Final SEA Report

Prepared for the

Strategic Environmental Assessment of South West Region of Bangladesh for Conserving the Outstanding Universal Value of the Sundarbans

November 2021

CEGIS
Center for Environmental and Geographic Information Services

in association with

integra CONSULTING

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Dedication

The SEA Team dedicates this report to two colleagues and friends. Dr Jean Jean-Roger Mercier, international consultant, passed away on 5th July 2020 after a short illness. He gave us sage advice, guidance, wit and inspiration. Dr Chowdhury Saleh Ahmed led the economic contributions to our work and provided strong support to the team. He passed away on 14 December 2020 after contracting Covid-19. We shall miss them both.

Acknowledgements

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Grateful thanks are especially due to all stakeholders, organisations and individuals who have provided perspectives, information, advice and support, and participated in video-based meetings to discuss key issues as well as the approach and focus of the SEA.

Authorship of Report

This report was compiled by Barry Dalal-Clayton (SEA Team Leader), Zahir Uddin Ahmed (Deputy Team Leader), Peter Tarr, Vladislav Bizek, Mir Sajjad Hossain, Farhana Ahmed, Kazi Md Noor Newaz, Mushfiq Ahmed and Md. Mustafizur Rahman. Air and water pollution modelling was led by Pronab Kumar Halder and H.M. Nurul Islam, respectively. Important contributions were also made by all other SEA team members as listed in Annex 2.

Transparency Statement

This SEA Report and all other reports prepared during the SEA process are intended as open access documents for sharing with all stakeholders, all those who have participated in the SEA process, and any other interested individuals or organisations. All documents are made available at the earliest opportunity to download on the SEA website at: **www.seasw-sundarbansbd.org.**

Suite of Linked SEA Reports

The outputs of this SEA comprise several documents. Earlier reports inform subsequent ones in a sequential manner, whilst later reports are back-referenced to early ones as regards specific details. The reports form an inter-linked suite. All earlier reports are available on the SEA website (www.seasw-sundarbansbd.org).

- Inception Report (March 2020)
- Mid-term Screening and Scoping Reports (September 2020)
- Prospectus (revised January 2021)
- Record of Stakeholder Consultations during August – November 2020 (January 2021)
- Final Screening Report (March 2021)
- Final Scoping Report (January 2021)
- Updated Draft Final SEA Report (September 2021)
- Updated Record of Stakeholder Consultations (November 2021)
- 13 thematic baseline reports (to be uploaded to the website shortly).

Revisions to Text of Draft Updated Final SEA Report

This final report contains a range of revisions to the text of the Updated Draft Final SEA Report (September 2021). The main changes include:

1. General revisions of the text to incorporate new/updated information and data, clarify explanations, respond to stakeholder's written and oral comments, and to correct typographical errors and cross-references, etc.
2. New section 1.4 on limitations of the SEA.
3. New appendix 10 providing responses to written comments received from government and non-government stakeholders on the Updated Draft Final SEA Report.
4. New appendix 11 listing the principles of SEA.

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Abbreviations and Acronyms

ABS	Access and Benefit Sharing
ADB	Asian Development Bank
AIDS	Acquired Immune Deficiency Syndrome
AOH	Adsorbable Organic Halides
ASR	Air Sensitive Receptor
BBIN	Bangladesh-Bhutan-Inidia-Nepal
BBS	Bangladesh Bureau of Statistics
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BCCT	Bangladesh Climate Change Trust
BDP	Bangladesh Delta Plan
BEZA	Bangladesh Economic Zone Authority
BFD	Bangladesh Forest Department
BIFPCL	Bangladesh-India Friendship Power Company Limited
BIWTA	Bangladesh Inland Water Transport Authority
BMET	Bureau of Manpower, Employment and Training
BOD	Biochemical Oxygen Demand
BOO	Build-Own-Operate
BSCIC	Bangladesh Small and Cottage Industries Corporation
BWDB	Bangladesh Water Development Board
CASE	Clean Air and Sustainable Environment (project)
CCGAP	Cliamte Change and GENDER Action Plan
CEGIS	Centre for Environmental and Geographic Information Services
CIP	Country Investment Plan
CMS	Conservation of Migratory Species (of wild animals)
CNG	Compressed Natural Gas
CO_2	Carbon dioxide
COD	Chemical Oxygen Demand
COPD	Chronic Obstructive Pulmonary Disease
COVID-19	Coronavirus disease 2019
CSO	Civil Society Organisation
DAP	Detailed Area Plan
Dba	Decibel A Scale - a logarithmic system of measuring sound as the human ear experiences it.
DEM	Digital Elevation Model
DoE	Department of Environment
DoF	Department of Fisheries
DPSIR	Driver, Pressure, State, Impact, Response (model)
DSM	Demand Side Management
DSRS	dISUSED Sealer Radioactive Source

DSS	Decision Suuport System
DWT	Dead Weight Tonnage
ECA	Ecologically Critical Area
ECR	Environmental Conservation Rules (1997)
EE	Energy Efficiency
EEZ	Exclusive Economic Zone
EFCC	Environment, Forest and Climate Change
EIA	Environmental Impact Assessment
EMF	environmental Management Framework
EMP	Environmental Management Plan
EPZ	Export Processing Zone
ESIA	Environmental and Social Impact Assessment
ETP	Effluent Treatment Plant
FAP	Flood Action Plan
FD	Forest Department
FGD	Flue gas de-sulphurization
	Focus Group Discussion
FNS	Food and Nutrition Security
FY	Financial Year
FYP	Five Year Plan
GAINS	Greenhouse Gas and Air Pollution Interactions and Synergies (IIASA model)
GBM	Ganga-Brahmaputra-Meghna
GDA	Ganges Dependent Area
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographical Information System
GMB	Ganges-Brahmaputra-Meghna
GNI	Gross National Income
GoB	Government of Bangladesh
GUI	Graphical User Interface
GWh	Gigawatt hour
Ha	Hectare
HFO	Heavy Fuel Oil
HIC	High Income Country
HIV	Human immunodeficiency virus
HSD	High Speed Diesel
HYV	High Yielding Variety
IAS	Invasive Alien Species
ICT	Information and Communications Technology
ICZMP	Integrated Coastal Zone Management Plan
IIASA	International Institute for Applied Systems Analysis

IIT	Indian Institute of Technology
INGO	International Non-Governmental Organisation
IPCC	Inter-governmental Panel on Climate Change
IPM	Integrated Pest Management
ISO	International Organisation for Standardization
IUCN	International Union for Conservation of Nature
IUU	Illegal Unreported and Unregulated
IWRM	Integrated Water Resources Management
JRC	Joint Rivers Commission
JWG	Joint Working Group
KCC	Khulna City Corporation
KDA	Khulna Development Authority
KJA	Khanjhanan Ali bridge
Km	Kilometre
LCS	Life Cycle Assessment
LDN	Land Degradation Neutral
LGED	Local Government Engineering Department
LNG	Liquid Natural Gas
LPG	Liquid Petroleum Gas
M&S	Monitoring and Surveillance
MEMR	Ministry of Energy & Mineral Resources
MEA	Multilateral Environmental Agreements
mg	Milligram
Mg	Magnesium
mg O_2/L	Milligrams of oxygen per litre
MIC	Middle Income Country
MIS	Management Information System
m-mhos/cm	Millimhos per centimetre
MoCAT	Ministry of Civil Aviation and Tourism
MoEFCC	Ministry of Environment, Forestry and Climate Change
MoFL	Ministry of Fisheries and Livestock
MoS	Ministry of Shipping
MoU	Memorandum of Understanding
MoWCA	Ministry of Women and Children Affairs
MoWR	Ministry of Water Resources
MPA	Mongla Port Authority
	Marine Protected Area
MSY	Maxiumum Sustainable Yield
MT	Million Tons
MVA	Motor Vehciles Agreement
MW	Megawatt

Na	Sodium
NAPA	National Adaptation Programme of Action
NBSAPB	National Biodiversity Strategy and Action Plan for Bangladesh
NCD	Non-Communicable Diseases
NCEA	Netherland Commission for Environmental Assessment.
NGO	Non-Governmental Organisation
NO_2	Nitrogen dioxide
$N0_3$	Nitrate
NORM	Naturally Occurring Radioactive Material
NOSCOP	National Oil and Chemical Spill Contingency Plan
NO_X	Nitrogen oxides
NSE	Nash–Sutcliffe model efficiency coefficient
NTFP	Non-Timber Forest Products
NWMP	National Water Management Plan
NWPGCL	Northwest Power Generation Company
N_2O	Nitrous oxide
OECD	Organisation for Economic Cooperation and Development
OECD-DAC	OECD Development Assistance Committee
OUV	Outstanding Universal Value
PBIAS	Percentage of Bias
PESSP	Power and Energy Sector Strategy Paper
PID	Proportional-Integral-Derivative
PIWT&T	Protocol on Inland Water Trasnit and Trade
PLC	Programmable Logic Controller
PM	Particulate Matter
PM_{10}	Particulate matter 10 micrometres or less in diameter
$PM_{2.5}$	Particulate matter 2.5 micrometres or less in diameter
PMO	Prime Minister's Office
PO_4	Phosphate
PPP	Policy, Plan, Programme
	Purchasing Power Parity
PSMP	Power System Master Plan
RHD	Roads and Highways Department
RMG	Ready Made Garment
RMIP	Rive Management Improvement Programme
RoW	Right of Way
RSR	Root Mean Square Error
RW	Radioactive Waste
SCADA	Supervisory Control and Data Acquisition - a system that for monitoring and controlling field devices at remote sites
SDG	Sustainable Devlopment Goal

SDS	Secondary Disposal Site (for solid waste)
SE	Sustainable Energy
SEA	Strategic Environmental Assessment
SEMP	Strategic Environmental Management Plan
SEZ	Special Economic Zone
SLM	Sustainable Land Management
SMART	Spatial Monitoring and Report Tool
SNF	Spent Nuclear Fuel
SO_2	Sulphur dioxide
SO_4	Sulphate
SPM	Suspended Particulate Matter
SPP	Small power plant
SREDA	Sustainable and Renewable Energy Development Authority
SRF	Sundarbans Reserve Forest
STD	Sexually Transmitted Disease
STP	Sewage Treatment Plant
SVRS	Sample Vital Registration System
SW	South West
SWAT	Soil and Water Assessmnent Tool
SWR	South West Region
TFR	Total Fertility Rate
TIA	Traffic Impact Analysis
TSP	Total Suspended Particles
UMIC	Upper Middle Income Country
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFPA	United Nations Fund for Population Activities – now UN Population Fund
UP	Union Parishad
USD	United States Dollar
USEPA	United States Environmental Protection Agency
$\mu g/m^3$	Micrograms per cubic metre of air
µS/cm	Microsiemens per centimetre
VGD	Vulnerable Group Development
VGF	Vulnearble Group Feeding
WARPO	Water Resources Planning Organisation
WHC	World Heritage Committee
WHO	World Health Organisation
WHS	World Heritage Site
WODA	World Dredging Association
WRF	Weather Research and Forecasting

Bengali Terms

Baor	Oxbow lake
Beel	A large wetland depression
Chatal	A low lying area with some permanent water – smaller than a beel
Chingri	Shrimp
Gher	Gher farming is a traditional agriculture system in Bangladesh. A pond is dug into a rice field to use for fish farming, with the removed soil used to create dykes around the pond for growing vegetables.
Haor	A bowl- or saucer-shaped shallow wetland depression. During monsoon, haors receive surface runoff water from rivers and canals to become vast stretches of turbulent water. They turn into a vast inland seas within which the villages appear as islands.
Jalmahal	Physically defined state-owned waterbodies for which the fishing rights are auctioned out by government
Khas	Government-owned fallow land
Upazila	Sub-district

Executive Summary

This Strategic Environmental Assessment (SEA) aims to assess the impacts of development in the SW region[1] of Bangladesh (Figure E.1) to ensure the sustainable development of the region and conservation of the Sundarbans, and to uphold its Outstanding Universal Value (OUV).

Chapter 1 is an introduction which describes the background and objectives of the SEA, outlines the role of SEA and the main steps involved.

Chapter 2 describes the methodology used. The SEA was undertaken between January 2020 and July 2021 in accordance with the Terms of Reference. It has been designed according to principles for good practice in SEA as contained in the SEA Guidance of the Development Assistance Committee of the Organisation for Economic Cooperation and Development (OECD-DAC 2006) (see Annex 11).

The COVID-19 pandemic has interrupted the work, particularly making physical stakeholder consultations unsafe during periods in 2020 and 2021.

During the *screening phase* (March-April 2020), 89 policies, plans and programmes covering 28 sectors and key issues were reviewed to identify their objectives and key activities/developments arising from them.

The main components of the *scoping phase* (April-November 2020) included:

- undertaking stakeholder analysis and consultations;
- preparing 13 thematic baseline papers and identifying the key environmental, social and economic issues and concerns on which the SEA focuses;
- reviewing the legal and regulatory framework of Bangladesh;
- setting environmental and socio-economic objectives for key issues – to be used during the main assessment phase;
- preparatory work for the development of growth scenarios;
- establishing a dedicated website for the SEA and producing a Prospectus that summarises the aims and approach of the SEA for stakeholders.

The main assessment (the heart of the SEA) was carried between December 2020 and March 2021. It was undertaken in two stages:

- an ***initial assessment*** – at a generic and 'broad-scale' level - of three growth scenarios (low, medium and high) to provide a comparative picture of the likely combined impacts of overall development across all sectors in the SW region over the next 20 years under each scenario (for details, see Chapter 6). A key element of an SEA is that it should assess alternatives to a policy, plan or programme. But since the SEA addressed 89 different PPPs, it was impossible to assess alternatives to each of these. Thus, the growth scenarios were selected as meta level[2] alternatives;
- a ***deeper assessment*** of the high growth scenario, undertaken on a sector-by-sector basis (for nine key sectors). This builds on the initial assessments of the three growth strategies but focuses specifically on the high growth scenario as this accords with the government's policy to achieve high income country (HIC) status by 2041 (for details, see Chapter 7).

[1] The SW region refers to one of the hydrological regions of Bangladesh. It was identified as the SEA focus area jointly agreed Bangladesh (the State Party) and UNESCO WHC (recorded in UNESCO 41; COM 2017) because of potential environmental and socio-economic impacts, particularly on the Sundarbans, arising from development activities in this region

[2] Meta level refers to a level which is above, beyond, or outside other levels, or which is inclusive of a series of lower levels. In this SEA, it refers to an umbrella level which encompasses all of the 89 PPPs considered by the SEA.

Chapter 3 describes the baseline conditions and key environmental and socio-economic issues in the SW region which are summarised in Table E.1. It also describes several important transboundary issues that are likely to influence the SW region and Sundarbans (including upstream dams and irrigation in the Ganges basin, and power plants and industries in neighbouring West Bengal); and mega projects particularly the Rampal coal-fired power plant and the Padma bridge (notably the. expansion of the communication network connecting to the SW region and increasing road and rail traffic resulting from its operation).

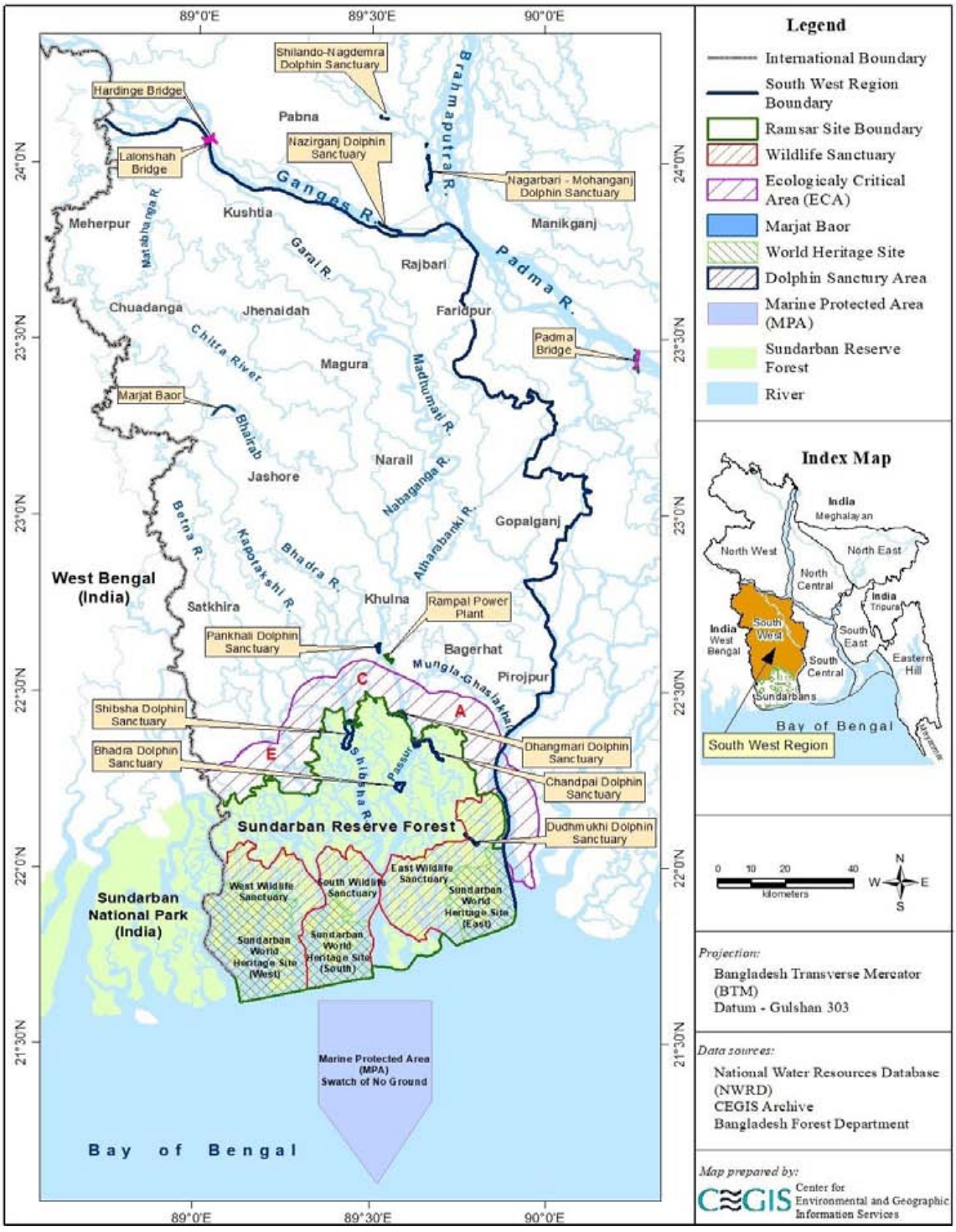


Figure E.1: The SEA Area of Focus, World Heritage Sites and Protected Areas

Table E.1: List of Priority Environment, Social and Economic Issues

Issues and concerns	Comment / examples of potential impacts
Environmental	
Pollution and waste (solid and liquid): • Surface water pollution. Brackish and sea water • Groundwater pollution • Air pollution • Soil pollution • Oil • Waste treatment and disposal • Plastics	Pollution & waste management is a major concern for the ecological integrity of the SWR of Bangladesh and the Sundarbans due to different developmental initiatives.
Water flow dynamics in rivers	Reduction of water flow in rivers of SWR may change the region's environmental and economic sustainability/integrity as well as livelihood patterns and crop production
Sedimentation and siltation (fluvial and tidal), *dredging and disposal*	Sedimentation and siltation management is a challenge to maintain river flows. Dredging (e.g. to restore river flows and river transportation, to facilitate the expansion of the Mongla Port, and of channels in and around the Sundarbans) may impact on benthic biodiversity and disposed dredged materials can affect the regeneration of trees & survival of existing forests as well as benthic aquatic biodiversity.
Salinity: • Groundwater • Soil	Due to reduced flow of upstream fresh water and channel sedimentation/siltation, and resultant sea water intrusion/inundation, soil and groundwater salinity has increased and soil productivity has decreased as well as livelihood diversity
Noise	• Exposure to excessive noise, particularly in urban and industrial areas and from vehicles, can cause health problems. • Noise from the regular movement of ships (notably along major rivers of Sundarbans) can disrupt wildlife movement, cause localisation (fragmentation) of populations and result in inbreeding. • Underwater noise can have impacts on aquatic fauna. • Future expansion of urban areas, industries and transport networks could enhance noise related problems in the region.
Habitat isolation	Several large tracts of the Sundarbans are separated by wide rivers which tigers and other fauna tend not to cross. This may lead to genetic isolation. Increased numbers of vessels passing along the navigable channels, the noise they cause and use of lights at night may also disrupt the dispersal of fauna. These factors tend to disturb animal behaviour (eg feeding, breeding) and may lead to genetic isolation and also threaten effective biodiversity conservation.
Loss of biodiversity	Some environmental as well as regional & local activities may affect biodiversity (particularly in the Sundarbans), with loss of keystone species and their prey base due to poaching and habitat degradation as a result of anthropogenic activities. Biodiversity losses may also occur due to climate change and natural dynamic changes in the ecosystem
Invasive alien species (IAS)	Water hyacinth has become a major problem, clogging baors and ponds, and some water channels. *Prosopis juliflora* is also spreading on embankments. At present, there are no major issues with IAS within the

Issues and concerns	Comment / examples of potential impacts
	Sundarbans. However, forest managers are concerned about their potential future spread and impacts.
River bank erosion	• River bank erosion is a particular concern in the Sundarbans due to river flow dynamics and changing river courses. It is linked to the formation of new islands and river bed siltation due to reduced freshwater flow. • Bank erosion also occurs due to bow-waves from the increased numbers of fast-moving ships and due to river bed siltation, formation of new islands and changed river courses, as well as increasing sea water inflow in SWR.
Climate change • Sea level rise • Salt water intrusion • Erratic rainfall & distribution • Increased average temperatures • Cyclones & storm surges • Greenhouse gas emissions	 • Sea level rise is a global threat that will impact on the region. • Many factors have reduced river flow in the region, decreasing flushing time, with increased periods of saltwater exposure. • Shifting of monsoon with erratic rainfall has impacted on the cropping season and pattern • Climate models predict a significant temperature increase in the future. • Cyclones making landfall have an impact on lives and livelihoods and cause damage). Cyclone intensity is predicted to rise in the future. • Rapid industrialisation and urbanisation is likely to lead to increased carbon dioxide emissions from power and energy sector (including transport). Expansion of flood-irrigated paddy rice has increased methane emissions. • Peat is extracted from areas around Gopalgonj and Khulna are used as fuel which may increase GHG emissions.
Flooding and waterlogging: • Freshwater floods (due to rain) upstream • Tidal • Poor drainage infrastructure and management	• Exceptional freshwater flooding and waterlogging may occur due to heavy rain in the upstream/catchment areas of SWR, lack of drainage infrastructure and high tidal flow, as well as because of changing river flow dynamics and river siltation. • Due to lack of periodic maintenance and management, parts of the polder system have become waterlogged in Khulna and Satkhira Districts.
Industrialisation: • Power generation – oil, gas, coal • Pipelines • Petroleum • Cement production • Brick production • Special economic zones	Industrialization of the inland parts of SWR can create air & water pollution as well as other potential impacts on biodiversity & livelihoods of the region.
Urbanisation	Rapid urbanization in the 14 districts of SWR as well as in the environmentally critical area around the Sundarbans can affect the extent of air & water pollution and agricultural productivity etc.
Land use changes	Land use changes in areas north of the Sundarbans are arising due to population & economic growth of SWR, e.g. shrimp cultivation,

Issues and concerns	Comment / examples of potential impacts
	infrastructures & urbanization, etc. Impacts of this include loss of biodiversity, reduced soil productivity and loss of livelihood opportunities
Conservation of protected areas	• Many highly sensitive & important biodiversity areas have been declared by law as protected areas. However, laws are not always strictly enforced and people lack adequate knowledge and awareness about the need for nature conservation in such areas.
Socio-economic	
Livelihoods:	
• Conflicts between economic sectors	• Salinity intrusion causes conflicts, e.g.: shrimp cultivators vs crop producers; powerful/rich land controller's vs the powerless, smallholder and marginalized people, etc.
• Access to resources (e.g. in Sundarbans)	• Access by forest-dependent people to forest resources (to support their livelihood options) is limited so as to prevent exploitation and to maintain a sustainable flow of resources – as prescribed in the Sundarbans Management Plan.
• Salinity	• Causes health problems (e.g. skin conditions), reduces drinking water quality – impairing people's ability to work, and affects crop production, etc.
Out-migration	Out-migration (mainly poor people) is common in SWR, especially from coastal areas. Much is driven by disasters, indebtedness, dispossession/land grabbing, lack of livelihood options, etc. Poor people move to unhealthy urban slums and become further marginalised in an uneven job market. Some educated people move to urban areas /overseas for employment. Migrant remittances can supplement family incomes and contribute to the national economy.
Health & sanitation: Water-borne, respiratory & salinity-related diseases	Local people, especially children and elderly people, are particularly susceptible to water-borne, respiratory and salinity-related skin diseases
• Diet	• Poor diet causes malnutrition.
• Pollution from cooking and open burning	• Can have serious health impacts
• Negative health impacts of indoor air pollution (mainly pollution by particulate matter and polycyclic aromatic hydrocarbons)	• Rural people still dominantly cook using fuelwood which, if indoors, can cause air pollution and can have serious health impacts.
• Inadequate health facilities and access	• Health service providers are based in city/urban and peri-urban and rural areas. There are community clinics and some alternative medical treatment facilities in both urban and rural areas, i.e. homeopathic, unani-ayurvedic. However, the specialized hospitals are located mostly in urban areas cannot be easily accessed by those requiring emergency treatment living in remote areas, due to poor communication networks. • Water supply and sanitation facilities in urban and semi urban areas (e.g. public toilets in public places and local markets) are either inadequate or in a poor condition.
• Arsenic contamination of water, and possibly of irrigated rice	• Arsenic contamination of drinking water is a serious issue in parts of the SW region.

Issues and concerns	Comment / examples of potential impacts
	• There is some evidence from a 2003 study of elevated levels of arsenic in paddy soils irrigated with groundwater in the north of the SW region, but no known subsequent published evidence. Research is needed to determine the situation and whether rice from such areas is contaminated to levels which would pose a health problem.
Gender-related issues	Women face socio-political exclusion in decision-making processes - both in the home and society. They also bear a heavy burden for collecting potable water, fuelwood (from the Sundarbans and adjacent areas), etc. Women are often vulnerable while travelling alone to/from remote areas.
Education: • Dropout and poor attendance • Low environmental awareness	• Males from poor households need to support family income, resulting in high drop out and/or lower attendance at school. • Drop out of students from poor households, particularly from secondary schools, is a significant problem. This can be due to: o Poor transport network and low income in rural areas which often discourages/hinders school attendance. o Early marriage, especially for women. • The above problems result in low levels of environmental awareness
Loss of traditional knowledge	Technological advancement & other development activities may be causing loss of traditional knowledge.
Loss of cultural and natural heritage	Due mainly to lack of proper maintenance & negligence of cultural sites due to low revenue return and inadequate budget allocation.
Tourism	There is concern regarding pollution and noise from tourism activities in and around Sundarbans area – noise is particularly disruptive to animal. If not properly and effectively managed, tourism could cause increasing problems, particularly as the sector grows
Illegal activities: • Poaching and hunting • Poison fishing • Illegal tree cutting • Trafficking of wildlife products • Corruption	These issue are of major concern in the Sundarbans, causing loss of habitat and biodiversity (terrestrial & aquatic) & economic loss for communities.
Institutional issues	Inadequate manpower, capacity development & logistics are major institutional issues – impeding environmental management and protection of the Sundarbans.

Chapter 4 presents the results of modelling of air and water quality for the high growth scenario till 2031 and 2041.

For *air pollution*, the results show that for the SW region as a whole:

- Pollution by particulate matter, especially $PM_{2.5}$, presents a very high risk for human health, and may also have an impact on fauna and flora.
- Pollution by NO_2 can be considered moderate from the point of view of both health impacts and impacts on vegetation/ecosystems.

- Pollution by SO_2 can be considered negligible from the point of view of both health impacts and impacts on vegetation/ecosystems.
- The Mongla – Rampal- Khulna and, Khanjan-Ali areas are currently the most polluted by PM and NO_2 in the SW region, and (according to modelling predictions) will remain so by 2031 and 2041. The higher PM and NO_2 levels found here are due to activities in or near Mongla.
- It is recommended to implement mitigation measure to manage PM but also NOx emission reduction measures that are feasible, efficient and cost-effective - preferably in the Mongla area.
- The most polluted sites as regards PM and NO_2 are near Mongla (both currently and predicted by 2031 and 2041). The modelling shows a field of already raised levels of PM in the baseline year (2019) in the Khulna area, moving south over time with the occurrence, by 2031 and 2041, of a field of more elevated PM and NO_2 concentrations (approximately 2,000 km^2) occupying a 30 km wide band (west to east) and 65 km long (north to south) - from Khulna to the Mongla area. This has major significance for the human health in that zone as well as non-negligible signification[3] for the health of vegetation therein.

With specific reference to *air quality* in the Sundarbans:

- The level of pollution by PM_{10}, $PM_{2.5}$, SO_2 and NO_2 is, and most probably will remain, lower (on average) in the Sundarbans that in the rest of SW region up to 2041.
- Within the Sundarbans, pollution levels in the southern part (World Heritage Sites) are lower than those in the northern part.
- The impact of NO_2 pollution on vegetation/ecosystems is, and most probably will remain, low in the southern part of Sundarbans. In the northern part of Sundarbans, it can be considered moderate at present, but will increase over the next 20 years (due to the increasing trend at all key receptors in the northern part of the Sundarbans).
- Pollution by SO_2 can be considered negligible.
- Pollution by PM, especially $PM_{2.5}$, is expected to remain stabilised or to decrease at six of nine key receptor points over the next 20 years, but still mostly exceeds national standards for the protection of human health. Moreover, it also represents 'non-negligible' (a term used in applying the Precautionary Principle) risk for fauna and flora (possible impact on morphological, biochemical and physiological aspects).
- In the case that the recently announced plans of the Bangladesh Government to scrap five planned/newly built coal-fired power plants and to transform a further five plants from coal to natutal gas are implemented, further reduction of air pollution by PM and NOx can be expected as well as a reduction of carbon dioxide emissions.
- It is recommended to implement PM and NOx emission reduction measures, preferably in the Mongla area; and also to implement appropriate measures in the Harbaria area to compensate (reduce) for the increase of emissions caused by expected economic growth Applying the Precautionary Principle[4], it is further suggested to select and implement appropriate measures to reduce emissions of NOx[5].
- It is recommended to develop an air quality monitoring network based on automated stations to generate 'near-to-real-time' information on actual air quality and to make that information available to the public.

[3] Non negligible is a term used in elation to the Precautionary Principle.

[4] https://en.wikipedia.org/wiki/Precautionary_principle

[5] Moreover, nitrogen oxides in addition to their direct negative impact on human health and vegetation also act as precursors of the formation of secondary particulate matter in the air.

- It is recommended to develop and regularly update an inventory of air pollutant emissions in accordance with international standards.
- Air quality modelling should be regularly re-run to incorporate up-dated and new data in order to provide revised information for the best management of pollution issues
- It is also recommended that research on the impact of PM on fauna and flora in the Sundarbans is undertaken.

For the assessment of *water quality*, organic pollution of surface water (in terms of BOD) was not included in the modelling due to the lack of reliable data.

The modelling of the nitrate and phosphate content of surface waters show that:

- Nitrate concentrations will decline from the baseline year (2020) by 2031 and further by 2041. However, in order to avoid any deterioration of river water quality in future, heavy industrial development should be accompanied with installation of efficient wastewater treatment facilities. Large municipalities should also be equipped with wastewater treatment plants (STPs).
- Current phosphate concentrations (in 2020) are somewhat elevated at some points in the wet season. This could be due to agricultural run-off from crop fields and grazing lands as well as municipal and industrial discharges. Such run-off and discharges containing high concentrations of dissolved phosphorous compounds need to be reduced/treated immediately. However, the model predicts that by 2031 and 2041, phosphate levels will remain within the safe limit value of 0.5 mg/L set by the inland surface water quality standards of Bangladesh (Draft ECR '2017). Stringent environmental regulations should be adopted and implemented. Furthermore, technologies to remove phosphorus compounds from waste water need to be implemented along with balanced agricultural practices.
- The BOD levels should be systematically monitored in all river systems of the SW region: river-specific monthly monitoring of vertical BOD profile, seasonal assessment of BOD levels of effluents from municipal sources, agricultural run-off and domestic discharges.
- Water quality monitoring should be extended to cover other relevant pollutants (COD [6] hydrocarbons, AOX[7], metals).
- In future, the levels of BOD and other pollutants at designated locations can be estimated by the model used in this SEA using systematically collected data.
- Scientific research is recommended to identify the major contributors to pollution causing raised BOD levels in the river systems

Conclusions for air and water quality

The air quality (particularly fine particulate matter, specifically $PM_{2.5}$) presents a risk to the overall SW region, particularly the human population. There are also risks for fauna (particularly benthic communities), flora, habitats and ecosystem functioning within the Sundarbans which needs to be investigated by research. The risk is more significant for the northern part of Sundarbans in the Mongla area which is expected to be influenced by the economic development in and around Mongla. This risk should be reduced by implementation of compensation measures – particularly to reduce emissions of air pollutants. Many PPPs include compensation measures (i.e. to reduce emissions of air pollutants and treat discharges of water pollutants) which should be implemented in a timely and efficient manner. Consideration should be given to making payments for eco-system services (PES).

[6] Chemical Oxygen Demand

[7] Adsorbable Organic Halides

Chapter 5 describes three alternative growth scenarios (high, medium and low) for the SW region over the next 20 years – as influenced by a range of interacting driving forces and recognising a number of uncertainties, e.g. climate and water variability, future pandemics, commodity prices, and the nature of governance:

- *High growth* represents the growth path that will be required – through added stimulus (investment, innovation, etc.) to achieve high income country (HIC) status by 2041. This is Bangladesh's central economic policy objective as committed to in the Second Perspectives Plan;
- *Medium growth* is equivalent to the country's current growth path aimed at achieving upper middle income country (MIC) status by 2031;
- *Low growth* – this scenario postulates a reduction of economic growth that *could* be triggered mostly by external factors – over which Bangladesh has little or no control (see section 5.2.1);

Each scenario incorporates indicators and projections of the developments that will be likely to arise over the next 20 years including, for example, new/upgraded infrastructure, new industrial and power generation facilities, changed environmental and social management regimes, changes to agricultural and fisheries activities, etc.

Chapter 6 provides the results of an initial 'broad scale' assessment of the high, medium and low growth scenarios. The assessment provides a comparative picture of the likely combined impacts of overall development across all sectors in the SW region over the next 20 years under each scenario. The impacts are reflected in terms of whether they will enhance or impede achieving objectives to address (avoid, mitigate or redress) the key environmental and socio-economic issues).

The scenarios have been assessed against two situations (Table E.2):

- various assumptions[8] being met ('mitigated' outcome); or
- the assumptions are not met ('risk' outcome).

The overall picture is that the medium and high growth scenarios will flow seamlessly from one to the other as government policy under the Second Perspectives Plan (2021-2041) progressively unfolds. Along this trajectory, there will be progressively more positive impacts and more beneficial outcomes if the 'M' column assumptions are fully met; but progressively more risks and negative environmental and socio-economic impacts (the 'R' column) if those assumptions are not met.

The low growth scenario is obviously not a policy choice, nor is it a prediction. But it does indicate a possible future if unforeseen and unexpected circumstances conspire to undermine development. At best, this could delay progress towards the country achieving its goals to achieve upper MIC status by 2031 and HIC status by 2041. At worst, if low growth is protracted, it could derail achieving these aims for a considerable period. This scenario is presented to enable government to consider response/contingency planning; and this includes implementing the measures in the SEMP just as much as it does for the medium and high growth scenarios.

[8] Existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced, and the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies – thus enhancing realizing the environmental and socio-economic objectives.

Table E.2: Outcomes of Scenario Assessments Compared

Scenario	Risk outcome (R)	Mitigated outcome (M)
High growth	**Mainly very negative environmental impacts** – severely impeding realising the environmental objectives. Rather than delivering anticipated socio-economic benefits, high growth would instead result in **either no change** in achieving about a third of the listed socio-economic objectives **or in slightly to very negative** effects which would significantly impede achieving two thirds of the socio-economic objectives. The implication of this outcome would be that **many of the current environmental and socio-economic challenges would continue or become worse.**	**Mainly significantly positive and very positive** effect on achieving the majority of the environmental objectives, with **some slightly and moderately positive** effects on achieving a few of the objectives **Very and significantly positive** effects on enhancing achieving socio-economic objectives
Medium growth	**Mainly moderately and very negative** effects on achieving the environmental objectives. Rather than delivering anticipated socio-economic benefits, medium growth would instead result in **either no change** in achieving about a third of the listed socio-economic objectives **or in a slightly to moderately negative** effect on achieving the other socio-economic objectives	**Dominantly moderately positive environmental and socio-economic** effects on achieving environmental objectives **Dominantly moderately positive effects** on achieving two thirds of the socio-economic objectives, with either slightly or **very positive effects** for the remaining socio-economic objectives.
Low growth	**Dominantly very and significantly negative** effects on achieving environmental objectives **Moderately negative effects** on achieving two thirds of the socio-economic objectives; with either slightly or very negative effects on achieving the remaining socio-economic objectives	**Dominantly neutral** effects on achieving environmental objectives, with some slightly positive and slightly negative effects. **Slightly positive effects** on achieving half of the socio-economic objectives, and no change as regards achieving the other half of the socio-economic objectives

Chapter 7 presents a deeper assessment which builds on the initial assessments of the three growth strategies. But it focuses specifically on the high growth scenario as this accords with the government's policy to achieve high income country (HIC) status by 2041. Separate assessments are made of nine key sectors: industry, transport[9], urban, power and energy, forestry, fisheries, water, tourism and agriculture. They follow the same procedure used for the initial assessment. The results are assimilated into a combined analysis to indicate (crudely) cumulative impacts (Tables E.3 and E.4).

[9] Includes transport by road, rail, water (including shipping, tourist and fishing boats) and air. These modes are assessed together as they are part of an integrated system with distinct links between them.

Table E.3: Comparison of Sector Assessments – Mitigated Scores

Scoring reflects whether the suite of developments likely to arise under each sector under a high growth scenario will enhance (+ scores) or impede (-ve scores) achieving the objectives

Range of scores

Very significant and significant negative scores: '-5' and '-4' respectively. Very negative score: '-3'. Moderately and slightly negative scores: '-2' and '-1' respectively.

Neutral [0]

Very significant and significant positive scores: '+5' and '+4' respectively. Very positive score: '+3'. Moderately and slightly positive scores: '+2' and '+1' [add tone] respectively.

Total scores: **15-20+**; 7-14 ; 1-6

Environmental and socio-economic issues and objectives			Industry	Transport	Urban	Power & energy	Forestry	Fisheries	Water	Tourism	Agriculture	Total
Environmental												
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	+4	+1	+1	+3	+4	+3	+4	+1	0	+21
	2	Reduce illegal activities related to protected areas and biodiversity	+2	0	0	+2	+4	+4	0	0	0	+12
	3	Reduce introduction and spread of Invasive Alien Species	+1	0	0	+1	0	+2	0	0	+3	+7
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	+2	+3	+4	+4	0	+3	0	+1	0	+17
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	+3	+3	+3	+4	0	+1	+4	+1	+1	+20
	6	Minimise emissions of greenhouse gases	+1	+2	+1	+2	+2	0	0	0	+1	+9
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity intrusion in rivers, floods, storm surges, etc.)	0	+2	+1	0	+2	0	+3	0	0	+8
Water	8	Increase dry season freshwater flow in rivers	0	0	0	0	+1	0	+4	0	0	+5
	9	Reduce high/peak flows in rivers during monsoon season	0	0	0	0	+1	0	+3	0	0	+4

Environmental and socio-economic issues and objectives			Industry	Transport	Urban	Power & energy	Forestry	Fisheries	Water	Tourism	Agriculture	Total
Land degradation	10	Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion, etc)	0	+1	0	0	+1	+2	+3	0	0	+7
Land use change	11	Minimise conversion of agricultural land (e.g. conversion to shrimp ponds)	+1	0	0	0	0	0	0	0	0	+1
		Cumulative score	***14***	***12***	***10***	***16***	***15***	***15***	***21***	***3***	***5***	
Socio-economic												
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	+4	+4	+4	+4	+2	+4	+4	+3	+3	+32
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	+2	+2	+2	+1	+1	+2	+4	+2	0	+16
Health and sanitation	14	Improve health services and health of society (eg by reducing vulnerability to diseases)	+2	+1	+3	+1	+3	0	+3	+1	0	+14
	15	Improve and extend water supply and sanitation services	+2	+1	+3	+1	0	0	+4	0	0	+11
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	+1	+1	+3	+1	+1	+1	0	+2	+1	+11
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	+3	0	+3	0	0	0	0	0	0	+6
Women and children	18	Improve gender equality and empowerment of women	+3	0	0	0	+1	0	0	+2	0	+6
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities in SW region	+2	0	+2	+1	+2	0	0	0	0	+7
Conflicts and security	20	Reduce conflicts over use of land	+2	0	0	+2	0	+3	0	0	0	+7
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.) and also Sundarbans natural heritage sites	+1	0	+2	+1	+3	0	+3	+3	0	+13
Food security	22	Improve food security	+2	+2	+1	+1	+1	+4	+4	+1	+3	+19

Environmental and socio-economic issues and objectives			Industry	Transport	Urban	Power & energy	Forestry	Fisheries	Water	Tourism	Agriculture	Total
Agriculture and fisheries	23	Increase agricultural and fish production	+1	+1	0	+1	+2	+4	+4	0	+3	+16
Power and energy	24	Increase uptake of renewable energy	+1	0	+3	+3	0	0	0	0	0	+7
	25	Increase efficiency in production and consumption of energy	+2	+1	+2	+4	+1	0	0	0	0	+10
	26	Increase access to affordable energy	+2	0	+2	+4	+1	0	0	0	0	+9
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts	0	+1	0	0	+3	0	0	+3	0	+7
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	0	+3	+2	+3	0	0	0	0	0	+8
	29	Optimise the existing and future physical footprint of transport services (rail, road, waterways)	0	+4	+2	+4	0	0	+2	0	0	+12
		Cumulative score	***30***	***21***	***34***	***32***	***21***	***18***	***28***	***17***	***10***	
		Overall cumulative score	***44***	***33***	***44***	***48***	***36***	***33***	***49***	***20***	***15***	

Table E.4: Comparison of Sector Assessments – Risk Scores

Scoring reflects whether the suite of developments likely to arise under each sector under a high growth scenario will enhance (+ scores) or impede (-ve scores) achieving the objectives

Range of scores

Very significant and significant negative scores: '-5' and '-4' respectively. Very negative score: '-3'. Moderately and slightly negative scores: '-2' and '-1' respectively.
Neutral [0]
Very significant and significant positive scores: '+5' and '+4' respectively. Very positive score: '+3'. Moderately and slightly positive scores: '+2' and '+1' [add tone] respectively.

Total scores: 14-20+ ; 7-13 ; 1-6 .

Environmental and socio-economic issues and objectives			Industry	Transport	Urban	Power & Energy	Forestry	Fisheries	Water	Tourism	Agriculture	Total
Environmental												
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	-3	-2	-1	-3	-3	-3	-3	-2	0	-20
	2	Reduce illegal activities related to protected areas and biodiversity	0	0	0	0	-3	-3	0	0	0	-6
	3	Reduce introduction and spread of Invasive Alien Species	0	0	0	0	0	-3	0	0	-3	-6
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	-3	-3	-3	-3	0	-2	0	0	0	-14
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	-3	-3	-3	-3	0	-1	0	0	-1	-14
	6	Minimise emissions of greenhouse gases	-2	-2	-1	-3	-3	0	0	0	-1	-12
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity intrusion in rivers, floods, storm surges, etc.)	0	-2	-1	0	-2	0	-3	0	0	-8
Water	8	Increase dry season freshwater flow in rivers	0	0	0	-1	-1	0	-4	0	0	-6
	9	Reduce high/peak flows in rivers during monsoon season	0	0	0	0	-1	0	-3	0	0	-4

Environmental and socio-economic issues and objectives			Industry	Transport	Urban	Power & Energy	Forestry	Fisheries	Water	Tourism	Agriculture	Total
Land degradation	10	Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion, etc)	0	-1	0	0	-1	-3	-3	0	0	-8
Land use change	11	Minimise conversion of agricultural land (e.g. conversion to shrimp ponds)	-1	0	0	0	-1	-4	0	0	0	-6
		Cumulative score	**12**	**13**	**9**	**13**	**15**	**19**	**16**	**2**	**5**	
Socio-Economic												
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	-2	-3	-3	-2	-1	-4	-4	-2	-2	-23
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	-1	0	-1	-1	-1	-1	-4	-1	-1	-11
Health and sanitation	14	Improve health services and health of society (eg by reducing vulnerability to diseases)	-1	-1	0	0	-3	0	-3	-2	0	-10
	15	Improve and extend water supply and sanitation services	-1	-1	-1	0	0	0	-3	0	0	-6
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	0	-1	-1	0	0	0	0	-1	0	-3
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	-2	0	-1	0	0	0	0	0	0	-3
Women and children	18	Improve gender equality and empowerment of women	-1	0	0	0	-1	0	0	-1	0	-3
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities in SW region	0	0	0	0	-2	0	0	0	0	-2
Conflicts and security	20	Reduce conflicts over use of land	-2	0	0	-2	0	-3	0	0	0	-7
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.) and also Sundarbans natural heritage sites	-1	0	0	-1	-3	0	-2	-2	0	-9
Food	22	Improve food security	-1	-1	0	-1	-1	-2	-4	0	-2	-12

Environmental and socio-economic issues and objectives			Industry	Transport	Urban	Power & Energy	Forestry	Fisheries	Water	Tourism	Agriculture	Total
Agriculture and fisheries	23	Increase agricultural and fish production	-1	-1	0	-1	-1	-1	-4	0	-2	-11
Power and energy	24	Increase uptake of renewable energy	0	0	-1	-1	0	0	0	0	0	-2
	25	Increase efficiency in production and consumption of energy	0	0	0	0	-1	0	0	0	0	-1
	26	Increase access to affordable energy	0	0	0	0	-1	0	0	0	0	-1
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts	0	-1	0	0	-2	0	0	-2	0	-5
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	0	-2	0	-1	0	0	0	0	0	-3
	29	Optimise the existing and future physical footprint of transport services (rail, road, waterways)	0	-2	-1	-2	0	0	-2	0	0	-7
		Cumulative score	**13**	**13**	**9**	**9**	**15**	**11**	**26**	**11**	**7**	
		Overall cumulative score	**25**	**26**	**18**	**22**	**30**	**30**	**42**	**13**	**12**	

Table E.3 shows how development arising from the implementation of PPPs under high growth can result in ***positive benefits*** under all of the key sectors through enhancing achievement of the objectives for the key environmental and socio-economic issues that face the SW region. However, this is dependent on the above mentioned assumptions being met.

The cumulative negative scores for each sector (environmental, socio-economic and overall are broadly distributed across all sectors. No sectors stand out as being more important in terms of generating negative environmental, or socio-economic outcomes, although the highest cumulative scores are attributed to although the highest cumulative scores are attributed to five particular sectors: water, forestry, transport, industry and fisheries.

The greatest total positive scores (thus the highest benefits) (aggregate score of 15 or more) were found for three environmental objectives and four socio-economic objectives: biodiversity, habitats and ecosystem services (objective 1); waste and pollution (objectives 4 and 5); economic growth (objective 12); employment (objective 13); food security (objective 22); and agricultural and fish production (objective 23).

Table E.4 shows how development arising from the implementation of PPPs under high growth could result in ***negative outcomes*** under all of the key sectors through impeding achievement of the objectives for the key environmental and socio-economic issues that face the SW region. No sectors stand out as being more important in terms of generating negative environmental, or socio-economic outcomes, although the highest cumulative scores are attributed to five particular sectors: water, forestry, transport, industry and fisheries.

The greatest total negative scores (thus the highest negative impacts) (aggregate score of 15 or more) were found in respect of three environmental objectives and one socio-economic objective (that the SEMP pays particular attention to) concerning: biodiversity, habitats and ecosystem services (objective 1); waste disposal and pollution (objectives 4 and 5); economic growth (objective 12); and employment (objective 13);

But significant total scores (7 to 13) – indicating issues of concern that the SEMP also focuses on – were also found for ten other objectives: greenhouse gases (objective 6); vulnerability to climate change and disasters (objective 7); land degradation (objective 10); employment (objective 13); health (objective 14); conflicts over land (objective 20); natural and cultural heritage sites (objective 21); food security (objective 22); agricultural and fish production (objective 23); and footprint of transport services (objective 29).

Chapter 8 interprets the deeper sector-by-sector assessment (Chapter 7) and discusses key negative environmental and socio-economic impacts of the high growth scenario (i.e. the risk) if adequate mitigatory measures are not followed:

- Existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced;
- No or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development; and/or
- The use of clean and sustainable technologies is not compulsory and adopted.

But, if such measures are put in place (as outlined in the accompanying SEMP), then, in most cases, the negative impacts will be considerably reduced or eliminated and, often, they will be turned into positive impacts so that beneficial outcomes are achieved for the environment, society and the economy.

Chapter 9 provides a more detailed analysis of cumulative impacts (positive and negative) – using linkage diagrams (see example in Figure E.2) - of the principal development activities likely to be implemented for the nine key sectors (listed in Table E.5).

Table E.5: Principal Development Activities for Key Sectors

Sector	Key activities during 2021-2041
Industry	Rapidly expanding industrialization in an efficient way
Transport	Expansion and or upgrading of the road and rail network
	Upgrading, maintenance and re-instatement of the river transport network
Urban	Expansion and modernisation of cities and towns
Power and Energy	New or upgradation of powerplants and transmission and distribution systems
	Technology investment for introduction of renewable energy sources and increased energy efficiency in both production and consumption
Forestry	Conservation of Sundarbans forests
	Promotion of social forestry on homestead and marginal land in the SW region
Fisheries	Increased shrimp and fish production (capture and cultured)
Water	Dredging of rivers and construction of diversion structures (to enhance dry season flow, and control floods and river bank erosion)
Tourism	Development of eco-tourism inside Sundarbans
	Diversified tourism activities outside Sundarbans
Agriculture	Industrialisation of agriculture and increased production

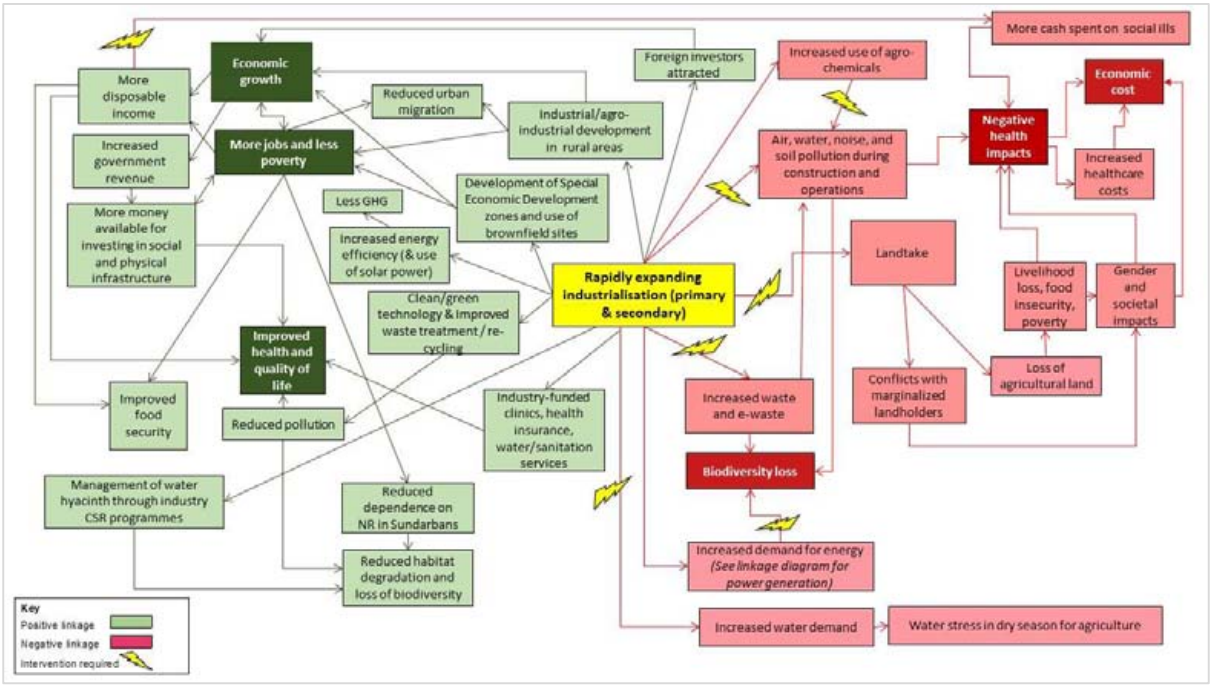


Figure E.2: Example Linkage Diagram for Rapidly Expanding Industrialisation

The linkage diagrams provide a very clear signal of the logic and importance of ensuring that the Strategic Environmental Management Plan (SEMP) is pursued with determination and commitment across government; and is fully and effectively implemented – in order to avoid, minimise or mitigate these impacts arising. Indeed, investing in the SEMP will mean avoiding the economic costs of the risks involved – which are highly likely to be significantly greater than the costs of implementing the SEMP itself. In other words, implementing the SEMP will be a good investment.

