200	600	1200	1500
21	Total Hardness (asCaCO3) in mg/l	IS 3025 (Part 21):2013	200	600	4620	1650
22	Cadmium (as Cd) in mg/l	IS 3025 (Part 41):1992(RA 2014)	0.003	No Relaxation	4.66	2.57
23	Cyanide (as CN) in mg/l	IS 3025 (Part 27):1986(RA 2014)	0.05	No Relaxation	<0.02	<0.02
24	Lead (as Pb) in mg/l	IS 3025 (Part 47):1994 (RA 2014)	0.01	No Relaxation	1.52	1.1
25	Mercury (as Hg) in mg/l	IS 3025 (Part 48):1994(RA 2014)	0.001	No Relaxation	<0.001	<0.001
26	Arsenic (as As) in mg/l	IS 3025 (Part 37):1988 (RA 2014)	0.01	0.05	0.07	0.07
27	Zinc (as Zn) in mg/l	IS 3025 (Part 49):1994 (RA 2014)	5	15	0.65	0.54
28	Total Chromium (as Cr) in mg/l	IS 3025 (Part 52):2014(RA 2014)	0.05	No Relaxation	0.36	0.31
29	Biochemical Oxygen Demand (as BOD)mg/l	IS 3025 (Part 44)-1993, RA:2014	----	-----	322.5	52
30	Dissolved Oxygen in mg/l	APHA 23rdEdition-2017, 4500-O-C	-----	-----	3.7	7.6

Sl. No.	Test Parameter	Test Method	Norms as perIS 10500 : 2012Amd. 2	Result	
				Near Kalitala	Samsher Nagar
1	E.coli/100ml	IS:15185-2016	Not Detectable	Detected	Detected
2	Total Coliform Bacteria/100ml	IS:15185-2016	Not Detectable	Detected	Detected

Table A7.7: Soil quality in the project area

Sl. No.	Test Parameter	Test Method	Result	
			Shamshernagar	Kalitala Village
1	pH at 25 0C	IS 2720 (Part 26): 1987(RA 2011)	7.33	7.42
2	Electrical Conductivity in µS/cm at 25 0C	IS 14767 :2000, RA 2016	648	880
3	Organic Carbon, %	Soil Analysis (Soil Science Society for America) Part II	0.40	1.19
4	Available Nitrogen (as N), %	IS 14684 (1999) RA 2014	0.04	0.06
5	Available Phosphorus (as P), in mg/kg	Soil Analysis (Soil Science Society for America) Part II	56.13	62.47
6	Available Potassium (as K), in mg/kg	Soil Analysis (Soil Science society for America) Part II	241.5	312.9
7	Available Sulphur (as S), mg/kg	IS 2720(Part-27): 1977 (RA 2015)	148.6	171.4
8	Available Boron (as B), in mg/kg	Soil Analysis (Soil Science Society for America) Part II	<0.25	<0.25
9	Available Zinc (as Zn), in mg/kg	EPA 3050 B: December, 1996, EPA 7000 B: February 2007	68.72	53.10
10	Available Iron (as Fe), %	Soil Analysis (Soil Science Society for America) Part II	3.11	3.91
11	Available Copper (as Cu), in mg/kg	EPA 3050 B: December, 1996, EPA 7000 B: February 2007	32.51	40.87
12	Available Manganese (as Mn), in mg/kg	EPA 3050 B- December, 1996, EPA 7000 B- February, 2007	462.5	387.2

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