Chapter 10 makes a range of conclusions (including on the status of the outstanding universal value (OUV) of the Sundarbans WHS) and makes various recommendations.

A full set of ***reference***s for all works cited in the text is included and the report is supplemented by a suite of ***annexes*** providing further information.

Overall conclusion

The SEA has responded to the concerns raised by UNESCO and others about the potential impacts on the Outstanding Universal Value (OUV) of the World Heritage Sites, and on the Sundarbans as a whole, of existing and planned developments in the SW Region. It has examined the impacts of current and planned future (over the next 20 years) developments in the SW region arising from implementing 89 policies, plans and programmes across multiple sectors. It has also taken into account transboundary pressures – those arising from neighbouring countries and elsewhere in Bangladesh.

The impacts have been addressed in terms of their significance for the SW region as a whole and its peoples, as well as for the Sundarbans. Clearly the government's development policies (particularly the Second Perspectives Plan: 2021-2041) will result in significant socio-economic benefits for the region. But this depends on various assumptions mentioned above (see section on Chapter 6) being fully met. But, if this is not the case, then there will be significant environmental and social risks which will generate significant environmental and socio-economic impacts – including significant economic costs.

The media, international and conservation organisations and others frequently assert that the Sundarbans is under threat from climate change, human development (particularly industrialisation). Some of the arguments advanced are somewhat emotive and some do not take account of the facts or scientific research into account. This SEA has examined the available data and looked at the potential environmental and socio-economic risks of rapid development in the SW region (as a whole). The risks are far more significant for the broader SW region and its peoples (particularly their health and livelihoods) than for the Sundarbans itself. However, modelling has shown that there is (and will continue to be) a field of elevated concentrations of PM and NOx (but with levels well below the Bangladesh standard) centred on Mongla. It is recommended to implement mitigation measure to manage PM, but but also NOx emission reduction measures that are feasible, efficient and cost-effective - preferably in the Mongla area.

The risks – for both the region and the Sundarbans (including the World Heritage Sites and their OUV) - can be minimised and managed provided that:

- the SEMP is fully and effectively implemented (to enable this, proposals are made in the SEMP for coordination arrangements under the PMO);
- there is full and effective implementation of existing environmental and socio-economic safeguards, laws, regulations and guidelines;
- clean (green) and sustainable technologies is ensured, at least for future developments;
- the upcoming new Sundarbans Management Plan is updated appropriately to reflect the findings of the SEA and recommendations in the SEMP;
- The Management Plans for the three existing (approved) Sundarbans Wildlife Sanctuary Management Plans (East, West and South) are fully and effectively implemented;
- there is effective liaison and improved cooperation (perhaps through a national level committee) between the Bangladesh Forest Department and other organisations/agencies that have activities that impact on the Sundarbans – particularly from shipping, industry, water and tourism - to ensure that required coordination, management and mitigatory actions are taken.

1. Introduction

1.1 Background to the SEA

With a land mass of 147,570 sq. km and a population of over 164 million, Bangladesh is one of the most densely populated countries (approx. 1116 per sq. km) in the world. In terms of area Bangladesh is a small country with international borders with India on east, north and west. If we take the capital Dhaka as the reference point, one would only have to travel 75-150 kms to reach international borders or the Bay of Bengal. An example can highlight this uniqueness, if 40% of the land area of Germany is inhabited by a combined population of Germany, France, Norway and Sweden, it would look like Bangladesh.

Despite the high population density and other resource constraints, Bangladesh is progressing forward with a steady economic growth of 6-7.5%; per capita income has thus increased to over 2,500 USD in fiscal year 2020-2021.

Landmark development successes have been fuelled by impressive achievements in a broad swath of the economy. For instance, Bangladesh is 4th in world in terms of fish production, 2nd in terms of Jute production, 2nd in terms of garments industry, and 4th in terms of rice production. Recent statistics of World Bank marks the increase of agriculture production in the country as the second highest in the world during the last 20 years. These are evidences of a mature strategy that has efficiently harnessed resources for the well being of the people.

A small country rich in biodiversity, Bangladesh boasts of more than 6000 floral species; and a total of 1619 faunal species which include various vulnerable and endangered species. Total forest area in Bangladesh is approximately 16.88% or 24,915 sq. km. currently, 3.17% of total land area of the country are considered as biodiversity hotspot or protected area which include two special biodiversity area, 13 ecologically critical areas, 2 marine protected area and 24 wildlife sanctuaries.

One of the most prominent biodiversity hotspots of Bangladesh is the Sundarbans with a total area of 6000 sq. km., out of which, 1397 sq. km. has been marked as world heritage site in 1997 by UNESCO shown in Figure 1.1. A reputed biodiversity hotspot harbouringnumerous species of birds, reptiles, mammals, fish as well as the famous Royal Bengal Tiger, the Sundarbans have undergone positive changes in the last decades with increase of the mangrove forest over the last four epochs (1976-2015) being from 436,617 ha in 1976 to 494,757 ha in 2015. Sundarbans acts as a major carbon sink for Bangladesh with a capacity of 136 million tons which is equivalent 499 million ton CO_2.

Bangladesh has managed to keep carbon emissions well under wraps even while pursuing ambitious developmental goals. It is ranked 148 out of 184 countries for per capita CO_2 emission. According to the Third National Communication, Bangladesh's per capita CO_2 emission is 0.98 which is very low in comparison to other countries. The 38 OECD countries emit about 35% of global CO_2 emissions, or an average of 8.9tons of CO_2 emitted per capita, from energy use. This of course does not take into consideration accumulated carbon emissions for past centuries.

The per capita carbon emission of the top countries with highest population count is given in the table below:

Table 1.1: Per capita CO_2 Emission of the top 10 highly Populated Countries

Country	Population (in millions, 2020)	Area (million sq. km)	Population Density	CO_2 emission (ton per capita, 2018)
China	1,410.9	9.42	149.7	7.4
India	1,380.0	2.97	464.1	1.8
United States	329.4	9.15	36.0	15.2
Indonesia	273.5	1.88	145.7	2.2
Pakistan	220.9	0.77	286.5	1.0
Brazil	212.6	8.36	25.4	2.0
Nigeria	206.1	1.27	162.7	0.7
Bangladesh	164.7	0.15	1116.0	0.98
Russia	144.1	16.38	8.8	11.1
Mexico	128.9	1.94	66.3	3.7

From the above table, it can be seen that although Bangladesh is densely populated, the carbon emission is very low at 0.98 tons per capita, making Bangladesh close to a carbon-neutral country.

Bangladesh is on a trajectory to become a High Income Country (HIC) by 2041. In contributing to achieving this goal, the SW region has significant prospects for development. The government is committed to ensuring that such development is sustainable and should not adversely affect the Outstanding Universal Value (see Box 1.1) of the Sundarbans.

The SW region is one of the hydrological regions of Bangladesh. It is largely under tidal influence and dependent on sweet water supplies from upstream, many parts having a unique brackish water ecosystem. The region has vast low-lying areas enclosed by man-made polders and is considered to be highly vulnerable to hazards induced by climate change. According to BIDS (2020), the population of the SW region was projected to reach 22.19 million by 2020 and reach 26.89 million by 2040. The region comprises the ten districts of Khulna Division, three districts of Dhaka Division and one district of Barisal Division. There are 50 municipalities, including Khulna City Corporation and six major cities: Faridpur, Chuandanga, Jeshore, Jhenaidah, Kushtia and Satkhira.

The Sundarbans covers 10,000 km^2 of land and water in the Ganges delta. It contains the world's largest area of natural mangrove forests. 60% (6017 km^2) of these forests occur in Bangladesh; the remainder in India. The area has both local and global significance due to its diversity, uniqueness, biological productivity and rich ecosystems, with a number of rare or endangered species living in the forest, including tigers, aquatic mammals, birds and reptiles. The area provides essential ecological services such as nursery grounds for many fish species, and coastal erosion protection against storms, tidal surges and cyclones.

Recently, concerns have been raised about the potential impacts on the Sundarbans of existing and planned developments in the SW region. In 2014 the UNESCO World Heritage Centre requested Bangladesh to undertake a comprehensive SEA to uphold the OUV of the Sundarbans (Box 1.1) (UNESCO Decision: 38 COM). Bangladesh agreed to conduct the SEA for SW region (acknowledged by UNESCO in the 41 COM, 2017). Accordingly, in 2018, Bangladesh prepared the ToR of the SEA to help assess the positive/negative, direct/indirect, domestic/transboundary and cumulative impacts at a landscape and regional scale covering nine key sectors. The overall aim is to ensure the sustainable development of the SW region whilst also ensuring the conservation of the Sundarbans.

In response, following an open tender process, the Bangladesh Forest Department (under MoEFCC) commissioned CEGIS and Integra Consulting to undertake the SEA. Work started in January 2020 and was carried out by a team of some 40 experts and specialists (Annex 2).

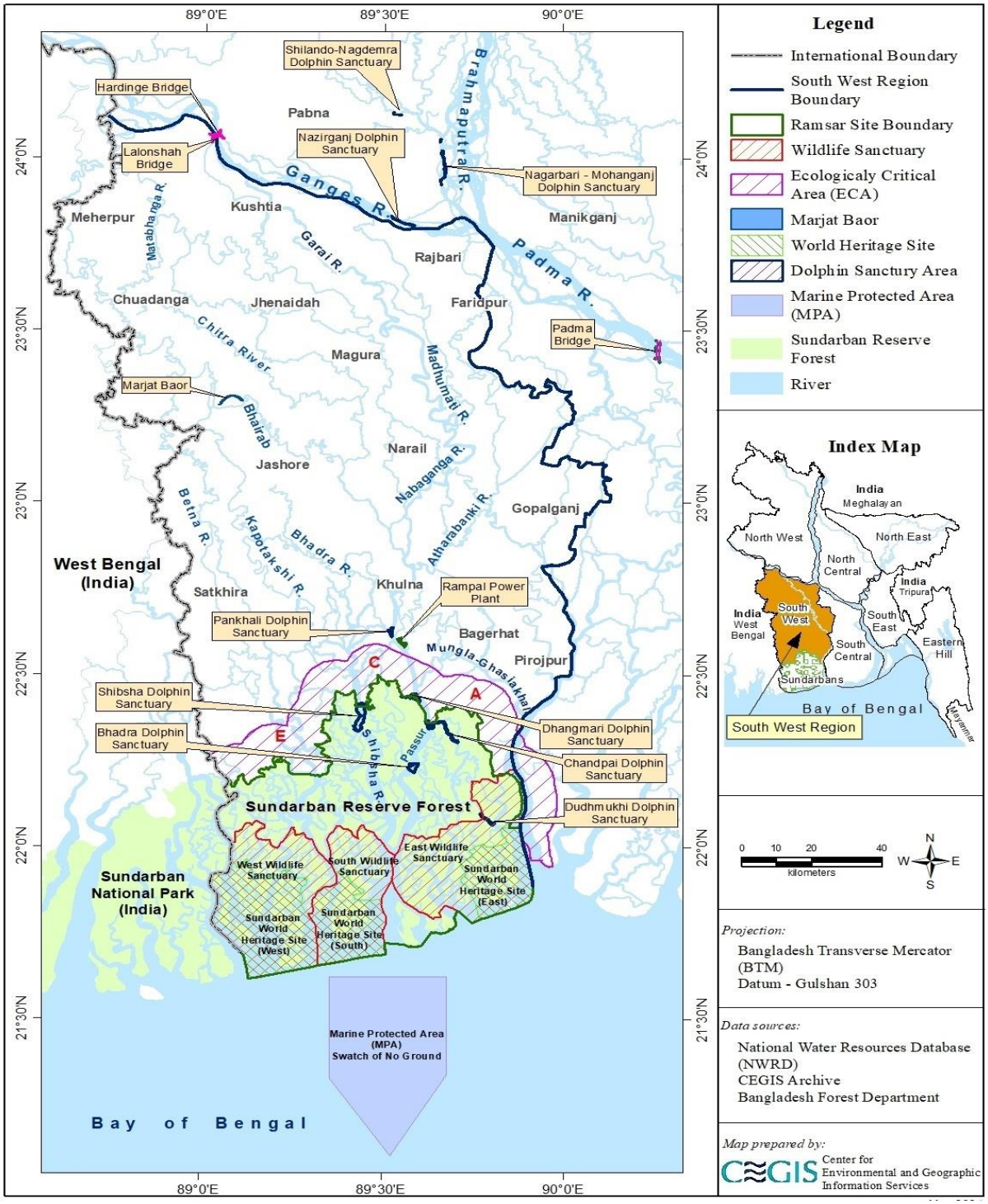


Figure 1.1: The SEA Area of Focus, World Heritage Sites and Protected Areas

Box 1.1: Outstanding Universal Value of the Sundarbans

The three wildlife sanctuaries in the south of the Sundarbans (Figure 1.1) cover an area of 139,700 ha and are considered core breeding areas for a number of endangered species. Situated in a unique bioclimatic zone within a typical geographical situation in the coastal region of the Bay of Bengal, it is a landmark of ancient heritage of mythological and historical events. Bestowed with magnificent scenic beauty and natural resources, it is internationally recognized for its high biodiversity of mangrove flora and fauna both on land and water.

The immense tidal mangrove forests of Bangladesh's Sundarbans Forest Reserve, is in reality a mosaic of islands of different shapes and sizes, perennially washed by brackish water shrilling in and around the endless labyrinths of water channels. The site supports exceptional biodiversity in its terrestrial, aquatic and marine habitats; ranging from micro to macro flora and fauna. The Sundarbans is of universal importance for globally endangered species including the Royal Bengal Tiger, Ganges and Irrawaddy dolphins, estuarine crocodiles and the critically endangered endemic river terrapin (*Batagur baska*). It is the only mangrove habitat in the world for *Panthera tigris* species.

According to UNESCO, ***"Outstanding Universal Value"*** means cultural and/or natural significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity. To be included on the World Heritage List, sites must be of outstanding universal value and meet at least one out of ten selection criteria. The Sundarbans has been accorded World Heritage Site status on the basis of meeting two criteria:

Criterion (ix): The Sundarbans provides a significant example of on-going ecological processes as it represents the process of delta formation and the subsequent colonization of the newly formed deltaic islands and associated mangrove communities. These processes include monsoon rains, flooding, delta formation, tidal influence and plant colonization. As part of the world's largest delta, formed from sediments deposited by three great rivers; the Ganges, Brahmaputra and Meghna, and covering the Bengal Basin, the land has been moulded by tidal action, resulting in a distinctive physiology.

Criterion (x): One of the largest remaining areas of mangroves in the world, the Sundarbans supports an exceptional level of biodiversity in both the terrestrial and marine environments, including significant populations of globally endangered cat species, such as the Royal Bengal Tiger. Population censuses of Royal Bengal Tigers estimate a population of between 400 to 450 individuals[10], a higher density than any other population of tigers in the world.

The property is the only remaining habitat in the lower Bengal Basin for a wide variety of faunal species. Its exceptional biodiversity is expressed in a wide range of flora; 334 plant species belonging to 245 genera and 75 families, 165 algae and 13 orchid species. It is also rich in fauna with 693 species of wildlife which includes; 49 mammals, 59 reptiles, 8 amphibians, 210 white fishes, 24 shrimps, 14 crabs and 43 molluscs species. The varied and colourful bird-life found along the waterways of the property is one of its greatest attractions, including 315 species of waterfowl, raptors and forest birds including nine species of kingfisher and the magnificent white-bellied sea eagle.

[10] This population estimate was made at the time of the WHS application. Following later changes in tiger counting methods - to a more scientific basis (camera trapping), the population of tigers within the Bangladesh part of the Sundarbans is now estimated at 114.

The Sundarbans Mangrove Forests

Source:
file:///C:/Users/bdala/AppData/Local/Packages/Microsoft.MicrosoftEdge_8wekyb3d8bbwe/TempState/Downloads/The%20Sundarbans%20-%20UNESCO%20World%20%20%20Heritage%20Centre%20(1).html

1.2 Objectives of the SEA

The overall aim is to ensure the sustainable development of the SW region (Figure 1.1) whilst also ensuring the conservation of the Sundarbans. The specific objectives of the SEA as set out in the Terms of Reference (Annex 1) are:

- Consideration of ***environmental and socio-economic consequences*** of existing policies, plans and programmes (PPPs) (national PPPs and those specific to SW region) and promoting that these issues be addressed when formulating and implementing future, as well as existing, PPPs with a view to promoting sustainable development in the region and conservation of the Sundarbans and its Outstanding Universal Value;
- Simultaneous assessment of the ***impacts of development initiatives*** on existing bio-physical settings and socio-economic conditions to facilitate informed decision-making regarding transitioning towards a sustainable, resilient and resource efficient economy;
- Identification ***of key stakeholders*** relevant to selected sectors and organising consultation meetings to obtain knowledge on existing bio-physical settings and socio-economic conditions, impacts of current and proposed developments, and potential strategies for future development of the SW region;
- Development of ***alternative strategies*** to minimize the direct/indirect, domestic/transboundary and cumulative impacts of development on the Sundarbans and more widely in the South West Region;
- Make ***recommendations to improve environmental performance management*** in both the public and private sectors as regards future development activities; and
- Formulation of a comprehensive framework in the form of a ***Strategic Environmental Management Plan (SEMP***) for the SW region to support decision making and monitoring of the implementation of policies, plans and programs that are likely to affect the environment and socio-economic conditions of the region and in particular the Sundarbans.

1.3 The SEA Study Area

The SW region refers to one of the eight hydrological regions of Bangladesh. It was designated as the SEA study area (and agreed by UNESCO WHC and Bangladesh (the State Party) in 41 COM 2017) because of potential environmental and socio-economic impacts, particularly on the Sundarbans, arising from existing and planned development activities in this region.

The SW hydrological region is fed primarily through the Ganges River System. The region is surrounded by an intricate rivers system with the Ganges to the North, the Kaliganga River to the East and joining the

Baleswar. The Ichhamati-Kalindi River lies to the west (flowing along the India-Bangladesh border) and joins with Raimangal near Shyamnagar.

There are 14 districts and 82 upazillas in this region. Mongla port is an important economic driver for the region.

The SW region is host to two World Heritage Sites: three wildlife Sancturies comprsing the Sundarbans (natural) WHS; and the Shat Gambuj Mosque (cultural) WHS. There is also one Ramsar Site (the Sundarbans) and Six Dolphin Sanctuaries.

1.4 Limitations to the SEA

Due to unforeseen circumstances of the COVID-19 pandemic which led to government shutdowns and limitations on holding physical meetings, it was not possible during various stages of the SEA to undertake the full process of consultations at all levels, as planned and outlined in the Inception Report. It was necessary to provide drafts of different reports to stakeholders by email and via the dedicated SEA website, but this proved un-successful in soliciting many written comments. A limited range of consultation workshops were able to be organized by video-conferencing and a separate Final Record of Stakeholder Consultations undertaken during the SEA (November 2021) (available on the website) provides details of all events, comments made and how they were responded to. Table 2.2 provides a summary analysis of stakeholder consultations.

1.5 About this Final SEA Report

This report SEA presents the outcomes of the main assessment phase of the SEA. It covers two steps:

a) An ***initial comparative assessment*** of three alternative growth scenarios (high, medium and low) carried out in December 2020 – January 2021. The results were presented in a stand-alone Initial SEA Report submitted in January 2021 and are repeated in this report. They provide comparative pictures of the outcomes of development likely to arise as a result of implementing policies, plans and programmes for all of the key sectors under these three growth scenarios. The Initial SEA Report was a 'stepping stone' to the main assessment phase.

b) The ***main assessment*** involving a deeper assessment of the high growth scenario carried out in February 2021. This also identified the outcomes likely to arise as a result of implementing policies, plans and programmes. But it was undertaken on a sector-by-sector basis covering nine key sectors: industry, transport (road, rail, air and shipping), urban development, power and energy (including pipelines), forestry, fisheries, water resources, tourism and agriculture.

The outcomes of both steps are depicted in terms of whether the balance of development under each growth scenario (step 'a'), or under each sector for high growth (step 'b'), will enhance or impede achieving a range of objectives targeted to address (avoid, mitigate or redress) the key environmental and socio-economic issues facing the SW region of Bangladesh and Sundarbans. These issues were identified during the scoping phase and are described in the Final Scoping Report (January 2021) and in further detail in a suite of baseline thematic reports (available on www.seasw-sundarbansbd.org). They are elaborated in Chapter 3 of this report.

Critical background for the two steps in the assessment is the analysis of policies, plans and programmes for all sectors contained in the Mid-Term Screening Report (September 2020). The Final Scoping Report describes the role and nature of SEA, how the SEA is being undertaken according to principles of international good practice, and the steps in the SEA process (as shown in Figure 2.1). It also discusses the legal, regulatory and policy framework of Bangladesh and role of key institutions as well as the international agreements that have been ratified by Bangladesh. None of this background and baseline material is repeated in this report.

2. Methodology

In accordance with the Terms of Reference (Annex 1), this SEA has been designed and implemented following principles for good practice in SEA set out in the SEA Guidance of the Development Assistance Committee of the Organisation for Economic Cooperation and Development (OECD-DAC 2006) (see Annex 11). It has also been undertaken in accordance with the eight UNESCO World Heritage Impact Assessment Principles (see Annex 11). The SEA has been conducted through a sequence steps as shown in Figure 2.1 and described below.

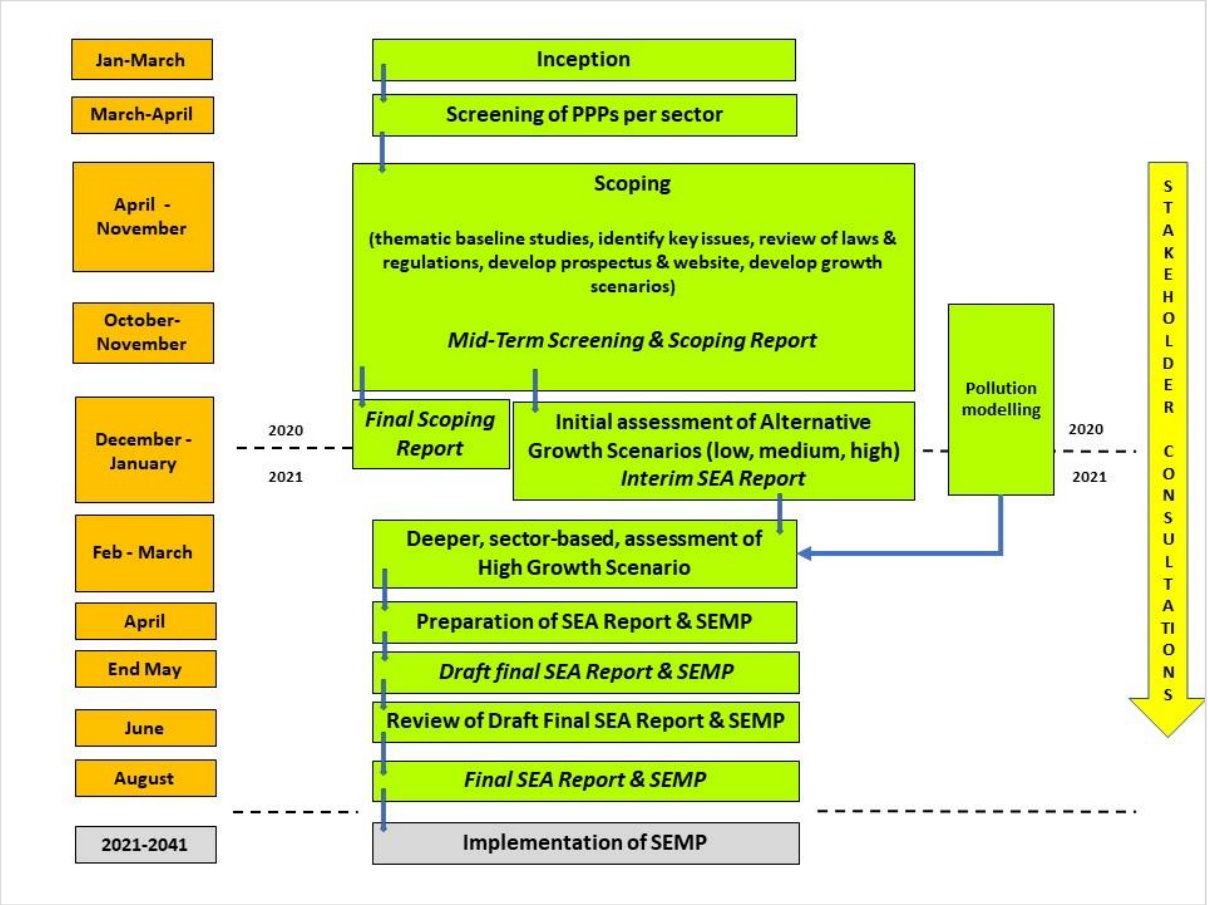


Figure 2.1: Steps in the SEA Process

2.1 Inception (January-March 2020)

This step involved initiation of the SEA, team mobilisation and planning for the work. An inception mission was undertaken during 2-6 February 2020 to hold orientation and planning meetings for the assembled SEA team (international and Bangladesh members) and discussions with the Forest Department (FD), MoEFCC and key sector ministry/department representatives, and IUCN on the scope and focus of the SEA. Certain elements of the Terms of Reference were then discussed with the FD and revised (approved on acceptance of the Inception Report, March 2020) (see Annex 1).

2.2 Screening (March-April 2020)

The purpose of the screening was to provide a 'picture' of the landscape of policies, plans and programmes (PPPs) having relevance to development in the SW region, and to provisionally assess – at a meta level - their significance in terms of potential impacts. This was a necessary step to identify which PPPs are likely to be responsible for the more significant impacts and thus to focus the SEA.

A total 89 PPPs were identified covering 28 sectors and key issue areas and then analysed. Key elements of each PPP were recorded in summary tables describing key objectives, main activities and likely impacts. In addition, a simple 'screening assessment' was made (based on expert judgement and experience) of whether individual PPPs would have the potential to give rise to high, medium or low environmental, social or economic impacts (both positive and negative), particularly within the SW region, assuming no mitigation measures would be put in place (see Table 2.1). The assessment did not specifically evaluate the actual impacts of PPPs that have already occurred under implementation to date. A more thorough analysis of the impacts of developments likely to arise when implementing the broad suite of sectoral and cross-sector PPPs was carried out in the main assessment stage of the SEA.

Table 2.1: Assessment Matrix Used during the Screening of PPPs

Environmental Impact (-ve)			**Social Impact (-ve)**			**Economic Impact (-ve)**				**Environmental Impact (+ve)**			**Social Impact (+ve)**			**Economic Impact (+ve)**		
Negative Impacts										**Positive Impact**								
H	***M***	***L***	***H***	***M***	***L***	***H***	***M***	***L***		***H***	***M***	***L***	***H***	***M***	***L***	***H***	***M***	***L***
H				M				L		H				M				L

Note: It is possible for a particular PPP to have both positive and negative impacts – either environmental and/or socio-economic

High **Med** **Low** **High** **Med** **Low**

The results of screening were presented in the Mid-Term Screening Report (September 2020) and Final Screening Report (March 2021). The screening provided a platform for the scoping stage and the design of the SEA as a whole. It:

- Provided a significant input to the identification of objectives for responding to key issues (as elaborated in Table 7.1 of the Final Scoping Report);
- Guided the development of the growth scenarios – providing an understanding of what developments may be likely as the suite of PPPs are further implemented during the next 20 years (see Chapter 5 of this report); and
- Indicated many of the impacts that are likely to arise as individual PPPs are implemented, and signalling where the most positive and negative impacts are likely to arise (including cumulative impacts), and critical aspects that the SEA would need to address.

2.3 Scoping

The scoping process aimed to confirm the focus of the SEA (on the important issues) and the content of the SEA, the scope of the analyses needed and the relevant criteria for assessment. The key steps were as follows.

2.3.1 Literature Survey and Document Review

A literature survey was conducted through online searches and interviews/contacts with key informants (government officials, experts and specialists, researchers, NGOs, etc.) to identify all documents that might provide information or be relevant to the SEA (e.g. PPP documents, important project documents, laws and regulations, reports and research publications, EIA/ESIA Reports, relevant media articles, etc.).

2.3.2 Stakeholder Analysis and Consultations

Stakeholder analysis was undertaken and covered government entities (at all levels) – on a sectoral basis, private sector organisations, NGOs, civil society organisations, resource user groups, etc, A full list of stakeholders is provided in Appendix 2 of the Final Scoping Report (January 2021).

The initial objective was to conduct a full array of stakeholder consultations during the scoping phase. It was planned to organise multi-stakeholder workshops at national and regional levels at key stages of the SEA process. In addition, it was planned to carry out semi-structured interviews with key informants and undertake random informal interviews in the field, and organise consultative workshops in all districts and in selected upazilas. Focus sessions were to be arranged for particular occupational groups (e.g. fisherfolk, farmers, urban dwellers, marginalised groups). Finally, special meetings were to be arranged for women, where appropriate.

However, as a result of the COVID-19 pandemic, it was not possible to undertake any of these activities during April-May 2020. As a substitute, emails were sent to all stakeholders requesting written comments on the preliminary list of key issues set out in the SEA prospectus, and comments on any issues to do with the SEA process. Discussions by video conferencing were also organised with selected NGOs, UNESCO and IUCN (regional) and Netherland Commission for Environmental Assessment (NCEA).

11 national, regional and local stakeholder consultations were organised during August to December 2020. The results of these consultations and how raised concerns have been addressed were presented in a standalone Record of Stakeholder Consultations (January 2021).

A presentation on the Mid-Term Scoping Report was made by video link to the Department of Environment on 24th October 2020 following which the team received written feedback and comments as well as from the SEA Technical Committee. Response to these comments are provided in Annexes 7 and 8, respectively, of the Final Scoping Report (January 2021).

A Liaison Group was established for the preparation of the Strategic Environmental Management Plan (SEMP) comprising focal points from key sector ministries which met regularly by video-link (see section 2.5 for details).

The Draft Final SEA Report and SEMP were placed on the SEA website on 21 September 2021, and then distributed to all stakeholders by email with a request to submit written comments by 20 October 2021. A regional stakeholder consultation (in Khulna) was held on 11th October 2021 and national stakeholder consultation workshop followed (in Dhaka) on 21st October 2021.

Annex 10 lists all written comments received and responses to them. Comments made during the scond regional (Khulna) and national (Dhaka) stakeholder workshops and responses to them are provided in the Updated Record of Stakeholder Consultations available on the SEA website (www.seasw.sundarbansbd.org).

Table 2.2 summarises the range of stakeholder consultation actions and events organised during the SEA process.

2.3.3 Site Visits

It was planned to undertake field visits to the study area for familiarisation (particularly for the international members of the SEA team), to observe conditions and features on the ground and discuss issues of concern to stakeholders that would need to be considered in the SEA. Unfortunately, the COVID-19 pandemic prevented the international team members from making further visit to Bangladesh after the inception mission. However, most of the Bangladeshi members of the team have undertaken research and fieldwork in the SW region and in the Sundarbans and are very familiar with conditions and issues. The consultations described in section 2.3.2 enabled stakeholders to raise issues of concern.

Table 2.2: Analysis of Stakeholder Consultation Actions

Action type	Location/subject	Number of events/ organisations	No. of participants (individuals or organisations)	No. of written or oral responses/ comments
Website	N/A	N/A	N/A	N/A
Consultation workshops	1st National Workshop – on Scoping report	1	120	12
	2nd National Workshop – on Updated Draft Final Reports	1	125	16
	1st Regional workshop on Scoping Report	1	50	20
	2nd Regional Consultation on Updated Draft Final Reports	1	52	15
	District level consultation (Khulna and Bagerhat) on socio-economic and environmental issues	2	104	32
	Upazila level consultations (*Rampal, Saharankhola, Mongla*) on socio-economic and environmental issues	3	100	35
	Local level consultations and focus group discussions (Chila, Southkhali, Sutarkhali, Burigoalini, Munshiganj) on socio-economic and environmental issues	15	275	62
Video conferences	With NGOs/INGOs	2	15 organisations 30 Individuals	25
	With multi-level stakeholders (govt., non-govt., international) – SEA approach methodology, socio-economic and environmental issues, possible output	9	390	85
Emails sent direct to stakeholders requesting comments on documents	On Mid-Term Screening and Scoping Report	6	285 individuals; including all related government sectors/departments, Univercities, NGO, CBO, IUCN, and other related organisations.	02 written 03 verbal
	On Draft Final Reports	6	236 individuals; including all related government sectors/departments, Universities, NGO, CBO, IUCN and other organisations.	12 written 05 verbal
Requests for interviews with key informants	N/A	30 requests	14 organization 30 individual	14 written 10 verbal

Action type	Location/subject	Number of events/ organisations	No. of participants (individuals or organisations)	No. of written or oral responses/ comments
Formal distribution of draft reports (hard copies) to government agencies by Forest Department	***Numbers distributed:*** • Inception report: 30 • Mid Term Screening and Scoping Report: 20m of each • Final Screening and Scoping Report: 40 (20+20) • Draft Updated Draft Final SEA Report: 30+			• 03 (review panel) • 00 • N/A • 11

First National Stakeholder Workshop 17/02/2021

Second National Stakeholder Workshop 21/10/2021

Second National Stakeholder Workshop 21/10/2021

Stakeholder consultation meetings at Chila Union Parishad, Mongla, Bagherhat and at Sutarkhali Union Parishad, Dacope, Khulna, November 2020

2.3.4 Identification of Key Environmental and Socio-economic Issues

During the inception mission, an initial team brainstorming process identified a provisional list of key environmental and socio-economic issues that the SEA would likely need to focus on. From this list, a set of thematic issues was selected for which baseline papers were prepared (see section 2.3.3).

The stakeholder consultations identified a large number of environmental, socio-economic and other concerns which amplified and confirmed the provisional list of key issues (Table 3.2 in Final Scoping Report and elaborated in Chapter 3 of this report). These stakeholder concerns are presented in the Record of Stakeholder Consultations during August to November 2020 (January 2021).

2.3.5 Thematic Baseline Papers

13 thematic baseline papers have been prepared by specialist members of the SEA team, as listed in Table 3.1. Other experts were also consulted for information and all papers have been revised following review

by members of the SEA core team. Each paper discusses the relevant factors and situation with respect to the theme and is based on available data and information presented in peer-reviewed and credible publications, but the SEA timetable and budget did not allow for new research or the collection of primary data.

2.3.6 Preparation of SEA Prospectus

A Prospectus for the SEA was developed to provide stakeholders with basic information about the SEA. It sets out the reasons for the SEA, its aims, scope and steps, and gives a brief introduction to its role, function and benefits. The prospectus was periodically updated to reflect progress and occasional changes of emphasis and scheduling.

2.3.7 Establishment of Dedicated Website

A website dedicated to the SEA has been established (www.seasw-sundarbansbd.org). This provides summary details of the aims of the SEA and background information and has been updated periodically, as required. All SEA reports linked to the SEA are available on the website to ensure open access.

2.3.8 Review of Legal and Regulatory Framework

A review was undertaken of the main legal and regulatory instruments for each of the key line sectors as well as for cross-sector or over-arching matters - those for which there are PPPs that are considered by the SEA – see Final Screening Report (March 2021). Chapter 5 of the Final Scoping Report (January 2021) describes the main elements of the legal instruments relevant to environmental or social management or regulation

2.3.9 Setting Environmental and Socio-economic Objectives for the Key Issues

Most of the world's SEA systems are 'baseline-led'. Like EIA, they start from an existing baseline and make predictions about how strategic actions will change this baseline. However, in this case, due to the high number of individual PPPs being considered and the wealth of developments likely to arise when implementing each PPP and important projects in SW Region, an 'objectives-led' approach was considered to be more appropriate.

The screening of PPPs identified their environmental, social and economic objectives. Based on this and further team brainstorming, a set of critical objectives was distilled (see Table 2.2). These respond to the main challenges posed by the identified key issues (described in Chapter 3). The objectives are designed either to (a) avoid, reduce/minimise the scale of the issue (mainly for environmental concerns), or (b) to enhance/promote measures to address the issue (mainly for socio-economic issues). The objectives were subsequently used as a basis against which to assess the impact of developments likely to arise under different growth strategies (see Chapters 6 and 7).

A review was also undertaken of the stated objectives of all the PPPs screened (see Appendix 1 of the Final Screening Report, March 2021) to identify those which are already set in government PPPs that are related to the key environmental, social and economic issues identified during scoping. These existing government PPP objectives are listed in Appendix 3 of the Final Scoping Report (January 2021). They have been drawn upon and incorporated in the objectives listed in Table 2.3.

Additionally, the selection of the objectives was undertaken with close regard to the UN Sustainable Development Goals which Bangladesh has integrated into its Second Perspectives Plan (2021-2041). The relationship between the objectives and relevant SDGs is also shown in Table 2.3.

Table 2.3: SEA Objectives for Key Issues, and Related Sustainable Development Goals

Issues		Objective	Relevant SDGs
Environmental			
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	6,14,15
	2	Reduce illegal activities related to protected areas and biodiversity	15
	3	Reduce introduction and spread of Invasive Alien Species	15
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	3,6,14
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	3,6,14,15
	6	Minimise emissions of greenhouse gases	13
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity intrusion, floods, storm surges, etc.)	1,13
Water	8	Increase dry season freshwater flow in rivers	6
	9	Reduce high/peak flows in rivers during monsoon season	6
Land degradation	10	Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion etc)	15
Land use change	11	Minimise loss of agricultural land (e.g. conversion to shrimp ponds)	15
Socio-economic			
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	8,9
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	8.9
Health and sanitation	14	Improve health services and health of society (eg by reducing vulnerability to diseases)	3
	15	Improve and extend water supply and sanitation services	3,6
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	4
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	10
Women and children	18	Improve gender equality and empowerment of women	4,5
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities of SW region	10,16
Conflicts and security	20	Reduce conflicts over use of land	15
Cultural and natural heritage	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.), and also Sundarbans natural heritage sites	11
Food	22	Improve food security	2
Agriculture and fisheries	23	Increase agricultural and fish production	2
Power and energy	24	Increase uptake of renewable energy	7,9
	25	Increase efficiency in production and consumption of energy	7,12,13
	26	Increase access to affordable energy	7

Issues		Objective	Relevant SDGs
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts; and remain within the carrying capacity of the Sundarbans for tourism.	8,15
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	11
	29	Optimise the existing and future physical footprint of transport services (rail, road, air, waterways)	9

List of Sustainable Development Goals

1. ***No poverty***: End poverty in all its forms everywhere
2. ***Zero hunger***: End hunger, achieve food security and improved nutrition and promote sustainable agriculture
3. ***Good health and well-being:*** Ensure healthy lives and promote well-being for all at all ages
4. ***Quality education****:* Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
5. ***Gender equality****:* Achieve gender equality and empower all women and girls
6. ***Clean water and sanitation***: Ensure availability and sustainable management of water and sanitation for all
7. ***Affordable and clean energy****:* Ensure access to affordable, reliable, sustainable and modern energy for all
8. ***Decent work and economic growth****:* Promote sustained and inclusive and sustainable economic growth, full and productive employment and decent work for all
9. ***Industry, innovation and infrastructure***: Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation
10. ***Reduced inequalities***: Reduce inequality within and among countries
11. ***Sustainable cities and communities*****:** Make cities and human settlements inclusive, safe, resilient and sustainable
12. ***Responsible consumption and production***: Ensure sustainable production and consumption patterns
13. ***Climate action***: Take urgent action to combat climate change and its impacts
14. ***Life below water***: Conserve and sustainably use the oceans, seas and marine resources for sustainable development
15. ***Life on the Land:*** Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
16. ***Peace, justice and strong institutions***: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
17. ***Partnerships for the goals***: Strengthen the means of implementation and revitalise the global partnership for sustainable development.

2.3.10 Development of Scenarios and Consideration of Alternatives

SEA aims to identify the impacts of a PPP. But a key principle is that the impacts of alternatives to the PPP in focus (or alternatives to elements of the PPP) should also be addressed. This then usually leads to determining which alternatives should be assessed in the next stage of the SEA. However, in this case, as set out in the Final Screening Report (March 2020), the SEA is dealing with 89 PPPs covering 28 sectors and key issue areas. Thus, it was not being possible to assess every PPP or alternatives to each of them. It was necessary to ensure that SEA was 'strategic' itself. Thus, it has considered three meta-level alternatives in the form of growth scenarios (low, medium and high). The characteristics and projected outcomes of these scenarios are discussed in Chapter 5.

2.3.11 Following the DPSIR Model

DPSIR (drivers, pressures, state, impact and response model of intervention) is a causal framework for describing the interactions between society and the environment: human impact on the environment and

vice versa because of the interdependence of the components (Figure 2.2). The SEA has followed this model to help structure thinking and the steps in the process, as shown in Table 2.4.

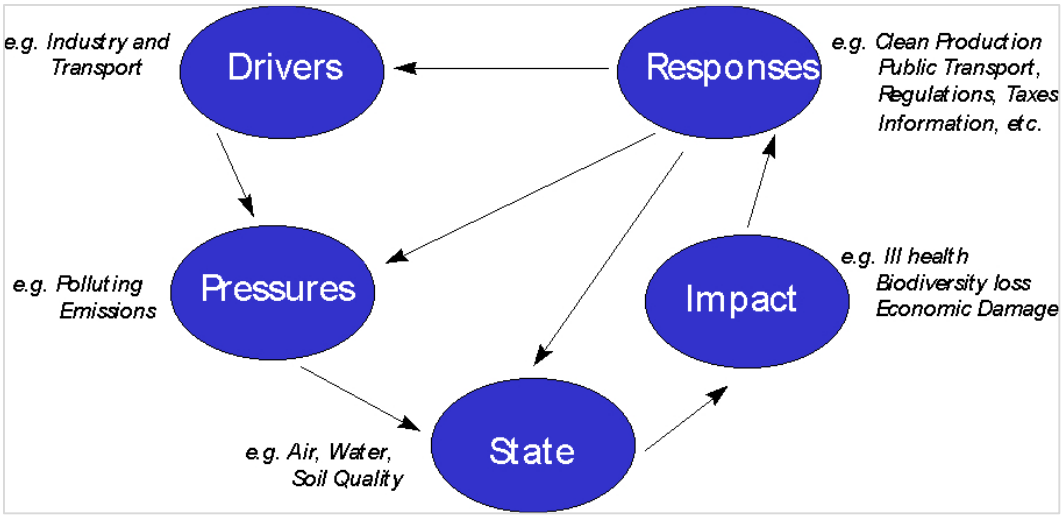


Figure 2.2: DPSIR Framework

Table 2.4: How the DPSIR Model has been Used during the SEA Process

Element of model	Examples	Where followed in SEA process
Driving forces	Globalisation, markets, government policies, climate change, natural disasters, pandemics, etc.	Identification and use of drivers of change to underpin development of growth scenarios (see Box 5.1)
Pressures	Pollution, water scarcity, floods, land use change, social conflicts, inadequate health and sanitation facilities, etc.	Identification/elaboration of key environmental and social issues – as set out in Chapter 3 of Final Scoping Report and Thematic Baseline Papers (summarised in Chapter 3 of this report)
States	Water, soil and air quality condition of habitat and vegetation, etc.	Baseline data and projections prepared for suite of indicators, used for assessment of growth scenarios (see Annex 7)
Impacts	Deterioration of public health, habitat fragmentation, economic crisis/recession, environmental damage, biodiversity loss	Predicted environmental and socio-economic impacts resulting from main assessment stage of SEA
Responses	Environmental management plan; improvement to regulatory and monitoring frameworks and instituitional mechanisms; changes to PPPs, laws or taxes, etc	• Suite of SEA objectives responding to key issues (see Table 2.2), • Recommendations set out in SEMP for monitoring and management of SW region or for revision of PPPs and/or legal instruments.

2.3.12 Mapping

A wide range of maps have been incorporated in the reports produced by the SEA. Some of these have been accessed from literature or other sources. Some have been generated as new maps or to update existing maps with new information, using GIS software. Others have been produced through modelling (e.g. pollution maps).

2.4 Main Assessment (December 2020 - February 2021)

2.4.1 Approach to Assessment

The main assessment (the heart of the SEA) was undertaken in two stages:

- an ***initial assessment*** – at a generic and 'broad-scale' level - of three growth scenarios (low, medium and high) to provide a comparative picture of the likely combined impacts of overall development across all sectors in the SW region over the next 20 years under each scenario (for details, see Chapter 6). A key element of an SEA is that it should assess alternatives to a policy, plan or programme. But since the SEA addressed 89 different PPPs, it was impossible to assess alternatives to each of these. Thus, the growth scenarios were selected as meta level alternatives
- a ***deeper assessment*** of the high growth scenario, undertaken on a sector-by-sector basis (for nine key sectors). This builds on the initial assessments of the three growth strategies but focuses specifically on the high growth scenario as this accords with the government's policy to achieve high income country (HIC) status by 2041 (for details, see Chapter 7).

The methodology for the assessment process built on preparatory work undertaken during the scoping phase which identified a range of ***key environmental and socio-economic issues*** facing the SW region (see detailed discussion in Chapter3 in the Final Scoping Report and summarised in Chapter 3 of this report); and established a range of ***objectives*** for addressing these issues (Table 2.3). The objectives were used as criteria for assessment. The initial and deeper assessments were both undertaken through ***expert judgement*** during brainstorming sessions. They determined whether developments likely to arise in the SW region when implementing PPPs over the next 20 years will either: (a) enhance (positive score) or (b) impede (negative score) achieving each of the objectives (the scoring scale is shown Table 2.5.).

Table 2.5: Assessment Table Used for Growth Scenarios and Sectors (under High Growth)

Issue	Objective	Score			Comments
			R	**M**	To justify or explain score, or illustrate how objective will be enhanced/impaired, or indicate how score can be improved by mitigation
A	1	**R**			
	1	**M**			
B	2	**R**			
	3	**M**			

Notes
Scoring reflects whether the suite of developments likely to arise under each scenario will enhance (+ scores) or impede (-ve scores) achieving the objectives

Range of scores
Very significant and significant negative scores: '-5' and '-4' respectively. Very negative score: '-3'. Moderately and slightly negative scores: '-2' and '-1', respectively.
Neutral [0].

Very significant and significant positive scores: '+5' and '+4' respectively. Very positive score: '+3'. Moderately and slightly scores: '+2' and '+1', respectively.

R: ***Risk score***: where existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced, and/or where no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory.

M: ***Mitigated score***: where existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced, and the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

For each scenario (initial assessment) or sector (deeper assessment), two separate scores were made for each objective: a risk score and a mitigated score (see Table 2.4 for explanation).

These scores took into account the potential environmental and socio-economic impacts of likely developments - whether positive or negative, direct or indirect, domestic or transboundary, cumulative, or synergistic or antagonistic.

2.4.2 Assessment of Cumulative Impacts

The assessment of cumulative impacts is a key aspect of SEA. Cumulative impacts are environmental or socio-economic changes - either positive (beneficial) or negative (harmful) caused by the combined impact of past, present and future human activities and natural processes. They are the result of implementing multiple activities (e.g. individual PPPs and the projects, activities or investment initiatives that arise from their promotion/implementation).

Individual direct impacts may be relatively minor but, in combination with others, they can result in significant environmental and socio-economic effects (Figure 2.3). The multiple impacts of different activities may have an additive, synergistic or antagonistic effect on one another and with natural processes. Cumulative effects can be difficult to predict and manage where baseline data is inadequate, processes (especially ecological ones) are complex, and due to the large scale at which human developments occur (e.g., across the SW region).

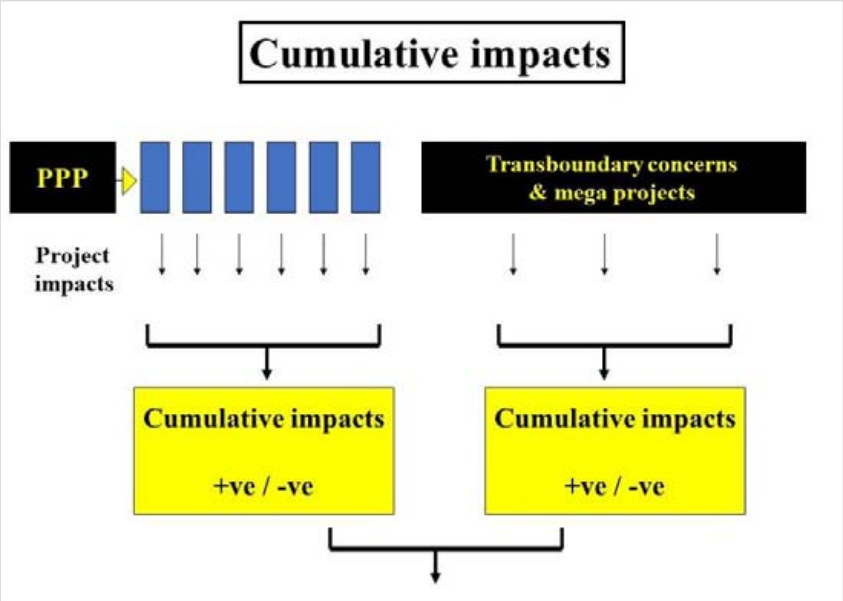


Figure 2.3: Cumulative Impacts

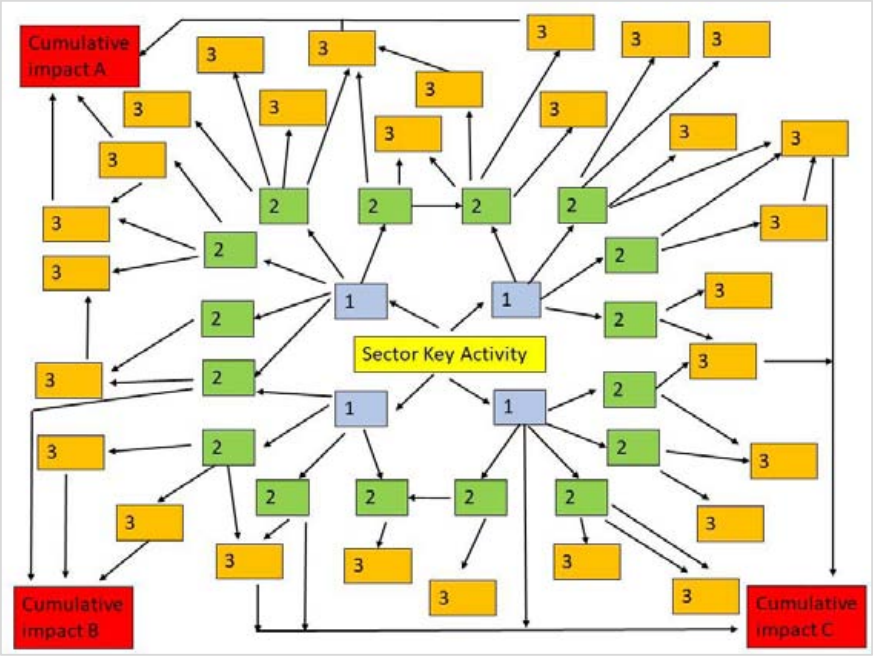
Positive cumulative impacts can be expected if existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced; and if the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

However, negative cumulative impacts will be likely to result if the opposite is the case, i.e. if existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced; and if no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory (i.e. if the SEMP is not effectively implemented).

To provide an initial broad picture of cumulative impacts, the individual objective scores for each sector were added to generate a total score (see Tables 7.1 and 7.2). This process has no scientific basis and no weightings were applied to either particular sectors or to particular objectives (it is not possible to assume

or assign such weightings). Nevertheless, the outcome (discussed in section 7.1) provides a useful overall sense of which objectives are most likely to be enhanced or impeded under high growth.

The way in which critical cumulative impacts (environmental and socio-economic) would be likely to arise for principal activities in individual sectors - as a result of implementing the main proposed or envisaged development initiatives under the Second Perspectives Plan and other PPPs - are examined more specifically in Chapter 9 using linkage diagrams. These diagrams plot how the principal activities may give rise to major impacts (positive or negative) (tier 1), each of which may then give rise to further impacts (tier 2), which may then cascade to further tiers of impacts. The linkage diagrams indicate the pathways through which particular types of impacts will become cumulative (e.g. pollution, deforestation, deteriorating health, migration) (Figure 2.4).



Note: 1,2,3 = impact tiers – indicating cascading pathways to cumulative impacts

Figure 2.4: Schematic Linkage Diagram

These diagrams provide a pictorial understanding of how such impacts might 'flow' from one to another, and their intended and unintended consequences (discussed in Chapter 9). Understanding such linkages is fundamental to the study of the behaviour of complex, coupled social-ecological systems. Decision-makers need to be aware of the web of relationships between activities and understand the linkages between cause and effect. In all kinds of developments/projects, there are desired outcomes (which justify those developments). But there are also a series of unintended consequences which are often cumulative. The linkage diagrams help to show where "vicious circles", "downward spirals", "antagonisms" and "synergies" may occur. They also show where interventions are needed (set out in the SEMP) to ensure that negative unintended consequences are avoided, whilst the desirable outcomes are still achieved or even enhanced.

2.4.3 Environmental Modelling

The methodologies used for modelling of air and water pollution are described in Chapter 4.

2.5 Development of Strategic Environmental Management Plan

The accompanying Strategic Environmental Management Plan (SEMP) is the instrument that sets out measures to implement a response to the findings of the SEA, addressing the management of both environmental and socio-economic issues. It recommends how to enhance positive impacts and how to avoid or mitigate negative impacts, and how to build synergies and avoid antagonisms between developments arising from

implementing policies, plans and programmes. The methodology for developing the SEMP is described in the SEMP itself.

The SEMP will require institutional, political and public understanding and support if it is to be acceptable and effective. Therefore, the SEMP has been developed in collaboration with a ***Liaison Group*** comprising senior level representatives of the key government institutions likely to be responsible for its implementation (e.g. monitoring indicators, enforcing regulations, managing resources, etc) (members are listed in Annex 5). The core for SEMP Liaison Group has been the SEA Project Management Committee which includes focal points from the key sectors. During SEMP development, regular meetings were held with the Liaison Group during March-May 2021 to discuss options and review text and recommendations. In effect, the SEMP has been prepared as a co-developed product. This partnership has helped to create buy-in and consensus on aims/modalities, and to ensure that the SEMP is framed within realities.

3. Baseline Profile and Key Environmental and Socio-economic Issues

3.1 Thematic Baseline Papers

13 thematic baseline theme papers have been prepared (Table 3.1) and are available on the SEA website (www.seasw-sundarbansbd.org). They cover key issues that the SEA has addressed, each presenting information and trends. Collectively, they provide a baseline. Chapter 3 of the Final Scoping Report (January 2021) contains a semi-detailed overview of the key issues. The following sections provide a summary.

Table 3.1: Scope of Thematic Baseline Papers

SL	Topics of thematic baseline papers	Scope of paper (beyond the common sections mentioned above)
1.	Climate and climate change	• Baseline climate of SW region and related issues (including trends and projections of GHG emissions); • Review of evidence for climate change, trends and projections; • Climate change scenarios; • Potential climate change impacts; • Adaptation and mitigation measures.
2.	Pollution and waste	• Pollution: air, water, soil, noise – impacts and futures scenarios; • Waste and waste management – municipal, rural, industrial, agricultural, e-waste, wrecked cars, waste oil, plastics, hazardous waste (e.g. obsolete pesticides) and reuse/recycling.
3.	Delta morphology, river dynamics, floods and water management	• Hydrological setting: river system, freshwater, water levels, tidal and drainage characteristics, future projections; • Morphological setting: river planform analysis, coast line changes, sedimentation, projections for erosion/accretion; • Natural disaster: floods, cyclones, tidal surges; • Development of water infrastructure; • Present and future risks; • Future plans to mitigate potential risks.
4.	Land resources	• Physical conditions: geography, physiography, land types, geology, hydro-meteorology; • Agro- and bio-ecological regions and land cover; • Soils; • Land resources management practices: agriculture, fisheries, forestry; • Major challenges and issues; • Coastal polders.
5.	The Sundarbans, other ecosystems and wildlife conservation	• Landscapes; • Protected areas and sanctuaries; • UNESCO World Heritage Site & its Outstanding Universal value; • Flora and fauna; • Management of the Sundarbans and other ecosystems; • Extraction of resources; • Contribution of the Sundarbans in the national and regional economy • Challenges and issues.

SL	Topics of thematic baseline papers	Scope of paper (beyond the common sections mentioned above)
6.	Tourism in SW Region and Sundarbans	• Status of tourism industry: major attractions and spots; facilities; limitations of sector development; visitor numbers and capacity; community involvement, culture tourism; • Development potential/future prospects for tourism: ecotourism, cultural tourism, archaeological & historical tourism, riverine & rural tourism; • Caring capacity and tourism in the Sundarbans • Impacts of COVID-19 on tourism.
7.	Fisheries, agriculture and other land uses	• Land use data; • Determinants of land use; • Land use policy; • Agriculture; • Forestry; • Fisheries; • Cities, towns and settlements; • Land use change and its impacts.
8.	Infrastructure	• History & background information on infrastructure and communications; • Current infrastructure estate and trends (2011-2020); • Road transport; • Water transport: inland water ways, navigation and shipping; • Communications; • Other infrastructure; • Summary of five-year and two perspectives plans; • Projections for transport sub-sectors; • Mega projects.
9.	Power and energy	• Basic information: energy sources, consumption, production, infrastructure (power plants and networks), indicators, impacts, accidents, etc; • Outlook: projections of energy production and consumption; intended new power plants, networks, pipelines etc; • Energy statistics; • Air pollution (current status and outlook); • GHG emissions (current status and outlook).
10.	Urbanization	• Background; • Cities and towns, functions and services: locations; land uses; • Trends and challenges: area & population; urbanization and land use changes; urbanization trends; key issues; waste management; air quality; transport; • Impact of urbanization; • Ongoing and proposed projects related to urbanization.
11.	Economic and industrial development in SW region	• State of the economy: employment; food security; exports/imports; prices; incentives; • Taxation and subsidy policies; • Economic activities: industries, SMEs; transport; agriculture; forestry; fishing; services; tourism; mining; shipping; etc. – and impacts; marketing • Development of Special Economic Zones; • Labour and employment opportunities and co-operatives; • Challenges in economic and industrial development; • Impacts of COVID-19.

SL	Topics of thematic baseline papers	Scope of paper (beyond the common sections mentioned above)
12.	Social issues and challenges	• Population; • Education; • Livelihoods; • Health; • Gender perspectives and children; • Culture, heritage and traditional knowledge; • Conflict, contestations, power structure; • Security, law and order situation; • Impacts of COVID-19.
13.	Institutional governance	• Background to institutional governance; • Central, regional and local government institutional hierarchy; • Governance of environmental assessment; • Major governance issues; • Relations between government and other organisations; • Trans boundary cooperation, treaties and MOUs.

3.2 Environmental Factors

3.2.1 Physical Setting and Soils

The SW region of Bangladesh is part of the delta the Ganges-Brahmaputra-Mehgna (GBM) river system draining the Himalayas. The delta comprises a huge thickness of sediments deposited over the millennia with intertidal segregation.

Whilst there is sediment deposition in the Ganges/Meghna estuary, frequently creating new land (chars), in the SW region there is little or no such accretion. In fact, studies by Brammer (2014b) show that in the period 1984-2007, there was a net loss of 54km^2 of coastal land to the west of the estuary– mainly along the Indian front of the delta. Land accretion in the coastal areas may continue with projected sea level rise. But areas lying immediately inland from the dynamic coastal areas are seasonally flooded by rainwater, and therefore do not receive sediment depositions during the annual floods that would raise land levels.

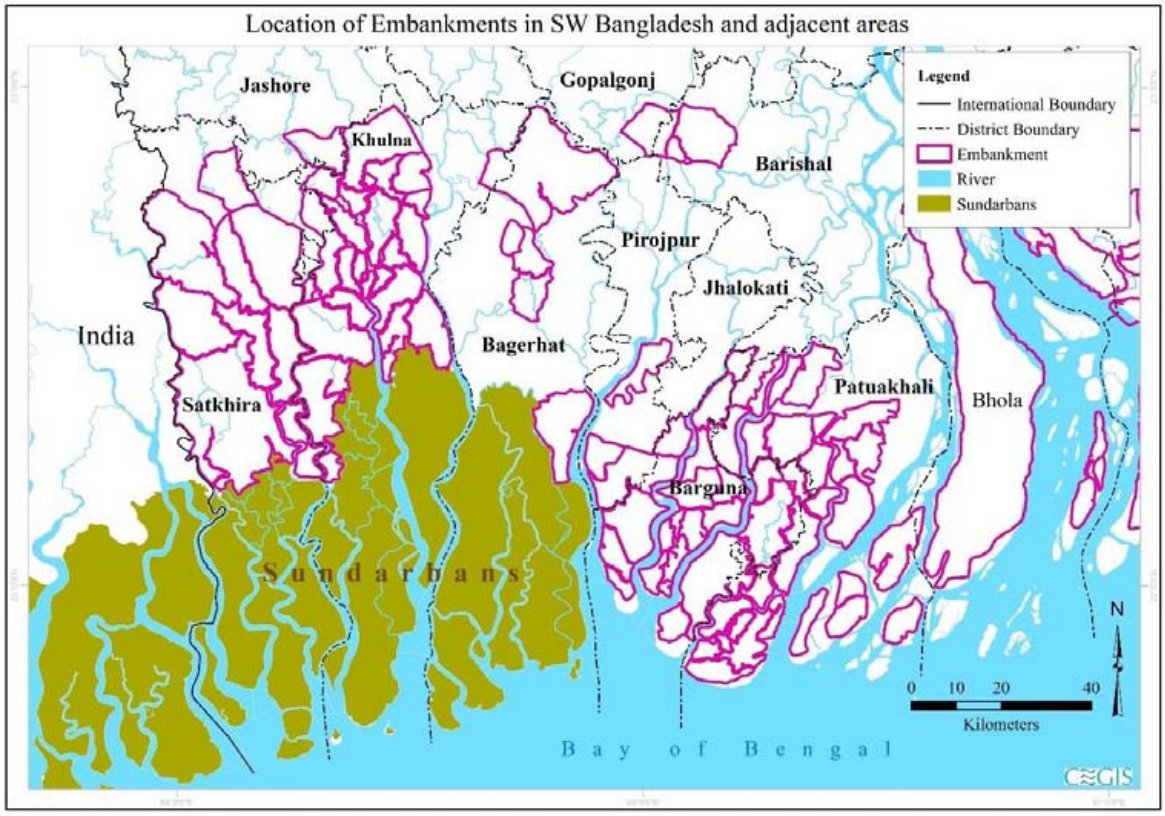
The SW region is part of the moribund Ganges delta (an area of 'dead' or 'dying' rivers). These floodplains have distinct landscapes and soils that are closely related to, and determine, land use and development possibilities and constraints.

During the 1950s and 1960s, embankments were constructed in coastal area (improving embankments along tidal rivers that had been built by landowners for several centuries), creating polders between the tidal rivers and extending 150 km inland in the west, and constraining flood dynamics (van Staveren *et al*., 2017). The embankments were built around continuous river banks (Figure 3.1), but they cut off the minor creeks which let water into and out of the enclosed areas under natural conditions. Under natural conditions, the rivers had levees on their banks surrounding lower basins behind them.

The purpose was to prevent salt-water flooding of the floodplain areas inland and provide increased security for monsoon-season rice production. Sluices in the embankments prevented inflow of salt-water at high tide and allowed ponded rainwater to drain away at low tide. There have been problems in the allocating of government funds for regular and adequate embankment and sluice maintenance. Land owners have also deliberately breached embankments to allow brackish water to flood polders for shrimp farming (which provides higher economic returns per ha than rice cultivation)[11]. However, this also

[11] Freshwater shrimps are also farmed in flooded polders in the non-saline areas.

displaced many small tenant farmers and reduced labour demand. Storm surges associated with severe cyclones (eg, 2007.2009 and 2020) breach some embankments causing salt-water flooding.



Source:
https://www.google.co.uk/search?q=bangladesh+embankments+map&source=lnms&tbm=isch&sa=X&ved=2ahUKEwibqYy_vojoAhWhmFwKHXpVCvYQ_AUoAXoECAwQAw&biw=1266&bih=591#imgrc=0H_UlZ-wbjj0YM

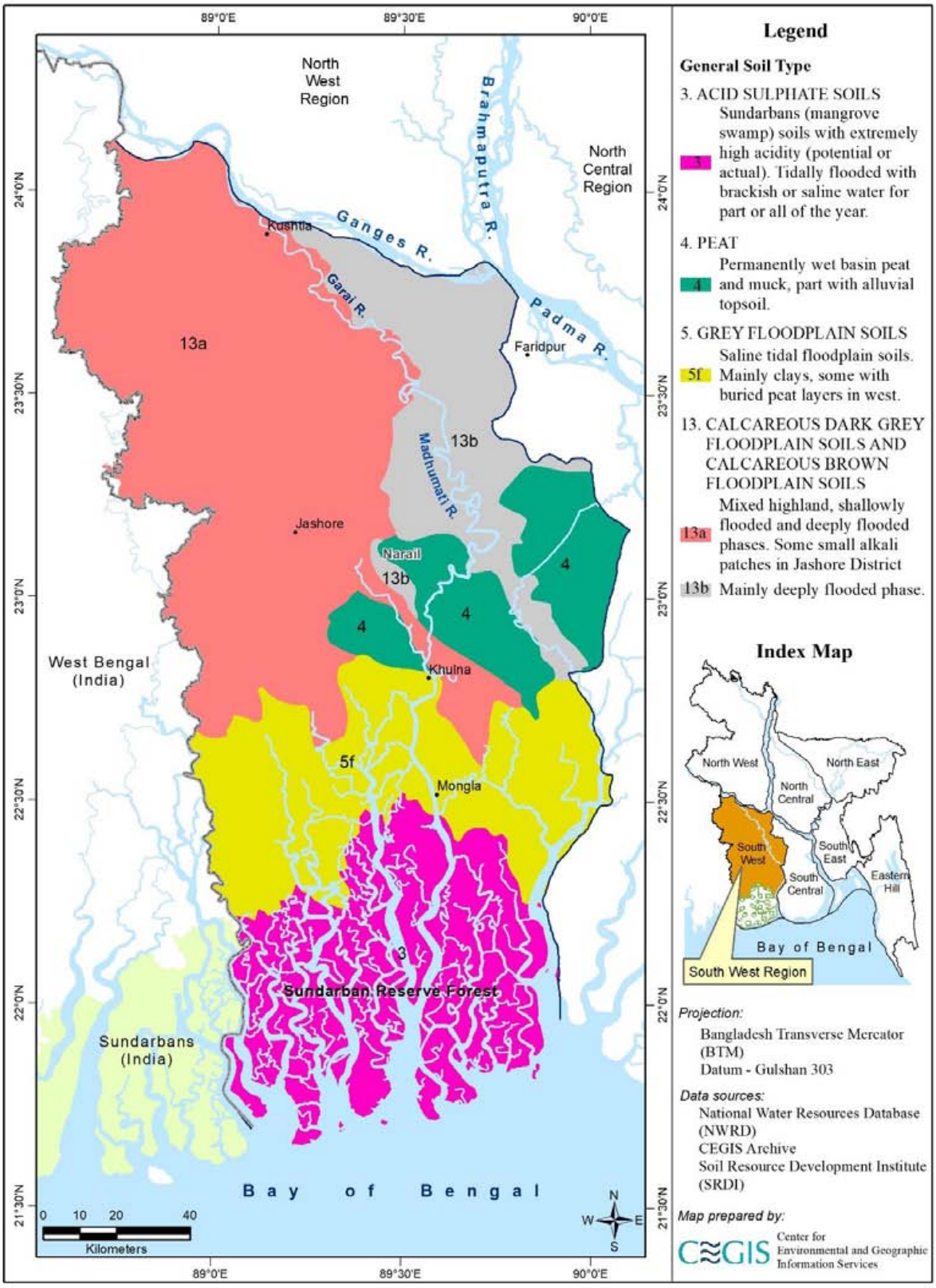
Figure 3.1: Location of River Embankments in SW Bangladesh and Adjacent Areas

The reconnaissance soil survey of Bangladesh identified 12 general soil types mantling the river and tidal floodplains of the SW region (Table 3.2 and Figure 3.2).

Table 3.2: Percentages (of Land Area) of General Soil Types in SW Region

General soil type	Percentage (river floodplain)	Percentage (tidal floodplain)
Non-calcareous alluvium	< 0.5	2
Calcareous alluvium	8	3
Acid sulphate soils	< 0.5	11
Peat soils	< 0.5	1
Non calcareous grey floodplain soils	1	56
Calcareous grey floodplain soils	< 0.5	6
Non-calcareous dark grey floodplain soils	6	2
Calcareous dark grey floodplain soils	54	10
Acid basin clays	< 0.5	--
Non-calcareous brown floodplain soils	< 0.5	< 0.5
Calcareous brown floodplain soils	19	1
Made-land soils	2	1

Source: Brammer 2016a



(Source: extracted from The General Soil Map of Bangladesh, Soil Resource Development Institute, 1997)

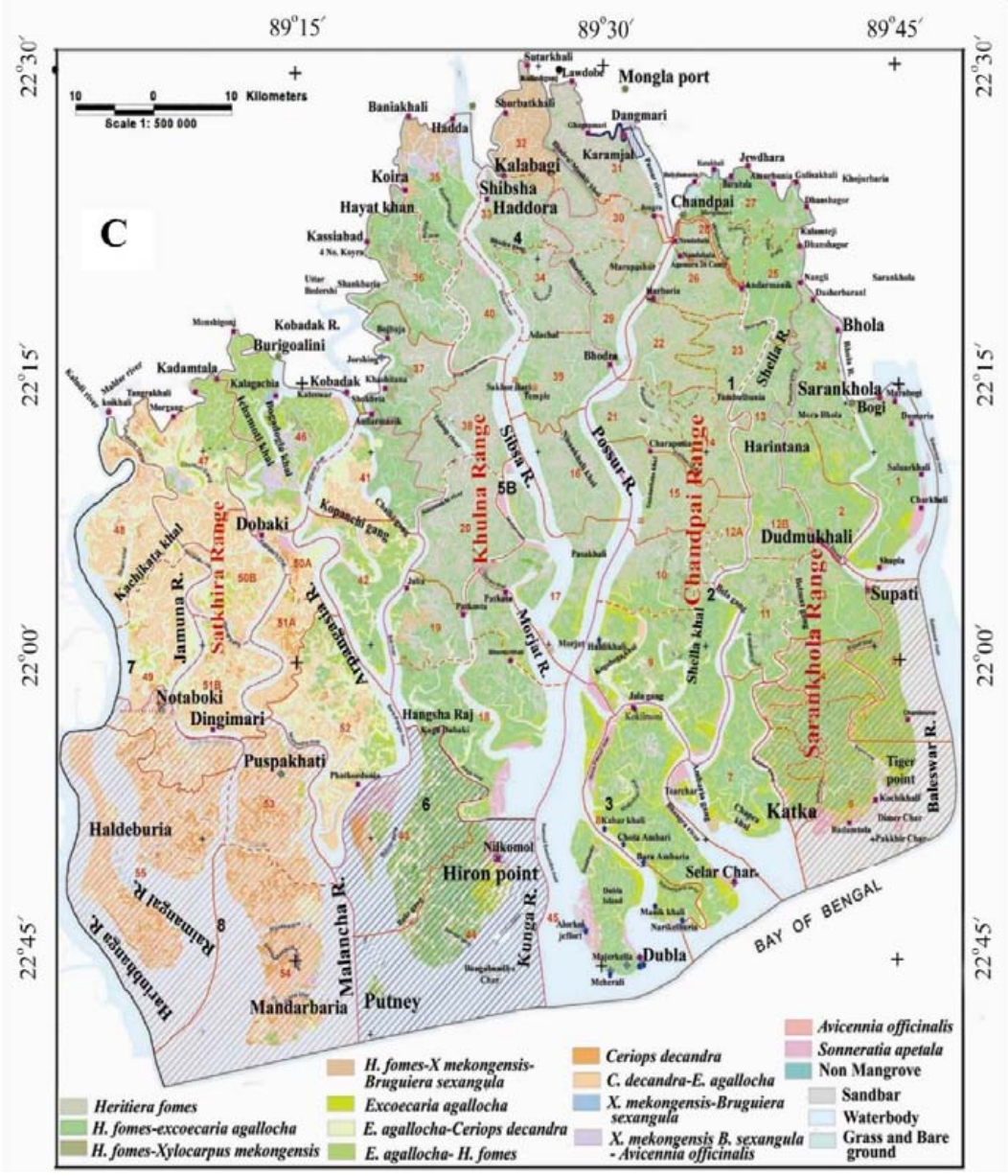
https://www.google.co.uk/search?q=general+soil+map+bangladesh&source=lnms&tbm=isch&sa=X&ved=2ahUKEwj9gp_LkMXoAhXiQxUIHbTzD9MQ_AUoAnoECAwQBA&biw=1280&bih=610#imgrc=pFVqJnbGsfUIQM

Figure 3.2: Soils of SW Region

3.2.2 Flora, Fauna and Protected Areas

Flora

A large part of the SW region is dominated by urban areas, settlements, farmland and aquaculture ponds. The numerous villages have multi-layered homestead forests (groves) of mango, jackfruit, bamboo, betel nut, coconut, date palm and species used for timber and fuelwood. A wide variety of trees are planted along the sides of the extensive network of roads and embankments/irrigation canals that connect the unions and villages. However, only the Sundarbans is covered with tropical evergreen mangrove forest. It contains a higher diversity of species than any other mangrove area in the world (Iftekhar 2006, Duke 1993). Its floristic elements are usually divided into mangroves and mangrove associates. The dominant tree species are *Heritiera fomes* (Sundri), *Excoecaria agallocha* (Gewa), *Ceriops decandra* (Goran), *Sonneratia apetala* (Kewra), and *Xylocarpus mekongensis* (Passur). Map 3.3 shows the distribution of mangrove species in the Sundarbans. Species composition in different areas is determined largely by salinity.



Source: https://www.mdpi.com/1424-2818/7/3/242

Figure 3.3: Distribution of Major Mangrove Species in the Sundarbans

Typical road side plantation on embankment

Sundri trees in Sundarbans

Fauna

The Sundarbans is rich in fauna, contains nearly 50% of all animal species found in the country, except for amphibians (Khan 2013). It provides habitats for a number of floral species (334 plants including 165 algae and 13 orchids) and faunal species (49 mammals, 290 fish, 355 birds, 87 reptiles and 14 amphibian) (IUCN, 2017), with varying status in the IUCN Red List of Bangladesh.

A number of these are rare and endangered and are included in the IUCN Red List[12] - including the Bengal tiger (latest estimate is 114 individuals with the Bangladesh Sundarbans), Irrawaddy Dolphins, and species of birds and reptiles (including the rare estuarine crocodile turtles and the Northern River Terrapin).

The mangrove aquatic ecosystem provides sanctuary and shelter for many aquatic animal species as well as nursery grounds for numerous marine and brackish water species, many of which are important for freshwater, inshore and offshore (deep sea) fishing. The forest swamps and mudflats a crucial breeding grounds for a large variety of finfish, crustaceans (including shrimps) and molluscs.

Inland wetlands (perennial beels, baors) support a variety of migratory birds during the winter months as well as amphibians, reptiles and fish.

Protected areas and hotspots

The Sundarbans contains a range of protected areas (Figure 2.3). There are three wildlife sanctuaries situated along the coast which have also been declared as World Heritage Sites (Figure 3.4). These are closed to hunting, shooting, trapping or harvesting of wild animals. In these sanctuaries, it is also forbidden to collect plants, animal or mineral resources, set fires, disturb or threaten wildlife, use chemicals, poisons, or explosives, introduce exotic animals/plants or domestic animals, dump material destructive to wild animals, divert, stop or pollute water course, and cultivate land. The inland margin of the Sundarbans is a 10 km wide Environmentally Critical Area (ECA) (effectively a buffer zone). Beyond the Sundarbans, Marjat Baor (oxbow lake) (325 ha) in Jhenaidah District is also an ECA and is known for hosting many species of fish and aquatic birds. The entire Sundarbans is also a Ramsar site (wetland of international importance). Six areas in the main distributary rivers passing through the Sundarbans have been declared as dolphin sanctuaries (one of these is located outside the Sundarbans Reserved Forest) and over 400 km of waterways are marked as dolphin semi-hotspots. There is also a marine protected area in the Bay of Bengal, 40 km off the coast of the Sundarbans.

[12] The Red List has seven levels of conservation: least concern (LC), near threatened (NT), vulnerable (VU), endangered (EN), critically endangered (CR), extinct in the wild (EW), and extinct (EX). Each category represents a different threat level (see: https://www.iucnredlist.org/).

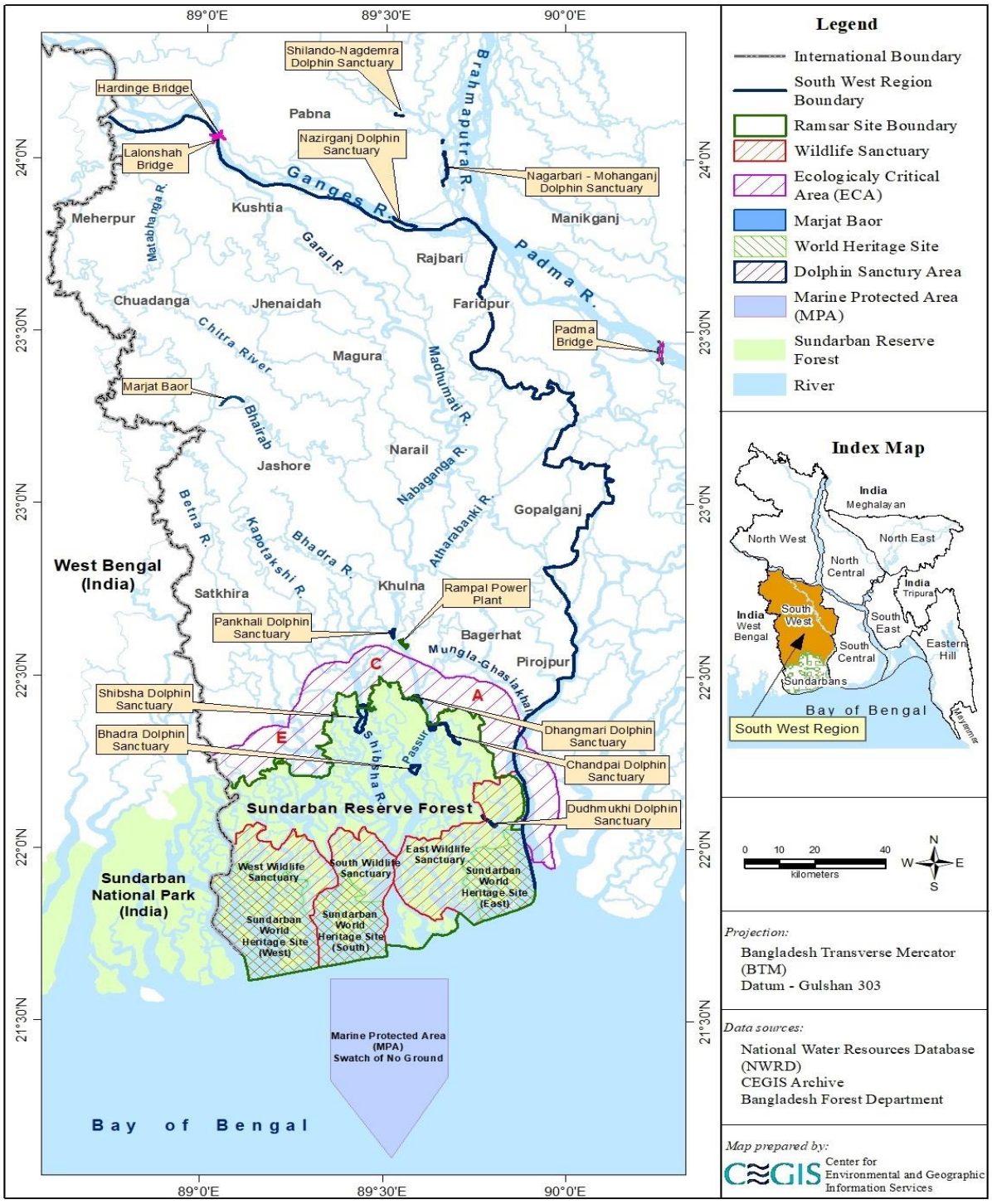


Figure 3.4: Extended Wildlife Sanctuaries and World Heritage Sites of the Sundarbans

The Forest Act 1927 restricts any entry, trespassing and attempt to cause damage to any resources such as trees, wildlife, water and soil within the Sundarbans and is strictly enforced.

The WHS enjoys additional protection under the Wildlife Act 2012 which, inter alia, provides for no extraction of resources from the land or water. Punishment for violation of the provisions this act is much more severe than for breaches the Forest Act. The Wildlife act also imposes imprisonment for killing a tiger and restricts industrialisation within 2 km from the boundary of a wildlife sanctuary. Activities harmful to nature are restricted (under the Environmental Rules 1997) in the 10km wide ECA adjacent to the Sundarbans. Millions of people in the areas surrounding the Sundarbans are highly dependent on its ecosystem services for their livelihoods which sometimes hinders the strict enforcement of laws. People lack awareness of the need to conserve wildlife and natural resources. In response, the Protected Area Rule 2017 introduced co-management in the Sundarbans to strengthen conservation efforts with the active involvement of stakeholders.

The Sundarbans is managed under a co-management approach (with improved governance) and including ten strategic management programs[13]. Moreover, specific projects are also implemented in the Sundarbans for the protection and management of wildlife, fisheries, tourism, employment diversification for the communities depending on the resources of the Sundarbans, women's development and livelihood and poverty alleviation as well as timber management and biodiversity conservation.

Ecosystem services provided by the Sundarbans

The real contribution of the Sundarbans Reserve Forest to the national economy has not been evaluated so far. But various authors have made estimates of some of the range of services provided by the Sundarbans mangrove forests in Bangladesh.

A study by Uddin (2011) concludes that the major ecosystem services provided by the Bangladesh Sundarbans are timber, fuel wood, fish, ecotourism, cyclone and storm protection, biodiversity, and habitat for flora and fauna. The value of the main types of services are summarized as:

Regulatory services and storm protection:	US$	42,250,000
Provision services:	US$	744,000
Cultural services:	US$	42,000
Total	*US$*	*43,034,000*

IUCN (2014) report that the Sundarbans provides ecosystem services amounting US $ 456 to 1191 per hectare per year.

It is estimated that the Sundarbans forests save human lives worth 870 billion takas (equivalent to 11 billion USD) for every cyclone that passes over (Hasnat and Hussain, 2017. According to BFD (2016), protection services contribute US$ 456.6 million annually, whilst tourism contributes US$ 48.7 million and livelihood services US$ 136.6 million.

The Carbon stock of the Sundarbans was estimated to be 136 million tonnes of carbon in 2019 (Bangladesh National Forest Inventory Report, 2021) which is equivalent to 499.12 million tonnes of carbon dioxide equivalent.

Whilst many aspects of the ecosystem services rendered by the Sundarbans are simply not measurable (Hasnat and Hussain, 2017), it is clear that the value of the Sundarbans to the national and regional economy, to livelihoods and the protection of people, is enormous. A comprehensive study of the full value of ecosystem services provided by the Sundarbans is needed.

[13] The management programmes are: habitat protection; wildlife sanctuaries management; sustainable forest management; food security and wetland management; climate change mitigation; climate change adaptation; ecotourism; facilities development; conservation outreach conservation research; participatory monitoring and capacity development; administration and budget

3.2.3 Climate and Climate Change

Present climate

Bangladesh has a tropical monsoon climate characterized by wide seasonal rainfall variations, moderate warm temperatures and high humidity. There are four distinct seasons:

- winter (December-February) - cool and dry;
- pre-monsoon (March-May) - hot summer;
- monsoon (June-September) – hot and humid with high rainfall;
- post-monsoon (October-November) – hot and humid, but drier autumn.

In general, climatic conditions in Bangladesh are characterised by seasonality, variability in arrival and departure of monsoon and variability between the climatic sub-regions. All but two of the seven climatic regions are represented in the SW region (Figure 3.5).

Average maximum temperature in the SW region ranges from 30.1°C in the east to 31.3°C in the west and minimum temperature ranges from 20.1°C towards the north to 22.0°C towards the south. April is the warmest month while January is the coldest month (Shahid *et al.,* 2012).

Mean annual rainfall in the region ranges from 1562 mm at Kushtia in the north to 1923 mm at Khulna in the centre to 1880mm at Mongla (Sundarbans) in the south. More than 70% of rainfall occurs in the monsoon season.

Bangladesh is periodically hit by tropical cyclones – the most recent was Cyclone Amphan in May 2020. They generally strike the country in two seasons: March to July and September to December, with the majority of storms arriving in May and October. According to analysis by CEGIS, the formation of deep depressions and occurrence of super cyclones (>222 km/hr) increased in the period 1990-2020 by 6% compared to the previous 30 years. Cyclones can cause substantial damage to property and crops by strong wind, heavy rainfall and storm surges (up to c. 9 m above normal sea-level) – the latter causing most of the human and livestock casualties, depending on whether they make landfall near high tide or low tide.

Climate change

Climate change scenarios (CEGIS, 2020) suggest a rise of 1.4 – 2.3°C in maximum temperature and a rise of 2.1 - 3.6°C in minimum temperature by the 2080s in the SW region. Models prepared by the Asian Development Bank (ADB, 2014) indicated that temperature in Bangladesh could rise by 2°C by 2050 and by around 4°C under the business-as-usual scenario - which would lead to considerable damage and losses to the economy. Other studies predict significant increases in maximum and minimum temperatures by the end of the century and increased rainfall variability (Rahman, 2019).

Climate change will put the country at risk of recurrent and intensive natural disasters such as riverine floods, recurrent and flash floods, tropical cyclones and storm surges, droughts, salinity intrusion, sea level rise, and riverbank and coastal erosion

Globally, climate change is predicted to give rise to sea level rise. There is some evidence for recent changes in relative sea-level change (how the height of the sea rises or falls relative to the land at a particular location) along the southwest coast. Analysis of data over 30 years reveals an increase in water levels at a rate of 7-8 mm/year (CCC, 2016).

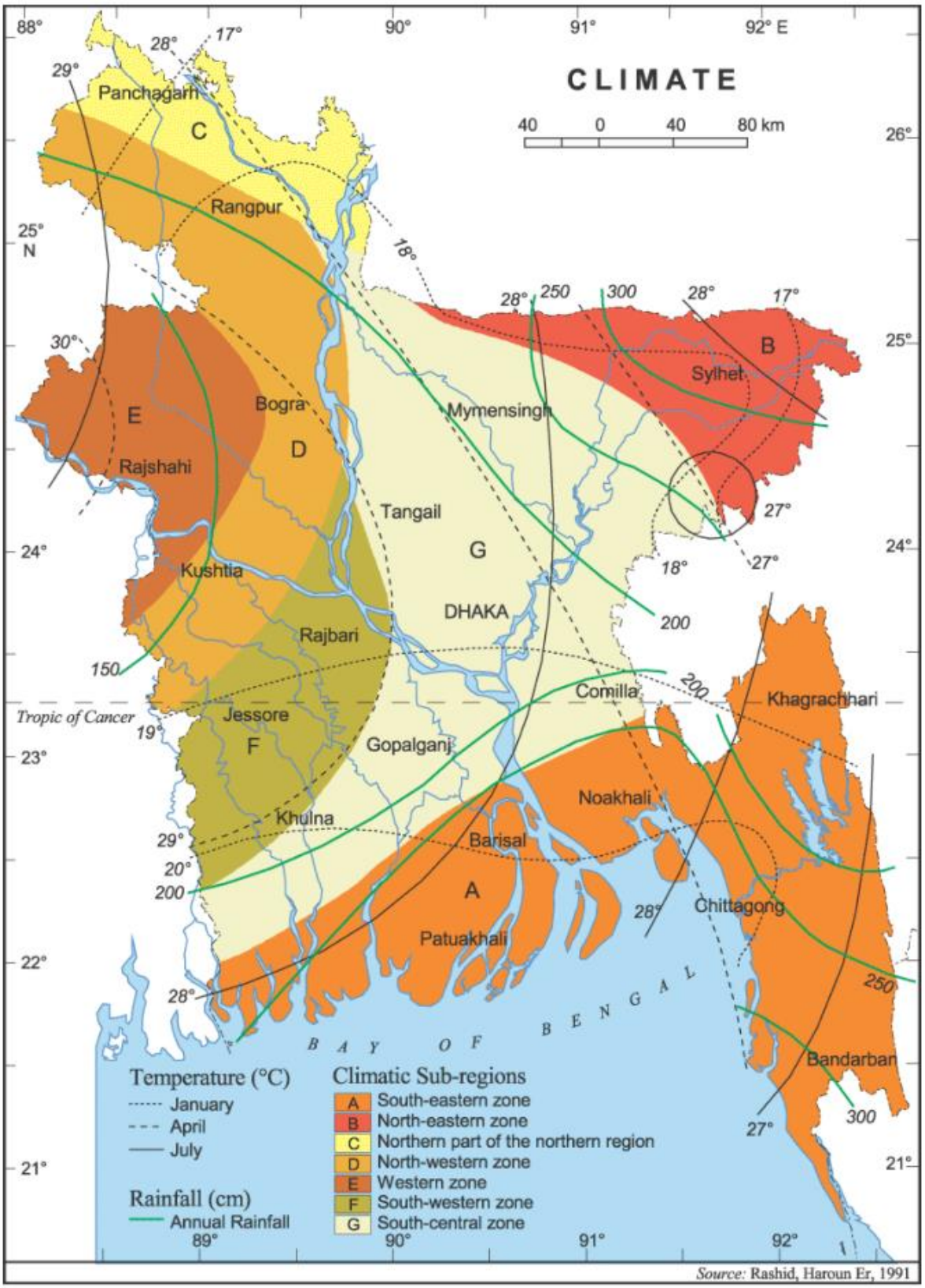


Figure 3.5: Climatic Sub-regions of Bangladesh

3.2.4 Pollution and Waste

Pollution

The SW region is characterised by *increasing industrialisation*, rapid but *unplanned urbanisation* (especially in Khulna, Bagerhat and Satkhira districts), port activities – particularly at Mongla - and navigation in water channels, intensive farming, shrimp cultivation and growing tourism. Each of these activities has impacts in the region, placing pollution pressure on the rivers and wetlands, and potentially on the Sundarbans mangrove forest (Rahman et al., 2009).

Diseases caused by environmental pollution were responsible for 28% of all deaths in Bangladesh in 2015 (21% due to air pollution – respiratory and coronary diseases - mainly due to particulate matter ($PM_{2.5}$). The country is considered *one of the most polluted countries* for particulate matter ($PM_{2.5}$) exposure (annual average 61.7 $\mu g/m^3$ in Khulna City in 2019). Increased concentrations of PM, especially $PM_{2.5}$, have serious impacts on human health[14] and probably have similar impacts on animals, and can cause considerable damage to plants[15].

Projections of national emissions of *particulate matter* (TSP, PM_{10} and $PM_{2.5}$) and the main gaseous air pollutants (SO_2. NO_X) have been developed by IIASA[16] using the GAINS[17] Asia model for the period 2015–2030[18]. Total emissions of PM_{10} and $PM_{2.5}$ are expected to grow by 17% and 15%, respectively, by 2030. Concentrations of PM are particularly high in Khulna City in the winter months. Air quality has been monitored around the Sundarbans since 2014 by the Bangladesh-India Power Company Ltd at several sites. Higher concentrations of PM at some sites has been attributed to road transport (both emissions from vehicles and fugitive emissions from roads), emissions from crop fields, industries and cooking. Concentrations within the Sundarbans were low. ***Neither SO_2 nor NOx represent a problem*** **in the Sundabans** and concentrations therein are generally within the national standard. Available data indicates that additional air pollution by dust, SO_2 and NOx from the Rampal power plant is not expected to have high impact on Sundarbans as this plant is being equipped with basic modern emission reduction technologies.

The north-western regions of India, neighbouring West Bengal and Nepal are the most probable transboundary sources of PM pollution likely to affect the SW region of Bangladesh. In West-Bengal (India), there are 15 coal-fired power plants with total installed capacity of 12 750 MW[19].

Fuel combustion in stationary installations is expected to be the *dominant source of CO_2* emissions in Bangladesh (66% in 2020, 73% in 2030). Emissions of CO_2 from fuel combustion are expected to be driven by electricity generation (40% in 2030) and industrial combustion (20% in 2030). It can be expected that newly-built fossil fuel-fired power plants will increase emissions of CO_2 considerably. The Rampal Thermal Power Plant alone could lead to an additional 7 million tons of CO_2 emissions per year[20].

[14] The main health effects of PM pollution include cardiovascular effects (cardiac arrhythmias and heart attacks), and respiratory effects such as asthma attacks and bronchitis.

[15] PM pollution can inhibit photosynthesis and protein synthesis as well increasing plant susceptibility to injuries by micro-organisms and insects. Constituents of PM (e.g. heavy metals and poly-aromatic hydrocarbons) may have an impact on the morphological attributes of plants (such as leaf area and number, stomata structure, flowering, growth and reproduction) as well as on biochemical parameters (such as pigment content, enzymes, ascorbic acid, protein, sugar and physiological aspects like pH and relative water content). Moreover, PM can have genotoxic impacts on plants (Rai, 2016). See https://www.sciencedirect.com/science/article/abs/pii/S0147651316300719

[16] International Institute for Applied Systems Analysis

[17] Greenhouse Gas and Air Pollution Interactions and Synergies

[18] Source: GAINS Asia https://gains.iiasa.ac.at/gains/ASN/index.login?accept_disclaimer=checked

[19] https://en.wikipedia.org/wiki/List_of_power_stations_in_West_Bengal

[20] BPDB (2013)

Pollution (including heavy metals) from industries in the SW region puts pressure on both the lacustrine (standing) water bodies and river systems of the region.

There are 11 navigable waterways (total 838 km) in the region used by a large number of vessels (Bangladeshi and international) throughout the year – all with the potential to pollute the riverine ecosystem, e.g. from the discharge of ballast and bilge water, oil spills and waste thrown overboard.

Livestock, shrimp/crab farming and the shrimp processing industry also pose a serious threat to the environment. Waste from livestock, especially poultry (particularly broiler excrement containing organic and inorganic nutrients and pathogens), pollutes the wetlands and other lowland water bodies in the region. Shrimp farming is increasingly accompanied by excessive feeding, the presence of high biomass due to high stocking density, the application of drugs, antibiotics and chemicals, and the production of effluents, all of which pollute the polders and adjacent rivers and canals - especially in Satkhira, Bagerhat and Khulna Districts. Agro-chemicals (fertilisers, pesticides and herbicides) applied in the cultivation of paddy rice and mixed vegetables are also a source of pollution in surface water bodies.

Surface, brackish and sea waters receive large amounts of pollutants from the above sources that may pose a threat to the riverine ecosystems and biodiversity. However, studies in the pre-monsoon and monsoon periods in the Gorai, Ruphsa, Passur and Kapothakho rivers found no pressure on the physical quality of the riverine ecosystem, especially as regards river water temperature, pH and dissolved oxygen level and total suspended solids (Khan, 2010)..

Noise results from many human activities (transport, construction, industry and recreation) although noise from industries is not particularly significant due to their predominantly small scale. In some areas of the Sundarbans, noise is an increasing problem, mainly due to commercial vessels (cargo and fishing) as well as tourist launches (using loudspeakers) - particularly during the winter. Underwater noise, particularly from ship's engines and propellers, can have considerable impacts on aquatic mammals (Box 3.1). There is currently no monitoring protocol to control noise pollution from shipping. Following the expansion of Mongla port, and as a result of the policy to expand exports, increased shipping traffic in the navigable channels through the Sundarbans will impact on wildlife, although to different extents depending on the exposure period. Noise (engines, music, shouting) from vessels can disturb communities residing along the riverine system. But it has a considerable impact on wildlife – affecting communication among animals, causing physiological damage, changing reproduction rates and sex ratios, and distressing marine mammals.

Box 3.1: Impacts of underwater noise on aquatic mammals

A number of studies have shown that underwater-radiated noise from commercial ships (particularly from engines and propellers) may have both short- and long-term negative consequences on marine life, especially marine mammals[21]. The documented effects include behavioural and acoustic responses, auditory masking, and stress. Amer (2020) points out how cetaceans are particularly sensitive to acoustic disturbance and noise pollution with common impacts including: fatal strandings; hearing damage; long-term avoidance of the noisy area; higher energetic costs; stress responses; changes in vocalisations – leading to disruptions in reproduction, foraging, and migration; and the masking or obstruction of important vocalisations and sounds. In a review of the literature on this problem, Erbe *et al*. (2019) note that there appears a bias to more easily accessible species (i.e., bottlenose dolphins and humpback whales), but there is a paucity of literature addressing vessel noise impacts on river dolphins,

[21]https://www.imo.org/en/MediaCentre/HotTopics/Pages/Noise.aspx#:~:text=Studies%20have%20shown%20that%20underwater,marine%20life%2C%20especially%20marine%20mammals.&text=Since%20ships%20routinely%20cross%20international,required%20a%20coordinated%20international%20response.

even though some of these species experience chronic noise from boats. One recent study (Dey et al., 2019) in the Ganges River in Bihar State, India, showed that river dolphins showed enhanced activity during acute noise exposure and suppressed activity during chronic exposure. Increase in ambient noise levels altered dolphin acoustic responses, strongly masked echolocation clicks, and more than doubled metabolic stress. Noise impacts were further aggravated during dry-season river depth reduction. The authors suggest that maintaining ecological flows, downscaling of vessel traffic, and propeller modifications to reduce cavitation noise, could help mitigate noise impacts on Ganges river dolphins.

The International Maritime Organisation has approved non-mandatory guidelines on reducing underwater noise from commercial shipping, to address the adverse impacts on marine life (IMO, 2014). The guidelines focus on primary sources of underwater noise, e.g. propellers, hull form, on-board machinery, and various operational and maintenance procedures such as hull cleaning. The IMO has also recommended that more research is needed.

In 2017, a resolution of the Conference of the Parties to the Convention on the Conservation of Migratory Species of Wild Animals (CMS) confirmed the need for international, national and regional limitation of harmful anthropogenic marine noise through management (including, where necessary, regulation) (CMS 2017). The resolution also included guidelines on Environmental Impact Assessment for Marine Noisegenerating Activities

The World Dredging Association (WODA) has also submitted technical guidance on underwater sound in relation to dredging activities to the Scientific Group of the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter, providing advice on managing the impacts of underwater sound, primarily from dredging.

In Bangladesh, there is currently no regulation on underwater noise in rivers, nor any formal restriction on the speed for vessels plying to and from Mongla Port Authority (MPA). However, there is a good practice of maintaining maximum 10 knot speed (for bigger vessels) in the port channel along the Passur river. Plus, it is a requirement for large vessels to take on a pilot for entry to and departure from Mongla port, who try to ensure compliance with this speed.

Waste

Solid waste is generated mainly in residential and industrial areas. Waste disposal in the region faces many challenges due to the limited management facilities and rapidly growing population. However, there have been some recent improvement in urban areas such as the expansion of waste management services from municipalities, Khulna City Corporation (KCC) and Paurashava, and waste sorting and management facilities.

Khulna produces 520 tons of municipal solid waste per day (KCC, 2017; Alamgir and Aminul, 2007), 53% of which is left discarded. Waste is generally deposited in community bins and secondary disposal sites (SDS) by citizens themselves, community-based organizations or NGOs through their door to door collection systems. In other municipal areas of the region, there are mixed approaches to solid waste management. There is no systematic waste management system in the rural areas of the SW region. Rural inhabitants and villagers usually dump waste indiscriminately in the open, and/or burn it, or discard it into water bodies or landfills, and also dispose it directly onto agricultural land. However, a large amount of waste generated from domestic animals, especially cow dung, is used as manure and for fuel. In addition, household kitchen waste and feedstuff waste is used to generate biogas and produce electricity.

Overall, the unsustainable management and disposal of waste in the region causes problems with pollution in rivers, beels and lowland areas – a problem that is worsening with population growth. Landfills and dumping waste on open ground are the cause of land degradation, impaired soil quality and reduced agricultural production. Such waste is of many kinds: construction materials (bricks, sand, ash and cement); plastic bottles and polythene; debris from engineering workshops; market and household wastes. Open dumping of these wastes reduces the transformation and filtering capacity of soil. New coal-fired power

plants will become an additional source of solid waste which will require careful treatment to minimize risks to the environment.

A huge amount of used plastic has become a major contributor to municipal solid waste and its management is a challenge. About 36% of the total plastic waste generated in Bangladesh is recycled, while 39% is landfilled, and the remaining 25% is considered leakage or discarded and finds its way into the marine environment (Waste Concern, 2019). Khulna city produces about 140 tons of plastic waste yearly (c. 3% of the total municipal solid waste generated). 8% of total per capita waste generation (0.346 kg/day) is plastic (Jambeck *et al.,* 2015). Most of the districts in the SW region have small-scale plastic recycling plants. Nevertheless, overall, plastic waste management in the region is poor, largely due to lack of facilities and infrastructure, and insufficient budget for waste management.

3.2.5 Water Flow Dynamics

The SW region is criss-crossed by numerous south-flowing rivers that form part of the dendritic distributary system of the Ganges river (Figure 3.6). The upstream fluvial channels are dominantly freshwater with dynamic processes (i.e. active bank erosion and changing courses),

Rivers of the northern part of the region are morphologically inactive and atrophying steadily. Many have narrowed due to siltation and have elevated bed levels which hinder upward tidal flow. Their flow has reduced, with some having substantially dried up. Thus, fresh water flow in the distributary system is a major problem. The off-take of the Mathabhanga River has become closed preventing flow to the Sundarbans. The Gorai River offtake has silted up and the channel dries up during low-flow dry season periods. Delft Hydraulics and DHI (1996) suggested an additional reason for the reduced flow in the Gorai river - reduced flow in the Ganges water in the dry season due to diversion of water into the Hooghly River in India by the Farakka Barrage, and withdrawal of water further upstream.

The government is pursuing a programme of dredging to increase river depth and water availability as well as navigability.

Tidal rivers carry much less sediment (mainly fine particles of silt and clay) and are relatively stable with far less short-term bank erosion and course shifting, or river widening. Upstream rivers carry more coarse materials which can rapidly alter channel morphology - shifting river courses and banklines and casuing bank erosion.

The embankments (Figure 3.1) have restricted the natural river flow, cut off numerous inter-connected branches and creeks, prevented sediment being deposited on adjacent land and caused its build up the river beds.

Only a few rivers are prone to bank erosion, increasing their width (the Madhumati River being the most at risk).

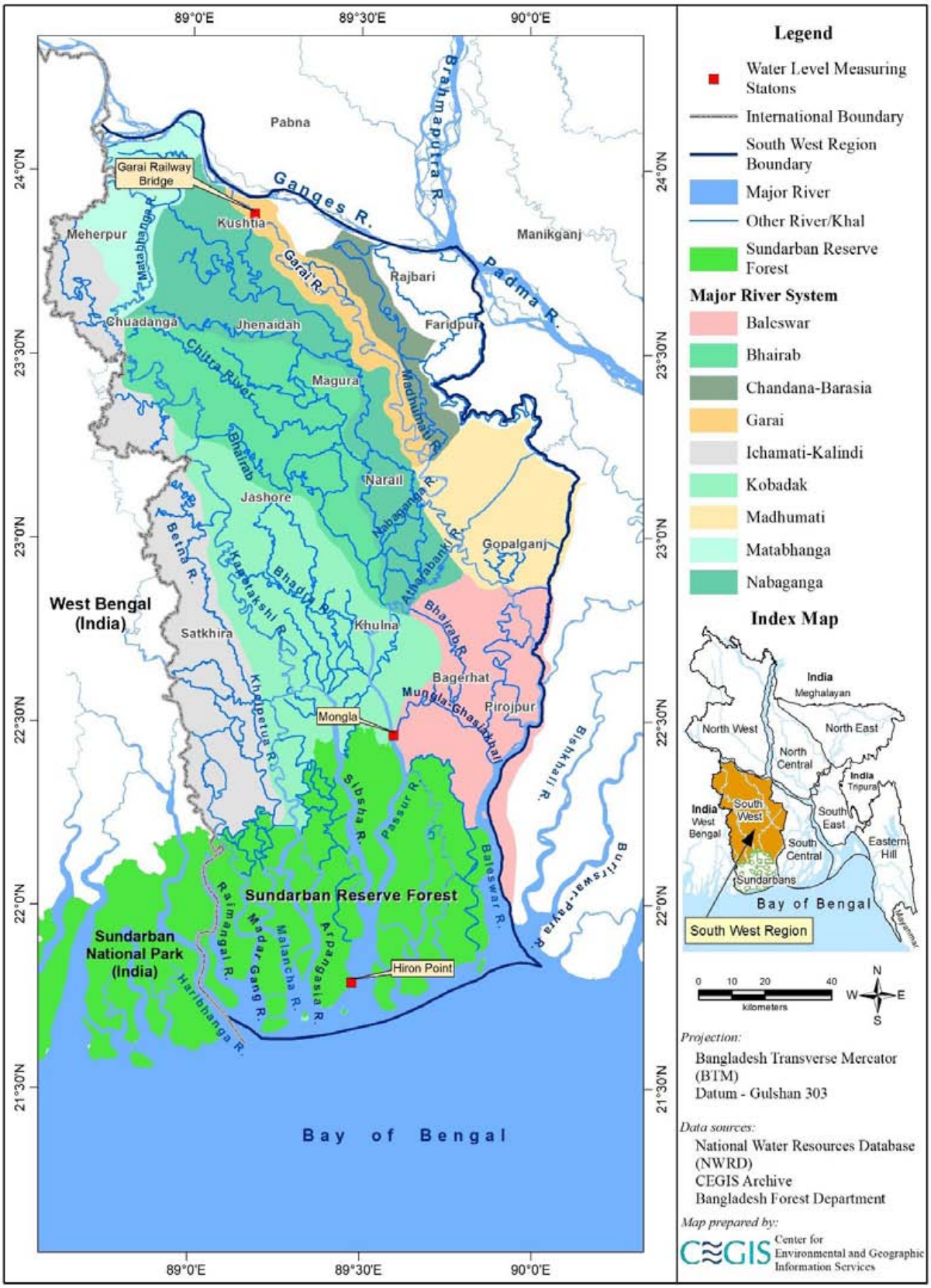


Figure 3.6: River Systems in the SW Region

3.2.6 Salinity and Arsenic Contamination of Groundwater

Freshwater from the Ganges/Padma River, passing through the northern part of the region helps to flush saline river water downstream. However, in the dry season and even in the monsoon (see below), salinity intrusion increases along the Passur-Rupsha-Nabagnaga-Gorai river system. In all coastal regions of Bangladesh, the extent of saline water entry into the delta varies daily, fortnightly and seasonally. Sea level rise due to future climate change is predicted to aggravate the problem (Pethick and Orford; 2013). Salinity is a major concern for paddy rice production, causing yields to reduce considerably.

There has been a considerable increase in salinity in the aquifers of the country's coastal districts (severely affecting its potability and practical use), mainly due to a large increase in unplanned use of groundwater for irrigation. It is also said that there has been subsurface intrusion of seawater due to sea-level rise caused by global warming, although there is no reliable data to validate this claim.

The people living in the areas affected by soil salinity follow some sustainable land management (SLM) practices for agricultural and other purposes. Gypsum (calcium sulphate) is applied to leach the salt from the soil. During the monsoon period, rain water is harvested and used for drinking, household and also agriculture use. Adaptation measures are also applied, e.g. cultivation of salt tolerant rice and vegetables, retention irrigation to conserve water in slightly saline areas to increase crop production. Some farmers in highly saline areas have shifted to shrimp culture and crab farming or practice gher agriculture (i.e. integrated rice-fish vegetable farming, manuring and vermicomposting, multi/ intercropping) to enhance the fertility of saline soil.

In the Sundarbans, increased salinity has had an adverse effect on the dominant mangrove species (Sundri) - a valuable timber species - which requires both freshwater and saline water for regeneration and growth. The power supply industry has also faced problems due to increased salinity, with increased costs as a result of having to import fresh water for cooling.

Arsenic contamination of shallow groundwater is a naturally occurring problem in some parts of the SW region. This presents a health risk when consumed (Rikta *et al*., 2016; Kibria *et al*., 2016; Frisbie *et al*., 2016). On average, arsenic concentration in the entire SW region is in the range of <50 µg/L to 200 µg/L. (Abedin and Rajib, 2013). This exceeds the recommended WHO allowable limit (≤10 µg/L) and the Bangladesh standard for drinking water quality (≤50 µg/L[22]). Frisbie *et al*. (2016) suggest that about 49% of the water is likely contaminated with concentrations above the WHO guidelines. There is some evidence of elevated levels of arsenic in paddy soils irrigated by groundwater at sites in the north of the SW region (Meharg and Rahman (2003). However, the SEA has found no subsequent studies on this issue. Research is needed to determine the situation and whether rice from such areas is contaminated to levels which would pose a health threat.

In summary, the main issues and challenges include:

- The quality of groundwater in the coastal aquifer is poor and salinity levels are often above potable limits. Most tube wells are found to be saline in this area.
- Salt intake by the people in the coastal parts of the SW region exceeds the recommended limit (1500 milligram/day), increasing risk of (pre)-eclampsia and gestational hypertension;
- The second aquifer (extending from 250 to 350m below the ground surface) is considered to be the main freshwater aquifer (Zahid *et al*., 2014).
- The construction and development of a commercial water supply system is very difficult due to inaccessibility of fresh water bearing aquifers at reasonable depths (200–300m);

[22] µg/L=Micrograms per Liter

- The region faces a persistent deficiency in freshwater supply for daily use due to the expanding population and irrigation;
- Potability of water is restricted due to increased contamination, seawater intrusion and arsenic pollution of groundwater;
- Where surface water and soils have become saline, cultivation and domestic use of water depends on the availability of groundwater.

3.2.7 Floods

Large parts of the SW region are subject to freshwater flooding every year to varying extents (Figure 3.7).

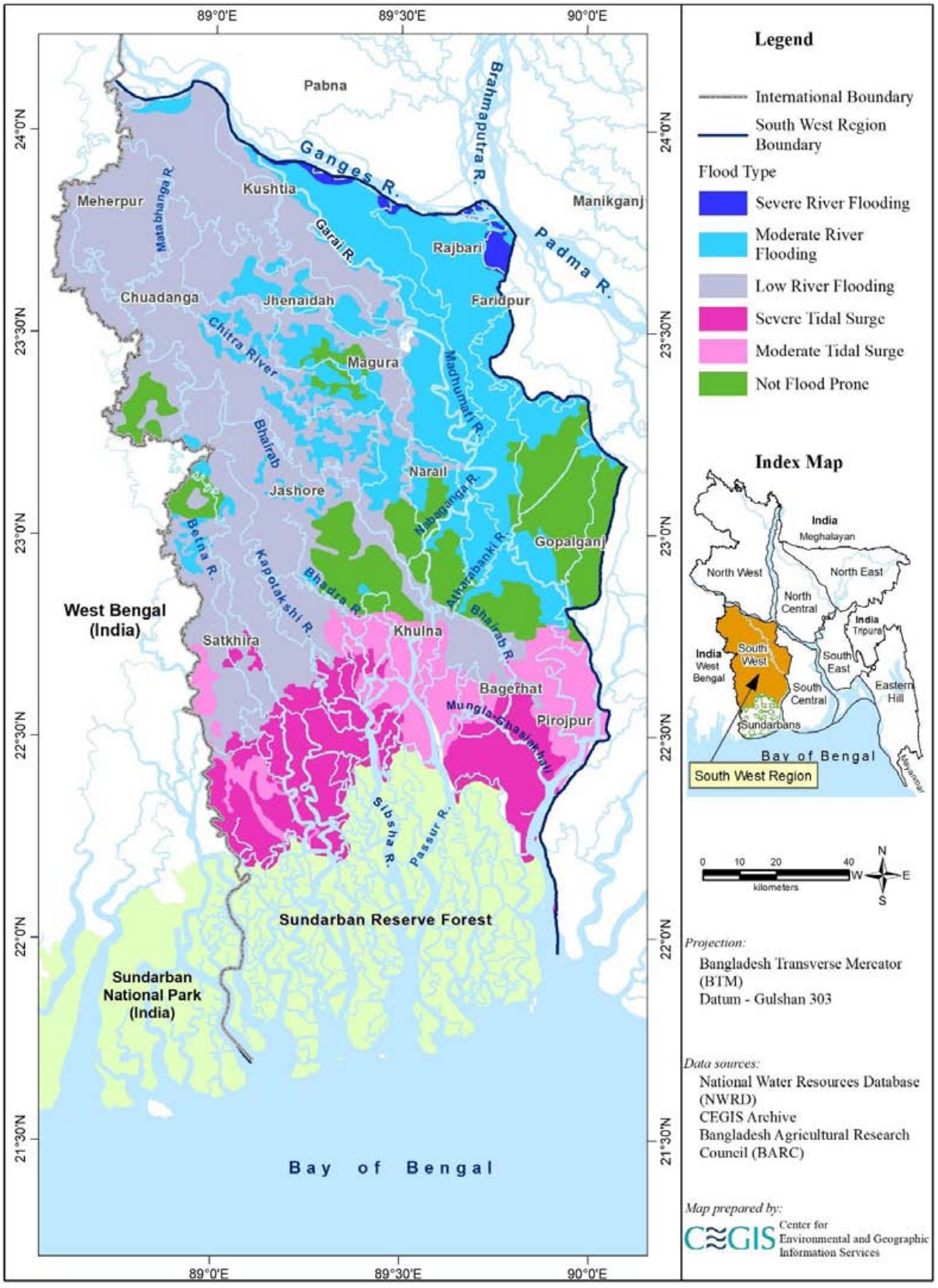


Figure 3.7: Flood Prone Areas in SW Region

It is important to distinguish between what is (a) normal (*barsha*) 'flooding' that occurs every year and to which rural people have adapted their traditional settlements and agricultural practices, and (b) abnormal (*bonna*) 'floods' occurring at intervals of several years which damage or destroy crops and property. The main areas affected in the region have been around and to the north east of Khulna.

More damaging 'catastrophic' floods which displace many thousands of people, cause extensive damage to property and crops, and sometimes cause many human and livestock casualties, occur at intervals of about 5–10 years or longer – examples are the floods of 1974, 1987, 1988, 1998, 2004 and 2009 (Brammer, 2016b).

Flooding and waterlogging (natural and man-made) are common in the SW region and can occur due to a variety of factors including siltation, excessive precipitation and tidal surges. They can also be caused due to unplanned and/or poorly constructed infrastructure such as embankments, sluice gates/regulators as well as the malfunctioning of such structures which can affect the drainage system and eventually lead to waterlogging.

The freshwater flood problem is exacerbated in the coastal areas when further combined with tidal floods. Every high tide can create tidal flooding in the lowlands. If the tidal flood merges with a cyclone, catastrophic flooding can occur.

Some of the embankments that surround polders in the downstream part of the region (Figure 3.1) have no or limited openings and often block the natural drainage system so that polders become waterlogged, even after small amounts of rain. The embankments have constricted the rivers, reducing their conveyance capacity such that many have become increasingly silted up (e.g. Hamkura and Kapotaksha rivers) which leads to flooding. Among the many components of the Action Plan for Flood Control (FAP) (World Bank. 1989) was the strengthening of embankments.

3.2.8 Ecological Issues

The Sundarbans mangroves is a frazile ecosystem influenced by the climate change, coastal erosion and other pressures including various anthropogenic factors. The migration of the Ganges river, loss of distributaries, diversion of water from upstream rivers for irrigation, increased salinity has all contributed to changes in the ecology of the Sundarbans. In the recent years, the rate of erosion has exceeded accretion in the Sundarbans (Rahman, 2012). Increased salinity has caused the gradual replacement of Heritiera fomes (Sundri) with Excoecaria agalocha (Gewa) - causing habitat changes and reducing food availability for deer (which can induce migration/movement to other areas of forest with more food availability), and affecting their health. Cyclones and tidal surges uproot and damage trees, kill birds and other widlife and cause river bank erosion, particularly along the sea-face. A large population of people living around the margins of the Sundarbans and dependent on its resources are over-using them.

Key ecological issues are discussed below.

Isolation of habitats in the Sundarbans

In some areas of the Sundarbans, large blocks of forest habitats are becoming increasingly isolated due to the width of the rivers and human activities (particularly shipping in cargo channels, noise and light – at night). This prevents terrestrial fauna such as the tiger and its prey species from crossing river channels and dispersing, leading to genetically isolated population clusters (Aziz 2017).

Loss of biodiversity

There is considerable concern about the depletion of resources in the Sundarbans and loss of biodiversity. A range of factors contribute to these losses including, for example, over-extraction of non-timber forest products (NTFP), poaching and trafficking, habitat degradation, use of destructive or prohibited fishing gear, fishing during the ban season, fishing in sanctuaries and breeding canals, illegal collection of post

larvae and poison fishing (IUCN, 2012), diseases, pollution, salinity changes and other edaphic factors, wildlife-human conflicts and extreme weather events.

Fishermen in the Sundarbans

Several studies have noted the loss of some species from the Sundarbans and the reduced abundance of many important fauna (e.g. *Pangasius pangasius*, Pangas fish) and flora (e.g. *Heritiera fomes,* Sundri - mangrove species). In response, the Forest Department banned the extraction of trees from Sundarbans in 1989 and, in 2010, introduced enhanced conservation, protection and monitoring activities following which there has been an increase in the density of *H. fomes* and *E. agallocha.*

About 2.5 million people living around the Sundarbans are directly and indirectly dependent on its resources. Licensed boats are allowed to enter the Sundarbans area to fish. There has been an increasing trend of fish harvesting with the Sundarbans contributing 2-5% of the total capture fishes of the country (Shah *et al*., 2010). However, fish production has reduced by 56% in the last four decades (BFD, 2010). The reasons are unclear but include over-exploitation and increase in salinity.

The Forest Department is now pursuing sustainable management of fish resources in the Sundarbans, e.g. through the Integrated Resources Management Plans for the Sundarbans (2010-2020) (BFD, 2010). Special steps have been taken to conserve biodiversity including the expansion of protected areas (now 52% of the total area of Sundarbans), introduction of SMART patrolling, the co-management system (in which the Sundarbans-dependent communities are made official actors to protect and conserve Sundarbans resources through a revenue sharing arrangement). These initiatives provide meausres to control illegal (including poison) fishing, poaching and combat human-tiger conflict. Other measures designed to improve conservation of the Sundarbans ecosystem include implementation of the Tiger Action Plan, crocodile management, the deer conservation programme, marine turtle management, cetacean conservation programme, and species reintroduction under the Bangladesh Wildlife Management Plan.

Invasive alien species

For a long time, alien species of animals and plants have been introduced into Bangladesh from different parts of the world. Gradually, they have become a threat to native species, displacing them in their natural habitats – literally as 'invaders'. In the SW region, among such invasive alien species (IAS), the water hyacinth (*Echhornia crassipes*) is the most widespread and destructive. It is found in almost all fresh water bodies, spreading over the surface and preventing sunlight and oxygen from reaching below, particularly where it is not regularly cleared. It also hampers fishing and water transport system. But it cannot survive in the Sundarbans due to salinity. Fast-growing *Prosopis juliflora* is found on embankments near Munshiganj (Shatkhiral district) close to the Sundarbans. It is hard and expensive to remove as the plant can regenerate from the roots/copicing. Several alien fish (mostly carps) and bird species (*Columba livia*) are also found.

Water hyacinth

Prosopis juliflora

3.2.9 Industries, Power and Energy

In recent years, the SW region has seen a decline of its major industries (jute, pulp, paper and matches). There are just nine jute companies and 48 associated spinning mills remaining in the region. The mills are on the banks of the Bhairab River and discharge processing wastes directly into the river without treatment. There are also seven big cement and bag processing businesses in the region. In addition, within the ECA, there are more than 70 rice mills and 80 food processing operations. LPG bottling is expanding to meet the increased demand as the population grows (LPG is increasingly used for cooking in urban areas). A number of LPG bottling plants, condensate storing facilities and refineries have been established in Mongla and Khulna region. Figures 4.3 and 4.14 indicates the location of industries and Figure 4.2 shows the location of brickfields.

The power and energy sector is prioritized by government and is one of the fastest growing in terms of capacity. The Power System Master Plan (PSMP), 2016, projects the generation of 24 GW of electricity by 2021, 40 GW by 2030, and 60 GW by 2041. At present, most of the power plants in the SW region are using either heavy fuel oil (HFO) or high speed diesel (HSD) – both of which require less pollution mitigation measures. HFO and HSD are transported to the power plants by river. At present, four new fossil fuel-fired power plants, with a total installed capacity 2550 MW, are being constructed: one (Rampal) is a coal-fired plant (1320 MW), one is a heavy fuel oil-fired plant (IPP: 100 MW), and two are natural gas/high-speed diesel-fired plants (BPDB: 330 MW, and NWPGCL: 800 MW) in association with renewable energy projects. The government plans to develop an initial three special economic zone (SEZ) (expanding to 10) in which to expand industrial activities in the SW region. These will increase the demand for power and energy considerably. The construction and operation of power plants and industries in the region requires a combination of associated infrastructure: ports, river routes, roads, railways, pipelines and power transmission lines.

To assure access to natural gas by industries and commerce in the SW region, a gas pipeline has been constructed connecting Jessore, Khulna, Barishal and Shabajpur. A gas distribution network has been constructed in five districts: Kushtia, Jhenaidah, Jessore, Khulna and Bagerhat. The Gas Sector Master Plan, 2017, proposes a 135 km transboundary gas pipeline from Ishwaripur in Satkhira District to Haldia in West Bengal, providing a link with the Indian gas transmission grid.

3.2.10 Urbanisation

In the SW region, there are 50 municipalities (pourashavas), including Khulna City Corporation (KCC) and six major cities. Over recent decades, with expanded urban development, there has been a steady influx of people to the cities in the region, including from the rural areas – seeking jobs and services. Migrants are driven by the consequences of frequent natural disasters (particularly cyclones, tidal surges, floods and river bank and char erosion), salinization and loss of livelihood opportunities. Almost all are poor and many are landless and are forced to live in urban slums and squatter settlements, particularly in the Khulna City

area. Here, they do not have access to urban amenities such as clean drinking water, hygiene services and health facilities. They are at increased risk of health issues from unhygienic and overcrowded living conditions and from water and sanitation problems. They often suffer from different waterborne diseases, under-nutrition and micronutrient deficiencies (Rahaman *et al*., 2018).

Between 1998 and 2011, the total urban area in the region increased from 708 km^2 to 808 km^2 and the urban population increased from 2.4 million to 2.7 million. This urban expansion has increased the pressure and challenges to manage waste (see section 3.2.4).

In the urban areas in all districts (except Bagerhat and Chuadanga), population density is increasing and this will increase the demand for jobs and housing and put increased pressure on social services.

Urbanisation (and industrial expansion) are encroaching upon the surface water bodies of the region, reducing their capacity to function as wildlife habitats and soaks for excessive rainfall – which may lead to an increase in urban flooding.

3.2.11 Land Use

The major land uses of the SW region are agriculture, shrimp and fish farming, forestry, urban development and other settlement needs (Figure 3.8). Livelihoods in the region are largely dependent on agriculture, mainly rice production (most of the rice production is in Jessore, Jhenaidah and Kushtia Districts). 39.8% of the land is used for crop cultivation. Apart from rice, other common crops include wheat, maize, sugarcane, tobacco, potatoes, sweet potatoes, jute (as a cash crop - mainly in Kushtia, Magura and Rajbari Districts) and vegetables, oilseeds, pulses and spices as well as fruits. There are more than 75 million head of livestock in the SW region. Poor rural people rear indigenous chicken, ducks and cattle and farmers keep some livestock at homesteads. But there has also been a notable growth of commercial poultry farms since 1990.

Flooding, physiography, soil salinity, drainage congestion and irrigation facilities are the important factors affecting land use for agriculture in the region. Agricultural cultivation in the coastal area is limited to the wet season because soil salinity is high in the dry season. A considerable amount of good quality agricultural land is lost annually to urbanization, building of new infrastructure (such as roads) and implementation of other development projects (approximately 80,000 ha/yr in Bangladesh as a whole) (World Bank, 2005).

The other major economic activity in the region is shrimp farming and aquaculture. The vast network of rivers, beels (natural depressions), baors (oxbow lakes), flood lands and ponds provide opportunities for both capture and culture fisheries. About 11% area of the region is used for shrimp farming and pond aquaculture (using control structures (sluices) in the embankments to allow salt water into ponds). Brackish water shrimp farms are mostly concentrated in the southwestern districts of Khulna, Satkhira and Bagerhat. They are mainly located within polders and most alternate between shrimp and rice production.

Analysis by CEGIS (2020) of land use changes between 2000 and 2019 show that agricultural crop land reduced by 7.5% whilst shrimp cultivation and fish farming increased by 6.8%. The conversion of agricultural land and mangroves (often forcibly and driven by commercial interests) to shrimp farming has been mostly carried out in an unplanned, haphazard and uncoordinated manner. It has resulted in wide-scale pollution, a decrease in local varieties of fish and shellfish, salinization of groundwater, changes to local hydrology, land-use conflicts and social unrest (Deb 1998; Firoze 2003; Kabir and Eva 2014; Karim and Stellwagen 1998).

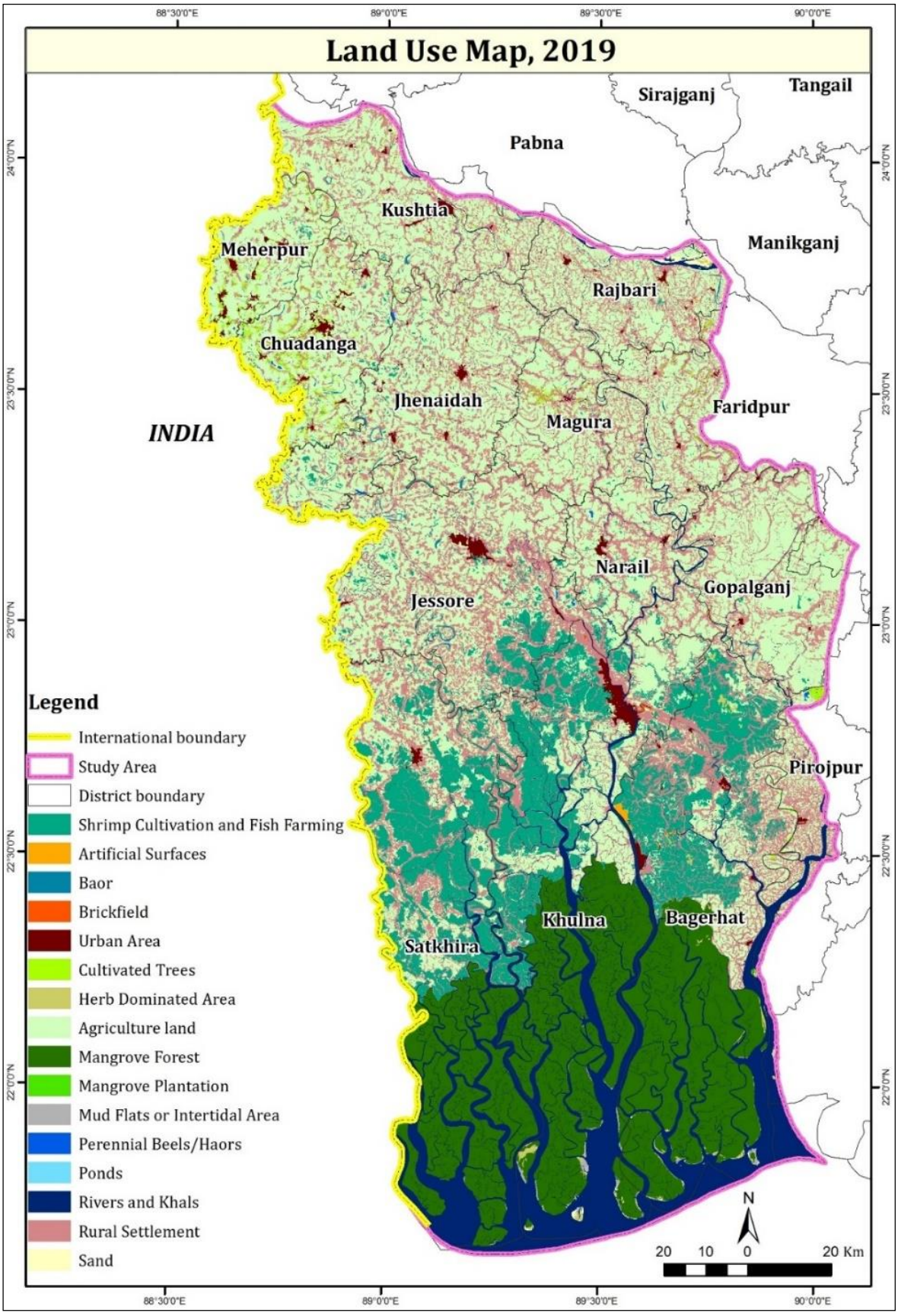


Figure 3.8: Land Use in SW Region, 2019

Shrimp gher in SW region

Land is being continuously degraded or lost owing to erosion, salinity, inundation, etc. According to Rahman and Ahsan (2001), 70% of the land of Barisal and Khulna Divisions is affected by different degrees of salinity, which reduces agricultural productivity, and 50% of coastal lands are subject to inundation of varying degrees and frequency that limits their effective use. This situation is expected to worsen due to climate change impacts (Islam 2006).

3.3 Socio-economic Factors

3.3.1 Population Dynamics

The population of Bangladesh has been increased rapidly since its independence (1971) and it is one of most densely populated countries in the world. The SEA study area accounts for 8% of the national population. According to the Population and Housing Census, 2011, the population of the SW region in that year (the base year) was 18.95 million. Projections by BIDS (2014) estimate that it would reach 22.19 million by 2020, 24.89 million by 2030 and 26.89 million by 2040. According to UNFPA, the population of Bangladesh will be declining after 2056.

During the last few decades, Bangladesh has undergone a demographic transition, with declining fertility accompanied by lower mortality and increased life expectancy. Analysis of components of population change (fertility, mortality and migration) indicates that, over the next few decades, the population structure will undergo considerable change.

The total fertility rate declined from 3.96 children per woman during 1990- 1995 to 2.36 during 2005-2010, and infant mortality and under-five mortality rates almost halved during the same period. Since 1990, life expectancy at birth has increased from 56 years to 69 years. Moreover, international out-migration has shown an increasing trend with a very low rate for females.

According to SVRS (2018), the proportion of the population below 15 years of age fell from 37.6% in 2005 to 28.8% in 2018. Over the same period the proportion aged over 60 years increased from 4.2% to 5.0%. Life expectancy has been improving in the last few years (from 70.7 in 2014 to 72.3 in 2018). There has been a sharp increase in the urban population of the SW region, particularly in Khulna city.

3.3.2 Livelihoods

According to BBS (2012), 40% of those aged over seven years, but not attending school, are employed. Of these, 75% are employed in the agriculture sector, 20% in service sectors and 5% in industry. Throughout the 14 districts of the SW region, agriculture is the dominant livelihood option. However, involvement in both the industry and service sectors is comparatively higher in Khulna District, the regional hub for industry. Other than this general pattern, four dominant livelihood strategies are evident around the Sundarbans area: agriculture (dominantly rice plus other crops and vegetables), fisheries (capture and

culture) and aquaculture (particulaly shrimp farming), forestry (harvesting non-timber products) and tourism (seasonal).

Local people, especially smallholders and marginal groups which engage in crop production, fishing and aquaculture, do not have secure livelihoods. Many work as labourers with low wages, and need to adopt secondary livelihoods to survive. Women and school children also contribute to household incomes.

A study by Mutahara *et al*. (2016) revealed six different marginal livelihood groups in the coastal area: (i) farmers, (ii) fisherman, (iii) dry fishers, (iv) fry collectors, (v) forest extractors (bawals, mouals), and (vi) wage labourers. These groups mostly work for others and do not have work all year round. In most cases, they do not have cultivable land other than homesteads and many are landless.

There are now more people of working age than children which has boosted the economy, but a large number of the younger working population lack employment and job opportunities, and the unemployment rate in Bangladesh is still high (5.3%)[23].

There is rising income inequality with the poorest 5% earning 0.78% of the national income in 2010, but only 0.23% in 2019 (Ramisa, 2019).

3.3.3 Migration

Rural to urban migration is the most prevalent form of migration in Bangladesh. It accounts for nearly two-thirds of all migration, with overseas migration less than a quarter (24%) and rural-to-rural migration 10% (Afsar, 2003). Estimates indicate that internal migration rates in rural and urban areas and in SW region as a whole are 7.81%, 22.83% and 14.42%, respectively (BBS, 2019).

Migration/mobility is critically important for the rural poor during lean farming seasons and is an important livelihood strategy (Afsar 2003). In the SW region, rural to urban migration is common, mainly for economic reasons, to find employment and to seek a chance to remit money back home (DECCMA, 2018). It is also driven by scarcity of potable water, food insecurity, health threats caused by salinity and increased treatment costs, and poverty due to frequent cyclone hits. The rate of temporary/seasonal migration (67%) is higher than permanent migration (20%), and most migrants (77%) move to cities. Lower economic groups (extremely poor, poor and lower middle class) are the main migrants in the SW region (Akhter *et al.*, 2016).

Overcrowding in urban areas due to migration, particularly in city slums, and the absence of sanitation and sewerage systems, has increased the prevalence of waterborne and airborne diseases. The lack of job opportunities and the high risk of disease drives slum dwellers even further into poverty (Alm *et al*., 2018)

Overseas migration has also been increasing (enabling remittances to become an integral part of the economy), although it is still too costly for most Bangladeshi families (Black *et al*. 2011b, cited by Martin *et al*., 2013). About 11% of total overeas migrants from the SW region move to countries in the Gulf and South East Asia (BMET, nd). It is still too early to judge the impact of the COVID-19 pandemic on such migration.

3.3.4 Health and Sanitation

Death rates due to communicable and non-communicable diseases (NCD) are 26% and 67%, respectively (DGHS, 2018). Among the communicable diseases, tuberculosis and diarrhea are the most prevalent. In the SW region, the prevalence of diarrhea is much higher in Barisal Division than in Khulna and Dhaka Divisions. Cases of acute respiratory diseases are highest in Khulna Division followed by Barisal Division. Diabetes is the most prevalent non-communicable disease in the country, followed by heart diseases and chronic obstructive pulmonary diseases (COPD) (DGHS, 2018). These diseases have a major impact on lives and livelihoods, especially for poor and lower middle class families.

[23] https://data.worldbank.org/indicator/SL.UEM.TOTL.ZS?locations=BD

All of the 14 districts of the region have district/general hospitals. In addition, there are some private medical facilities (i.e. hospitals, clinics, diagnostic centres, authorized dispensaries) in the Division/District/Upazila headquarters in the region. There are also some alternative medical treatment facilities in both urban and rural areas (i.e. homeopathic, unani-ayurvedic). The COVID-19 crisis has exposed that health care facilities are poorly managed, fragile and function poorly in emergencies[24]. Nursing care and treatment facilities in hospitals are poor and insufficient.

During the monsoon period, connectivity between some villages and upazila/district headquarters becomes difficult, mainly constrained by the cost and availability of transport. Some of the Upazila health complexes have no ambulance facilities.

Currently, management and disposal of medical waste is inadequate and unsafe - creating a risk of spread of infection, directly and indirectly. It is often openly dumped to landfills creating a serious public health and environmental hazard.

3.3.5 Gender

The government has adopted various policies, plans and programmes to eliminate discrimination against women and girls in all spheres and to promote women's equality. Women play a pivotal role in the economy and are increasingly involved in home-based economic activities such as raising cattle and poultry, vegetable production, gardening, post-harvest activities, agro-forestry and, importantly, income-raising and expenditure-saving activities (Kabeer, 2001, cited by Khan and Rahman, 2016). Men usually work outside the home in agriculture, trading, marketing, etc. Furthermore, women from poor households are increasingly involved in micro-credit programmes and are attaining co-breadwinner status within the family through helping their male counterparts with post-harvest agricultural activities (Karim and Law, 2013, cited by Khan and Rahman, 2016). Since the 1980s, women have accounted for about two-thirds of the total number employed in the garment industry. It has played an important role in changing employment opportunities for women with little or no education (Rahman and Islam, 2013, cited by Khan and Rahman, 2016).

The lives of women and girls in the SW region are constrained by unequal power relations and deeply rooted attitudes about gender roles and potentials. Women and girls are disadvantaged by multiple gender-based inequalities, including: wage discrimination; limited mobility; limited decision-making authority within the household; risks of exploitation; abuse and violence; limited access to basic services and social and legal protections; and limited visibility in society. But there has been considerable improvement in providing education for girls.

The government has undertaken social safety net programmes to reduce poverty and improve gender outcomes, including providing various allowances/stipends (for the elderly; widows, deserted and destitute women; maternity; urban low-income lactating mothers, disabled students). Violence against women and girls is common and can include physical, sexual, psychological and economic abuse.

3.3.6 Education

Bangladesh has achieved spectacular success in improving access to education as well as retention of students in education, along with gender parity in both primary and secondary education. Primary education is mandatory and primary schools are found even in remote villages in the SW region. Each district has secondary schools, colleges, alia madrasahs and tertiary vocational education facilities. In addition, most districts (except Meherpur, Rajbari, Magura, Narail, Bagerhat and Pirojpur) have universities or medical colleges.

[24] https://asiatimes.com/2020/06/bangladesh-and-covid-19-disaster-within-a-disaster/

Most of the remotely situated primary schools face multiple hazards, e.g. damage during cyclones and from erosion, with students and teachers vulnerable to water salinity. Some schools lack drinking water facilities, sanitation, electricity and communications. There is also an inadequate number of teachers to meet the increasing demand.

In the rainy season, the roads become submerged and very muddy which makes it hazardous for students to travel to school. As a result, a significant percentage of students (40%) stay away from school, repeat years and eventually drop out. The overall drop-out rate from secondary education for boys tends to be slightly higher than for girls. For the poorest families, the opportunity cost of sending a relatively young child to school creates a major barrier to increasing the number of years of school participation.

3.3.7 Culture and Heritage

The SW region has a diversity of ethnic and cultural groups with distinctive religions, traditions, rituals, customs and beliefs. According to the Bangladesh Population and Housing Census 2011, about 86% are Muslims, 13.5% Hindus and 0.26% Christian. The main Islamic festivals are Eid-Ul-Fitr (end of the fasting month of Ramadhan), Eid-ul-Azha, Muharram and Miladunnabi (birth day of the Prophet). The biggest Hindu festival is the Durga Puja whilst Christians celebrate Christmas. The annual fair on Dubla Island (known as *Rash Mela*) takes place on the auspicious day of Raash Purnima and attracts Hindus from India and other countries.

Three wildlife sanctuaries in the Sundarbans have been declared as World Heritage Sites (natural) by UNESCO, and the mosque (tomb) of Khan Jahan Ali in Bagerhat District has been designated as an archaeological site representing 'ancient heritage of mythological and historical events' (UNESCO, 1997). A number of Bengali folk songs and dances centre on folk heroes, several deities and goddesses who are specific to the Sundarbans (*Banabibi and Dakshin Rai*) and to the lower Gangetic Delta (*Maa Manasa and Chand Sadagar*). The Sundarbans' forest dwellers embrace a culture of their own, and the folk traditions and beliefs are very strong and popular among the people of this area. Proper budget and management is required to monitor and preserve the culture and heritage of this region and to promote the natural, aesthetic, historical and cultural value of the Sundarbans.

3.3.8 Conflicts, Power and Security

Since the 1980s, commercial shrimp cultivation and linked processing industries have boomed supported by state financial incentives. With this strong support, there followed an increase in efforts by large landholders to control land. The per capita amount of land controlled by small-scale owners and landless people decreased considerably. Much of the land under shrimp cultivation in the area is now controlled by absentee landlords, notably national and local political leaders, often in cooperation with each other. As a result, the number of landless people has continued to increase (Adnan, 2013; Pokrant, 2014; Rahman *et al.*, 2006).

Presidential Order 135 (1972) prioritised agricultural khas (government ownd fallow land) distribution to the landless poor people (Siddiqui, 1981). However, the Act was modified in 1974 to enable rich people to acquire leases on khas land, leading eventually to a wide disparity between large landowners and landless poor. As a result, preference in khas land distribution was given to large landholders by the state, leading to accelerated land grabbing by local elites and the dispossession of landholders (Adnan, 2013). This type of land control and land transformation has led to conflicts, contestations, court cases, and demonstrations by people over claims and counter-claims concerning land rights (Mahmud *et al*., 2020)

Shrimp expansion has thus had various consequences for the poor and landless: displacement and land dispossession, loss of livelihoods for many local people, health hazards, unemployment, marginalization of landless and smallholders, etc.

Ongoing development initiatives in the SW region have generated emloyment opportunities for many people. But they have also led to controversial dynamics. The hiring of local labourers to work on

construction of projects (e.g. Rampal power plant) has often favoured people familiar to the recruiters. The dispossed have particularly been unable to benefit from employment in development projects. In such manual work, there is no written agreement to safeguard the workers. As a result, recruiters can suspend the workers verbally at any time without prior notice or compensation. This situation has often generated tensions between local people/workers, recruiters and their political allies (Mahmud *et al.*, 2020).

3.3.9 Seasonal Tourism

Tourism in the SW region is centred on the Sundarbans as well as historical, archaeological and religious sites. The busiest months for tourism are November to February (with their warm sunny days and cooler nights) although tourists also visit the country during the rainy season. In 2012, Bangladesh received about 600,000 tourists. In 2013, tourism accounted 4.4% of GDP. The country faces challenges to attract tourists including because of the poor maintenance and management of tourist sites.

Increasing tourism would lead to an increased demand for fresh water - for hotels, facilities, swimming pools and personal use, and would increase the load of sewage and solid waste to be managed – and potential pollution. The construction of tourism infrastructure (hotels, lodges, port facilities, marinas, etc.) and the transport of tourists (e.g. by boat both inside and outside in the Sundarbans) can have a substantial affect on agricultural lands and habitats (e.g. due to land clearing, fuelwood collection) and can affect or disturb wildlife (e.g. through pollution and noise – section 3.2.4). Tourism can also be a vector for the spread of infectious diseases.

3.3.10 Institutional Issues

The institutional framework in Bangladesh and the SW region is discussed in Chapter 4 of the Final Scoping Report. Citizen participation is a key component of a good governance framework. Recently, the government formulated acts to ensure public engagement in Union Parishads decision-making (for plans and budgets). Yet, at the national level, policies and programmes are formulated and implemented without an appropriate process of citizen consultation. There is a serious lack of capacity in local government institutions.

3.4 Transboundary Issues

A number of issues are of concern due to policies, plans, developments and activities occurring beyond the international border of Bangladesh, notably in India and Nepal.

3.4.1 Water Management in the Ganges Basin

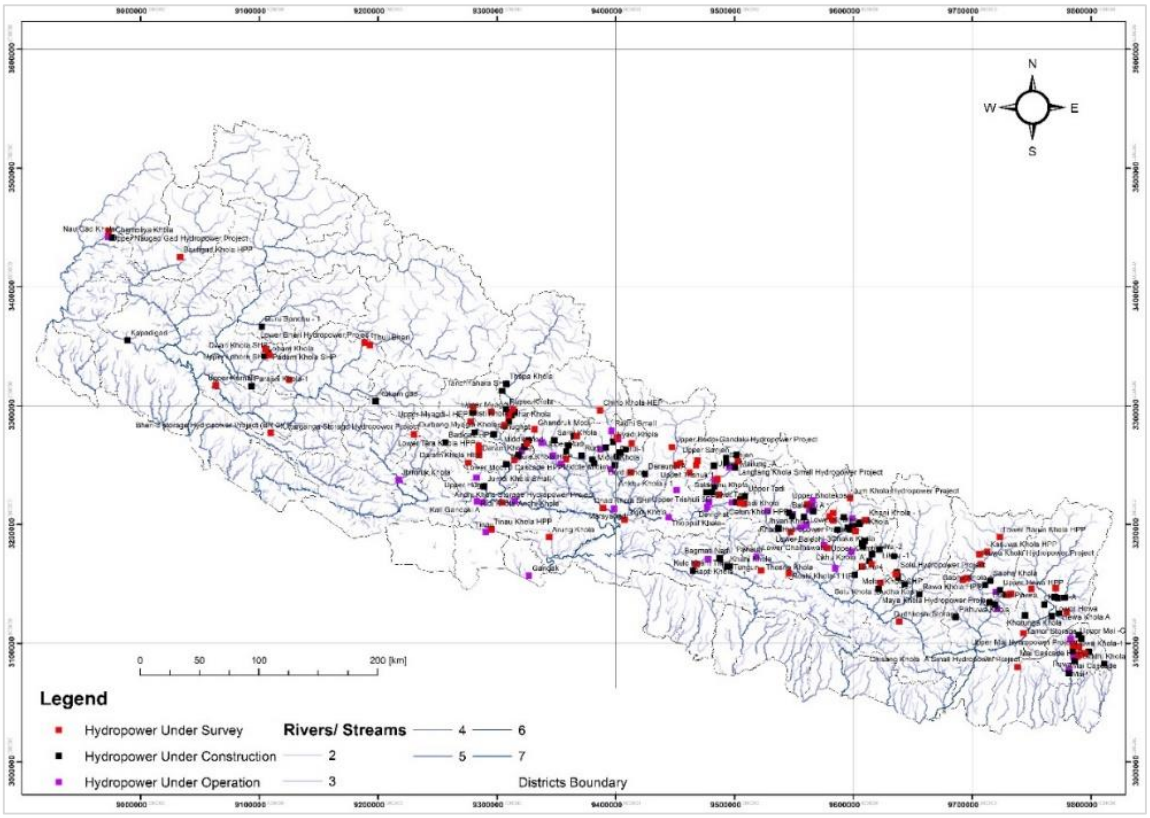
The SW Region is heavily dependent on water delivered via distributaries of the Ganges, particularly the Gorai River. But it has no control and little influence over the watershed management policies of India and Nepal and the construction/operation of hydropower dams and irrigation schemes, and water abstraction for urban and industrial use, etc. Farakka barrage on the Ganges River 18 km upstream of the Bangladesh-India border, completed in 1970, has been a particularly contentious issue. It was constructed to ensure water flow to the Bhagirathi-Hooghly River so as to maintain the navigability of Kolkata port in West Bengal. A Joint River Commission was formed in March 1972 and discussions eventually led to signing the 30-year Ganges Water Treaty on sharing of the Ganges water (1996-2026). The treaty guarantees releases of water according to a formula.

Views on the impacts of Farakka barrage vary. Some claim that water flow in the Padma River in the dry season is considerably lower (as much as 50%) since pre-Farakka times (e.g. Parven and Hassan, 2018). There is considerably less sediment from the Ganges River system being deposited in the south west part of the delta. It is being held back by multiple dams, weirs and barrages that divert much of the water upstream in India and Nepal (to a lesser extent). The entire delta is also sinking by a few mm per year (Sarker *et al*., 2012).

There are more than 1,000 dams and reservoirs on rivers in the Ganges basin (major ones are indicated in Figure 3.9) Nepal has huge hydropower potential, largely still untapped. There are over 100 micros (run-of-river) hydropower plants. Only four schemes have reservoirs. 12 major hydropower projects are under construction and nine more are proposed (Alam *et al*. 2017). Figure 3.10 shows the distribution of hydropower schemes that are operating, under construction or being surveyed in Nepal. Several countries led by India and China have been negotiating with Nepal for possible investment in large-scale hydropower projects in the country.

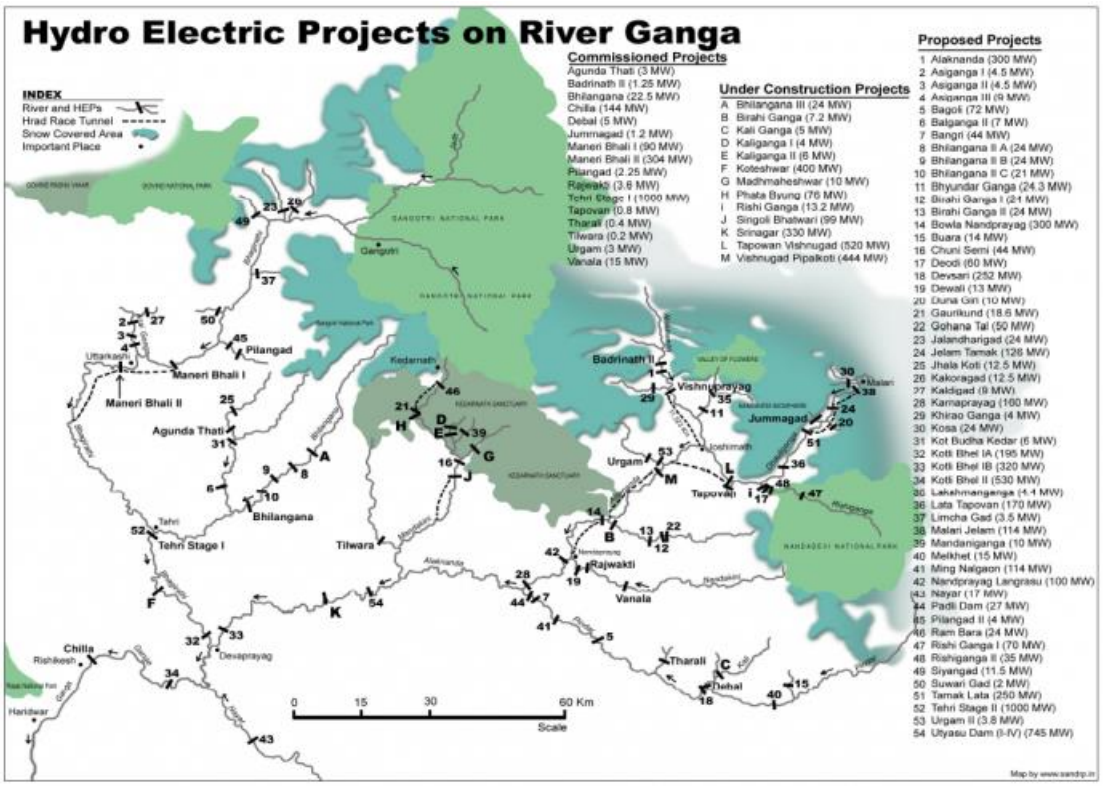
The hydroelectric potential of the Ganges basin has also been exploited in India. Figure 3.11 indicates the location of some of these projects. Himalayan reservoirs are expected to release water stored during the wet season for use in the dry season. The releases from the Indian dams are utilized in India mostly for irrigation.

Figure 3.9: Major Dams and Barrages in the Ganges Basin



(Source: Ajay Mathema (pers.com), School of Environmental Science and Management, Kathmandu, Nepal. Map based on data from Department of Irrigation, Nepal)

Figure 3.10: Map Showing Location of Dams in Nepal



Source: https://www.internationalrivers.org/resources/hydro-electric-projects-on-river-ganga-7575

Figure 3.11: Hydro-electric Projects on the River Ganges in India

There are five barrages on the Ganges itself in India including Farraka which divert a huge amount of water in the dry season. The major polluting industries on the Ganges in India are the leather industries, especially near Kanpur, which use large amounts of chromium and other chemicals, much of which find their way into the river.

A comprehensive River Basin Management Plan for the Ganges is currently being prepared by a consortium of seven Indian Institutes of Technology (IITs) (Kanpur, Delhi, Madras, Bombay, Kharagpur, Guwahati and Roorkee)[25]. Its objectives are to take comprehensive measures for the "restoration of the wholesomeness of the Ganga ecosystem and improvement of its ecological health, with due regard to the issue of competing water uses in the river basin".

Overall, given population growth, expanding urbanisation and increasing demand for energy in India and Nepal, the likelihood is that the number of dams and hydropower installations on rivers in the Ganges basin will increase in the coming years. In addition, there is likely to be increased diversions and sand mining in the river courses, as well as groundwater withdrawals for irrigation (currently, about 90% of water demand in the Ganges basin is for irrigation with some of the lowest productivity levels in the world[26]). Consumption (drinking, cooking, bathing, etc.) and industrial use of water will also increase. It is estimated that water demand in India will increase by 30% by 2050[27]. Together, these demands are bound to have cumulative impacts on river flow and characteristics in the Ganges and Padma and their distributaries. In addition, climate changes may lead to changes in rates of warming and snow/glacier melt, and increased extreme events in the mountains, which may also affect flows. The Indian River Interlinking Project[28] would also have an impact on the availability of the Ganges. Whilst much data is reputed to be collected in the Indian parts of the Ganges basin on water-related matters, it is largely inaccessible. This makes it very difficult to make deductions or predictions concerning the downstream impacts of changes and trends in upstream water use and offtake and the amount and quality of water entering the SW region of Bangladesh.

3.4.2 Industries in West Bengal

Kolkata is home to many industrial units operated by large public- and private-sector corporations. The major sectors include steel, heavy engineering, mining, minerals, cement, pharmaceuticals, food processing, agriculture, electronics, textiles, and jute. The State Government is planning to establish a modern 1000-acre complex outside the city of Kolkata to produce footwear, leather goods and garments. An Export Processing Zone is already operational in the district of 24-Parganas (South) on the left bank of the Hooghly River.

In the immediate vicinity of the Indian Sundarbans, there no large- or medium-scale industries. Based on mostly traditional skills, there are only small industrial units.

Most of the brick kilns are coal-fired and often use low grade, high sulphur coals. They emit fly ash, particulate matter and high concentrations of CO and SOx.

[25] https://nmcg.nic.in/grbmp.aspx

[26] Sharan Jain - https://www.ceh.ac.uk/sites/default/files/Future%20Ganga%20Workshop%20-%20Sharad%20Jain%20-%20NIH.pdf

[27] Sharan Jain - https://www.ceh.ac.uk/sites/default/files/Future%20Ganga%20Workshop%20-%20Sharad%20Jain%20-%20NIH.pdf

[28] A proposed large-scale civil engineering project that aims to effectively manage water resources in India by linking Indian rivers by a network of reservoirs and canals to enhance irrigation and groundwater recharge, reduce persistent floods in some parts and water shortages in other parts of India (https://en.wikipedia.org/wiki/Indian_Rivers_Inter-link#:~:text=The%20Indian%20Rivers%20Inter%2Dlink,and%20water%20shortages%20in%20other)

There are 15 coal-based and three gas-based power stations in West Bengal. The outputs of these have been taken into account (included into the background emissions) in pollution modelling undertaken for this SEA (see Chapter 4).

3.4.3 Cross-boundary Transport and Infrastructure

There are plans to integrate the currently isolated Bangladesh gas network with those of neighbouring countries. A 135 km pipeline connection between Haldia and Ishwaripur in Satkhira District, Bangladesh, is being considered (Ramboll, 2018). A receiving terminal is to be constructed at Khulna.

The government is undertaking a project to expand the capacity and facilities at Mongla[29]. This is likely to lead to a considerable increase in vessels using the port and also in road and rail traffic transporting goods to and from the port – not only from destinations within Bangladesh but also from India, Nepal and Bhutan.

A Joint Communiqué signed on January 12, 2010, between Bangladesh and India set the stage for offering multi-modal transit access to India, and port access to Nepal and Bhutan, using road and rail as well as river transit. India and Bangladesh subsequently signed a MoU on the use of Chattogram and Mongla ports in 2015. This envisages transit of goods from Mongla Port to north eastern states of India through waterways, roads and railways[30]. Missing links in the rail network have been identified and actions are being taken to address these, including 'gauge conversion' where necessary.

Northeast India's access to sea ports in Bangladesh is expected to give momentum to Bangladesh-Bhutan-India-Nepal (BBIN) quadrilateral cooperation, and may influence Bhutan to ratify the BBIN Motor Vehicles Agreement (MVA) that aims at enhanced regional connectivity through facilitation of regional cross-border road transport.

According to an article in 2006 in Hindustanbusinessline.com[31], total traffic passing through the land border at Benapole in 2029-30 was projected to reach 2938 trucks per day and the passenger traffic 3,924 people per day.

Undoubtedly, when the Padma Bridge is completed and operational, this will lead to an increase in cross-border road traffic (particularly lorries) through Benapole. Padma Bridge will provide direct links between two major seaports (Mongla and Chittagong) and provide a connecting link for the Tamabil-Sylhet-Sorail-Kanchpur-Dhaka-Mawa-Bhatiapara-Norail-Jessore-Benapole highway. It will be an integral part of the Asian Highway No 1 and Trans-Asian railway network systems[32]. The infrastructure improvements and increased rail, road and water transport in the SW region may have consequential negative impacts often associated with such activities.

3.4.4 Activities in Neighbouring Regions of Bangladesh

Various large-scale projects are under operation, being constructed or planned in neighbouring regions of Bangladesh. Examples include:

- The Payra Power Plant – a 1,320 MW coal-fired power station in Kalapara Upazila of Patuakhali District in southern Bangladesh.

[29] The Executive Committee of the National Economic Council has approved a $710 million project for construction of two container terminals, one container handling yard, one container delivery yard, and extension of a service jetty, yard and sheds, among others. The target date for completion of the modernization project is by 2021.

[30] http://www.maritimegateway.com/mongla-port-adds-muscle/

[31] Hindustanbusinessline.com, 18 June, 2006: https://www.thehindubusinessline.com/todays-paper/tp-economy/Petrapole-infrastructure-to-be-beefed-up/article20211599.ece

[32] Source: https://www.adb.org/sites/default/files/linked-documents/35049-01-ban-eiaab.pdf.

- The Payra deep seaport - under construction and, when complete, expected to have a 16-meter channel, terminals and associated facilities such as an EEZ, airport, port city, dockyard/shipyard, and eco-tourism facilities.
- The Ruppur nuclear power plant (2.4 GWe) adjoining Paksey in the Ishwardi Upazila of Pabna District, on the bank of the river Padma, 140 km west of Dhaka – expected to go into operation in 2023. It will abstract water from the Padma River.

Such projects may give rise to impacts that would affect the SW region and/or on the Sundarbans (also addressed in the SEA's pollution modelling – see Chapter 4).

3.5 Mega Projects in the SW Region

Two particular mega projects – Rampal coal-fired power station in the power sector and Padma Bridge in the infrastructure sector - have been the focus of discussion for development in the SW region. Both pose considerable challenges in terms of their ultimate potential environmental and socio-economic impacts.

3.5.1 Rampal Coal-fired Power Station

The Rampal site is located 23 km to the south of Khulna City in an area dominated by shrimp farms. It is 14 km north-east of Mongla port, 14 km north-west of the nearest point of the Sundarbans and 4km north west of the declared Ecologically Critical Area of the Sundarbans.

Construction started in 2017 with commissioning expected by 2022. The project will use modern technology for the plant with a capacity of 1320 MW (two units, each with a capacity of 660 MW). The plant has been designed in such a way that it will ensure minimum environmental pollution through state-of-the-art technologies and abatement measures, and will maintain all MoEFCC and IFC standards. Measures to control pollution, fresh water removal and manage ash are described in Box 3.7 in the Final Scoping Report.

The plant will need 12,000 tonnes of coal daily. This will be imported through Mongla port navigational facilities and brought to the power plant jetty by smaller covered barges (to minimise dust) following 'safe movement' procedures and practices.

Concerns have been raised about the potential of the project to cause damage to the unique eco-system of the Sundarbans and World Heritage Sites - particularly issues such as:

- the regular transportation and handling of coal on small barges through the Passur river;
- the risk of environmental disaster if such barges sink—as some petroleum carrying barges have sunk in the recent times;
- the possibility of coal dust spreading while loading and unloading coal;
- release of ash into the air;
- release of waste to the Passur River.

These issues and others were addressed by the two EIAs for the plant and coal transportation which concluded that, overall, the project will not have significant adverse impacts and will not significantly impact on the Sundarbans ecosystem. Most of the identified impacts have been addressed by appropriate embedded control measures in the Feasibility and Design Phase of the Project as well as additional mitigation measures and the environmental management plan (EMP).

3.5.2 Padma Bridge

The new Padma bridge (see Figure 3.4 for location) is a two-level, multi-purpose bridge with a four-lane highway above and a single track railway below. Crossing the Padma River, it will provide improved communication between the SW region and other parts of the country and stimulate socio-economic development with increased accessibility to markets, ports and growth centres. A range of direct (only)

environmental and social impacts were identified in the project EIA report and have been addressed during construction and operational measures.

Padma bridge under construction

However, the bridge may lead to rapid, uncontrolled and unplanned urbanization around the project area and along the Asian highway and railway corridor. Apart from such urbanization, induced development activities along these areas will occur in the SW region (development of business - including agriculture and fisheries, industry, tourism, urbanization, etc.) which may trigger environmental and social impacts (both positive and negative) at local and regional level. These indirect impacts of the bridge might include: land acquisition, tree-cutting and resettlement, air and noise pollution, waste generation, health impacts, job opportunities, etc. Relevant government agencies, under their respective mandates and exercising controls prescribed by laws and regulations, will need to monitor development proposals and take appropriate environmental and social safeguard actions.

4. Air and Water Quality Modelling

4.1 Air Quality Modelling

4.1.1 Introduction

The air quality modelling is done as a part of SEA study to understand the spatial and temporal situation of ambient air quality under different pathways of development with respect to existing situation. Air quality of South-west region is directly influenced by the seasonal wind flow, physiographic features (terrain, surface friction,), regional weather pattern (temperature, rainfall, humidity, sunshine hour etc.) of SW region, sources of pollution (point, line, area, volume), coastal shoreline fumigations etc. To assess the air quality of South-west region, every relevant features in the airshed of SW region has been included (Figure-4.1) for the regional modelling study.

Figure 4.1: The Air Quality Modelling Area

Modelling of air quality was undertaken for 300 x 300 km (90,000 km^2) area shown in Figure 4.1 which incorporates the SW region and surrounding areas. In this regard, the advance dispersion modelling software CALPUFF was chosen as the most appropriate for assessing the annual average ground level concentration of the selected pollutants in the study area. The USEPA regulatory model CALPUFF was used to predict the impact of SO_2, NO_x, $PM_{2.5}$ and PM_{10} emissions on ambient air quality. There are many other dispersion models available, but CALPUFF was selected for to the following reasons:

- It is designed for long-range analysis, more than 50 kilometers from the source of pollution;
- It can accurately model both simple and complex terrain;
- It can model both urban and rural areas;
- It can take into account multiple point, line, area, and volume sources of emissions;
- It can be used for assessing the impact of emissions up to 200-300 km from the source.

Three cases were considered: (a) baseline situation (current state of air quality - 2019); and pollution under a high growth scenario in (b) 2031 and (c) 2041 (growth scenarios are discussed in Chapter 5). However, the modelling was based on the following assumptions, some of which will lead to a reduction in air pollution, some to an increase:

- Legal requirements related to environmental protection will remain at least at the current level and will not be 'softened';
- Investment projects and other relevant activities assumed in existing PPPs will be implemented within indicated/proposed timelines;
- Expected population growth will bring about an increased demand for electricity as well as for road and water transport performance;
- The energy mix will be developing with progressively increased share of renewable energy in accordance with the BPDB programme;
- The future background concentration of the air pollutants has been assumed to be equivalent with the baseline status.
- Certain existing highly polluting industrial installations will be gradually converted into environmental friendly industries (e.g. brick kilns);
- Energy efficiency measures will be implemented for both production and consumption of energy;
- Newly built power plants and industrial installations will be equipped with modern energy-efficient and low-waste technologies and with pollution abatement techniques to comply with the legal requirements;
- The vehicle fleet will progressively change to using higher shares of natural gas or electricity as well as low emitting engines.
- Chemical transformation from primary to secondary pollutants has not been considered in the modeling study.

The air quality assessment study considers particulate matter (fractions PM_{10} and $PM_{2.5}$) and two gaseous pollutants – sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) as criteria pollutants for modelling. Results of modelling are expressed in terms of annual average ground level concentration in μg/m3.

Furthermore, it is considered (based on expert judgement) that the rate of background emission will be increased by 1.5 times in 2031 and 2 times in 2041. This will be because of increasing emissions from different sources (not included individually in the emission inventory) to meet the quality of life demand for the future population as well as expected economic growth. Despite using pollution minimising technologies, the increased emission sources will be likely to cumulatively affect the airshed of SW region. In general, it is assumed that the expected increase of the criteria pollutants in ambient air quality will probably be partially reduced in future through the proper implementation of the SEMP.

4.1.2 Methodology

The modelling used CALPUFF[33] (version CALPUFF 9.0). This is an internationally recognised, advanced non-steady-state meteorological and air quality modelling system which consists of three main components and a set of pre-processing and post-processing programmes. The main components of the system are CALMET (a diagnostic three-dimensional meteorological model), CALPUFF (an air quality dispersion model), and CALPOST (a post-processing package).

Emissions inventories were prepared for particulate matter, sulphur dioxide and nitrogen oxides from four source categories:

- Stationary point sources (power plants, steel industries, brick kilns, rice mills, etc.);
- Area sources (cement factory, landfills, airports, seaports);
- Line sources (roads, railways, river routes, marine routes)[34];
- Volume sources (buildings).

Emissions were estimated using the US EPA AP-42 Emission Factors Compilation[35] taking into account other relevant available sources of information (EIA reports, design documentation).

The result of the modelling is an estimate of the total concentration of the relevant pollutant, which is formed by the sum of the background concentration and the calculated cumulative contribution of the individual stationary, line and area sources included in the emission inventory.

Background concentration covers emissions that are not included in the emission inventory which arise from small stationary sources (e.g. cooking in households), smaller line sources, small area sources, volume sources (buildings), sources outside the modelling zone and also long-distance/transboundary transfer of pollution. In the case of particulate matter, it also covers emissions from natural sources (e.g. wind erosion).

Baseline background concentration was assessed by model calibration during baseline modelling using real data from air quality monitoring stations. To establish values for 2031 and 2041, the baseline values (2019) were increased by multiplying them a factor of 1.5 (for 2031) and 2 (for 2041),

4.1.3 Baseline Modelling

For baseline modelling, all existing major sources (point, line and area sources) were included in the emission inventories:

- 1179 point sources (12 power plants, 12 oil refineries, 2 steel industries, 72 rice mills and 1081 brick kilns) (major sources are listed in Table 4.1);
- 24 line sources (11 roads, one connected railway, 12 water routes) (major sources are listed in Tables 4.2 and 4.3);
- 22 area sources (19 cement factories, one airport, one seaport and one waste landfill) were taken into account (major sources are listed in Table 4.4).

The major sources are also shown in Figures 4.2 and 4.3.

[33] The CALPUFF model was originally developed by the Sigma Research Corporation (SRC) in the late 1980s under contract with the California Air Resources Board (CARB) and it was first issued in about 1990. See http://www.src.com/

[34] A line source was considered an area source if the breadth exceeds 20% of the length.

[35] See https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors

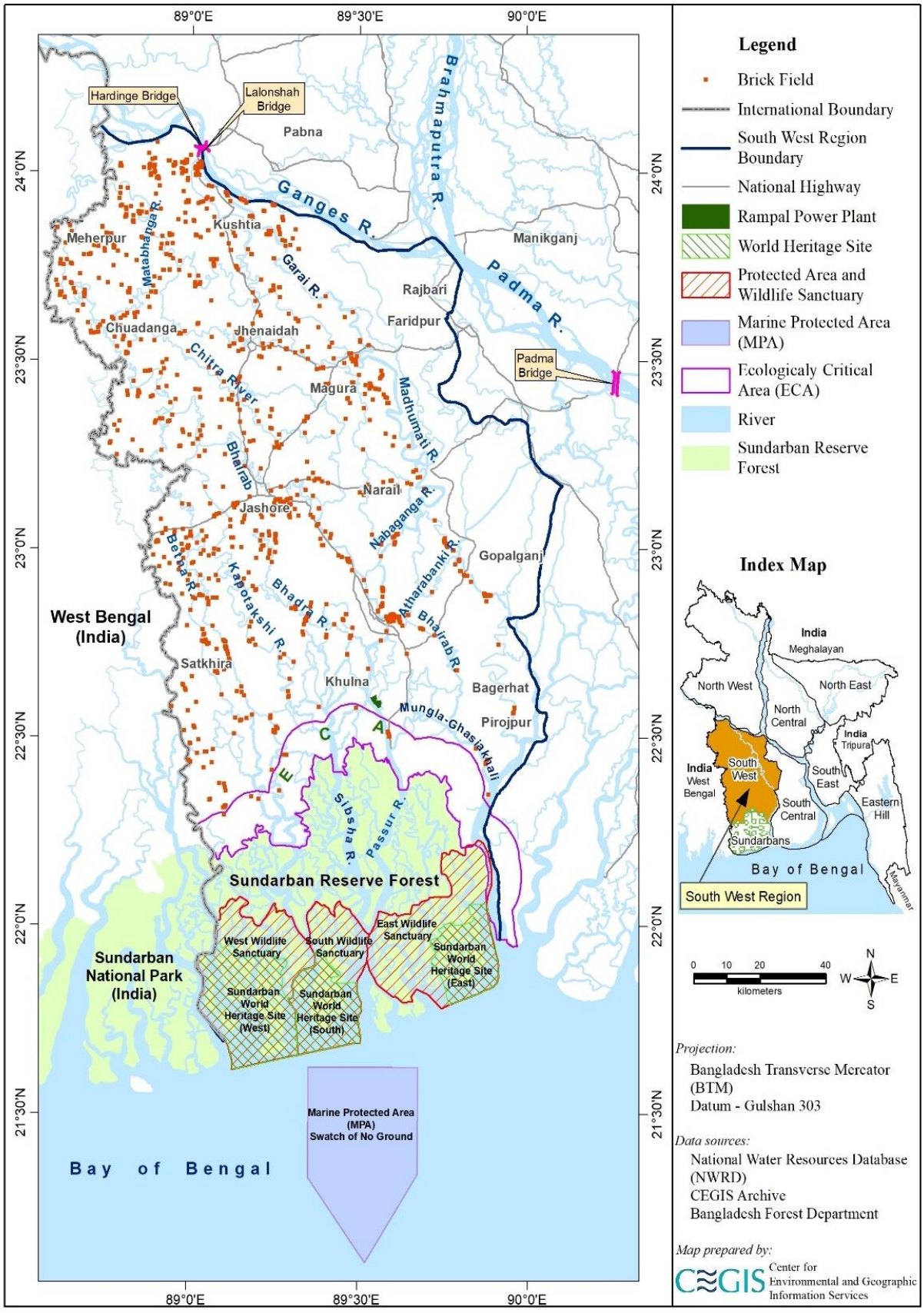


Figure 4.2: Active Brick Kilns in SW Region of Bangladesh

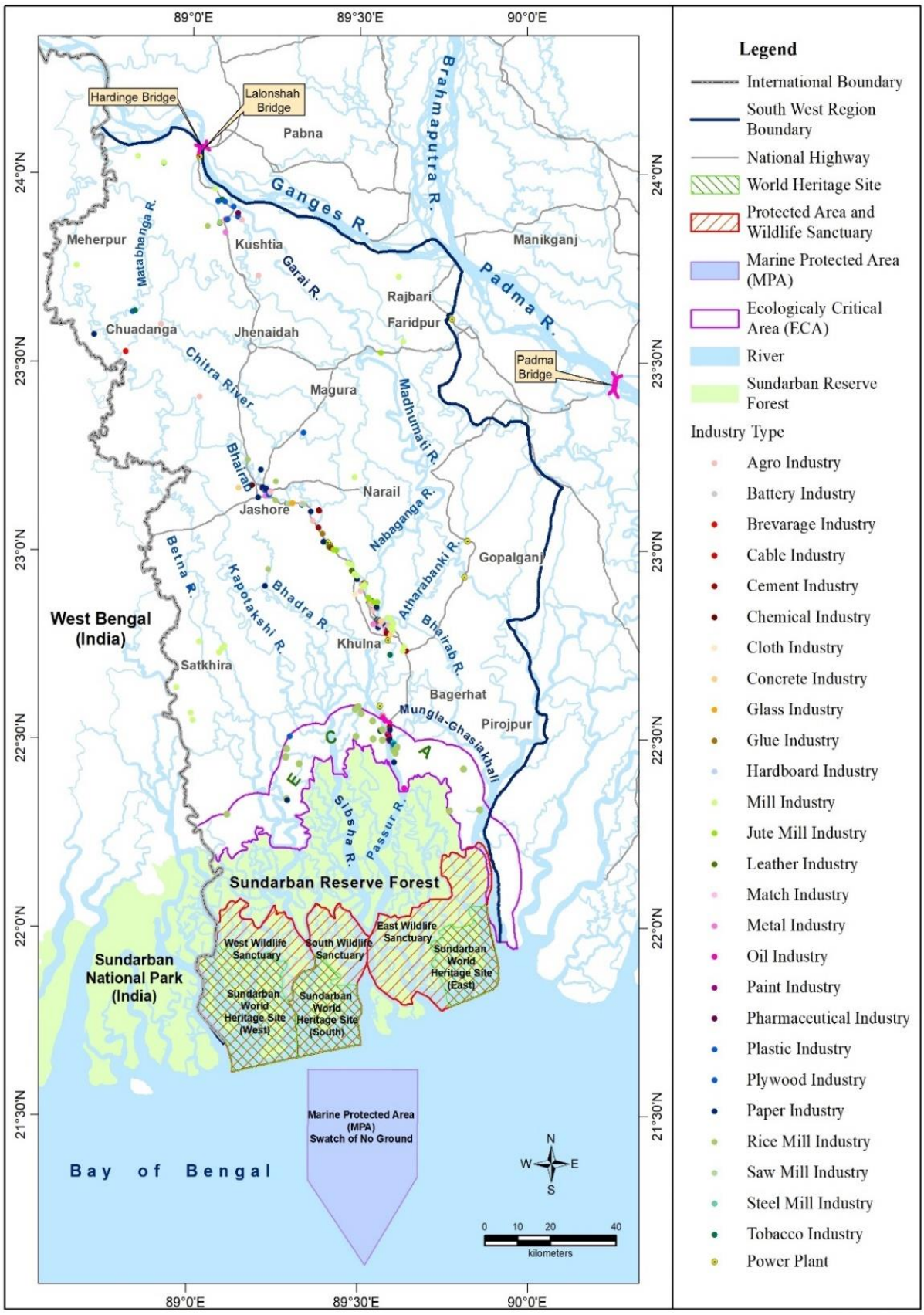


Figure 4.3: Location of Major Air Polluting Industries in SW Region of Bangladesh

Table 4.1: Emission of Criteria Pollutants from Point Sources (Different Industries) in SW Region

Present Running Power Plant	No	Emissions Rate (g/s)				UTM Coordinates		Fuel Type [36]	Sources
		$PM_{2.5}$	PM_{10}	SO_2	NOx	East.	North.		
NWPGCL 225 MW CCPP	1	1.85	1.85	80.6	37	760246.8	2530868	HSD	EIA Report
Bheramara 60MW	1	0.19	0.19	0.02	6.2	705194.5	2661080	CNG	AP-42: Stationary Sources
Bheramara 410 MW CCPP	1	1.6	1.6	4.8	25.6	705207.6	2661214	HSD	Continuous Monitoring
Noapara 100 MW PP (Bangla Track)	1	6.8	10.2	34.6	261.8	747355.2	2547518	HSD	AP-42: Stationary Sources
Noapara 105 MW Power Plant	1	0.8	0.8	24.2	15.6	747333.72	2547060.9	NG	AP-42: Stationary Sources
Faridpur 50 MW Peaking PP	1	5.6	5.6	106.8	147.3	782973.1	2614754	HFO	AP-42: Stationary Sources
Gopalganj 100 MW Peaking PP	1	11.3	11.3	213.6	294.6	788997.8	2549607	HFO	AP-42: Stationary Sources
Modhumoti, Bagerhat 100 MW PP	1	9.3	9.3	273.8	176.3	788302.3	2538901	HFO	AP-42: Stationary Sources
KPCL 110 MW HFO Power Plant (1st Phase)	2	65.6	78.4	541.2	241.5	760322.6	2531185	HFO	AP-42: Stationary Sources
KPCL 115 MW HFO Power Plant (2nd Phase)		68.5	81.9	565.3	252.5	760288.9	2531184	HFO	AP-42: Stationary Sources
Khanjahan Ali 40MW Power Company Ltd (KJAPCL)	1	4.1	4.1	121.2	78	746517	2548288	HFO	AP-42: Stationary Sources
Rupsa, Khulna 105 MW PP (Orion)	1	5.2	5.2	401.9	260	765345.1	2519997	HFO	AP-42: Stationary Sources
Brick Kilns	1081	2.12	6.44	7.15	0.214	Figure 4.2		Coal	BEI, NILU and AP-42
Steel Industries	2	1.3	1.4	2.7	2.4	Figure- 4.3		Coal	AP-42: Stationary Sources
Oil Refinery Industries	12	-	-	-	2.19	Figure-4.3		oil	AP-42: Stationary Sources
Rice mills	72	0.008	0.05	-	-	Figure-4.3		husk/ wood	Air Emission Inventories of CPCB, India

[36] HSD = High Speed Diesel, CNG = Compressed Natural Gas, HFO = Heavy Fuel Oil

Table 4.2: Emission of Criteria Pollutants from Major Line Sources (Road and Railway)

Roads and Locomotives		**Baseline (gm/s/m)**			
	Width (m)	$PM_{2.5}$	PM_{10}	SO_2	NOx
N 709 (Khulna - City By Pass)	6.8	0.0000066	0.000017	0.00000098	0.000117
N 702 (Jessore-Magura)	7.5	0.0000078	0.000022	0.00000112	0.000138
N 704 (Jhenaidah Kushtia Paksey)	7.6	0.0000127	0.000032	0.00000175	0.000214
N 706 (Jessore-Benapole)	4.0	0.0000077	0.000022	0.00000108	0.000125
R706 (Khulna-Chuknagr-Satkhira)	4.5	0.0000083	0.000025	0.00000107	0.000126
R755 (Jessore - Mrpur-Kpur-Chuknagar)	5.7	0.0000040	0.000014	0.00000057	0.000071
R720 (Magura-Narail)	5.5	0.0000032	0.000007	0.00000038	0.000048
R745 (Kustia - Mpur-Cdanga-Jhenaidah)	5.8	0.0000056	0.000018	0.00000071	0.000085
R771 (Rupsha-Fakirhat-Bagerhat)	4.5	0.0000058	0.000013	0.00000059	0.000067
Internal City Road	3.0	0.0001004	0.0004198	0.0000011	0.0001004
Emission from the SW regional railway	1.6	0.0000010	0.0000011	0.0000013	0.0000258

Note: Derived from the https://www.rhd.gov.bd/OnlineRoadNetwork/Default.asp and Updated Emission Factors of Air Pollutants from Vehicle Operations in GREET TM Using MOVES, 2013, Argonne National Laboratory, USA. For roads and https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100500B.pdf for railways

Table 4.3: Emission of Criteria Pollutants from Major Line Sources (River Vessels)

Name	**Emission Rate (g/s-m2)**				**Release Height (m)**
	$PM_{2.5}$	**PM_{10}**	**SO_2**	**NOx**	
Fairway Buoy to Harbaria	0.00000035	0.00000002	0.00000021	0.00000132	35
Harbaria to ChandpaiShela	0.00000030	0.00000002	0.00000018	0.00000113	15
ChandpaiShela to Katakhali	0.00000270	0.00000015	0.00000160	0.00001020	15
Katakhali to Chila Bazar	0.00000179	0.00000010	0.00000106	0.00000673	15
Banshtola Bazar to Chila Bazar	0.00000034	0.00000002	0.00000020	0.00000129	15
Chila Bazar to Baniashanta Bazar	0.00000189	0.00000011	0.00000113	0.00000713	15
Baniashanta Bazar to Mongla Powerhouse	0.00000299	0.00000017	0.00000177	0.00001120	15
Mongla Powerhouse to Loudop	0.00001150	0.00000065	0.00000685	0.00004340	3
Loudap to Baju Bazar	0.00000263	0.00000015	0.00000156	0.00000991	3
Baju Bazar to Khulna	0.00000058	0.00000003	0.00000035	0.00000219	3
Protocol Route	0.00000010	0.00000001	0.00000006	0.00000039	3
Nalan to Akram	0.00000034	0.00000002	0.00000020	0.00000126	3

Note: Calculated based on data from Mongla port Authority, Khulna Divisional IWT Owners' Group and BIWTA using the USEPA guideline https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10102U0.pdf

Table 4.4: Emission of Criteria Pollutants from Major Area Sources in the SW Region

Area Sources	**Emission Rate (g/s-m2)**					**Emission Sources**
	No.	**$PM_{2.5}$**	**PM_{10}**	**SO_2**	**NOx**	
Cement factories	19	0.00015300	0.00016800	-	-	USEPA AP-42:Volume-1, Emission from Stationary point and Area sources
Air Port	1	0.00000014	0.00000015	0.00000012	0.00000130	Air Quality Assessment, Emissions Inventory and Source Apportionment Studies : Mumbai

Area Sources	Emission Rate (g/s-m2)					Emission Sources
	No.	$PM_{2.5}$	PM_{10}	SO_2	NOx	
Mongla Sea Port and surrounding Industries	1	0.000278	0.00183	-	-	https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10102U0.pdf
Solid waste landfills	1	23.5	34.6	2.2	13.0	AP-42, Vol. I, CH 2.4: Municipal Solid Waste Landfills

4.1.4 Modelling of High Growth Scenario 2031 and 2041

For the 2031 modelling, the emission inventory includes a number of construction projects that are currently under construction or being planned, and will all be operational by 2031. These include the Maitree Super Thermal Power Plant, Rupsha Power Plant, Goalpara Power Plant, new railway lines and roads, and three economic zones (export processing zones) to be developed at Mongla, Bagerhat and Kustia by 2031. However, the major emitting sources of criteria pollutants have been stipulated for modelling studies as:

- 976-point sources (13 power plants, 16 oil refineries, 3 steel industries, 94 rice industries and 850 brick kilns) (major sources are listed in Table 4.5);
- Volumes of emissions from line sources were increased (to account for an expected increase in the length of roads and railways along with an expected increased in the number of road vehicles and trains (Table-4.6) as well as th expected increased number of vessels on the protocol routes (emission from the riverine sources are presented in Table 4.7);
- 31 area sources (25 cement factories, one airport, one seaport and one waste landfill with increasing the emission) were taken into account (major sources are listed in Table 4.8).

As a result, the emission inventory for 2031 includes some new emission sources while some of the current emissions sources included in the baseline (2019) are omitted.

Table 4.5: Estimated Emissions from Major Point Sources by 2031

Future Power Plant	No	Emissions Rate (g/s)				Stack Height (m)	Fuel Type	Emission Inventories
		$PM_{2.5}$	PM_{10}	SO_2	NOx			
NWPGCL 225 MW Combined Cycle Gas Power Plant	1	1.31	1.31	0.73	19.6	60	LNG [37]	EIA study Report
Bheramara 60MW	1	0.19	0.19	0.02	6.2	30	CNG	AP-42: Stationary Sources
Bheramara 410 MW CCPP	1	1.6	1.6	4.8	25.6	60	HSD	Continuous Monitoring
Noapara 100 MW PP (Bangla Track)	1	6.8	10.2	34.6	261.8	10	HSD	AP-42: Stationary Sources
Gopalganj 100 MW Peaking PP	1	11.3	11.3	213.6	294.6	50	HFO	AP-42: Stationary Sources
Modhumoti, Bagerhat 100 MW PP	1	9.3	9.3	273.8	176.3	60	HFO	AP-42: Stationary Sources
Noapara 105 MW Power Plant	1	0.8	0.8	24.2	15.6	50	NG	AP-42: Stationary Sources

[37] LNG = Liquefied Natural Gas

Future Power Plant	No	Emissions Rate (g/s)				Stack Height (m)	Fuel Type	Emission Inventories
		$PM_{2.5}$	PM_{10}	SO_2	NOx			
Rupsa ,Khulna 105 MW PP (Orion)	1	5.2	5.2	401.9	260	45	HFO	AP-42: Stationary Sources
Khulna 330 MW CCPP (D/F)	1	2.1	2.1	1.2	31.7	50	LNG	EIA Report
Rupsha 800 (2*400) MW CCPP	2	1.6	1.6	4.8	25.6	70	LNG	EIA Report
BIFPCL, Rampal, Coal Fired Power Plant	1	19.5	43.9	206.2	328.2	275	Coal	Design Specification
Faridpur 50 MW Peaking PP	1	5.6	5.6	106.8	147.3	50	HFO	AP-42: Stationary Sources
Gopalganj 100 MW Peaking PP	1	11.3	11.3	213.6	294.6	50	HFO	AP-42: Stationary Sources
Brick Kilns	850	2.12	6.44	7.15	0.214	38.1	Coal	BEI, NILU and AP-42
Steel Industries	3	1.3	1.4	2.7	2.4	-	Coal	AP-42: Stationary Sources
Oil Refinery Industries	16	-	-	-	2.19	-	Oil	AP-42: Stationary Sources
Rice mills	94	0.008	0.05	-	-	-	Oil	Air Emission Inventories of CPCB, India

According to the Brick Kiln Policy 2019, about 34% of the brick kiln industry will be upgraded in SW region by introducing modern green technology which will reduce air pollutants emissions considerably. But there will be increased emissions from new railways to be constructed in the SW region (Khulna to Mongla; Mongla to Gopalgong and Padma bridge to Faridpur-Gopalgonj-Barishal) as well as from vehicles following completion of the Padma Bridge. But, this will be offset as improvements are made to the quality of the vehicle fleet (lower emitting vehicles) and with increasing use of cleaner fuel. However, the rate of future emission of particulate and gaseous pollutant has been estimated in Table-4.6.

Table 4.6: Emission of Criteria Pollutants from Major Line Sources (Road and Railway) in 2031

Roads and Locomotives		Baseline (gm/s/m)			
	Width (m)	$PM_{2.5}$	PM_{10}	SO_2	NOx
N 709 (Khulna - City By Pass)	6.8	0.0000086	0.0000221	0.0000013	0.0001521
N 702 (Jessore-Magura)	7.5	0.0000101	0.0000286	0.0000015	0.0001794
N 704 (Jhenaidah Kushtia Paksey)	7.6	0.0000165	0.0000416	0.0000023	0.0002782
N 706 (Jessore-Benapole)	4.0	0.0000100	0.0000286	0.0000014	0.0001625
R706 (Khulna-Chuknagr-Satkhira)	4.5	0.0000108	0.0000325	0.0000014	0.0001638
R755 (Jessore - Mrpur-Kpur-Chuknagar)	5.7	0.0000052	0.0000182	0.0000007	0.0000923
R720 (Magura-Narail)	5.5	0.0000042	0.0000091	0.0000005	0.0000624
R745 (Kustia - Mpur-Cdanga-Jhenaidah)	5.8	0.0000073	0.0000234	0.0000009	0.0001105
R771 (Rupsha-Fakirhat-Bagerhat)	4.5	0.0000075	0.0000169	0.0000008	0.0000871
Internal City Road	3.0	0.0001305	0.0005457	0.0000014	0.0001305
Emission from the SW regional railway	1.6	0.0000013	0.0000014	0.0000017	0.0000335

Note: Projected from the https://www.rhd.gov.bd/OnlineRoadNetwork/Default.asp and Updated Emission Factors of Air Pollutants from Vehicle Operations in GREET TM Using MOVES, 2013, Argonne National Laboratory, USA and https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100500B.pdf for railways

Emissions from the navigation will increase due to an increase in shipping entering Mongla port. It is planned that the number of ships and shipping activities at Mongla port will be double by 2031. Table 4.7 lists potential emission rates from navigation routes by 2031.

Three Export Processing Zones (EPZ) are currently under construction at Mongla, Bagerhat and Kustia, and will be fully operational by 2031. Potential air pollutant emissions from these area sources are shown in Table 4.8.

Developments from 2031 to 2041 are uncertain. The emission inventory for 2041 includes the inventory for 2031 and known planned stationary sources – power plants listed in Table 4.9. Few power plants will be shut down after completing its economic life cycle. Energy efficient, cogeneration and green technologies, environment friendly measures will be adopted for the industrial sectors. Though the quantity of vehicles will be increased but the fuel system will shift from oil to natural gas or electricity mostly. However, the major emitting sources of criteria pollutants have been stipulated for modelling studies as:

- 181-point sources (9 power plants, 28 oil refineries, 6 steel industries, 160 rice industries) (major sources are listed in Table 4.9);
- Line sources emission will be increased (Increasing roads and railways along with increase the vehicles: Table-4.10), Increase the number of vessels on the protocol routes (emission from the riverine sources presented in 4.11);
- 48 area sources (33 cement kilns, one airport, two seaports and two waste landfill with increasing the emission) were taken into account (major sources are listed in Table 4.12).

Table 4.7: Emissions of Criteria Pollutants from Major Riverine Sources by 2031

Name	Emission Rate (g/s-m2)				Release Height (m)
	$PM_{2.5}$	PM_{10}	SO_2	NOx	
Fairway Buoy to Harbaria	0.000000525	0.00000003	0.000000315	0.00000198	35
Harbaria to ChandpaiShela	0.00000045	0.00000003	0.00000027	0.000001695	15
ChandpaiShela to Katakhali	0.00000405	0.000000225	0.0000024	0.0000153	15
Katakhali to Chila Bazar	0.000002685	0.00000015	0.00000159	0.000010095	15
Banshtola Bazar to Chila Bazar	0.00000051	0.00000003	0.0000003	0.000001935	15
Chila Bazar to Baniashanta Bazar	0.000002835	0.000000165	0.000001695	0.000010695	15
Baniashanta Bazar to Mongla Powerhouse	0.000004485	0.000000255	0.000002655	0.0000168	15
Mongla Powerhouse to Loudop	0.00001725	0.000000975	0.000010275	0.0000651	3
Loudap to Baju Bazar	0.000003945	0.000000225	0.00000234	0.000014865	3
Baju Bazar to Khulna	0.00000087	0.000000045	0.000000525	0.000003285	3
Protocol Route	0.00000015	0.000000015	0.00000009	0.000000585	3
Nalan to Akram	0.00000051	0.00000003	0.0000003	0.00000189	3

Note: Calculated based on data from Mongla port Authority, Khulna Divisional IWT Owners' Group and BIWTA using the USEPA guideline https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10102U0.pdf

Table 4.8: Emissions of Air Pollutants from Area Sources by 2031

Name	Emission Rate (g/s-m2)					Sources
	No.	$PM_{2.5}$	PM_{10}	SO_2	NOx	
Cement factories	25	0.00015300	0.00016800	-	-	USEPA AP-42:Volume-1, Emission from Stationary point and Area sources
Air Port	1	0.00000018	0.0000002	0.00000016	0.00000169	Air Quality Assessment, Emissions Inventory and

Name	Emission Rate (g/s-m2)					Sources
	No.	$PM_{2.5}$	PM_{10}	SO_2	NOx	
						Source Apportionment Studies : Mumbai
Mongla Sea Port	1	0.000278	0.00183	-	-	https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10102U0.pdf
Solid waste landfills	2	23.5	34.6	2.2	13.0	AP-42, Vol. I, CH 2.4: Municipal Solid Waste Landfills
Special Economic Zone (SEZ)	3	0.000049	0.000079	0.000025	0.000021	Data from Dhaka Economic Zone office

Table 4.9: Estimated Emissions from Major Point Sources by 2041

Future Power Plant	No	Emissions Rate (g/s)				Stack Height (m)	Fuel Type	Emission Inventories
		$PM_{2.5}$	PM_{10}	SO_2	NOx			
NWPGCL 225 MW Combined Cycle Gas Power Plant	1	1.31	1.31	0.73	19.6	60	LNG[38]	EIA study Report
Bheramara 410 MW CCPP	1	1.6	1.6	4.8	25.6	60	HSD	Continuous Monitoring
Noapara 100 MW PP (Bangla Track)	1	6.8	10.2	34.6	261.8	10	HSD	AP-42: Stationary Sources
Modhumoti, Bagerhat 100 MW PP	1	9.3	9.3	273.8	176.3	60	HFO	AP-42: Stationary Sources
Noapara 100 MW PP (Bangla Track)	1	6.8	10.2	34.6	261.8	50	HSD	AP-42: Stationary Sources
Rupsa ,Khulna 105 MW PP (Orion)	1	5.2	5.2	401.9	260	45	HFO	AP-42: Stationary Sources
Khulna 330 MW CCPP (D/F)	1	2.1	2.1	1.2	31.7	50	LNG	EIA Report
Rupsha 800 (2*400) MW CCPP	2	1.6	1.6	4.8	25.6	70	LNG	EIA Report
BIFPCL, Rampal, Coal Fired Power Plant	1	19.5	43.9	206.2	328.2	275	Coal	Design Specification
Steel Industries	6	1.3	1.4	2.7	2.4	-	Coal	AP-42: Stationary Sources
Oil Refinery Industries	28	-	-	-	2.19	-	Oil	AP-42: Stationary Sources
Rice mills	160	0.008	0.05	-	-	-	Husk /coal	Air Emission Inventories of CPCB, India

[38] LNG = Liquefied Natural Gas

Table 4.10: Emission of Criteria Pollutants from Major Line Sources (Road and Railway) in 2041

Roads and Locomotives		Baseline (gm/s/m)			
	Road Width (m)	$PM_{2.5}$	PM_{10}	SO_2	NOx
N 709 (Khulna - City By Pass)	6.8	0.0000112	0.0000289	0.0000017	0.0001989
N 702 (Jessore-Magura)	7.5	0.0000133	0.0000374	0.0000019	0.0002346
N 704 (Jhenaidah Kushtia Paksey)	7.6	0.0000216	0.0000544	0.0000030	0.0003638
N 706 (Jessore-Benapole)	4.0	0.0000131	0.0000374	0.0000018	0.0002125
R706 (Khulna-Chuknagr-Satkhira)	4.5	0.0000141	0.0000425	0.0000018	0.0002142
R755 (Jessore - Mrpur-Kpur-Chuknagar)	5.7	0.0000068	0.0000238	0.0000010	0.0001207
R720 (Magura-Narail)	5.5	0.0000054	0.0000119	0.0000006	0.0000816
R745 (Kustia - Mpur-Cdanga-Jhenaidah)	5.8	0.0000095	0.0000306	0.0000012	0.0001445
R771 (Rupsha-Fakirhat-Bagerhat)	4.5	0.0000099	0.0000221	0.0000010	0.0001139
Internal City Road	3.0	0.0001707	0.0007137	0.0000019	0.0001707
Emission from the SW regional railway	1.6	0.0000017	0.0000019	0.0000022	0.0000439

Note: Projected from the https://www.rhd.gov.bd/OnlineRoadNetwork/Default.asp and Updated Emission Factors of Air Pollutants from Vehicle Operations in GREET TM Using MOVES, 2013, Argonne National Laboratory, USA and https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100500B.pdf for railways

Table 4.11: Estimated Emissions from Riverine Sources by 2041

Name	Emission Rate (g/s-m2)				Release Height (m)
	$PM_{2.5}$	**PM_{10}**	**SO_2**	**NOx**	
Fairway Buoy to Harbaria	0.0000007	0.00000004	0.00000042	0.00000264	35
Harbaria to ChandpaiShela	0.0000006	0.00000004	0.00000036	0.00000226	15
ChandpaiShela to Katakhali	0.0000054	0.0000003	0.0000032	0.0000204	15
Katakhali to Chila Bazar	0.00000358	0.0000002	0.00000212	0.00001346	15
Banshtola Bazar to Chila Bazar	0.00000068	0.00000004	0.0000004	0.00000258	15
Chila Bazar to Baniashanta Bazar	0.00000378	0.00000022	0.00000226	0.00001426	15
Baniashanta Bazar to Mongla Powerhouse	0.00000598	0.00000034	0.00000354	0.0000224	15
Mongla Powerhouse to Loudop	0.000023	0.0000013	0.0000137	0.0000868	3
Loudap to Baju Bazar	0.00000526	0.0000003	0.00000312	0.00001982	3
Baju Bazar to Khulna	0.00000116	0.00000006	0.0000007	0.00000438	3
Protocol Route	0.0000002	0.00000002	0.00000012	0.00000078	3
Nalan to Akram	0.00000068	0.00000004	0.0000004	0.00000252	3

Sources: Calculated based on data from Mongla port Authority, Khulna Divisional IWT Owners' Group and BIWTA using the USEPA guideline https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10102U0.pdf

Table 4.12: Emission of Criteria Pollutants from Major Area Sources in 2041

Name	Emission Rate (g/s-m2)					Sources
	No.	$PM_{2.5}$	PM_{10}	SO_2	NOx	
Cement factories	33	0.00015300	0.00016800	-	-	USEPA AP-42:Volume-1, Emission from Stationary point and Area sources
Air Port	2	0.00000014	0.00000015	0.00000012	0.00000130	Air Quality Assessment, Emissions Inventory and Source Apportionment Studies : Mumbai
Mongla Sea Port	1	0.000278	0.00183	-	-	https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10102U0.pdf
Solid waste landfills	2	23.5	34.6	2.2	13.0	AP-42, Vol. I, CH 2.4: Municipal Solid Waste Landfills
SEZ	10	0.000049	0.000079	0.000025	0.000021	Data from Dhaka Economic Zone office

It is assumed that for the period 2031-2041, low emission technologies will be installed gradually in the energy sector and in industries, there will be a continuing switch to electricity or LPG as fuel for cooking, and the quality of both the road and water vehicle fleet will also increase. This will partially mitigate the incremental emissions. Thus, the assumption of 2 times increase of background emissions (emissions from smaller sources and fugitive emissions not included in the emission inventory) by 2041 is a rather pessimistic description of the worst case situation. The actual situation by 2041 will probably be better.

4.1.5 Meteorological Data

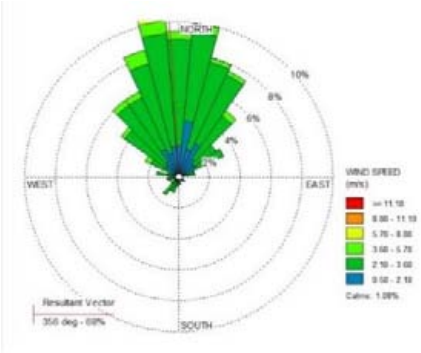
A numerical system combining the MM5 meteorological model[39] and the air quality model CALMET (a diagnostic three-dimensional meteorological model which is a part of the CALPUFF package[40]) was applied to the SW region. Pre-processed hourly Weather Research and Forecasting (WRF) meteorological data (resolution of 4 km) for January 2013 to December 2015 (3 years) was used for running CALMET. Wind speed data and direction were obtained from the analysis of upper atmospheric data collected for 2019-2020 by Lakes Environmental Consultants Inc., Canada[41].

The monthly wind rose diagrams for the Khulna area (Figure 4.4) show predominant wind directions broadly towards the north (narrowly northeast, north and northwest directions) for eight months (March to October). During April-May, the SW Region is particularly affected by north-easterly wind (Kalboishakhi). However, wind direction is towards the southeast and south for the other four months (November to February). In the latter period, the cross boundary wind (from West Bengal in India) may carry air pollutants to the SW region. Mobile sources, industries and other area sources (e.g. industrial areas) combine to raise air pollution in the SW Region during the winter months, and this may affect the Sundarbans as such sources are mainly located in the southern parts of the SW region. Wind direction in October is very mixed. There is a high potential for cyclones to affect the SW region during October and November. In addition to wind directions, presented in Figure 4.4, coastal weather also has a considerable influence on the airshed of the SW Region. Wind direction in October is very mixed.

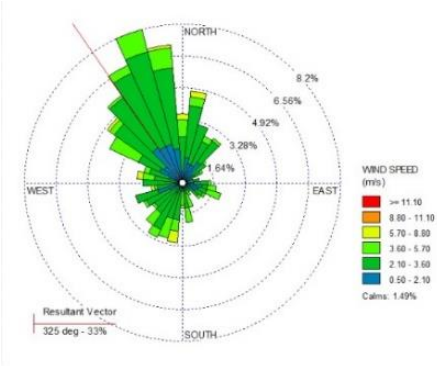
[39] See https://www2.mmm.ucar.edu/mm5/

[40] See http://www.src.com/

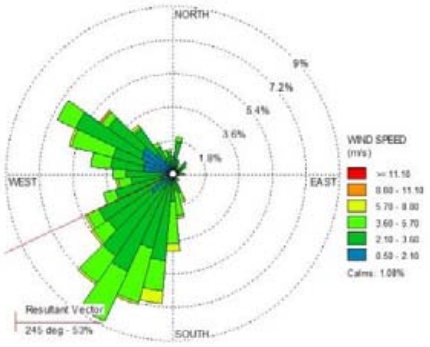
[41] See: https://www.weblakes.com/?AspxAutoDetectCookieSupport=1



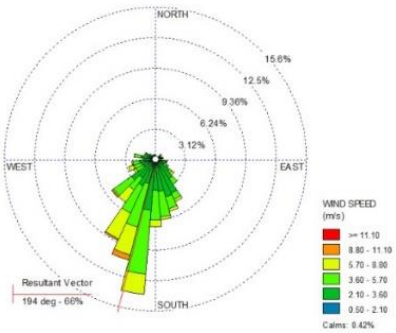
January 2019



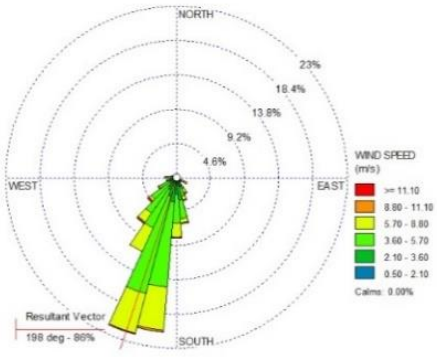
February 2019



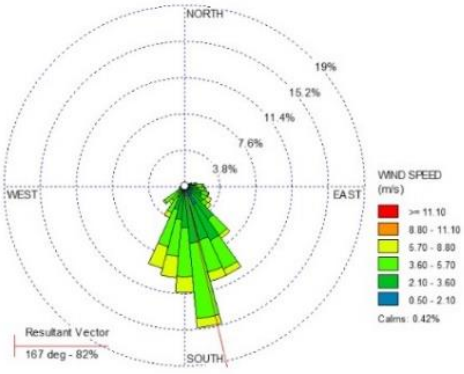
March 2019



April 2019



May 2019



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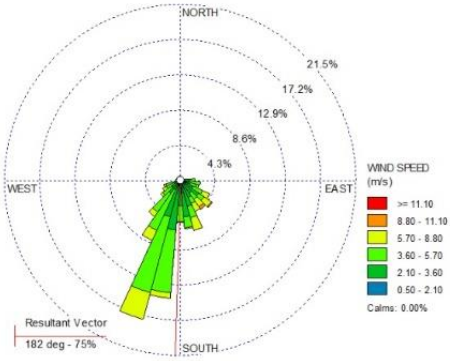
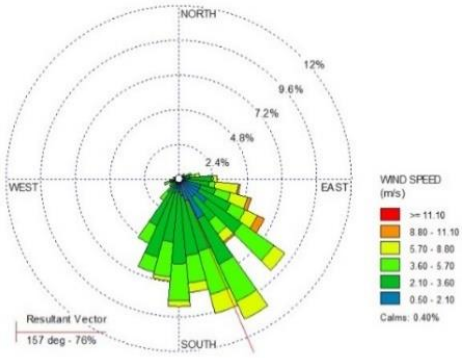
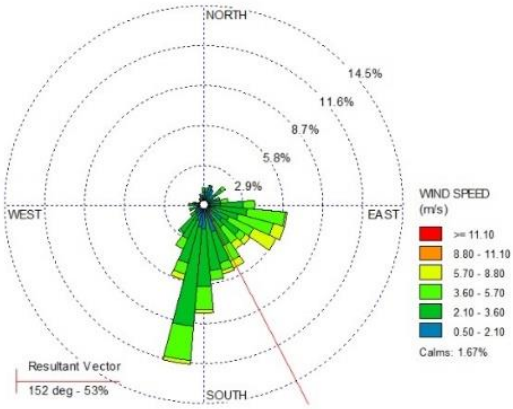


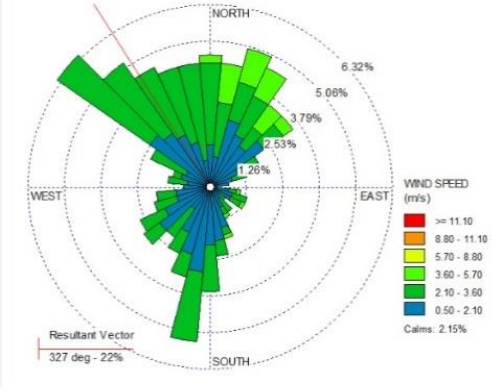
July 2019



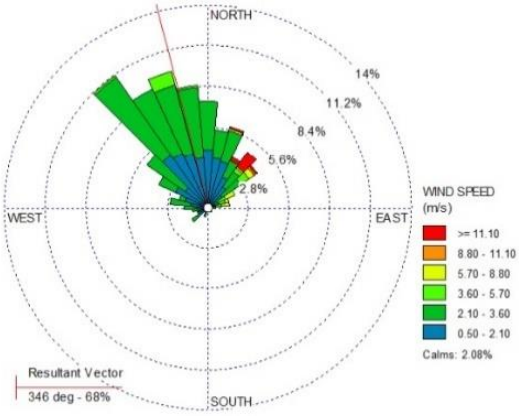
August 2019



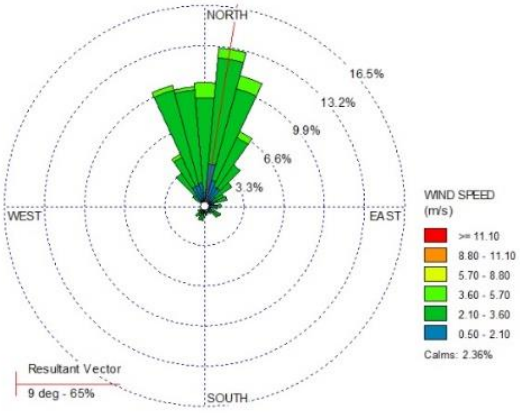
September 2019



October 2019



November 2019



December 2019

Figure 4.4: Monthly Wind-rose Diagrams for the Khulna Area

4.1.6 Air Quality Data

This study used air quality data for 2012 – 2019 obtained from the Continuous Air Quality Monitoring Stations network (CAMs–9.0) operated by the DoE's Clean Air and Sustainable Environment Project (CASE) project (Figure 4.5).

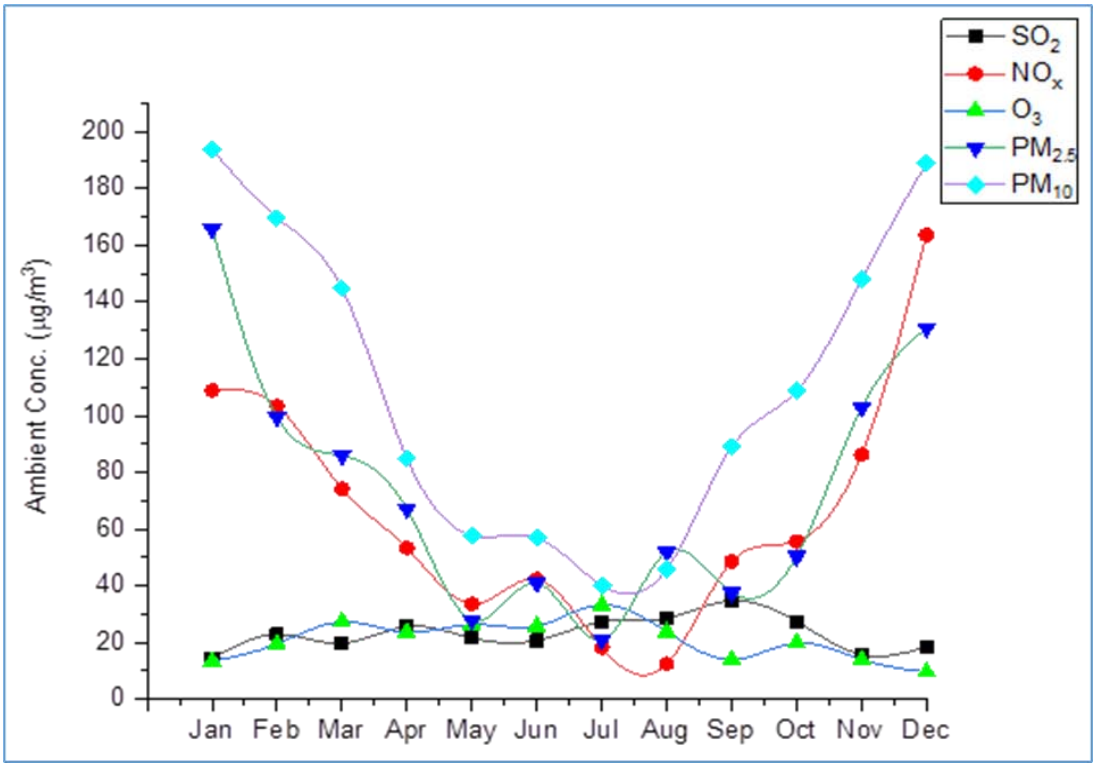


Figure 4.5: Monthly Ambient Air Quality at CAMs-9 (Khulna City)

Air quality was found to be compliant with national air quality standards for SO_2 and NO_2, but extremely poor as regards particulate matter (PM_{10} and especially $PM_{2.5}$.). Annual average ground level concentration of $PM_{2.5}$ was 77.9 µg/m³ – far exceeding national standards.

The Bangladesh-India Power Company Ltd. (BIFPCL) has been monitoring the environmental status of the area influenced by the Maitree super thermal power project at Rampal since 2014. In this area, the maximum concentrations of all criteria pollutants were found in winter at Khan Jahan Ali Bridge area (i.e. in the Khulna area). The lowest concentrations were recorded in the Sundarbans area for all the pollutants. The highest concentration of $PM_{2.5}$ (more than 40 µg/m³) was also recorded in the Khulna area in all seasons. Similarly, the concentration of PM_{10} was found to be higher (124 µg/m³) in the Khulna area than in other areas in all seasons, except the post monsoon season when the concentration was higher (around 90 µg/m³) in the Mongla area than the Khulna area. The concentration of SPM[42] was roughly the same in Khulna and Mongla in the pre-monsoon period, but higher in Khulna than Mongla in the winter period in the Sundarbans (Figure 4.6).

[42]SPM = Suspended Particulate Patter

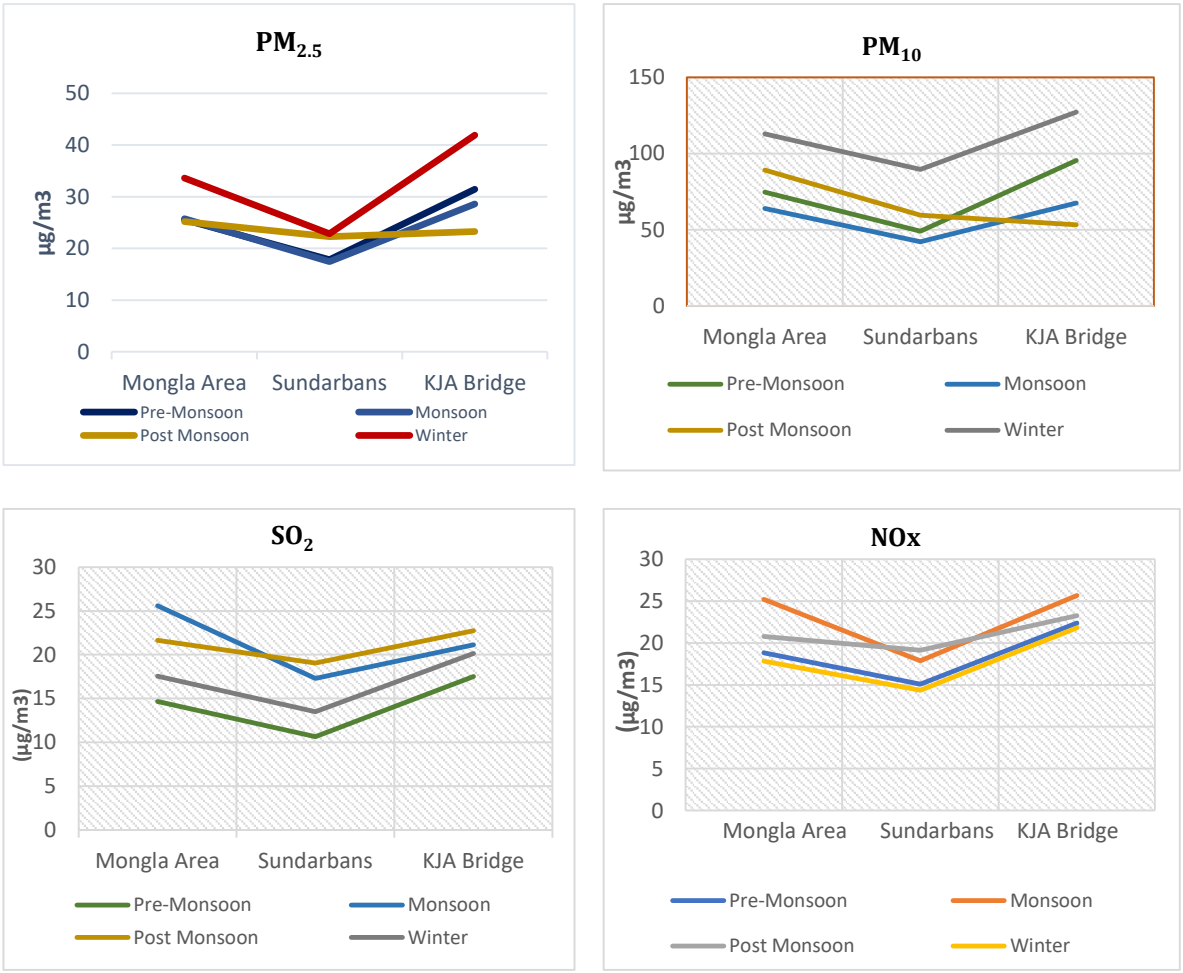


Figure 4.6: Seasonal Variation of Air Quality at Mongla, Sundarbans and KJA Bridge

Trends in PM concentration are influenced by seasonal factors like very high PM concentration in the winter season, especially in January; the minimum is during the wet season, especially in July. The most PM-polluted months in the Khulna area are December to January followed by February, March and November. However, Bangladesh is commited to reduce 17% and 14% of mean urban air pollution by the year 2025 for both PM_{10} and $PM_{2.5}$ respectively as mentioned in the Eighth Five Year Plan.

The concentration of SO_2 also varies depending on the fluctuation of emission sources, location and quantity, and weather conditions. Ambient SO_2 is increased during the dry period (November to March) and reduced during the monsoon (June to September) due to wet wash by rain.

In the SW region, the maximum concentration of all criteria pollutants is found in winter at Khan Jahan Ali bridge area (Khulna). By comparison, the lowest concentrations of all pollutants were recorded in the Sundarbans area. Similarly, the concentration of $PM_{2.5}$ was found to be higher (124 µg/m^3) in the Khulna area than in other areas during all seasons except the post-monsoon season when the concentration was higher (around 90 µg/m^3) in the Mongla area than the Khulna area.

The concentration of suspended particulate matter (SPM) was roughly the same in Khulna and Mongla in the pre-monsoon period, but higher in Khulna than Mongla in the winter period.

The average concentration of SO_2 was higher (25 µg/m^3) in the Mongla area than the Khulna area during the monsoon period, but in other seasons it was slightly higher in Khulna area than in Mongla and the Sundarbans area. The average values of NOx were also higher (25 µg/m^3) in the monsoon period in the Khulna and Mongla areas than in the Sundarbans area.

4.1.7 Model Calibration

The emission inventories presented in sections 4.1.3 and 4.1.4 do not (and cannot) include all sources of emissions. So, calibration of the model was carried out to ensure that it represented the real situation. The calibration compared the concentrations resulting from modelling and based on listed emission data with real concentrations measured at air quality monitoring stations. The difference between measured and calculated concentrations is the 'background concentration'. This covers emissions from small sources (e.g. cooking in households), smaller line sources, resting area sources, volume sources (buildings), sources outside the modelling area and long-distance/transboundary transfer pollution. In the case of particulate matter, it also covers emissions from natural sources (e.g. wind erosion).

4.1.8 Receptors

A uniform sampling grid was used to record the maximum concentration of pollutants spatially for different time intervals. The whole 300 x 300 km modelling area was divided into a 4 x 4 km grid, with receptors located at the center of each grid square for plotting air quality data (in total 5,625 receptors). Discrete locations corresponding to specific sites of interest (sites most sensitive and vulnerable to air pollution) were identified. These sensitive receptors were located in areas where there are children (i.e. schools) and patients (i.e. clinic and hospitals), and eco-sensitive places such as strategic points in the Sundarbans. From the total of 5,625 receptors, the modelling used 80 air sensitive receptors (ASRs) within the SW region (Figure 4.7), nine of which are located within the Sundarbans area (Peak Point of Sundarbans, Hiron Point, Akram Point, Harbaria, Dublar Char, Satkhira Range, Kotka, Notabeki, Majhar Point), hereinafter referred to as "key receptor points". Receptor points were selected based on:

- Being representative of all the areas of SW region;
- Being in sites where new emission sources are expected to emerge in the coming years;
- Being in sites with higher density of sensitive population or where objects especially sensitive to air pollution are placed.

Air quality is highly sensitive to the public health especially the sick people and children. Therefore, hospitals, public health complex and primary school have been selected as sensitive receptor points. Usually, those are located inside the communities.

Increasing air pollutants in ambient air also affects the historical places like monument or archaeological sites. Raising particulate matters in the wind erode those structures and sometime lowering pH due to wet deposition of SO_2 and NOx amplify the damage of the historical/archeological sites. Therefore, those air pollutant vulnerable sites have been selected as sensitive receptors for this air quality study.

National reserve forest is also selected as sensitive receptor. Total 9 receptor points have been established in the SRF to address the future ambient air quality throughout the SRF. Among the 9 points 3 are located in WHS which represent the ambient air quality in 2031 and 2041. Their position is specified comparatively near to the emission sources. Alike, four receptor points have been selected along the shipping line and trans-shipment points of Mongla port. Finally, two receptors have been fixed at peak point of Sundarbans of Khunla range and Satkhira range. Those points are important with respect to study of air pollution movement and circulation in the SRF from the significant sources.

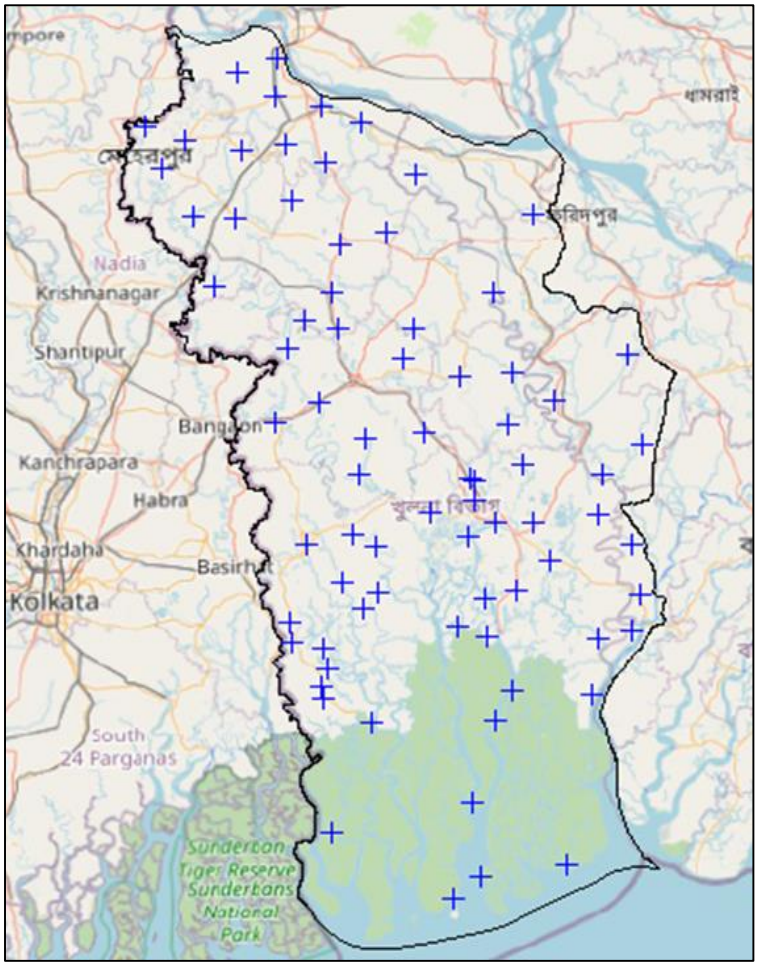


Figure 4.7: Location of Key Receptor Points

4.1.9 Dispersion Modelling for Particulate Matter

The spatial distribution of $PM_{2.5}$ and PM_{10} concentration for the baseline year (2019) and projected for 2031 and 2041 are shown in Figures 4.8 and 4.9, respectively.

Annual average ground level concentrations of $PM_{2.5}$ and PM_{10} for the five key receptor points with the highest concentrations in the SW region are presented in Table 4.13.

The modelling shows a field with an already raised concentration of PM in the Khulna area in the baseline year (2019). It is shown to move south with the occurrence, by 2031 and 2041, of further elevated PM concentrations occupying a 2,000 km^2 area encompassing the Mongla area - occupying a 30 km wide band (west to east) and 65 km long (north to south) from Khulna to the Mongla area.

At the remaining 75 key receptor points, none of the modelled concentrations of $PM_{2.5}$ exceed 30 $\mu g/m^3$ in any year; at 66 points, a concentration of 25 $\mu g/m^3$ is not exceeded in any year; and at 42 points, a concentration is less than 20 $\mu g/m^3$ in any year. The lowest modelled concentrations of $PM_{2.5}$ are 17.1 $\mu g/m^3$ in 2019, 18.3 $\mu g/m^3$ in 2031 and 18.38$\mu g/m^3$ in 2041.

In the case of PM_{10}, modelled concentrations at the remaining 75 key receptor points are lower than 73.2 $\mu g/m^3$; and at 19 points, the concentration is 60 $\mu g/m^3$ or above. At 50 points the average annual concentration usually does not exceed 60 $\mu g/m^3$ in any year. The lowest modelled concentration of PM_{10} is 53.2 $\mu g/m^3$ in 2019, 53.6 $\mu g/m^3$ in 2031 and 54.0 $\mu g/m^3$ in 2041. The concentrations of particulate matter are usually higher than the national standard due to increasing the background concentration. Generally, it will increase in future and will shift from Khulna areas to Mongla region.

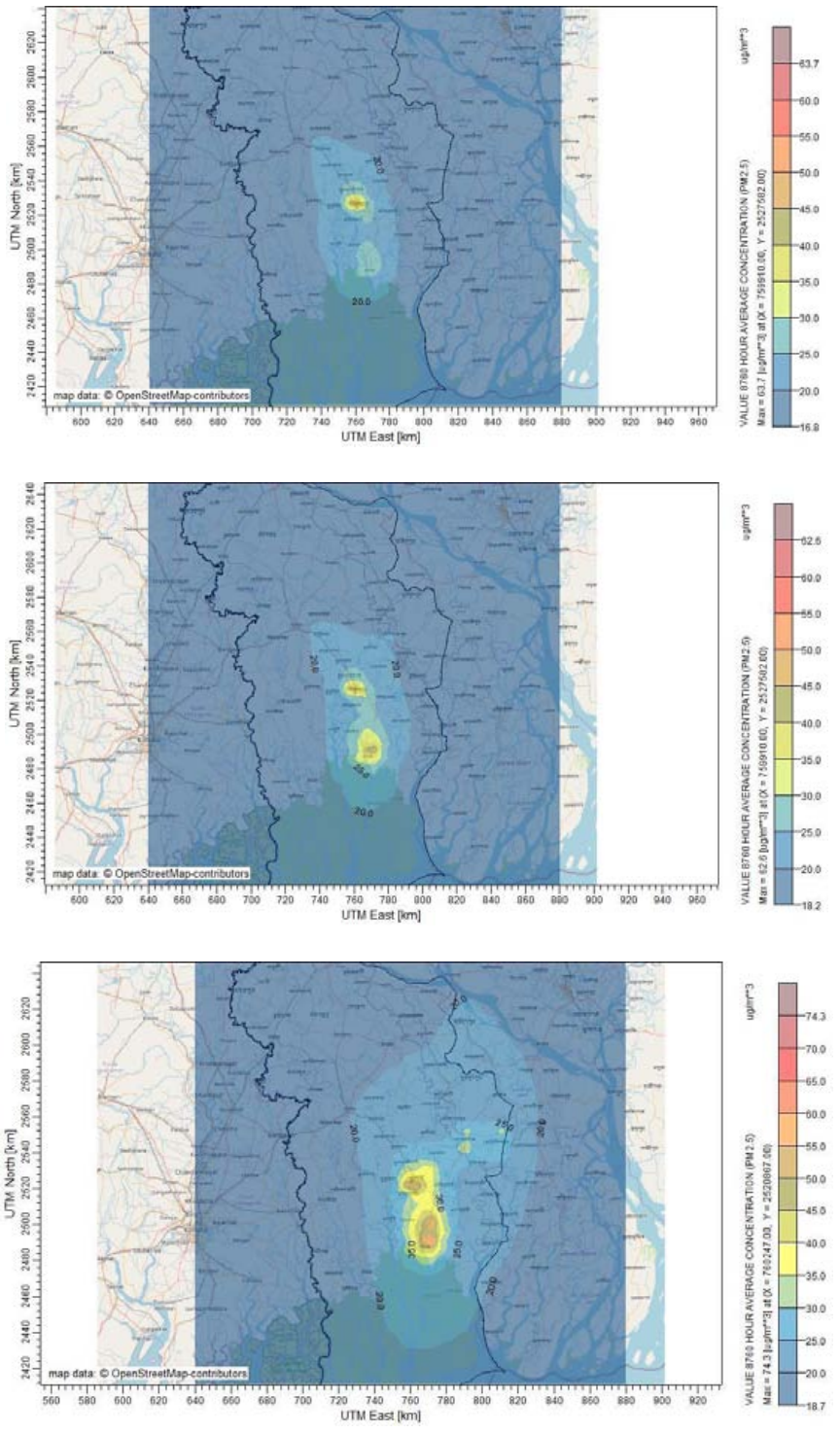


Figure 4.8: Spatial Distribution of PM2.5 Concentrations for Baseline and Projected for 2031 and 2041 (Annual Average Ground Level Concentrations)

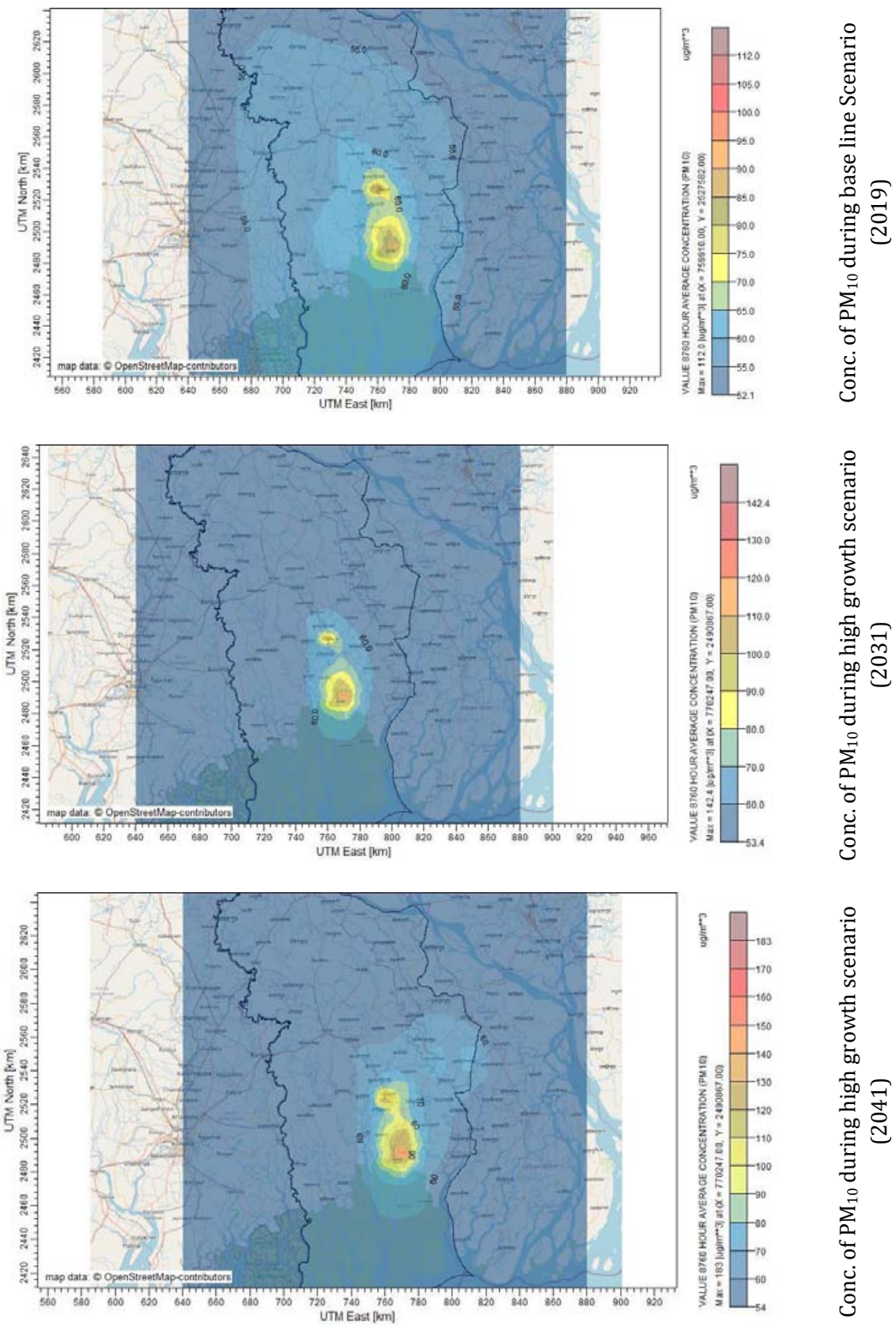


Figure 4.9: Spatial Distribution of PM_{10} Concentration for Baseline and Projected for 2031 and 2041 (Annual Average Ground Level Concentrations)

Table 4.13: Key Receptor Points with the Highest Concentrations of $PM_{2.5}$ and PM_{10}

Receptors	Annual GLC for $PM_{2.5}$ (µg/m3)				Annual GLC or PM_{10} (µg/m3)			
	ECR, 2005	2019	2031	2041	ECR, 2005	2019	2031	2041
Hospital at Rampal	15	25.9	42.40	62.34	50	73.5	107.14	129.53
CAMs-9, DOE (Khulna City area)	15	53.5	32.67	39.83	50	116.5	86.04	98.82
AQ-Mongla Port Area	15	30.0	59.84	65.30	50	82.8	148.53	152.73
Maidra-Passur Confluence area	15	28.6	49.72	58.39	50	79.0	124.95	133.19
Khan Jan Ali Bridge	15	30.0	30.85	43.65	50	75.5	76.38	88.83

Note: For international standards and those in other countries, see Annex 9.

Taking into account the fact that the key receptor points are relatively evenly distributed across the SW region (see Figure 4.7) and noting the fields of elevated PM concentrations (see Figures 4.8 and 4.9), the modelling shows that the concentration of $PM_{2.5}$ across the majority of the SW region is, and will remain, below 25 µg/m^3, while the high particulate pollution is, and will stay, concentrated in relatively small areas (Khulna and Mongla). Air quality (PM_{10} and $PM_{2.5}$) exceeds the standards for Bangladesh due to increased background concentrations levels (unaccounted sources, e.g. cooking, wind erosion, construction activities, pollen, transboundary etc.) in the airshed.

Comparing the results of modelling with national standards, it can be concluded that national standard for PM_{10} is currently exceeded, and most probably will be exceeded at all key receptor points by 2031 and 2041. In the case of $PM_{2.5}$, the national standard most probably will be exceeded at all 80 key points by 2031 and 2041.

Particulate matter in the Sundarbans area

Assessment of air quality in the Sundarbans has been carried out separately for the southern part of the area (which includes the World Heritage Sites) and for the northern part. Annual average ground level concentrations of PM_{10} and $PM_{2.5}$ at the key receptor points within the Sundarbans are presented in Table 4.14.

Table 4.14: Concentrations of PM_{10} and $PM_{2.5}$ at Key Receptor Points within the Sundarbans

Important points in Sundarbans	$PM_{2.5}$ (µg/m^3)				PM_{10} (µg/m^3)			
	ECR 2005	2019	2031	2041	ECR, 2005	2019	2031	2041
Northern part								
Upper Peak Point of Sundarbans	15	20.9	21.6	24.0	50	63.5	62.7	67.4
Harbaria Points	15	20.1	21.6	24.3	50	61.8	63.1	68.4
Satkhira Range Sundarbans	15	19.2	18.9	19.5	50	59.1	55.3	55.7
Majhar Point in Passur River	15	19.4	20.4	22.2	50	59.6	59.5	62.8
Southern part								
Hiron Point in Passur River	15	18.1	18.8	19.5	50	55.9	54.9	55.7
Akram Point in Passur River	15	18.5	19.2	20.2	50	57.1	56.0	57.4
Dublar Char in Sundarbans	15	18.1	18.8	19.6	50	56.0	55.1	56.1
Kotka Point in Sundarbans	15	17.9	18.7	19.6	50	55.3	54.8	55.9
Notabeki in Sundarbans	15	18.4	18.6	19.2	50	56.9	54.6	54.9

Note: For information on international standards and those in other countries, see Annex 9.

Table 4.14 shows that:

- Current and projected future concentrations of PM_{10} at all key receptor points located within the Sundarbans currently exceed national air quality standard, and most probably will continue to exceed them by 2031 and 2041 (see Table 4.14);
- Current and projected future concentrations of $PM_{2.5}$ at the key receptor points located within the Sundarbans area exceed the national air quality standard at all 9 points;
- Current and projected concentrations of both PM_{10} and $PM_{2.5}$ in the southern part of the Sundarbans (where the World Heritage Sites are located) are lower than those in the northern part;
- A negative (increasing) trend in concentrations of both $PM_{2.5}$ and PM_{10} can be expected at point R_71 (Harbaria) and at point R_1 (the Upper Point of Sundarbans) and a moderately negative trend at point R_80 (Majhar Point). All of these points are located in the reserve forest.

4.1.10 Dispersion Modelling for Gaseous Pollutants

Figures 4.10 and 4.11 show the level of annual average ground level concentration of SO_2 and NO_x/NO_2 for the baseline (current situation 2019) and high growth scenario by 2031 and 2041 (it is assumed that 100% of the NO_x emissions are converted into NO_2).

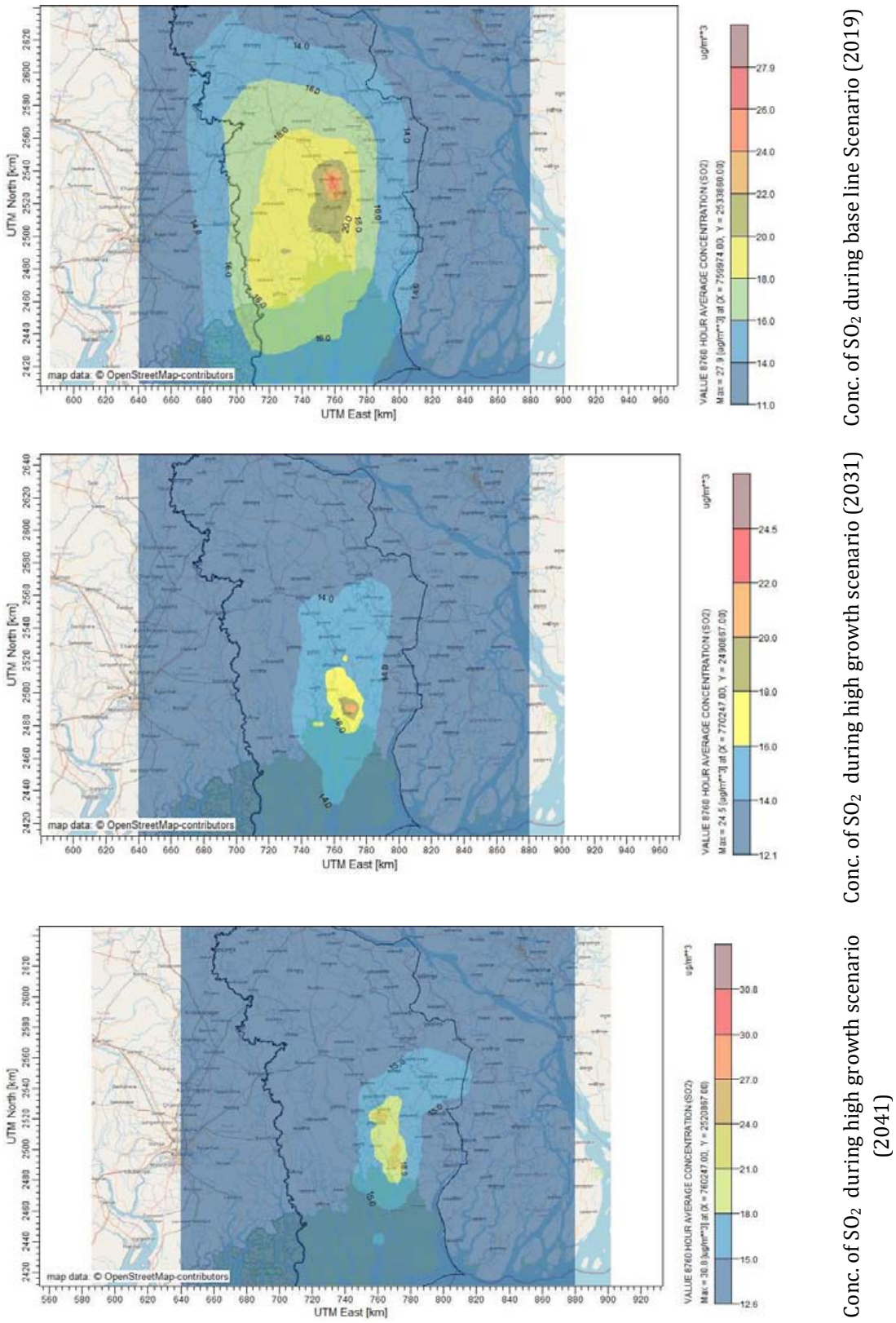


Figure 4.10: Spatial Distribution of SO_2 Concentrations for Baseline Year (2020) and Projected for 2031 and 2041 (Annual Average Ground Level Concentrations)

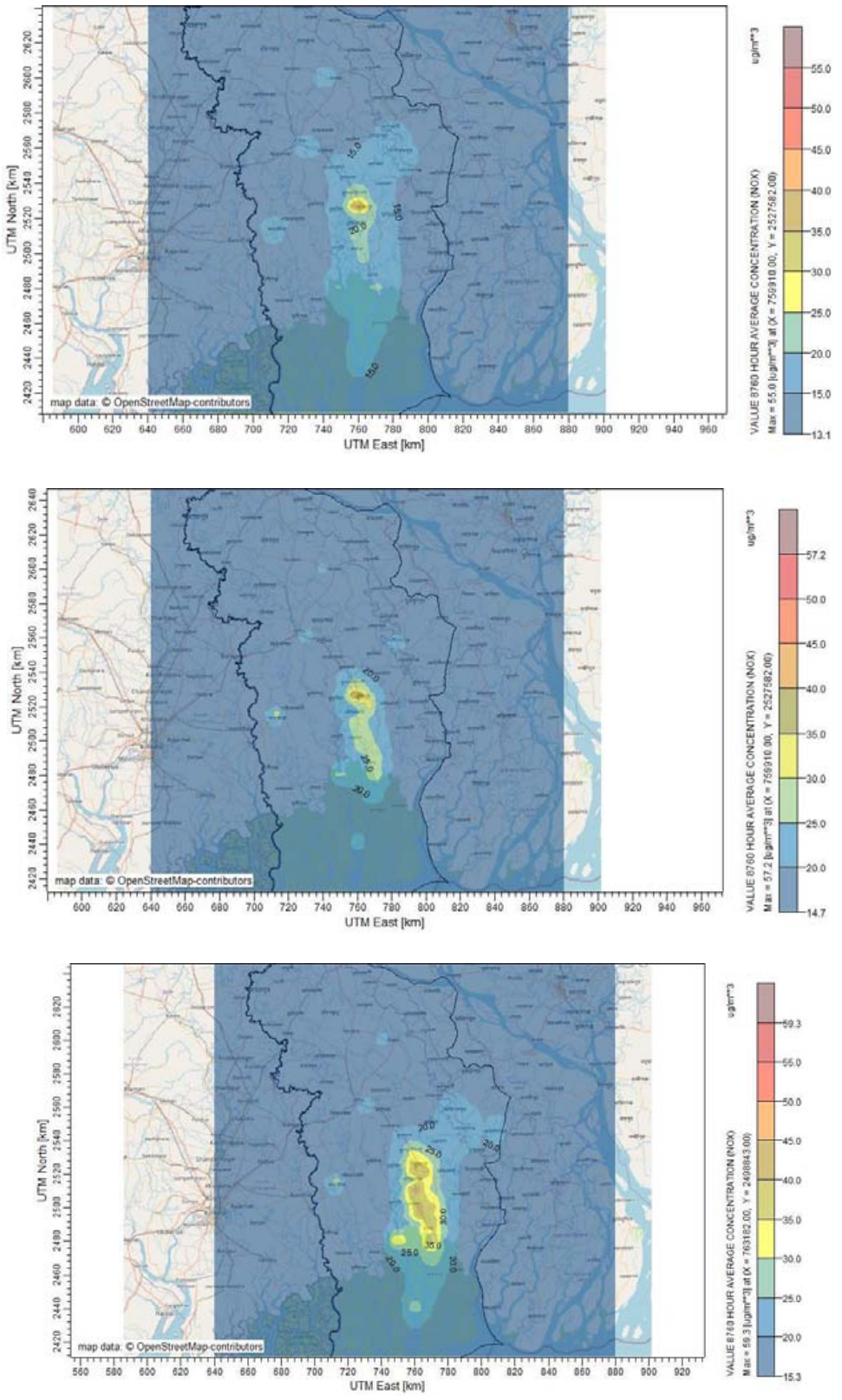


Figure 4.11: Spatial Distribution of NOx /NO_2 Concentrations. for Baseline Year (2020) and Projected for 2031 and 2041 (Annual Average Ground Level Concentrations)

SW region

The eight key receptor points with the highest annual average ground level concentrations of SO_2 are listed in Table 4.15.

Table 4.15: Key Receptor Points with the Highest Concentrations of SO_2 in the SW Region

Receptors	Coordinates		SO_2 (µg/m3)			
	Lat (km)	Long (km)	ECR, 2005	2019	2031	2041
Rampal Hospital	772.29	2501.14	80	17.9	16.5	23.5
Batiaghata Hospital	758.26	2516.79	80	21.4	15.2	16.2
Dighalia Hospital	759.97	2533.86	80	27.9	15.3	16.4
Historical Place in Dghalia	758.63	2534.19	80	25.7	16.2	17.5
CAMs-9, DOE (Khulna City area)	759.91	2527.58	80	25.0	15.6	16.9
Maidra – Passur Confluence Arrea	763.18	2498.84	80	21.6	19.7	23.5
Khan Jan Ali Bridge	766.26	2521.16	80	21.2	16.7	20.1

Note: For information on international standards and those in other countries, see Annex 9.

At the remaining 73 key receptor points, none of the modelled concentrations of SO_2 exceeds 20 µg/m^3 in any year; and only in 3 points is it greater than 20 µg/m^3 in 2041. The lowest modelled concentrations of SO_2 were µg/m^3 12.1 in 2019, 12.3 µg/m^3 in 2031 and 12.6 µg/m^3 in 2041. Overall, the maximum yearly concentration of SO_2 is expected to follow a decreasing trend towards 2041.

Taking into account that the key receptor points are relatively evenly distributed across the SW region (see Figure 4.7) and noting the fields with elevated SO_2 concentrations;

(see Figure 4.10), the modelling shows that the concentration of SO_2 across the majority of the SW region is, and will remain, below 20 µg/m^3 while the slightly increased pollution is, and will be concentrated, around the Mongla-Khulna roads. However, the values of SO_2 at all receptor points are well below the national standard (ECR 2005) of 80 µg/m^3.

The key receptor points with the highest concentrations of NO_2 are presented in Table 4.16 (it is assumed that 100% of the NO_x emissions are converted into NO_2).

Table 4.16: Key Receptor Points with the Highest Concentrations of NO_2 in the SW Region

Receptors	Coordinates		NO_2 (µg/m^3)			
	Lat. (km)	Long. (km)	ECR, 2005	2019	2031	2041
Rampal Hospital	772.29	2501.14	100	16.9	23.0	35.8
Satkhira Hospital	712.59	2514.40	100	23.0	34.6	34.9
Dighalia Hospital	759.974	2533.86	100	21.5	22.1	25.8
Historical Place in Dighalia	758.63	2534.19	100	23.6	28.1	35.3
CAMs-9, DOE (Khulna City area)	759.91	2527.58	100	55.0	57.2	40.3
Harbaria Point	771.09	2471.41	100	18.0	22.8	29.3
Mongla Port Area	763.38	2487.49	100	17.5	22.9	29.4
Maidra - Passur Confluence Area	763.18	2498.84	100	27.6	38.3	59.3
Khan Jan Ali Bridge	766.26	2521.16	100	24.4	37.5	42.4

Note: For information on international standards and those in other countries, see Annex 9.

At the remaining 71 key receptor points, none of modelled concentrations of NO_2 is less than 25 µg/m^3 in any year; at 55 of them, the concentration is less than 20 µg/m^3 in any year. The annual average ground level concentration of NO_2 is expected to follow an increasing trend towards 2041 which can be related to increased traffic as well to new industrial activities burning fuels (power plants and other industries, etc.); and also to the shift of industrial activity towards the Mongla region.

The modelling shows the occurrence of a field with an already raised concentration of NO_2 in the Khulna area in the baseline year (2019). It is shown to move south with the occurrence, by 2031 and 2041, of further elevated NO_2 concentrations occupying an area of 2,000 km^2 in a 30 km wide band (west to east) and 65 km long (north to South) from Khulna and its vicinity to the South and Mongla and its vicinity to the North.

Taking into account that the key receptor points are relatively evenly distributed across the SW region (see Figure 4.7) and noting the field with elevated NO_2 concentrations (see Figure 4.11), it can again be concluded that the concentration of NO_2 across the majority of the SW Region is, and will remain, below the Bangladesh standard of 100 µg/m^3 while the higher pollution is, and will continue to be, concentrated in small but growing areas (Khulna and Mongla).

The modelling shows that:

- Concentrations of SO_2 at all receptor points located within the SW region show a decreasing trend from 2019 to 2041 and are well below the Bangladesh standard.
- Concentrations of NO_2 at almost all of the key receptor points located within the SW region show a (mostly slight) increasing trend from 2019 to 2041 but are well below the Bangladesh standard.

Sundarbans area

Assessment of air quality in the Sundarbans is carried out separately for its southern part (which includes the World Heritage Sites) and for its northern part (which lies adjacent to the Environmentally Critical Area (ECA), settled and industrial areas). Current and projected annual average ground level concentrations of SO_2 and NO_2 at the key receptor points within the Sundarbans are presented in Table 4.17.

Table 4.17: Current and Projected Annual Average Concentrations of SO_2 and NO_2 at the Key Receptor Points within the Sundarbans

Key receptors poinst in the Sundarbans	SO_2 (µg/m^3)				NO_2 (µg/m^3)			
	ECR, 2005	2019	2031	2041	ECR, 2005	2019	2031	2041
Northern part								
Upper Peak Point of Sundarbans	80	19.1	15.0	15.4	100	15.5	18.5	21.4
Harbaria in Passur River	80	17.1	15.5	16.3	100	18.0	22.8	29.3
Satkhira Range	80	18.3	13.7	13.4	100	13.9	15.9	16.8
Majhar Point in Passur River	80	16.7	14.7	15.3	100	16.4	20.2	24.4
Southern part								
Hiron Point in Sundarbans	80	14.8	13.4	13.6	100	13.9	16.2	17.3
Akram Point in Sundarbans	80	16.0	14.3	14.7	100	16.1	19.6	23.5
Dublar Char in Sundarbans	80	14.9	13.6	13.8	100	14.4	16.9	18.6
Kotka in Sundarbans	80	14.0	13.2	13.4	100	13.8	15.9	16.9
Notabeki in Sundarbans	80	16.1	13.3	13.2	100	13.7	15.5	16.3

The modelling shows that:

- Concentrations of SO_2 at all key receptor points located within the Sundarbans show a decreasing trend from 2019 to 2041 and are well below the Bangladesh standard.
- Concentrations of NO_2 at all key receptor points located within the Sundarbans show an increasing trend from 2019 to 2041; but are well below the Bangladesh standard[43].

4.1.11 Conclusions and Recommendations

SW region

- The most polluted sites as regards PM and NO_2 (predicted by 2031 and 2041) are in the Mongla–Rampal-Khulna and Khanjan-Ali areas. The higher PM and NO_2 levels found here are due to activities in or near Mongla (both current levels and those predicted by 2031 and 2041).
- Pollution by PM, especially $PM_{2.5}$, presents a very high risk for human health, and may also have an impact on fauna and flora.
- Pollution by NO_2 can be considered moderate from the point of view of both health impacts and impacts on vegetation/ecosystems - however (in accordance with the Precautionary Principle), it is not negligible.
- Pollution by SO_2 can be considered negligible from the point of view of both health impacts and impacts on vegetation/ecosystems.
- It is recommended to implement PM emission reduction measures.
- It is recommended to develop an air quality monitoring network based on automated stations to generate 'near-to-real-time' information on actual air quality across the region and to make that information available to the public.
- It is recommended to develop and regularly update an inventory of emissions of air pollutants (in accordance with international standards).
- Air quality modelling should be periodically re-run to incorporate up-dated and new data in order to provide revised information for the best management of pollution issues

Sundarbans area

- In general, the predicted pollutant concentration in the Sundarbans is lower than that in the rest of SW region up to 2041.
- Within the Sundarbans, criteria pollution levels in the southern part (where the World Heritage Sites are located) are lower than those in the northern part.
- The level of particulate matter pollution (PM_{10}, $PM_{2.5}$) is relatively stabilized in the Sundarbans Reserve Forest but shows a slightly increasing trend close to the sources like shipping routes or port areas. Moreover, it also represents 'non-negligible' (a term used in applying the Precautionary Principle) risk for fauna and flora (possible impact on morphological, biochemical and physiological aspects as suggested by available scientific data (Rai, 2016).
- As regards gaseous pollutants, the concentration of SO_2 will reduce considerably by 2041 in the Sundarbans Reserve Forest and is considered negligible. But NO_2 shows an increasing trend particularly close to source points up to 2041.
- The impact of NO_2 pollution on vegetation/ecosystems is, and most probably will remain, low in the southern part of Sundarbans. In the northern part of the Sundarbans, it can be considered moderate at present but will increase over the next 20 years (due to the increasing trend at all key receptors in the northern part of the Sundarbans).

[43] For international standards, see Annex 9.

4.2 Water Quality Modelling

4.2.1 Introduction

The modelling addressed levels of nitrate (NO_3^-) and phosphate (PO_4-) those are generally considered as limiting nutrients in freshwater and the tidal influenced brackish and marine environments.

It was the intention to include biochemical oxygen demand (BOD) as an important water quality parameter in the modelling. However, it proved difficult to estimate BOD reliably or accurately due to a lack of systematic spatial and temporal BOD data for the river systems of the SW region. Furthermore, the limited data made it very difficult to understand the changing nature of BOD levels in the rivers under tidal influence.

Three cases were considered: (a) baseline (current state of water quality - 2019); pollution under a high growth scenario in (b) 2031 and (c) 2041 (growth scenarios are discussed in Chapter 5).

Modelling was based on the following assumptions, some of which will lead to a reduction in water pollution, some to an increase:

- Legal requirements related to environmental protection will remain at least at the current level and will not be 'softened';
- Investment projects and other relevant activities assumed in existing PPPs will be implemented within proposed/planned timelines;
- Newly built industrial installations will be equipped with modern energy and material efficient technologies and operated with water pollution abatement techniques to comply with the legal requirements;
- There will be a shift to balanced agricultural practices with less use of chemical fertilisers in Bangladesh.
- Flow augmentation in the Passur-Sibsa river systems along with the other systems in the South-West Region.

4.2.2 Background

The tidal river system of the SW region is characterised by river segments with either freshwater or saline water (some segments brackish). Existing industrial, agricultural, fisheries and other activities in the SW region result in the pollution of the rivers and other surface waters in the region (see Chapter 3). Modelling has been undertaken to predict the future water quality status of the Passur-Shibsa river system under a high growth scenario up to 2031 and 2041. This channel carries almost all of the industrial discharges as well as domestic and agriculture-based runoff to the Sundarbans and lastly to the Bay of Bengal.

The modelling addressed levels of nitrate (NO^{3-}) and phosphate (PO_4^{3-}). These are generally considered as limiting nutrients in freshwater and tin tidal-influenced brackish and marine environments. Bangladesh is an agrarian country where nitrate and phosphate are the prime contributors to the degradation of surface water quality. The enrichment of water bodies by nitrate and phosphate can cause eutrophication[44] and result in algal blooms[45].

[44] Eutrophication can cause serious effects such as algal blooms (often microscopic, unicellular organisms) that block light from getting into the water and harm the plants and animals that depend on it. If there's enough growth of algae, it can deplete oxygen levels, making it hypoxic and creating a dead zone where no organisms can survive.

[45] Some algal bloom can release toxins that contaminate drinking water.

4.2.3 Methodology

The study was based on a hydrological model developed by CEGIS using SOBEK suite[46]. All the major rivers of the SW region (Gorai-Modhumati, Rupsha-Passur, Shibsa, Mathabanga, Chitra, Kapotaksha, Betna, Bhairab, Vadra, Arpangachiya) were included in this hydrological modelling. In addition, various other interconnected rivers and canals in the SW region were included in this model (Figure 4.12).

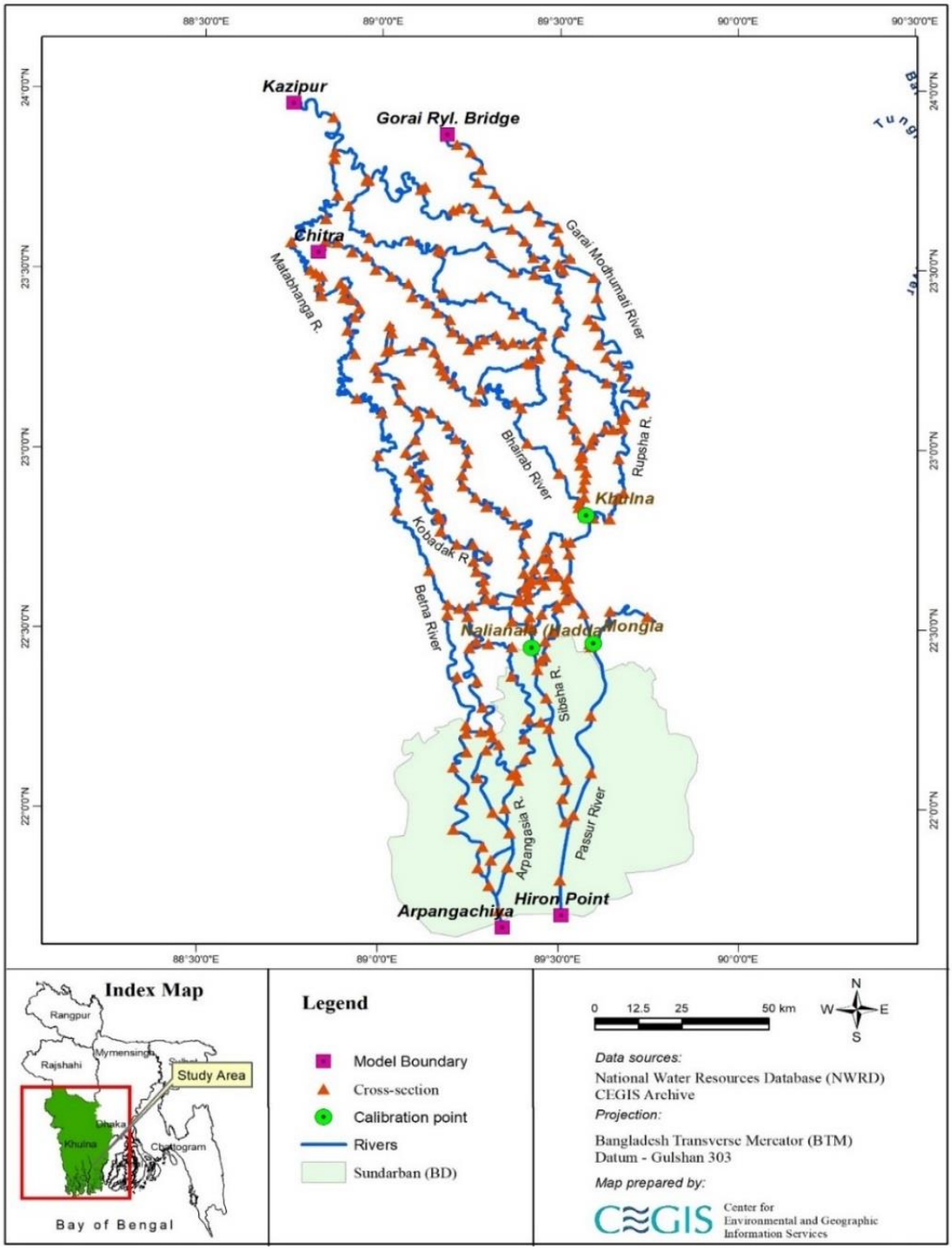


Figure 4.12: Computational Domain of the Hydrodynamic Model

[46] SOBEK is a powerful modelling suite for flood forecasting, optimization of drainage systems, control of irrigation systems, sewer overflow design, river morphology, salt intrusion and surface water quality (see https://www.deltares.nl/en/software/sobek/).

To characterise the river flow, velocity and water level, a 1-D hydrodynamic model in the SOBEK suite was also developed, and later calibrated and validated using the standard procedures. Before starting the water quality modelling, input data sets were prepared using the available primary measurements gathered by the Department of Environment and information from literature review (line agency reports and national and international journal articles). Effluents from all the industries listed in Table 4.16 were sampled to analyse the nitrate and phosphate concentrations. Industrial wastewater discharge volume was also measured through field survey. In the cases of two industrial units named Bangladesh Small and Cottage Industries Corporation (BSCIC) estates and Mongla Export Processing Zone (EPZ), only the main waste discharge drainage systems were sampled and analysed. Discharge volume of these industrial units were also measured in the main drainage systems.

Agricultural and surface runoff was calculated using the Soil and Water Assessment Tool (SWAT) model developed by CEGIS for the SW region[47].

Domestic discharges and other city drainage discharges were calculated based on per capita water consumption and the effluent quality of drainage discharges.

The DELWAQ water quality model[48] was calibrated and validated by datasets describing the actual (present) situation through trial and error. For high growth scenario for 2031 and 2041, hypothetical projections were made for pollution sources, volumes and the concentrations of the relevant model parameters. The overall study approach is shown in Figure 4.13.

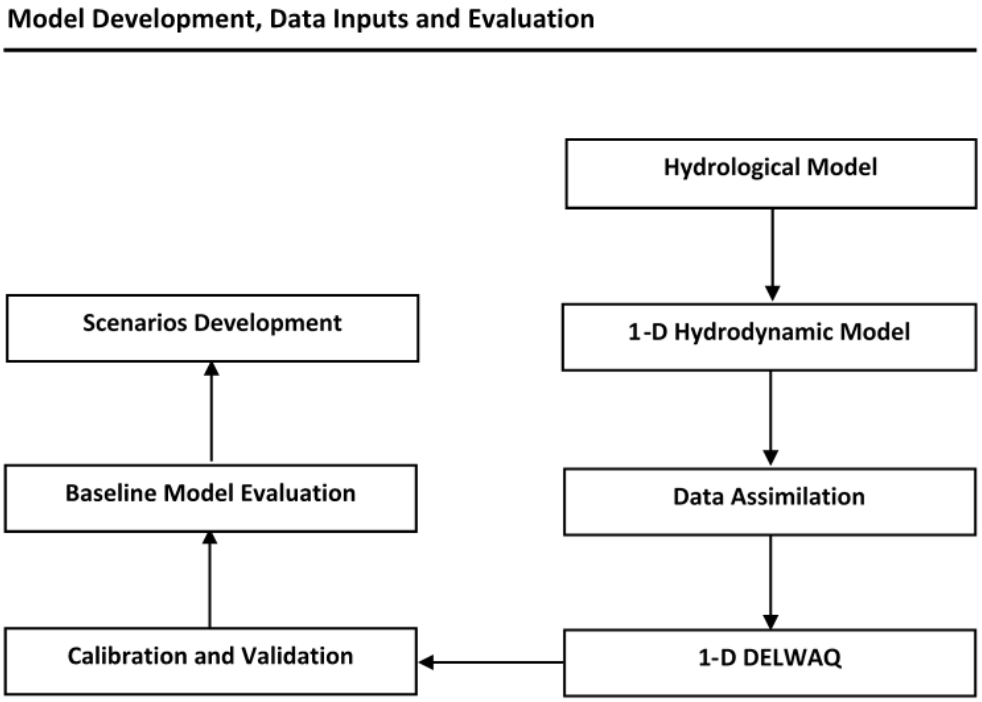


Figure 4.13: Approach of the Water Quality Modelling

[47] SWAT is a semi-distributed hydrological model which is used to simulate the catchment hydrology and water quality. The model simulates the hydrological, nitrogen, phosphorous and crop cycles of the area (see https://swat.tamu.edu/).

[48] DELWAQ is the engine of the D-Water Quality and D-Ecology programmes of the Delft3D suite. It is based on a rich library from which relevant substances and processes can be selected to quickly put water and sediment quality models together.(https://oss.deltares.nl/web/delft3d/delwaq1/-/message_boards/category/205375#:~:text=DELWAQ%20is%20the%20engine%20of,and%20sediment%20quality%20models%20together.).

Limitations of the modelling study include:

- Water polluting point and non-point sources (discharges from municipalities and industries, crop cultivation run-off, drainage discharges, effluents from shrimp ghers, etc.) are not being monitored - either systematically or periodically in the SW region;
- Data on effluent volumes and level of water contaminants from different types of industries are not gathered and stored properly;
- Lack of up-to-date information on the percentage of urban population connected to water supply and sewerage systems city wise;
- Data on volume of agricultural run-off from per unit of crop fields and on the quality status like NO3- and PO43- in the south west region is lacking;
- No information on river-based adsorption rate, detritus carbon, detritus nitrogen and detritus phosphorous level in sediment along with the particulate organic carbon;
- Up-to-date information on all aspects of water quality is lacking. There is no monthly or quarterly nutrients and chemicals data representing water quality in particular segments of the river system.

However, the challenges have been addressed by conducting direct survey for assessing effluent quality and discharge volume of industries, SWAT modelling for surface and agricultural runoff and relevant national published reports and articles for the river water quality baseline determination.

4.2.4 Water Quality Data Inventory

Water pollution sources

a) Industrial sources

The main pollution sources are the industrial units that are concentrated along the rivers, mainly between Khustia City and Mongla Port (Figure 4.14), as this zone is having good transportation networks either by roads or rivers. A survey carried out by CEGIS (2021), identified 111 separate industrial unit in this zone, including two Bangladesh Small and Cottage Industries Corporation (BSCIC) estates (in Khulna and Jashore)[49] and the export processing zone (EPZ) (at Mongla)[50]. The most numerous are the various types of industries/mills, medium and small-scale processing zones, factories and small-scale enterprises (see Table 4.16-4.19). Because of ready access to navigation routes, an oil refinery and storing plants along with LPG stations are found close to the Sundarbans as well. Industries (cement factory, rice mills, warehouses, brick kilns, printing and packaging etc.) which do not release significant amount of nitrates and phosphates to the receiving water bodies have not been considered in this water quality model exercise (Officers of Khulna DoE).

The industries listed in Table 4.18-4.21 discharge liquid waste into the adjacent rivers and canals, which mostly flows to the Passur-Shibsa river system and also flows to the other interlinked river systems in the south west region. In the industry list, there are two BSCIC estates and one EPZ which were counted as single industrial units (as there was no access to these three restricted industrial hubs when determining their liquid waste discharge loadings to the river system).

Some industries have effluent treatment plant facilities. However, of these, some are functional and others are not. According to the DoE, there are 71 industries (registered) producing moderate to huge liquid wastewater in the SW region under its Khulna Divisional Office. Of these, 16 establishments have their own

[49] These estates have various types of industries, especially: sea food processing, flour mills, jute mills, steel and metal industries, dry food processing and packaging, biscuits and bread factory, chemical agro industry, knitting industry and some pharmaceuticals.

[50] The major investment in Mongla EPZ comprise: food processing, textiles and leather. Other industries include light engineering, IT and hardware (PwC, 2015).

active liquid wastewater treatment plants. 45 have their own treatment plants but are not active, 4 have their own zero discharge treatment plants, and 6 have no effluent treatment plants.

The Environmental Conservation Rules (1997) require that any industry producing liquid wastes must have its own effluent treatment plant. Therefore, industrial discharge quality was assessed from the outlets points to the receiving water bodies to capture the exact wastewater quality coming to the natural aquatic systems.

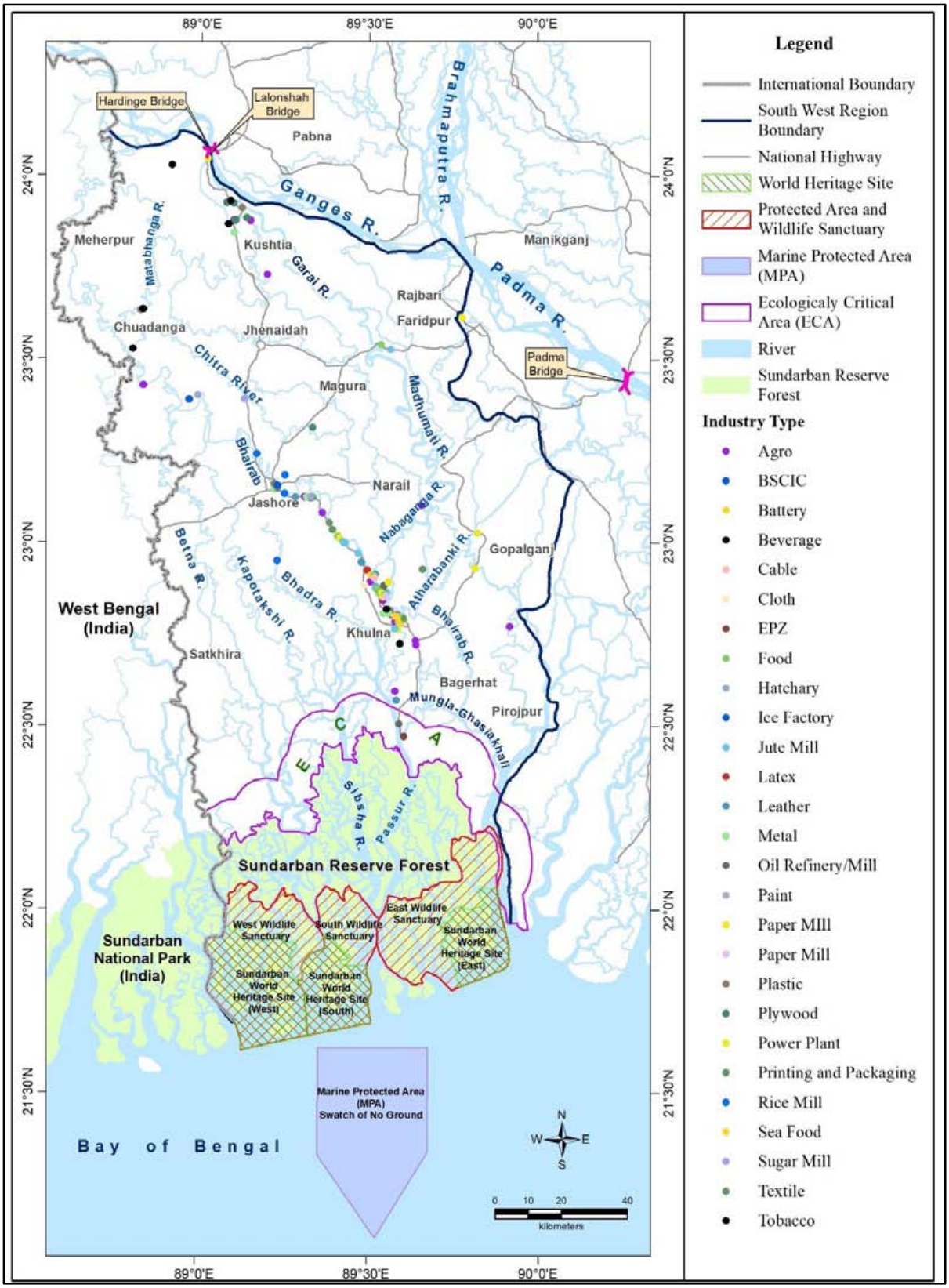


Figure 4.14: Distribution of Industrial/Mills, Medium and Small-scale Processing Zones, Factories and the Small-scale Units Discharging Liquid Wastes Directly to the River Systems in SW Region

Table 4.18: Types of Industry/Mills Releasing Nitrates and Phosphates into the Passur-Shibsa River System in the SW Region

Industries/Mills	Number
Agro-Food Processing	11
Jute Mill (private)	5
Power Plant	12
Steel and Metal	10
Sugar Mill	2
Total	40

Source: CEGIS Survey, February 2021

Table 4.19: Types of Medium and Small-scale Processing Zones Releasing Nitrates and Phosphates into the Passur-Shibsa River System in the SW Region

Medium and Small-scale PZ	Number
BSCIC	2
EPZ	1
Total	3

Source: CEGIS Survey, February 2021

Table 4.20: Types of Factories Releasing Nitrates and Phosphates into the Passur-Shibsa River System in the SW Region

Factories	Number
Battery Manufacturing	2
Beverage Production	1
Food Production and Processing	10
Leather Processing	5
Plastic Processing	9
Sea Food Processing	19
Tobacco Processing	6
Total	52

Source: CEGIS Survey, February 2021

Table 4.21: Types of Small-scale Enterprises Releasing Nitrates and Phosphates into the Passur-Shibsa River System in the SW Region

Small-scale enterprises	Number
Cable Manufacturing	1
Oil Refinery	4
Plywood and Wood Processing Mills	5
Textile	6
Total	16

Source: CEGIS Survey, February 2021

b) Urban domestic discharges

Domestic discharges from Kushtia, Jhenaidah, Chuadanga, Magura, Jashore, Noapara, Khulna and Mongla enter into the Bhairab-Passur-Shibsa river system. Sewage discharge is calculated by multiplying the urban population of 2020 (2.457 million) (Source: BBS, 2012 and hence following the projection for 2020) by

average per capita water consumption (88 l/day in Khulna City) (Milton et al., 2006). Sewage composition data were taken from the Pagla Sewage Treatment Facility of Dhaka (nitrate 50 mg/l and phosphate 10 mg/l,) (Hossain et al., 2018) due to the absence of any wastewater or sewage treatment facility in the urban areas of the SW region.

c) City drainage discharges

Drainage and canals within cities in the SW region carry huge volumes of used water from shops and households, storm water and releases from piped water supply networks, and also from small water bodies present in the cities that contain run-off residues from urban agricultural land inputs and paved areas. Direct measurement of nitrate and phosphate consternations along with discharges volume were performed for this segment as input data.

d) Shrimp gher discharges

Shrimp ghers are very popular and common in the SW region, even displacing agricultural practices, particularly in the western part of the region (e.g. Sathkhira, Paikgacha, Dacope and Koyra districts). In the more upstream areas of this western area (Dumuria, Khulna, Fultala, Beel Dakatia, etc.) both prawn culture and boro rice are prominent. In the areas of the region (around Bagherhat and Rampal) boro rice is grown, either alone or mixed with shrimps and prawns. Usually, more than 90% of ghers are managed following traditional methods along with fertilizers inputs (e.g. urea, triple super phosphate and lime). The pollutants are released when gher water is discharged (six times a year) to improve production (quality and quantity). Average wet season nitrate and phosphate concentrations found in the outlets of shrimp ghers are 0.23 mg/L and 0.18 mg/L respectively (Zillur et al., 2015 and projected for 2020 based on current practices). In the South West region, 281,809 ha is under shrimp culture of which Satkhira contains 36%, Bagerhat 28%, Khulna 28% and Jashore 8% (CEGIS Data, 2020).

e) Agricultural and surface runoff

A large proportion of nitrate and phosphate pollution is due to run-off of agrochemical residues. Table 4.22 summarises water quantity and quality estimates (for nitrate and phosphate) for the SW region, simulated using the SWAT model (see section 4.2.2).

Table 4.22: Model Estimated Mean Monthly Surface Runoff and Pollution Concentration from the SW Region of Bangladesh

Month	Flow (m3/s)	Nitrate (mg/L)	Phosphate (mg/L)
Jan	82.0	0.2	0.2
Feb	66.4	0.5	0.6
Mar	95.2	1.2	0.8
Apr	140.0	1.2	0.4
May	320.3	1.7	0.2
Jun	1064.3	0.2	0.3
Jul	1536.6	0.3	0.5
Aug	1571.4	0.2	0.5
Sep	1657.6	0.1	0.5
Oct	1221.5	0.1	0.4
Nov	627.4	0.6	0.2
Dec	261.7	0.6	0.2

Source: CEGIS SWAT Model for the South West Region

Status of water pollution sources: 2031 and 2041

a) Changes in industrial status

Changes in the composition of industrial activities in the SW region can be expected over the next 20 years with implementation of the Second Perspectives Plan (2021-2041) and sector plans, and taking into account transport infrastructure, available resources and trends - as projected in Table 4.23. This industrial projection was performed based on the baseline statistics of the industries responsible for nitrate and phosphate releasing into the water bodies. Scenario of 2031 and 2041 were projected respecting the baseline situation. To do so, policy plan and programs, perspective plan, trend of industrialization in the region and the sector expert judgment were considered. At first, percentile increase and decrease was justified for developing the scenarios and then the industry number were calculated using the baseline statistics. It was found that the total industrial units could be around 230 those will release nitrate a phosphate while it may further increase to more than 330 in 2041. At the present situation there is no Economic Zone (EZ) in the region which will be 3 (three) in 2031 and 7 (seven) in 2041 as per the plan of the Bangladesh Economic Zone Authority (BEZA).

Table 4.23: Projected Changes in the Composition of Industrial Activities in the SW Region: 2031 and 2041

SL	Industry Type	Baseline (2020)	Projected Industry (2031)	Projected Industry (2041)
1	Agro Food Processing Industry	11	13	17
2	Jute Mill/Industry	5	9	14
3	Power Plant	12	12	12
4	Steel and Metal Industry	10	22	33
5	Sugar Mill/Industry	2	2	2
6	BSCIC	2	6	9
7	EPZ	1	6	9
8	Battery Manufacturing Factory	2	11	17
9	Beverage Production Factory	1	6	11
10	Food Production and Processing Factory	10	17	28
11	Leather Processing Factory	5	11	17
12	Plastic Processing Factory	9	22	33
13	Sea Food Processing Factory	19	28	33
14	Tobacco Processing Factory	6	9	11
15	Cable Manufacturing and Warehouse	1	6	11
16	Oil Refinery	4	11	17
17	Plywood and Wood Processing Mills	5	11	22
18	Textile	6	22	33
19	Economic Zone (EZ)	0	3	7
Total		111	227	336

It is assumed that current pollution will be reduced by up to 75% through the installation of treatment facilities by 2031, and will be further reduced by 2041 when almost complete compliance with ECR'1997 standards for discharging of the industrial waste into natural water bodies[51] is expected to be achieved. Thus, the concentration levels of nitrate and phosphate are projected to be one-third of the baseline (2020)

[51] ECR'1997: Schedule 8; standards for industrial waste water discharges into surface water bodies.

level for the scenario development of 2031. For 2041, the DoE recommended discharge quality of 10 mg/L for nitrate and 5 mg/L for phosphate were considered.

b) Urban domestic discharges

The concentration of nitrate and phosphate in urban discharges in the SW region are relatively low and well within Bangladesh's sewage quality discharge standards (ECR'1997: 250 mg/L for nitrate and 35 mg/L for phosphate). Therefore, for the projection for urban discharge quality to 2031, the baseline concentration was reduced by 50%; and for 2041, the ECR'1997 standard was adopted (Table 4.24).

Table 4.24: Projected Urban Population and the Discharges Quality for 2031 and 2041

Urban Area	*Urban Population (2031)	*Urban Population (2041)	Water Quality Status of Domestic Discharges (2031)	Water Quality Status of Domestic Discharges (2041)	Per Capita Water Consumption in Urban Areas
Kushtia	737,257	1,080,588	Nitrate=25 mg/L Phosphate= 5 mg/L	Nitrate=10 mg/L Phosphate= 5 mg/L	88 L/day for both 2031 and 2041
Magura	357,559	518,789			
Khulna and Mongla	1,386,564	1,755,721			
Jessore and Noapara	1,240,014	1,713,491			
Jhenaidah	743,358	1,050,641			
Chudanga	609,118	794,797			

** Projection data sourced from Projection of Population, GDP and Income Distribution 2050. Bangladesh Integrated Water Resources Assessment Project Report (BIDS, 2014).*

c) Drainage discharges in cities

According to expert opinion by CEGIS, drainage discharges are expected to be double of the baseline level by 2031 and one-third of the baseline situation by 2041 as a result of expansion of urban and pourashava areas and an increase number of shops, small water bodies, paved areas, amusement areas and amenities. By 2041, almost 100% of the urban areas will be connected to the storm water and sewerage network.

d) *Shrimp gher discharges*

The extent of shrimp ghers has been relatively static for the last 10 years – mainly due to diseases and conflicts between rice and shrimp cultivators. It is projected that the extent of shrimp ghers will be the same as baseline situation in 2031, but may reduce by 2-5% of the baseline situation by 2041.

e) Agricultural and surface runoff

Improved agricultural practices, more balanced use of agrochemicals and more efficient use of irrigation water will reduce the volume of polluted run-off water and leachate entering adjacent water bodies. It is projected that surface runoff from agricultural land will reduce by about one-third of the baseline level by 2031, and by 50% by 2041. The nutrient content of irrigation water is projected to also reduce by 50% by 2031 and 2041.

Flow augmentation scenarios in the South West River Systems: 2031 and 2041

The Ganges River has three major distributaries namely, the Hisna-Mathabanga, Gorai Madhumati, and Chandana-Barashia. Those distributaries are the major source of fresh water flow in the southwest region. The increase in freshwater flow, especially during the dry season supposed to decrease the pollution level in the southwest region. Therefore, the model has been simulated considering the flow augmentation

through the above three distributaries from the Ganges River. The Ganges Barrage Study[52] estimated the optimum flow augmentation considering the water availability and demand of the Ganges dependant area (GDA) as shown in Table 4.25. The model was simulated considering those augmented flow values through the Hisna-Mathabanga, Gorai Madhumati, and Chandana-Barashia river systems.

Table 4.25: Estimated Mean Monthly Discharge for Three Major Distributaries of Ganges River according to Ganges Barrage Project

Month	Discharge (m3/s)		
	Gorai-Madhumati	Hisna-Mathabanga	Chandana-Barasia
Jan	225	231	46
Feb	227	234	57
Mar	225	232	77
Apr	230	242	80
May	194	184	44
Jun	500	300	50
Jul	2,500	400	200
Aug	7,600	500	300
Sep	7,600	500	300
Oct	2,500	400	300
Nov	2,500	400	300
Dec	1,000	300	200

4.2.5 Model Development

Selection of modelling package

The 'SOBEK' modelling set developed by Deltares was used. Its 1D flow module was used to simulate the hydrodynamic behaviour of rivers (e.g. flow, velocity, water level, etc.). The 1DWAQ (Water Quality) module was used to simulate water quality parameters. It uses the DELWAQ programme and is based on a library from which relevant substances and processes can be selected to create water and sediment quality models. The water quality model derives the water balance from the water flow module. The SOBEK 1D and water quality modules were coupled together and used sequentially to ensure the dynamic linkage between the modules.

Hydro-dynamic model development

A 1D hydrodynamic model was developed for the study area to simulate characteristics such as flow, velocity, water level, etc. The hydrodynamic parameters are used to transport and mix river pollutants. The model setup comprises schematization of the river network, selection of boundary conditions, input of cross-section and boundary data, and friction parameters.

a) Model schematization

The Gorai-Modhumati, Rupsha-Passur, Sibsha, Mathabanga, Chitra, Kapotaksha, Betna, Bhairab, Vadra and Arpangachiya rivers were included in the model (Figure 4.12), together with various other interconnected rivers and khals in the SW region. The upstream part of the model area is non-tidal. So, daily discharge data were used as the upstream model boundary condition. In the downstream part of the model area, the river

[52] Feasibility report: volume-II: main report; Ganges Barrage Study Project, Dhaka, September 2012, GOB, MoWR, BWDB: Ganges Barrage Study Project

system is tidal. Therefore, here, hourly water level data were used as the downstream boundary of the model to capture the tidal behaviour of the rivers. The boundary conditions of the model including data type are shown in Table 4.26. In total, 289 cross-sections that are regularly measured by the Bangladesh Water Development Board (BWDB) were used to represent the geometry of the rivers and to establish the model (Figure 4.12). For some portions of the rivers, especially for the coastal region, the cross-sections were generated from the bathymetric chart of Bangladesh Inland Water Transport Authority (BIWTA).

Table 4.26: Model Boundary Conditions

Name	Location	Boundary type	Data type	Data Sources
Gorai Railway Bridge, Gorai river	upstream	Discharge	Daily	BWDB observed data
Kazipur, Mathebanga river	upstream	Discharge	Daily	BWDB observed data
Chitra river	upstream	Discharge	Daily	Estimated from rainfall-runoff model
Hiron point, Passur river	upstream	Water level	hourly	BIWTA observed data
Arpangachia	upstream	Water level	hourly	BIWTA observed data

b) Model simulation

The developed hydrodynamic (1D) model was simulated with a computational time step of 30 minutes. The model simulated water level and depth, discharge and flow velocity. The output was generated at every 1-hour interval. Manning's roughness coefficient was used for the computation of the flow[53].

c) Model calibration and validation

Once the model setup is completed, it needs to be calibrated and validated against the observed data to determine its ability to reproduce the actual phenomena observed in the field. Manning's 'n' was selected as the resistance parameter - the major controlling calibration parameter for the hydrodynamic model. After calibration, the model was validated with another set of observed data different from model calibration.

The model was calibrated against observed water levels at Mongla on the Passur River, Khulna on the Rupsha River and Nalianala on the Sibsha River (Figure 4.13). Hourly observed water level data were available for the Mongla station and daily maximum-minimum water level data were available for Khulna and Nalianala stations. Calibration and validation were performed against those observed data.

Calibration and validation periods were selected as 2010 and 2014 based on the availability of observed data at both boundary and calibration locations. Calibration (through 'trial and error') gave Manning's n values for different rivers between 0.015 and 0.025.

Model performance was evaluated both graphically and statistically. Examples of the visual comparison of observed and simulated water levels for the Mongla station during both calibration and validation are shown in Figures 4.15- 4.17. The model results are in reasonable agreement with the observed data for both dry and wet seasons[54] during calibration and validation.

The model simulates tidal behaviour of the rivers including the tidal phase, amplitude, and range with reasonable accuracy. The performance of the model was very good during both the calibration and validation period at Mongla station where consistent hourly-observed data was available. For the other two

[53] The Manning formula is an empirical formula estimating the average velocity of a liquid flowing in a conduit that does not completely enclose the liquid, i.e., open channel flow. 'n' is a coefficient. which is dependent on many factors, including surface roughness and sinuosity.

[54] Wet season = June to early October, dry season = later October – May.

stations, (Khulna and Sibsha), the model captured the tidal characteristics with reasonable accuracy. Whilst modelled peak flow slightly underestimates the observed data for the calibration period, it satisfactory reflects the trend in the observed data. In relation to the objective of the modelling, the performance of the model was found acceptable for both calibration and validation periods.

The model was evaluated statistically using four indicators: Nash efficiency (NSE)[55], percentage of bias (PBIAS), root mean square error (RSR) and correlation coefficient (R2). The statistical evaluation was made only for the Mongla station where hourly data is available. The NSE values were 0.90 and 0.94, and the values of the correlation coefficient were 0.94 and 0.96 for the calibration and validation period respectively. Similarly, the model was also found to perform satisfactorily for PBIAS and RSR. Thus, statistically, the model performed very well for both calibration and validation periods.

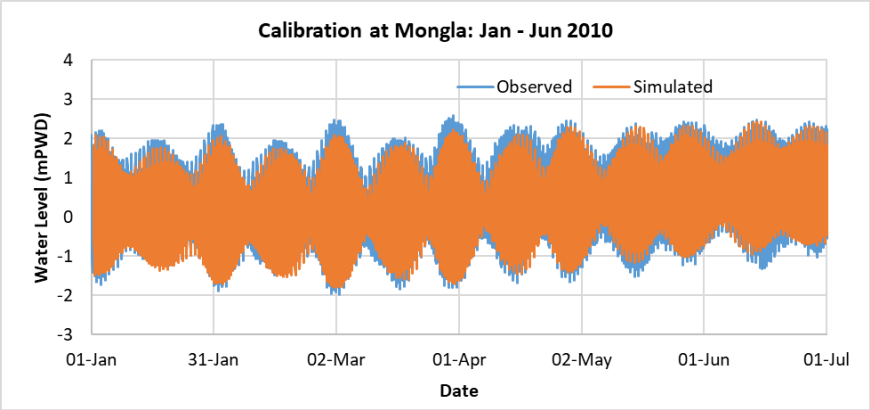


Figure 4.15: Observed and Simulated Water Levels for Calibration Period at Mongla Station on the Passur River (Jan – Jun 2010)

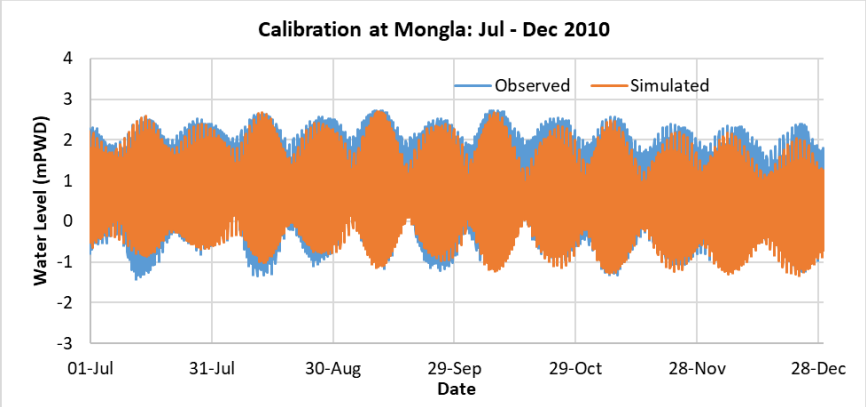


Figure 4.16: Observed and Simulated Water Levels for Calibration Period at Mongla Station on the Passur River (Jul – Dec 2010)

[55] The Nash–Sutcliffe efficiency is calculated as one minus the ratio of the error variance of the modelled time-series divided by the variance of the observed time-series. In the situation of a perfect model with an estimation error variance equal to zero, the resulting Nash–Sutcliffe Efficiency equals 1 (NSE = 1).

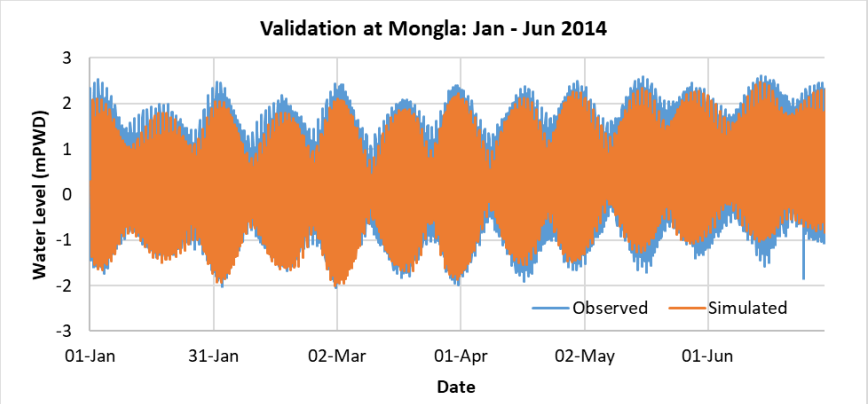


Figure 4.17: Observed and Simulated Water Levels for Validation Period at Mongla Station on the Passur River (Jan – Jun 2014)

Water quality model development

The 1D hydrodynamic model developed for the SW region was adopted as the base for modelling water quality using DELWAQ.

a) Model schematization

The boundary location of the water quality model is the same as the boundary of the hydrodynamic model (Figure 4.12). Dry and wet season concentrations of nitrate and phosphate (estimated from field observations and data cited in literature) were used to indicate water quality boundary conditions (Table 4.27). Intermediate values were generated through the linear interpolation function built-in SOBEK model.

Table 4.27: Boundary Conditions of the Water Quality Model

Location	Nitrate (mg/L)		Phosphate (mg/L)	
	Dry season	Wet season	Dry season	Wet season
Gorai Railway Bridge	2.5	2.3	0.75	1.0
Kazipur	2.5	2.3	0.75	1.0
Chitra river	2.0	2.0	1.0	1.0
Hiron point	2.6	1.3	0.1	0.5
Arpangachia	2.6	1.3	0.1	0.5

Source: DoE, CEGIS Monitoring Data and Published reports/articles

Other pollution sources such as industrial effluent, municipal sewerage, shrimp gher discharges and agricultural and surface runoff were included in the model (see section 4.24).

b) Simulation setup

The water quality model was coupled with the hydrodynamic model and simulated sequentially with a computational time step of 30 minutes. Outputs were generated at hourly intervals.

c) Model evaluation

The performance of the water quality model was evaluated at three locations during both dry and wet seasons. Dispersion coefficient was used as a calibration parameter and calibration was by 'trial and error'. The simulated and observed average concentrations of nitrate and phosphate during the wet and dry season are shown in Table 4.28. The model was found to replicate phosphate concentration with reasonable accuracy for both seasons. The simulated concentration of nitrate was also found to be within the range of the observed datasets.

Table 4.28: Simulated and Observed Water Quality Parameters for Three Locations

Location	Season	Nitrate (mg/L)		Phosphate (mg/L)	
		Observed	Simulated	Observed	Simulated
Khulna	Dry	2.5-3.5	3.97	0.25-0.40	0.26
	Wet	2.6-2.8	2.44	0.80-1.30	0.58
Mongla	Dry	3.3-4.0	3.78	0.20-0.30	0.22
	Wet	2.0-2.5	2.49	0.50-0.70	0.58
Harbaria	Dry	3.2-3.5	3.60	0.20-0.30	0.21
	Wet	2.1-2.5	2.55	0.50-0.60	0.58

The model predicts comparatively high nitrate concentrations during dry period, and vice versa during wet season – mirroring the trend from measured data for all river system of the SW region. Over 90% of the simulated data matched measured nitrate concentrations in the different cross section of the river system. Increased nitrate concentration in the dry season can be due to agro-chemical run-off, discharges from industrial sources and domestic and municipal wastes (e.g. foods, market wastes, etc.) as well as reduced freshwater flow from upstream.

The concentration of phosphate in the Shibsa-Passur river system is low during dry period but high in the monsoon period – due run-off from crop fields (which mixes inorganic and organic fertilizers). Organic fertilizers often contain cow dung and other matter with a high phosphate concentration. In addition, surface runoff mixes with dust and sediment particles, eventually increasing the phosphate concentration of the river system during the monsoon. The model performed well and accurately simulated the same pattern, mirroring measured concentrations found at almost all observed points.

In conclusion, the model was able to explain both the nitrate and phosphate concentrations in the river systems in both wet and dry seasons.

4.2.6 Model Simulation and Results

The water quality model was used to simulate concentrations and distribution of nitrate, and phosphate at 10 locations (see Figure 4.18 and Tables 4.29 and 4.30) in the different river systems – for the baseline (2020) and for 2031 and 2041 (illustrated in Figure 4.19 for wet season nitrate concentrations). Four locations are inside the Sundarbans area (Harbaria, Akram Point, Hiron Point and Arpangachiya). Estimates of industrial growth, population growth, sewerage water management, agricultural management by 2031 and 2041 were made during the development of scenarios described (see Annex 7).

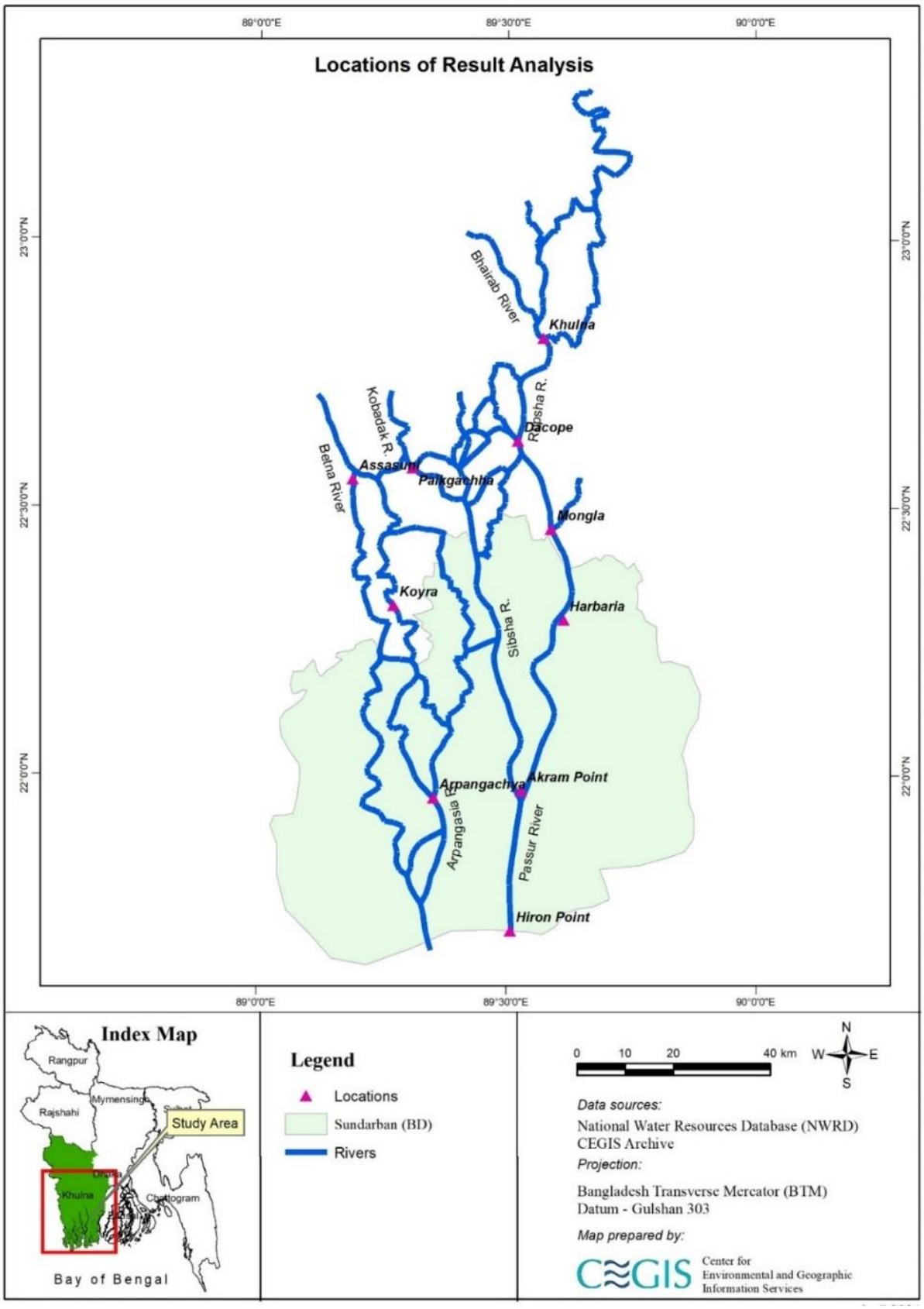


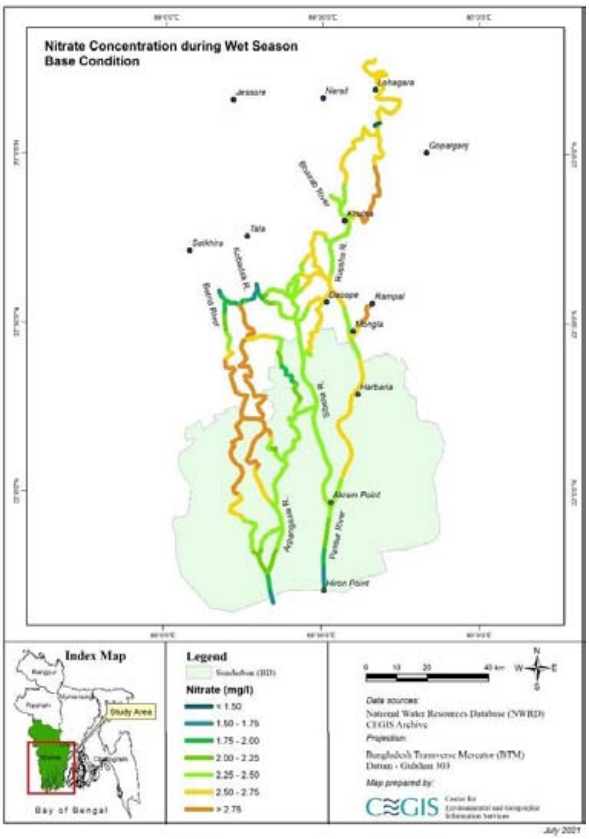
Figure 4.18: Simulation Site Locations

Table 4.29: Nitrate Concentration at Different Locations for Baseline Year (2020), 2031 and 2041 (with Flow Augmentation in the River Systems)

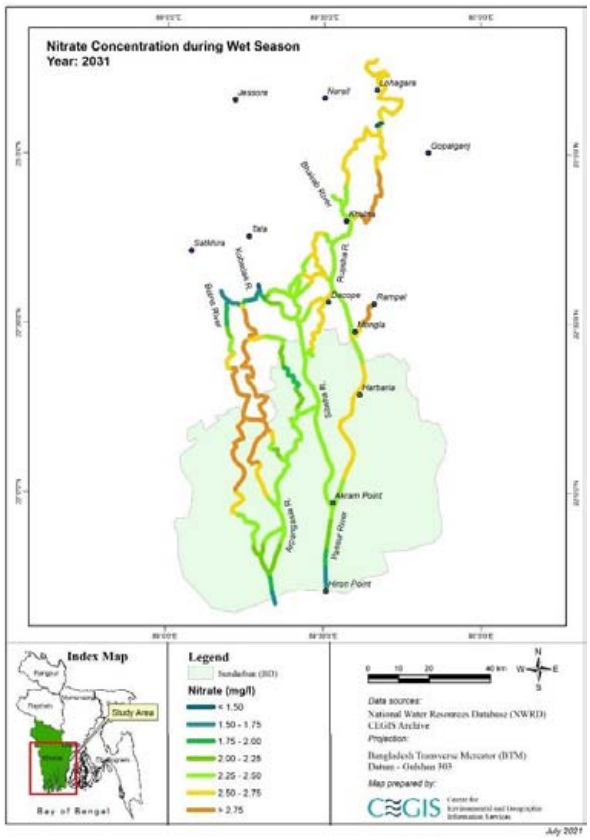
Location	Nitrate during dry season (mg/l)			Nitrate during wet season (mg/l)			Inland Surface Water Quality Standard (ECR'1997 and Draft ECR'2017)
	Base	Y_2031	Y_2041	Base	Y_2031	Y_2041	
Khulna	3.97	2.48	2.48	2.44	2.54	2.48	5.0 mg/L
Dacope	3.84	2.76	2.76	2.50	2.50	2.42	
Mongla	3.78	2.85	2.84	2.49	2.50	2.41	
Harbaria	3.60	2.97	2.97	2.55	2.62	2.52	
Akram Point	3.14	3.04	3.04	2.41	2.67	2.62	
Hiron Point	2.78	2.77	2.77	1.56	1.85	1.84	
Paikgacha	3.64	3.28	3.28	2.28	2.76	2.64	
Assasuni	3.91	0.92	0.74	1.90	1.60	1.38	
Koyra	4.38	4.23	4.22	3.12	3.54	3.46	
Arpangachiya	3.11	3.09	3.09	2.46	2.89	2.85	

Table 4.30: Phosphate Concentration at Different Locations for Baseline Year (2020), 2031 and 2041 (with Flow Augmentation in the River Systems)

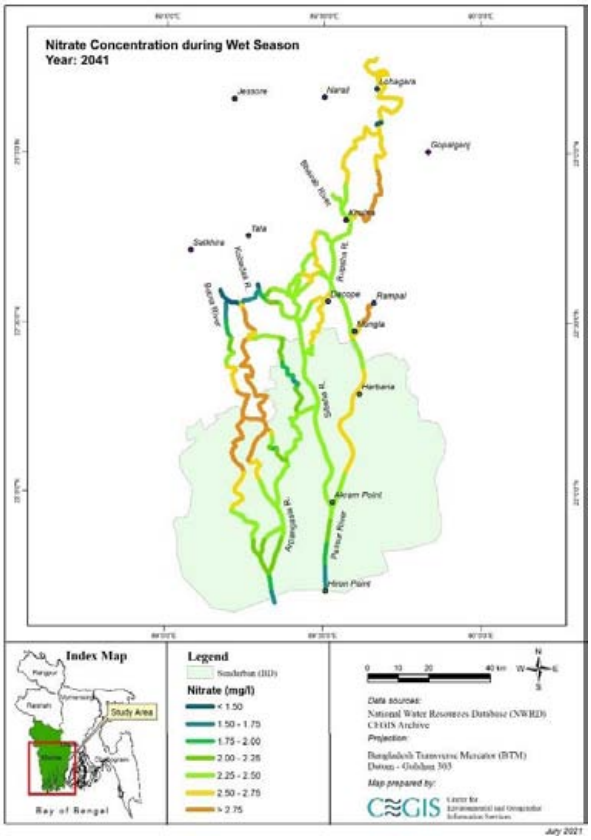
Location	Phosphate during dry season (mg/l)			Phosphate during wet season (mg/l)			Inland Surface Water Quality Standard (ECR'1997 and Draft ECR'2017)
	Base	Y_2031	Y_2041	Base	Y_2031	Y_2041	
Khulna	0.26	0.18	0.19	0.58	0.36	0.36	0.5 mg/L
Dacope	0.23	0.18	0.19	0.59	0.38	0.39	
Mongla	0.22	0.18	0.19	0.58	0.41	0.41	
Harbaria	0.21	0.18	0.18	0.58	0.41	0.41	
Akram Point	0.17	0.16	0.17	0.48	0.28	0.28	
Hiron Point	0.15	0.15	0.15	0.21	0.17	0.17	
Paikgacha	0.19	0.18	0.18	0.56	0.46	0.46	
Assasuni	0.21	0.05	0.06	0.48	0.41	0.40	
Koyra	0.19	0.19	0.19	0.46	0.29	0.29	
Arpangachiya	0.16	0.16	0.16	0.30	0.22	0.22	



Baseline (2020)



Scenario 2031



Scenario 2041

Figure 4.19: Nitrate Concentration during Wet Season for Baseline (2020), 2031 and 2041

During dry season, nitrate usually is high in the south-west river systems than the wet season. The baseline concentrations of nitrate at all the points are less than 4.0 mg/L except Koyra which is 4.38 mg/Lduring the dry period. However, the concentrations of Nitrate at all points in both dry and wet seasons are within Inland surface water quality standard (5.0 mg/L) recommended by Bangladesh (Table 4.27).

Projected concentrations between 0.74 mg/L and 4.22 mg/L are similar to those in the European rivers. For instance, according to Poikane et al., 2019) the concentrations of nitrate found in rivers in the EU are within the range 1.0 – 5.7 mg/L.

A number of factors might contribute to the predicted slight reduction in nitrate concentration in the dry period by 2031: improvement of the waste discharge regulations and monitoring system; improved industrial technology (reducing effluent volume); the introduction of wastewater treatment facilities; and the clustering of industries in zones and their better management of nitrate discharges. Last but not the least, flow augmentation will play a key role in reducing the nitrate concentrations in the river systems in future.

The normal pattern (base year value) of phosphate levels in the river systems of the SW region is comparatively high during the wet season (0.21-0.59 mg/L) and low during the dry season (0.16-0.26 mg/L). However, the model predicts much variations in phosphate concentrations between the baseline year (2020), 2031 and 2041 for either the dry or wet season (see Table 4.28). The level of discharged phosphate from point sources was very low, and phosphate from agricultural fields and surface run-off was not high enough to change the concentration much by 2031 and 2041. In addition, flow augmentation dilutes the phosphate concentrations in the systems. The model did not consider atmospheric deposition in any of the seasons. Phosphate is strongly adsorbed by soil particles. The average phosphate concentration over all localities for two modelled years (2031 and 2041) are 0.16 mg/L for the dry period and 0.34 mg/L for the wet period). The Bangladesh permissible limit for phosphate is 0.5 mg/L (Draft ECR, 2017) which hasn't cross the limit in 2031 and 2041 scenarios as well.

At the sites of Khulna, Dacope, Mongla, Harbaria and Paikgacha, baseline phosphate concentrations are found slightly higher (0.56-0.58 mg/L) than the Bangladesh standard. However, at all the sites, values for the projected years (2031 and 2041) are found lower than the national standards.

4.2.7 Conclusions

- The model was able to satisfactorily predict nitrate and phosphate concentrations in the rivers of the SW region during both wet and dry seasons.
- The model shows that nitrate concentrations will decline from the baseline year (2020) by 2031 and further by 2041. However, in order to avoid any deterioration of river water quality in future, heavy industrial development should be accompanied with installation of efficient wastewater treatment facilities. Large municipalities should also be equipped with wastewater treatment plants (STPs).
- Current phosphate concentrations (in 2020) are somewhat elevated at some points in the wet season. This could be due to agricultural run-off from crop fields and grazing lands as well as municipal and industrial discharges. Such run-off and discharges containing high concentrations of dissolved phosphorous compounds need to be reduced/treated immediately. However, the model predicts that by 2031 and 2041, phosphate levels will remain within the safe limit value of 0.5 mg/L set by the inland surface water quality standards of Bangladesh (Draft ECR '2017). Stringent environmental regulations should be adopted and implemented. Furthermore, technologies to remove phosphorus compounds from waste water need to be implemented along with nutrient-balanced agricultural practices.
- The BOD levels should be systematically monitored in all river systems of the SW region: river-specific monthly monitoring of vertical BOD profile, seasonal assessment of BOD levels of effluents from municipal sources, agricultural run-off and domestic discharges.

- In future, BOD levels in the rivers downstream of the big cities should be estimated by the model used in this SEA using systematically collected data.
- Scientific research is recommended to identify the major contributors to pollution causing raised BOD levels in the river systems.
- Monitoring of water quality as well as important water pollution point sources should be extended by including additional pollutants (COD[56], oil pollution, hydrocarbon pollution, dissolved organic carbon, AOX[57], heavy metals).
- It is recommended that, under the SEMP, the modelling is periodically re-run to incorporate up-dated and new data in order to provide revised information for the best management of pollution issues.

[56]Chemical Oxygen Demand

[57]Adsorbable Organic Halides

5. The Growth Scenarios

5.1 Introduction

SEA aims to identify the impacts of a PPP. But a key principle is that the impacts of alternatives to the PPP in focus (or alternatives to elements of the PPP) should also be addressed. This should then lead to determining which alternatives should be assessed in the next stage of the SEA.

However, in this case, as set out in the Final Screening Report (March 2021), this SEA is dealing with 89 PPPs covering 28 sectors and key issue areas. It is not possible to assess every PPP or alternatives to them. Therefore, the SEA has been designed to be 'strategic' itself. Thus, it considers three meta-level alternatives in the form of growth scenarios:

- ***High growth*** represents the growth path that will be required – through added stimulus (investment, innovation, etc.) to achieve high income country (HIC) status by 2041. This is Bangladesh's central economic policy objective as committed to in the Second Perspectives Plan (2021-2041).
- ***Medium growth*** is equivalent to the country's current growth path aimed at achieving upper middle income country (MIC) status by 2031.
- ***Low growth*** – this scenario postulates a reduction of economic growth that could be triggered - mostly by external factors, and over which Bangladesh has little or no control (see section 5.2.1).

5.2 Scenario Development

The future will be shaped by the interacting effect of many factors or drivers of change and uncertainties (Box 5.1) – particularly factors which are external to the country and beyond its direct control. Some of these are discussed in Section 5.2.1.

Box 5.1: List of Potential Drivers of Change and Uncertainties

Economic drivers

- Domestic demand (e.g. for locally-produced goods and services and imports);
- Global and regional markets (e.g. for exports);
- Prices of energy related raw materials (coal, oil, natural gas);
- Lack of access to capital for domestic investors;
- Foreign direct investment;
- Global financial crisis (since 2008, and now due to COVID-19 pandemic);
- Globalization and possible de-globalization as a result of COVID-19;
- Tourism;
- Remittances;
- Government policy to achieve transformation of Bangladesh into an upper middle-income country by 2031 and higher income country by 2041;
- Garments, pharmaceuticals, textiles and leather industries.

Environmental drivers

- Climate change:
  - Sea level rise - leading to migration away from vulnerable areas;
  - Salt water intrusion;
  - Increase in temperatures.
- Natural disasters (storms, tidal surges):
  - Causing coastal erosion and driving relocation;

  - Influencing use of building materials and designs;
  - Creating more demand for building materials (e.g. dredged material (i.e. sand), imported from other countries such as China).
- Increasing soil salinity (mainly due to reduced fresh water flows in rivers and increasing abstraction for irrigation and urban use) - reducing land productivity (for crops and livestock);
- Increasing pollution of air, water and land – leading to declining human health, impeded ecosystem functioning and reduced ecological services.

Social drivers

- COVID-19 and future pandemics;
- Increasing changes in lifestyles;
- Out-migration – in search of work (e.g. in Middle East);
- In-migration to urban areas from rural areas;
- Cultural factors:
  - Increasing rate of women in paid employment;
  - Influence of globalisation;
  - External influences on culture (e.g. TV, films, internet, western values, lifestyles);
- Gender factors:
  - Increase in domestic violence;
  - Women's participation in socio-economic activities;
- Health;
- Access to education (plus high drop-our rates);
- Job opportunities.

Governance and legal instrument drivers

- Legislation and regulations;
- National, regional and municipal policies;
- International legally binding instruments to which Bangladesh is a signatory (e.g. UN treaties, conventions, etc.);
- Institutional factors (status of coordination and integration of government agencies);
- Inadequate skills and capacity;
- Politics.

Other drivers

- Donors (multilateral, bilateral, UN agencies, etc.);
- Technology:
  - New technologies available for power generation (providing advanced low-carbon or zero-carbon energy) and higher efficiency of conversion;
  - New technologies available in industry (enabling higher energy efficiency, lower emissions, less waste, improved recycling);
  - Availability of more energy-efficient appliances;
  - Phones and laptops;
  - White goods (fridges, televisions, air conditioners, etc.) – making life easier/more comfortable (but increasing energy demand);
- Access to information and portals:
- Enabling increased freedom of speech;
- Affecting accountability and transparency – citizens are able to keep leaders and others accountable;
- Allowing people to be more vocal about issues;
- Infrastructure – e.g.:
- Padma bridge (under construction)– providing easier access to SW region;
- Expansion and improvement of railway network;
- Communications network.

The use of scenarios in this SEA is to help explore systematically what the future might look like over the next 20 years under three growth scenarios (high, medium and low) and to ensure that the analysis and projections made for the three scenarios are as realistic and robust as possible.

The three growth scenarios selected are commonly used in SEA where the focus is on multi-sectoral development in a defined area. Different levels of growth provide alternatives for the way in which the 'body' of sectoral PPPs are likely to be implemented and the likely manner and extent of major developments that will have environmental and socio-economic (cumulative) impacts.

Narratives have been developed for the three growth scenarios (see section 5.3) through brainstorming, team consultation and by reference to existing government policies. This approach was used rather than a quadrant-based method. The latter contrasts several sets of different drivers and results in multiple possible scenarios, and is commonly used by industry (e.g. insurance, financial investments, pension funds) where many alternative futures need to be considered. This is not appropriate for an SEA, and particularly not for a multi-sectoral SEA, and would make assessment impossibly complex and confusing.

5.2.1 Scenario Assumptions and External Factors (Uncertainties) that Might Influence the Future

In developing the scenarios elaborated in section 5.3, a number of assumptions have been made:

- Population growth rate will be highest in the low growth scenario but is likely to decline under high growth.
- Climate change and water variability are both major uncertainties (see section 5.2.1), but changes will unfold in the same way under all three economic scenarios. However, the potential or ability of Bangladesh to respond or adapt to these variables may differ under each scenario due to differing economic conditions or circumstances - which will determine what can be afforded or invested in. Further comment on these two uncertainties is provided in sections 5.2.1.1 and 5.2.1.2.
- Industrial and manufacturing expansion will play the major role in GDP growth.
- Increasing demand for power will be covered by newly built power plants.
- There is a strong emphasis on ensuring a smooth transition from an agrarian economy to an industrial economy.
- Increasing demand for meat and milk will be met through replacing local breeds of cattle with more productive hybrid and imported breeds.
- The government will pursue decentralized urban development through political, legal, institutional and financial reforms and incentives.
- Rural-urban migration will be discouraged through the 'My Village-My Town' programme and other measures.
- Small- and medium-sized entrepreneurship will be encouraged and supported.
- The government will seek to eliminate gender discrimination, and increase female literacy and employment.
- Bangladesh will continue to enjoy internal and external peace and security under the dynamics of international and regional geopolitics (e.g. the policies, influence and actions of other countries).
- The government will implement all current policies and associated environmental and socio-economic measures as stated.
- The global and regional economies will recover post COVID-19 (particularly for the high growth scenario).
- Other countries will also invest in infrastructural development and mass transport systems in Bangladesh.

- The Padma Bridge (under construction) will improve communication with the SW region.
- The Ganges Water Treaty will be renewed by 2026 and will be fully implemented with released flows from Farakka barrage no less than at present.
- Regarding the operation of Mongla port:
    - The policy and agreement for trade (Article viii of the trade Agreement between Bangladesh and India Protocol on Inland Water Transit and Trade (PIWT&T)) will be upheld by both countries;
    - Ships of similar capacity and dead weight will be allowed to enter in Mongla Port in future;
    - The Mongla-Ghashikhali channel will be dredged periodically to maintain navigability. Only the Pashur river will be used as a route for entering or exiting Mongla Port;
    - The types of cargo imported and exported through Mongla Port will remain much the same as now;
    - No major embargoes will be imposed on products exported from Bangladesh or then imported into other countries;
    - Blue economy-based developments within the extended maritime boundary will lead to an increase in the number of cargo ships harbouring at Mongla port;
    - No new protocol route other than the existing protocol route with India will be allowed in the SW region[58].

Climate variability

The Intergovernmental Panel on Climate Change (IPCC) has produced a sequence of reports providing assessments of the status of knowledge concerning climate change. The analyses show that, since the mid-20th Century, human activity has resulted in an unprecedented impact on the Earth's climate system. This is due to emissions of greenhouse gases, mainly carbon dioxide (CO2) and methane (IPCC 2018). Whilst the IPCC has developed climate change scenarios and made predictions about possible changes to the climate, there remain considerable uncertainties as to what changes may occur in particular countries.

Section 3.3.6 of the Final Scoping Report (January 2021) discusses current climate data, trends and studies of future climate change in Bangladesh. Some analysts report an increasing trend in rainfall in the SW region. Various reports conclude that climate change could lead to increases in temperature and more erratic rainfall (e.g. with dryer winters and wetter monsoons). Studies of future climate change show a wide range of uncertainties (Dastagir, 2015; Basak et al., 2010; Fahad et al., 2017; Islam 2008; Islam, 2014; and CIAT, 2017). But they indicate high chances of a rise in temperature and increased rainfall variability. The IPCC models predict a rise in sea levels, but by how much is still being studied.

As a low-lying country, Bangladesh is particularly vulnerable to sea level rise. The impacts of climate change could be an increase in the number and/or severity of cyclones, storm surges, floods and drought, with increased damage to houses and crops, saline intrusion, and impacts on ecosystems and such gradual or slow-onset events could also result in major displacements of people and stress migration.

Water variability

The socio-economy of the SW Region is heavily reliant on water from the Ganges river which flows through various distributary river systems (see section 3.3.2 of the Final Scoping Report). The biodiversity and

[58] Under the Indo-Bangladesh Protocol on Inland Water Transit and Trade between India and Bangladesh, inland vessels of one country can transit through the specified routes of the other country. These routes are termed as "India-Bangladesh Protocol Routes".

ecosystems of Sundarbans are substantially dependent on the freshwater delivered by these river systems which maintains balance between fresh and saltwater.

Flow in the Ganges river decreases naturally during the dry season. But this flow is further affected by upstream development (particularly dams and irrigation schemes) in the upper riparian countries (Nepal and India) – over which Bangladesh has no control - where 96% of the catchment area lies. Most of the flow is diverted by the Bhimgoda Barrage, Narora Barrage and the Farakka Barrage in India. Based on a recently conducted feasibility study for the Ganges Barrage Project, about 8 billion m3 of fresh water could be delivered by rivers to the SW region during the dry season (January – May) - but only under the high growth scenario when funding is predicted to be available for constructing augmentation structures and carrying out dredging.

Agriculture, fisheries and marine aquaculture, navigation in the region, and the ecology of the Sundarbans, are dependent on there being a balance between the freshwater inflow originating from the Ganges and the tidal influx from the Bay of Bengal.

Sustainable planning and development of water resources in Bangladesh depends on equitable sharing and management of the transboundary rivers. To this end, the Indo-Bangladesh Joint Rivers Commission (JRC) was established in 1972 and the Ganges Water Treaty was adopted in 1996 which guaranteed the provision of water through Farakka for every 10-day period during the months of January to May every year (see section 3.5.1 of Final Scoping Report). However, the treaty has a 30-year life span and will need to be renewed by 2026 to ensure that water continues to be available. This represents a considerable uncertainty. However, as stated above and for the purposes of this SEA, it is assumed that the treaty will be renewed and will be fully implemented with released flows from Farakka barrage no less than at present.

Future pandemics

A pandemic is an epidemic of an infectious disease that has spread across a large region, for instance multiple continents or worldwide, affecting a substantial number of people. The problem is exemplified by COVID-19 which is currently challenging all nations. But it is not the first such event. Throughout human history, there have been a number of pandemics of diseases such as smallpox and tuberculosis. The most fatal pandemic in recorded history was the Black Death (also known as The Plague), which killed an estimated 75–200 million people in the 14th century. The term was not used at that time, but was for later pandemics including the 1918 influenza pandemic (Spanish flu). More recent pandemics include swine flu (2009), SARS-CoV-2 and HIV/AIDS.

The world is experiencing a rapid evolution of technology and increasing inter-connectedness on the planet. The World Bank warned about the risk of pandemics throughout the 2000s and the 2010s. A broad consultation with eminent scientists organised by the WHO in 2015 concluded that disease outbreaks will be inevitable – particularly in known hotspots for their emergence, and recommended various steps to minimise or prevent the spread of epidemics. An article in June 2020 in The Conversation[59] commented that it can be predicted with reasonable confidence that there will be further pandemics in the next few decades because of the recent increased frequency of major epidemics (such as SARS and Ebola), and because of social and environmental changes driven by humans.

As with COVID-19, such pandemics are likely to have a major impact on global and national economies (see Box 5.5), livelihoods and health. Bangladesh, like almost all other countries, was initially ill-prepared for COVID-19 and lacked a rapid response ability. Establishing such preparedness for future pandemics, and remaining prepared, will be expensive and a major challenge.

[59] https://theconversation.com/the-next-once-a-century-pandemic-is-coming-sooner-than-you-think-but-covid-19-can-help-us-get-ready-139976

Commodity prices

Commodity price risk is the financial risk to an entity's financial performance/ profitability due to fluctuations in the prices of commodities that are out of the control of the entity or the government since they are primarily driven by external market forces.

Commodity prices (particularly food items) are important in Bangladesh since expenditure on food accounts for around one-third of the annual household expenditure of the poor and marginal population. Rises in the prices of food and essential commodities (notably rice, wheat, pulses, sugar, edible oils, ginger, garlic, onions and potatoes) impact particularly on the welfare of the poor. They can occur due to breakdown of the supply-chain for a variety of reasons, e.g. natural calamities and export bans in the countries of origin. There has been considerable uncertainty that the COVID-19 pandemic might affect the export of supplies of basic foods and other essential materials to Bangladesh.

Certain commodities in the energy sector (coal, oil, LPG, natural gas after 2031) are imported and their consumption is expected to increase in coming years which will make Bangladesh increasingly vulnerable to changing prices.

Commodity price risk is amplified when there is hoarding of goods. When such risk arises, government may be required to implement emergency measures such as opening letters of credit for importers and exporters, or opening market sales of commodities to control the price, and the Central Bank may allow authorized dealers to hedge prices (offset the risk of price movements in the physical market by locking in a price for a commodity in the futures market).

Governance

In this SEA, it is not possible to be certain what the nature of governance will actually be over the coming two decades. It could play out differently and have different influences and consequences for each of the three growth scenarios, particularly in terms of managing the internal risks and opportunities associated with each of the scenarios. These are not linear and one cannot predict how they will unfold. Thus, it is not appropriate to try to predict these outcomes for the three scenarios. However, some perspectives are provided below.

Combining high and green growth is the ideal approach: In this case, the high-growth scenario would mean more money circulating in an increasingly diversified and healthy economy, increased levels of employment and increased tax collection. This would enable the Government of Bangladesh (GoB) to increase funding for the environment, conservation of natural and heritage assets, and to subsidize green alternatives (e.g. pollution abatement in cars, factories, municipalities and private homes), improve public transport and provide facilities for non-motorised transport (e.g. cycle lanes). An improved economy should also enable GoB to install renewable energy power plants and convert coal-fired power stations to cleaner technology. GoB institutions (e.g. environmental, social and municipalities) will be better resourced so that better skilled and qualified professionals and officials will be employed, relevant policies, laws and strategies will be better and more effectively implemented and regulations properly enforced. Improved education will enhance environmental (and other) literacy and improved girl-child education will likely slow population growth. There will also be an improvement in gender equality and women's empowerment. In combination, all of the above will make the country and society more resilient to climate change and other externalities. Achieving this combination will require a commitment to good governance.

However, if high growth is pursued at all costs, this will still mean that more money will circulate in an increasingly diversified and healthy economy, with increased levels of employment and increased tax collection. But the GoB may be so focussed on boosting economic growth that funding is not provided (at least not in adequate amount) for the environment, conservation of natural and heritage assets and the subsidization of green alternatives. This has happened in many countries and in recent years, even in the USA. GoB institutions might remain under-resourced and unable to enforce the necessary social and environmental safeguards. In combination, all of the above will make the country wealthier in the short term, but society and the environment will be neglected and increasingly vulnerable to climate change and

some other externalities in the longer term. It is recognised that Bangladesh has in place plans, rules and regulations to support sustainable development. The allocation of adequate financial resources will be necessary to guarantee their full and effective implementation and enforcement (with updating where necessary - recommended measures are provided in Annex 6).

The same two governance trajectories might play out in the medium-growth scenario, but the temptations for "growth at all costs" are higher in the high growth scenario and also in low growth scenarios where there might be increasing frustration at the poorly performing economy and whatever funds are available might be diverted to boosting the economy. It is common for governments to argue that they should "fix the economy first and only later look after the environment". In the low-growth scenario, environmental neglect is a real risk. It can be assumed that environmental and natural resource management and conservation will deteriorate and problems like waste management will get worse, resulting in an escalation of human diseases and all kinds of social ills.

5.3 Scenario Narratives

The high, medium and low growth scenarios are described in the following sections. A comparative summary of the scenarios is provided in Table 5.1, and projections for indicators that informed the scenarios are set out in Annex 7. Selected indicators from this set were subsequently used as a basis for the Strategic Environmental Management Plan (SEMP).

5.3.1 High Growth Scenario

High economic growth occurs if Bangladesh fully pursues a transition to High Income Country (HIC) Status[60] by 2041 – a principle objective in the Second Perspective Plan. It assumes achieving this by fully implementing the main developments and changes that it sets out across all sectors (see PPP No. 088 in Appendix 1 of the Final Screening report (March 2021) for a summary of this plan). Key features of this scenario are listed in Box 5.2.

Box: 5.2: High Growth Scenario

(A) Economic factors

Economic growth

- Rapid ***economic growth*** (aimed to be efficient and sustainable), driven by innovation, ICT, an increased skills base and trained manpower, and considerably improved labour productivity.
- GDP grows much faster than the population - at 2.1% between 2031 and 2041, with GNI per capita reaching US$ 12,536+ (2019) by the year 2041, and a continuing trend of a positive balance of payments.
- Major increase in the ***share of GDP*** of industry, agricultural, transport and services.
- Seven economic zones are operational and jute mills are fully functional.

Industry and exports

- A high rate of ***industrialization*** with an emphasis on export-oriented manufacturing, and transformation of the rural agrarian economy to a primarily industrial and digital economy.
- A considerable increase in the volume of ***exports*** via Mongla sea port, where the facilities will be well-maintained and regularly upgraded to increase capacity.
- ***Dredging*** is done regularly in the Mongla port outer bar area and Pashur Channel- inner bar area to maintain navigability. Capital dredging will be undertaken to increase the draught limit in these routes.
- A large increase in ***freight*** transported by inland waterways.

[60] A high-income economy is defined by the World Bank as a country with a gross national income (GNI) per capita of US$12,536 or more in 2019, calculated using the Atlas method a method used by the World Bank since 1993 to estimate the size of economies.

Employment

- Decline in people employed in agriculture in SW – but still dominant.
- Moderate increase in job opportunities in service and industrial sectors.

Agriculture and aquaculture

- Considerable investment, intensification and diversification of ***agricultural production and coastal aquaculture***, with expanded mechanization, major shift from use of inorganic to organic and bio-fertilisers, increased use of SMART technologies, big reduction in groundwater dependency since water supply will increase by river flow augmentation interventions and dredging of rivers. Increase in agro-based small industries and manufacturing, with producers emphasizing high value products such as vegetables, fruits, pulses edible oils and also meat, fish, egg and milk, especially for the urban people.
- A high level of food security with better quality (i.e. nutritious food).

Power and energy

- A considerable increase in demand for ***energy*** to support high industrialization, expanded urbanization, and to meet the demands of increased population and transport will be addressed through:
- Focus on low-cost and low-carbon/zero carbon power generation (for Bangladesh as a whole) (renewables, natural gas, clean coal and LPG); with high-cost rental power plants phased out;
- Increased efficiency in use of installed capacity of power plants;
- Extensive governmental support for fuel switch to LPG in cooking;
- Expansion of energy trade;
- Strengthening and enhancement of power grid network;
- Conversion to renewable energy, as per the Renewable Energy Policy of Bangladesh, 2008 (around 10% of total energy generation will come from the renewable sources).

Infrastructure, transport, connectivity and communication

- Major expansion of ***infrastructure*** development, e.g. expansion of pipelines for transportation of petroleum; installation of LNG floating storage and re-gasification units, power transmission and distribution; small further increase in the density of roads, and more emphasis on inland water transport and railways with rapid extension in railway network of south-west region due to high passenger count and growth in income.
- High growth in ***motorised traffic***, with non-motorised traffic on highways discouraged.
- Substantial improvement in management of ***urban traffic*** (e.g. fitness certificates, illegal or unfit vehicle not permitted on roads, proper application of restrictions on sounding car horns and noisy engines, more efficient traffic management measures).
- Strong inter-district and inter-regional ***connectivity*** with neighboring countries for passengers, goods and services.
- A large increase in the usage of ***mobile phones***.

Urbanisation

- An ***urban physical environment*** where there is a balance between environmental requirements and the needs of the urban population. In particular, all cities will be flood-free with effective drainage, modern sewerage and fully functioning waste management.
- The majority (80%) of the rural population enjoying ***facilities*** similar to those available in urban areas.

Tourism

- A moderate to high rate of growth in the ***number of tourists*** visiting the Sundarbans (average 7%/year).

(B) Environmental factors

Water flow and salinity

- Appreciable increase in ***dry season flow*** in the Gorai River (compared to base line value) due to investment in flow augmentation interventions (e.g. diversion facilities, dredging) at the Gorai offtake and along the channel, which will lead to a substantial decrease in the current level of downstream ***salinity***.

Conservation, wildlife and habitats

- The ***tiger population*** in the Sundarbans will increase above current levels and reach the anticipated carrying capacity of the habitat by 2041 - due to considerable reduction of anthropogenic pressure and improved management practice, suitable habitat improves due to increased fresh water flow (since vegetation are salt sensitive), the prey-base increases for strict enforcement of various legal mandates, and poaching is brought to a minimum level due to protection using SMART tools.
- ***Dolphin*** habitat and population and ***Heritiera fomes (Sundri)*** habitat and extent will both increase due to: (a) higher level of fresh water supply (Sundri is sensitive to salinity) as a result of river flow augmentation interventions, diversion facilities, dredging etc within Bangladesh; (b) increase of prey-base; (c) decrease of anthropogenic pressure due to improved alternative livelihood opportunities; and (d) decrease of pollutants with strict enforcement of regulations and industrial management requirements.
- Considerable improvement in protection measures through implementation of ***regulations*** using SMART tools, strict implementation of ***co-management*** plan and efficient ***use and conservation of natural resources***, and in functioning of extension services – resulting in:
    - Major reduction in illegal activities in protected areas;
    - Conservation of open water capture fishery resources;
    - Large increase in fish brood stock, availability of good quality spawn, fries, feed and other inputs through aquaculture entrepreneurships, investments and law enforcement – leading to flourishing, high intensive, inland aquaculture;
    - Ready availability of quality feed;
    - Good quality and virus-free shrimp in the post larvae (PL) stage;
    - High productivity shrimp/prawn and coastal aquaculture.

Invasive alien species

- Highly improved implementation of management measures for reducing current extent, or at least preventing further spread of ***water hyacinth***.
- Considerable increase in multipurpose use of water hyacinth for bio-fertiliser, cattle feed and for seed beds etc.
- Appropriate measures to minimise the growth of water hyacinth adopted (e.g. plans and deployment of mechanical equipment).
- Participatory approaches for management of water hyacinth applied.

Land degradation

- ***Land degradation*** with be greatly reduced by extensive river bank protection and through widespread implementation of sustainable land management (SLM) making Bangladesh a Land Degradation Neutral (LDN) country by 2030 following SDG and Perspective Plan targets.

Land use change

- Increase in the extent of land converted to shrimp cultivation and fish farming - as shrimp is high value and so considerably more people are investing in shrimp farming.

Waste

- Big improvement in implementation of ***waste collection*** mechanisms and waste treatment facilities,
- Large increase in capacity to convert waste to usable resources through recycling.

Pollution

- Increased air pollution by transport, power generation and industrialisation, considerably compensated by emission reduction measures (switch to LPG. Improved vehicle fleet and traffic management, abatement techniques in power plants and industries, etc.).
- Major improvement in dry season water quality (as result of large increase of freshwater flows due to dredging and interventions).
- Substatial decrease in the noise level of the protected areas of Sundarbans.
- Moderate to high increase in noise in highly populated areas (accumulated periods in which noise exceeds Bangladesh standard in daytime) with introduction of technology (including vehicles) compensating for increased traffic and industrial intensity.
- Large increase in greenhouse gas emissions, partially compensated by energy efficiency measures and increased use of renewables.
- Pollution is fully and effectively managed through
  - Implementation of pollution reduction measures and regulations;
  - Establishment of effluent treatment plants (ETP) in all industries and economic zones;
  - Sufficient sewage treatment capacity to deal with volume generated;
  - Adoption of modern and upgraded technology and stringent air quality mitigation measures including clean fuel.

Vulnerability to climate change and natural disasters

- Moderate reduction in extent of land inundated (due to improvement to embankments), with a moderate reduction in the number of households affected.
- Substantial improvement warning system and increased number of shelters.
- Adequate adaptation & mitigation measures implemented (embankments strengthened, coastal afforestation).

(C) Social factors

Population

- ***Total population*** will be marginally increased over the baseline, but lower than under medium growth scenario.
- ***Population growth rate*** will be reduced due to lower total fertility rate as a consequence of improved education and employment of women - thus delaying age of marriage, and prohibition of early marriage.
- Very big reduction in migration from rural to urban areas due to the implementation of the 'My Village My Town' programme.

Land administration

- Land administration system will be upgraded by curbing corruption and implementing land digitization projects.
- Good governance will be promoted in the land management and administration system.
- Substantial decrease in the number of ***land disputes/conflicts*** as more cases are resolved by formal and informal processes and improved governance for their management is in place.

Education

- Considerably improved ***educational system*** and delivery with an emphasis on quality. The labour force is well-educated and trained. The private sector plays a dominant role in delivering tertiary education and skill training, while the public sector remains dominant in delivering primary and secondary education.

Health and sanitation

- Considerably improved ***health care*** with a large increase in the number of physicians and in well-equipped health care services affordable for most of the population.
- Moderate increase in ***life expectancy***.

- Large improvement in percentage of population connected to water supply and sanitation services.

Women empowerment

- A notable increase in the number of *women employed* in the productive sectors of the economy, participating in ***decision-making*** and participating in ***formal education and skills development***.

Poverty and equality

- Large reduction in ***poverty and inequality*** due to major increase in productive employment (with fair and equitable remuneration).
- An increase in alternative forms of income generation and a reduction in people's dependence on the Sundarbans forests, with a reduction in the amount of illegal felling.
- Moderate engagement of ***landless and marginal people*** in development activities.

Cultural and natural heritage sites

- Improved management, maintenance and preservation of existing ***Cultural and Natural Heritage Sites*** and development of new sites.
- Well managed plan and activities for ensuring the outstanding universal value of the Sundarbans natural heritage site.

5.3.2 Medium Growth Scenario

Medium economic growth represents the situation arising as Bangladesh pursues transitioning to an upper middle income country status[61] by 2031 – a principle objective the Second Perspective Plan. The country already achieved lower middle-income country status in 2015 and has since progressed. Key features of this scenario are listed in Box 5.3.

Box: 5.3: Medium Growth Scenario

(A) Economic factors

Economic growth

- Moderate ***economic growth*** with some improvement in efficiency, an increase in innovation, improved ICT and a moderate increase in the skills base and availability of trained manpower.
- ***GDP*** grows slightly faster than the population at 1.6% per annum between 2031 and 2041, with GNI per capita reaching 4,046 to 12,535 USD (upper middle-income) by the year 2031.
- Moderate increase in the ***share of GDP*** of industry, agricultural, transport and services, though scope for improvement.
- Start in development of seven ***economic zones*** in SW region and resumption of operation of jute mills.

Industry and exports

- A moderate rate of ***industrialisation*** with some increase in export-oriented manufacturing, and a start to transforming the rural agrarian economy to a primarily industrial and digital economy.
- A moderate increase in the volume of ***exports*** via Mongla sea port, where the facilities will be well-maintained and regularly upgraded (up to 2031) but the full capacity is not utilised.
- Maintenance ***dredging*** is done periodically to maintain navigability and draught limit in the channels near Mongla Sea Port.
- ***Freight*** will be transported by a mix of road, rail and inland waterways.

[61] The world's Middle Income Countries (MICs) are a diverse group by size, population, and income level. They are defined by the World Bank as lower middle-income economies - those with a GNI per capita between $1,036 and $4,045; and upper middle-income economies - those with a GNI per capita between $4,046 and $12,535 (2021)

Employment

- Decline in people employed in agriculture in SW – but still dominant.
- Modest to moderate increase in job opportunities in service and industrial sectors.
- Agriculture and aquaculture
- Moderate investment, intensification and diversification of ***agricultural production*** (with HYV used in more than half of the agricultural land and moderate use of organic and bio-fertilisers) and ***coastal aquaculture***, at least 50% reduction of groundwater use for crop production, with some expansion in mechanization and a moderate increase in agro-based small industries and manufacturing.
- A moderate to high level of ***food security with increased nutritional values and affordability***.
- A decline in ***employment in agriculture*** in the SW region, although it will still remain dominant due to an emphasis on agro-based food processing in economic zones.

Power and energy

- A moderate increase in demand for ***energy*** to support increased industrialization, urban expansion, and to meet the growing demands of an increasing population and improved transport, will be addressed through:
- A continuing reliance on coal-fired power generation, but only a moderate increase in the use of renewable energy, natural gas and LPG); with a start to phasing out high-cost rental power plants;
- Limited increase in the efficiency of use of installed capacity of power plants;
- Moderate governmental support for fuel switch to LPG in cooking;
- Limited expansion of energy trade;
- Started expansion of power grid network for power transmission and distribution;
- At least 5% of power generation plants will use renewable energy source.

Infrastructure, transport, connectivity and communication

- Moderate expansion of ***infrastructure*** development, e.g. expansion of pipelines for transportation of petroleum; installation of LNG floating storage and re-gasification units, power transmission and distribution; start of development of new sea port (at Payra in South Central Region), moderate increase in the density of roads and an emphasis on creating inter-district connectivity and upgrading national highways.
- Moderate growth in ***motorised traffic***.
- Moderate improvement in management of ***urban traffic*** (e.g. fitness certificates, illegal or unfit vehicle not permitted on roads, proper application of restrictions on sounding car horns and noisy engines.
- Moderate improvement in inter-district and inter-regional ***connectivity*** with neighboring countries for passengers, goods and services.
- A moderate increase in the usage of mobile phones.

Urbanisation

- An urban physical environment where there are growing initiatives to achieve a balance between environment requirements and the needs of the urban people (i.e. in only some cities and municipalities). Only main cities are protected from floods. There is a mix of traditional and modern sewerage systems and partial development in waste management.
- A third of the rural population enjoying ***facilities*** similar to those available in urban areas.

Tourism

- Moderate growth in the ***number of tourists*** visiting the Sundarbans (average 5%/year).

(B) Environmental factors

Water flow and salinity

- Increase in ***dry season flow*** in the Gorai river (compared to base line value) due to dredging at the Gorai offtake and along the channel, and thus there will be decrease in current levels of downstream salinity.
- Conservation, wildlife and habitats
- There will be an increase in growth in the tiger population of the Sundarbans though not reaching thew carrying capacity of the habitat - due to reduction of anthropogenic pressure at medium level, with the suitability of the habitat for tiger and the prey-base remaining unchanged, better law enforcement in place and poaching at moderate levels.
- Dolphin habitat and population and habitat and extent of Heritiera fomes (Sundri) will increase moderately compared to the baseline due to: (a) moderate increase of fresh water supply (Sundri is particularly sensitive to saline water), as a result of partial flow augmentation interventions within Bangladesh, (b) a small decrease of anthropogenic pressure due to improved alternative livelihood opportunities, and (c) decrease of pollutants due to partial enforcement of regulations and management requirements.
- Moderate improvement in implementation ***of regulations, better management and efficient use and conservation*** of natural resources – resulting in, e.g.:
- Moderate reduction in illegal activities in protected areas while co-management plan not effectively implemented;
- Slight decrease in wild fish resources, but increased production (though not species diversity) from fish farming;
- Moderately increasing fish brood stock, increased availability of good quality spawn, fries, feed and other inputs through entrepreneurships, investments and law enforcement;
- Government quality control measures implemented to eliminate the international concerns about quality and social compliance for exported fish and fishery products (particularly shrimp and prawn);
- Moderate improvement in restoration of the breeding, spawning, nursery and natural areas of major species like shrimp, Hilsa and carps as well as of hundreds of other species;
- Improved protection of open water resources through increased community level participatory and sustainable management of fisheries resources.

Invasive alien species

- Moderate improvement in implementation of management measures for reducing current extent, or at least preventing further spread of, ***water hyacinth***.
- Poor agricultural and aquaculture practices.
- Moderate use of water hyacinth as bio-fertiliser, cattle feed and for seed beds.
- Poor implementation of measures to minimise the spread of water hyacinth (e.g. plans and deployment of mechanical equipment).

Land degradation

- Moderate reduction in ***land degradation*** by river bank protection and with increasing application of sustainable land management (SLM) practices and moderate rate of change in land use from agriculture, forest and wetlands to other uses.

Land use change

- Moderate increase in the extent of land converted to shrimp cultivation and fish farming.

Waste

- Moderate implementation of improved ***waste collection*** mechanisms and adoption of waste treatment facilities.
- Moderate increase in ***capacity to convert waste*** to usable resources, with about half of the municipalities and pourashavas equipped with waste recycling plants.

Pollution

- Increased air pollution by transport and industrialization partially compensated by emission reduction measures (switching to LPG, emission abatement techniques, etc.).
- Moderate deterioration in dry season water quality within permissible limit.
- Moderate increase in greenhouse gas emissions.
- Moderate decrease in the noise level of the protected areas of Sundarbans.
- High to very high increase in noise in highly populated areas (accumulated periods in which noise exceeds Bangladesh standard in daytime) due to increased traffic intensity and industrial activity.
- Pollution management is improved through:
- Partial implementation of pollution reduction measures and regulations;
- Establishment of effluent treatment plants (ETP) in most of the industries and economic zones;
- Increased sewage treatment capacity.

Vulnerability to climate change and natural disasters

- Little initial change to extent of land inundated but with moderate improvement in later years (due to strengthening of embankments), with an initially moderate - and later low - increase in the number of households affected.
- Improved warning system and increased number of shelters.
- Adaptation and mitigation measures implemented (embankments strengthened, coastal afforestation).

(C) Social factors

Population

- ***Total population*** will be marginally higher than the baseline and higher than for the high growth scenario.
- ***Population growth rate*** will reduce due to lower total fertility rate as a consequence of a higher number of women being in employment.
- Considerable reduction in migration from rural to urban areas.

Land administration

- Small and marginal landholders will be forced to ***sell their land*** to enable an increase in industrial enterprises.
- ***Agricultural land*** is increasingly converted for urbanization and industrialization, especially in urban and semi urban areas.
- Moderate increase in the number of ***land disputes/conflicts*** due to increased land acquisition and land grabbing but improved governance for their management.
- Improved transparency and accountability in leasing and providing ***access for fishers to public water bodies***.
- Farmer-fisher conflicts over land resolved by courts/informal measures.

Education

- Moderately improved ***educational system*** and delivery, with increased investment in education sector, particularly in secondary education.

Health and sanitation

- Moderately improved ***health care*** with a moderate increase in the number of physicians.
- Modest increase in ***life expectancy***.
- Moderate improvement in percentage of population connected to ***water supply and sanitation services***.
- Women empowerment
- A moderate increase in the number of ***women employed*** in the productive sectors of the economy, participating in ***decision-making***, and participating in formal education and skills development.
- High ***population*** growth due to higher ***total fertility rate*** (which declines after 2026).

Poverty and equality

- Moderately reduced ***poverty and inequality***, but limited new or alternative income generating opportunities for people living around the Sundarbans.
- No change in their dependence on the Sundarbans forests with a continued moderate level of illegal felling.
- Modest improvement in the engagement of ***landless and marginal people*** in development activities.

Cultural and natural heritage sites

- Modest improvement in management, maintenance and preservation of ***cultural and natural heritage sites***.
- Good planning for retaining the outstanding universal value of the Sundarbans as a heritage site.

5.3.3 Low Growth Scenario

Low economic growth postulates a reduction of economic growth that could be triggered by one or more previously unforeseen external factors, e.g. COVID-19 (see Box 5.5) or further pandemics (which are predicted to be likely to happen), global recession, collapse of international airline industry/tourism, etc.). This does not represent government policy or desire, nor does the SEA predict that it will happen. But it presents a situation that could arise. A low growth scenario due to COVID-19 may be of limited duration (possibly a few years only) but would have the effect of setting back achieving government goals and plans. But other unforeseen external factors could impact on Bangladesh and retard growth. Key features of this scenario are listed in Box 5.4.

Box 5.4: Low Growth Scenario

(A) Economic factors

Economic growth

- Low or stagnant ***economic growth*** with no improvement in efficiency, limited or no innovation, minor improvement in ICT and no increase in the skills base or availability of trained manpower.
- ***GDP*** and GNI per capita grows only at rate of population increase, but could decline. If there is any later economy recovery, growth in GDP per capita will be modest but will fail to meet upper MIC value by 2031.
- No or limited increase in the ***share of GDP*** of industry, transport and services; but small increase in share of agriculture.
- Few economic zones are operational and few jute mills are fully functional.

Industry and exports

- A low rate of further ***industrialisation*** with minor increase in export-oriented manufacturing, and a no immediate transformation of the rural agrarian economy to a primarily industrial and digital economy (perhaps moderate such transformation after 2030).
- The volume of ***exports*** via Mongla sea port remain static. Port facilities are not well maintained and developed, and the full capacity of the port is not utilized. Ship handling is hampered due to lack of logistics and manpower.
- Maintenance ***dredging*** is sporadic in the channels near Mongla Sea Port. Ships have difficulty in entering and leaving Mongla Port. Leading to less ships entering and leaving the port during period with no dredging.
- The amount of ***freight*** transported is below available capacity. Roads and railways are preferred over inland waterways for freight transportation.

Employment

- Decline in number of people employed in agriculture in SW as less labour-demanding shrimp cultivation expands.
- Small increase in people employed in service and industrial sectors.

Agriculture and aquaculture

- No or limited further investment, intensification and diversification of ***agricultural production and coastal aquaculture***. It remains mainly on an 'extensive' basis (i.e. using traditional methods), is wasteful use of fertilisers, land and water resources – surface and groundwater), more than a third of crop production is based on groundwater abstraction, there is limited expansion in mechanization and a limited increase in agro-based small industries and manufacturing.
- A moderate level of ***food security***, although with a reduced level of nutritional value and affordability.
- A decline in ***employment in agriculture*** in the SW region as less labour-demanding shrimp cultivation expands, and more people are employed in industry and the service sector.

Power and energy

- A moderate increase in demand for energy to support low increase in industrialization, some urban expansion, and to meet the growing demands of the increasing population and continuing transport needs will be addressed through:
- A continuing reliance on coal-fired power generation, but a low increase in the use of renewable energy, a modest increase in use of natural gas and LPG but no phasing out high-cost rental power plants;
- Limited increase in the efficiency of use of installed capacity of power plants;
- Limited expansion of energy trade;
- No change in expansion of power grid network for power transmission and distribution;
- Limited use of renewables (around 1%).

Infrastructure, transport, connectivity and communication

- Limited expansion of ***infrastructure*** development, e.g. pipelines for transportation of petroleum; installation of LNG floating storage and re-gasification units, power transmission and distribution; no change in the density of roads.
- A considerable increase in ***non-motorized vehicles***.
- Deterioration in management of ***urban traffic***.
- Limited improvement in inter-district and inter-regional ***connectivity*** with neighboring countries for passengers, goods and services.
- A small increase in the usage of ***mobile phones***.

Urbanisation

- No transition of agrarian economy to an urban based industrial economy along with the poor harmonization in urban ecosystem management, sewerage treatment and solid waste management.
- Initiatives to achieve a balance between environment requirements and the needs of the urban people stagnate or cease, with no improvement of sewerage and waste management systems and poor maintenance of existing systems.
- No change in the proportion of the rural population enjoying ***facilities*** similar to those available in urban areas.

Tourism

- Low growth in the ***number of tourists*** visiting the Sundarbans (average increase at 3%/year).

(B) Environmental factors

Water flow and salinity

- Deterioration in ***dry season flow*** in the Gorai river (compared to base line value) due to limited investment in flow augmentation interventions (e.g. diversion facilities, dredging) yet made at the Gorai offtake and/or along the channel but inadequate to reduce ***salinity***.

Conservation, wildlife and habitats

- There will be a reduction in the ***tiger population*** of the Sundarbans as a result of deteriorating suitable habitat, a decrease in the prey base and high level of poaching due to inadequate protection.

- ***Dolphin*** habitat and population and ***Heritiera fomes (Sundri***) habitat and extent will both reduce considerably due to: (a) lack of any interventions within Bangladesh to ensure adequate fresh water supply (Sundri is sensitive to salinity); (b) decrease of dolphin prey-base area due to large increase of anthropogenic pressure as a result of lack of inadequate alternative livelihood opportunities; and (c) a large increase of pollution due to inadequate enforcement of regulations and industrial management requirements.
- Less protection measures being implemented due to inadequate implementation of co-management plan, inadequate implementation ***of regulations and deterioration of environmental and natural resource management and conservation***, as well as extension services - resulting in, e.g.:
- Increase in illegal activities in protected areas;
- Much poorer waste management with escalation of human diseases and various of social ills;
- Decreasing breeding, spawning, nursery and natural areas;
- Large decrease in fish brood stock for shrimp hatcheries due to disturbance to the life cycle of shrimp juveniles and adults, decrease in good quality spawn, fries, feed and other inputs;
- Use of low quality fish feed and virus-mixed shrimp[62].

Invasive alien species

- Poor/no effective management of water hyacinth.
- Very poor agricultural and aquaculture management practices.
- Less use of water hyacinth as bio-fertiliser and cattle feed, and for seed beds.
- Very poor implementation of measures to minimise the spread of water hyacinth (e.g. plans and deployment of mechanical equipment).

Land degradation

- ***Land degradation*** will increase due to inadequate river protection measures and ongoing conversion of agricultural land and forest land to other uses and improper management of land and water resources.

Land use change

- No change in the extent of land converted to shrimp cultivation and fish farming despite shrimp being a high value product.

Waste

- Poor waste collection mechanisms and adoption of waste treatment facilities.
- Limited capacity to convert waste to usable resources where only the Khulna City Corporation is equipped with ***waste recycling plants***. Elsewhere, traditional waste dumping continues with very limited recycling options.

Pollution

- No significant change in air quality. There will be some decrease in (polluting) industrial activity but, due to population increase, there will be increased demand for energy and some increase in transport.
- Considerable deterioration in dry season water quality.
- Moderate increase in greenhouse gas emissions.
- No appreciable change from base line situation in the noise level of the protected areas of Sundarbans.
- Noise in highly populated areas
- High increase in noise in highly populated areas (accumulated periods in which noise exceeds Bangladesh standard in daytime) due to increase in traffic without technological improvements (traffic and industry) and high incidence of old vehicles in use.
- Pollution management is poor due to:
- Ineffective implementation of pollution reduction measures and regulations;

[62] Virus-mixed shrimp: Virus infestation of shrimp may appear from the after larval stage (post larvae) to the adult stage.

- Establishment of effluent treatment plants (ETP) in only a limited number of industries and economic zones.
- Limited sewage treatment capacity

Vulnerability to climate change and natural disasters

- Moderate increase in extent of land inundated (due to poor maintenance and deterioration of embankments) – with a large increase in the number of households affected.
- Inadequate warning system and inadequate number of shelters for the increasing population.
- Inadequate adaptation and mitigation measures implemented (embankments strengthened, coastal afforestation).

(C) Social factors

Population

- High ***population growth*** due to higher total fertility rate.
- High population growth due to higher ***total fertility rate*** (which declines after 2026.
- Large reduction in migration from rural to urban areas.

Land administration

- An increase in ***unplanned development*** and poor land administration.
- Voluntary and involuntary ***land transfer*** will transform smallholders into marginal and landless people
- Small increase in the number of ***land disputes/conflicts*** due to increased land acquisition and land grabbing and poor or inadequate governance of land related disputes.
- Lack of transparency and accountability in leasing and allowing ***access for fishers to public water bodies***.

Education

- No change to the ***education system***, quality and delivery (particularly at the primary level) and to job-based training. Public sector education remains dominant with less investment in education sector.

Health and sanitation

- No change to ***health care*** with little increase in the number of physicians.
- Small increase in ***life expectancy***.
- No change initially in percentage of population connected to ***water supply and sanitation services***, with a moderate improvement in later years.

Women empowerment

- A limited or no increase in the number of ***women employed*** in the productive sectors of the economy, participating in ***decision-making***, and participating in formal education and skills development.
- Low level of participation of ***women in the job market***; and no changes in numbers of women ***participating in formal education*** and skills development (remains good).

Poverty and equality

- No reduction in levels of poverty and inequality with people having few alternative income generating opportunities.
- An increase in their dependence on the Sundarbans forests, and with increased illegal felling.
- Modest improvement in the engagement of ***landless and marginal land holders*** in development activities.

Cultural and natural heritage sites

- Poor management, maintenance and preservation of cultural and natural heritage sites.

Box 5.5: Effects of COVID-19 on Economies

- Severe downturn in economies, low growth, increased debt.
- Predicted 4% contraction in global GDP in 2020-21 (World Bank).
- Decline in GDP growth rate in Bangladesh from 5.2% to 3.6% in 2020-2021[63]
- Contraction of per capita income.
- Deep global recession.
- Fluctuations in stock markets – affects savings and pensions.
- Lower investment.
- Real GDP growth Q1 2020: Bangladesh 2.5 – 5%.
- Interest rates slashed.
- Jobs lost, unemployment.
- Disruption to factories and logistics.
- Supply chain disruptions.
- Trade restrictions.
- Difficulty to service debt.
- Millions on job retention schemes (furlough schemes) / support programmes.
- Businesses gone bankrupt / closed (cannot meet cash flows, payments, cannot function).
- Markets undermined, disrupted.
- Supply shortages (eg pharmaceuticals, electronic goods, timber).
- Airlines collapsed.
- Collapse of international travel industry.
- How long will shock last? (5 years? More?) Rebound to rebuild?
- Lost consumer confidence (drops in high street shopping, surge in online shopping).
- Temporary food shortage.
- Price spikes.
- Increased inequality and poverty.
- Pressure on weak health care systems.
- Loss of trade and tourism.
- Some loss of overseas employment for Bangladeshis.
- Dwindling remittances.
- Subdued capital flows.
- Tight financial conditions amid mounting debt.
- Great uncertainty.
- A reduced amount of overall economic and business activities.

A report on global economic prospects (World Bank, January 2021) notes that policy-makers face formidable challenges (in public health, debt management, budget policies, central banking and structural reforms) as countries start to embark on a still-fragile global recovery. The report states that governments, households and firms all need to embrace a changed economic landscape. While protecting the most vulnerable, successful policies will be needed that allow capital, labour, skills, and innovation to shift to new purposes in order to build a greener, stronger post-COVID economic environment.

[63] Bangladesh National Budget 2021-22 speech
https://mof.portal.gov.bd/sites/default/files/files/mof.portal.gov.bd/page/b29661b6_927f_4012_9f83_5ac47dbd6ebd/Speech%202021-22%20English%20Final%20Press.pdf

For South Asia, the report states that:

> *"The pandemic has had a devastating impact, leading to an estimated 6.7% output contraction in 2020. The region is projected to grow by 3.3% in 2021 and 3.8% in 2022, substantially weaker growth than during the decade leading up to the pandemic. COVID-19 is expected to inflict long-term damage on growth prospects by depressing investment, eroding human capital, undermining productivity, and depleting policy buffers. The outlook is highly uncertain and subject to multiple downside risks, including the possibility of more severe and longer-lasting damage from the pandemic, financial and debt distress related to an abrupt tightening of financing conditions or widespread corporate bankruptcies, adverse effects of extreme weather and climate change, weaker-than-expected recoveries in key partner economies, and a worsening of policy- and security-related uncertainty. Financial sector fragility in many economies requires active intervention by policy-makers to mitigate the risk of crisis……*
>
> *In Bangladesh, which had been one of the fastest-growing 'emerging market and developing economies' (EMDEs) prior to the pandemic, growth decelerated to an estimated 2.0% in FY2019/20, as the pandemic suppressed both domestic activity and caused a double-digit contraction in export."*

In Bangladesh, with an economy that relies on external sources of growth such as manufacturing exports,

> *"the recovery is likely to be particularly modest…. Export growth is forecast to remain weak, especially in the readymade garment sector…... The projected drag from remittances is less certain given their recent strength. Remittances may be adversely affected by the weak recovery in Gulf Cooperation Council (GCC) countries, the resurgence of outbreaks in the United States and Europe, and difficulties facing migrants trying to return to host countries."*

Source: World Bank (2021).

Table 5.1: Growth Scenarios Compared

Factors	Low growth	Medium growth	High growth
Economic			
Economic growth			
GDP growth rate	Low or stagnant	• Moderate • GDP grows slightly faster than population (1.6% 2031-2041)	• Rapid • GDP grows considerably faster than population (2.1% 2031-2041)
GDP per capita	GDP per capita grows only at rate of population increase, but could decline	$ 4,046 to 12,535 by 2031	$12, 536 or more by 2041
Increase of share of GDP in main sectors (e.g. agriculture, industries and services)	No or limited increase	Moderate	Considerable
Development of 7 economic zones in SW	Operational (3)	Operational (5)	Operational (10)
Jute mills in SW	Closed (7)	Resumed operation (7)	Fully operationalized
Employment in agriculture	Decline in SW – but still dominant	Decline in SW – but still dominant	Decline in SW – but still dominant
Industry & exports			
Rate of industrialisation	Low	Moderate	High
Volume of exports	Minor increase in export-oriented manufacturing	Moderate increase in export-oriented manufacturing	Large increase in export-oriented manufacturing
Rural economy	No immediate transformation of the rural agrarian economy (perhaps moderate after 2030)	Start to transforming the rural agrarian economy to a primarily industrial and digital economy.	Transformed rural agrarian economy to a primarily industrial and digital economy.
Dredging for Mongla port	Sporadic maintenance dredging	Regular maintenance dredging	Regular maintenance dredging
Mongla port facilities	• Not well maintained and developed • Full capacity not utilised • Less ships using port	• Well-maintained and regularly upgraded (up to 2031) • Full capacity utilised • More ships using port	• Well-maintained and developed • Full capacity utilized • High number of ships using port
Freight/cargo traffic	• Roads and railways preferred over inland waterways	• By mix of road, rail and inland waterways	• Large increase by inland waterways as well as by roads and railways

Factors	Low growth	Medium growth	High growth
	• Volume below available capacity		
Agriculture and aquaculture[64]			
Intensification/diversification of production	• No or limited intensification/ diversification of agricultural production and coastal aquaculture • Limited expansion of mechanisation • Remains mainly 'extensive' (i.e. using traditional methods) • Wasteful of fertilisers • More than two third of crop production is based on groundwater • Limited increase in agro-based industries	• Moderate intensification/ diversification of agricultural production and coastal aquaculture • Some expansion in mechanisation • Moderate use of organic/bio-fertilisers • 50% reduction in groundwater use • Moderate increase in agro-based industries • HYV used in >50% of agricultural land	• Considerable intensification/ diversification of agricultural production and coastal aquaculture • Expanded mechanisation • Major shift to organic/bio-fertilisers • Groundwater dependency reduced by at least 70% • Extensive increase in agro-based industries • Emphasis on high value products
Food security	Moderate, with reduced nutritional value and affordability	Moderate – high, with increased nutritional value and affordability	High, with better quality of food and nutritional value
Power and energy			
Increase in demand for energy	Moderate	Moderate	Large
Power use and production	• Continuing reliance on coal-fired power generation • Low increase in the use of energy from renewables, a modest increase in use of natural gas and LPG • No phasing out of high-cost rental power plants	• Continuing reliance on coal-fired power generation • Moderate increase in the use of energy from renewables, natural gas and LPG • Start to phasing out high-cost rental power plants	• Reduced reliance on coal-fired power generation • High increase in the use of energy from renewables, natural gas and LPG • Focus on low-cost energy generation • High-cost rental power plants phased out
Efficiency in use of installed capacity of power plants	Limited increase	Limited increase	Increased
Energy trade	Limited expansion	Limited expansion	Completion of expansion as per government target

[64] Aquaculture includes both freshwater and marine fish, shrimp and crabs.

Factors	Low growth	Medium growth	High growth
Renewable energy	1%	5%	10%
Power grid network	Remains same as base condition	Started expansion	Strengthening and enhancing
Mitigation measures for air pollution	Insufficient to change current situation	Moderate	Full mitigation measures , adoption of modern technology and stringent ambient air quality standards and emission limit values
Infrastructure, transport, connectivity and communication			
Infrastructure development	Limited expansion of: • railway network. • pipelines for transportation of petroleum • installation of LNG floating storage and re-gasification units, power transmission and distribution	Moderate expansion of: • railway network. • pipelines for transportation of petroleum • installation of LNG floating storage and re-gasification units, power transmission and distribution	Major expansion: • railway network. • pipelines for transportation of petroleum • installation of LNG floating storage and re-gasification units, power transmission and distribution
Road density	Small increase	Moderate increase	Widened and upgraded roads
Mass rapid transport & metro rail networks	Start of development (only Dhaka city)	Start of development (8 major cities)	In all major cities
Motorised traffic	Low increase	Moderate increase	High increase
Non-motorised traffic	Large increase	Moderate reduction compared to baseline	Discouraged in the major roads
Management of urban traffic	Poor management	Moderate improvement	Considerable improvement
Rail network (management/maintenance)	Poor management and maintenance of existing rail network	Moderate improvement	More emphasis on and extensive use and maintenance of railways and inland water transport
Inland waterways (management / maintenance)	Limited use and maintenance	Moderate use and maintenance	
Inter-district, inter-regional and national connectivity	• Limited improvement	• Moderate improvement • Emphasis upgrading national highways	• Major improvement • Upgraded national and regional highways
Mobile phone use	Small increase	Moderate increase	Large increase

Factors	Low growth	Medium growth	High growth
Urbanisation	• No transition of agrarian economy to an urban based industrial economy along with the poor harmonization in urban ecosystem management, sewerage treatment and solid waste management. • Initiatives to achieve a balance between environment requirements and the needs of the urban people stagnate or cease, with no improvement of sewerage and waste management systems and poor maintenance of existing systems. • No change in the proportion of the rural population enjoying facilities similar to those available in urban areas.	• Growing initiatives to achieve a balance between environment requirements and the needs of the urban people (i.e. in only some cities and municipalities). • Only main cities are protected from floods. There is a mix of traditional and modern sewerage systems and partial development in waste management. • A third of the rural population enjoying facilities similar to those available in urban areas.	• A balance between environmental requirements and the needs of the urban population. • All cities flood-free with effective drainage, modern sewerage and fully functioning waste management. • The majority (80%) of the rural population enjoying facilities similar to those available in urban areas
Rural population enjoying facilities	No change	One third of rural population	Majority (80%)
Growth of tourism	Low	Moderate	Moderate to high
Environment			
Dry season water flow	Deterioration	Moderate increase	Large increase
Salinity intrusion (in downstream reaches of rivers)	Increase	Decrease	Substantially decrease
Conservation, wildlife and habitats			
Tiger population	Small Reduction	Medium growth	Healthy growth
Management and efficient use and conservation of natural resources	Poor	Good	Very good
Forest and tree cover in Sundarbans	Small reduction	Moderate increase	Increase
Illegal activities in protected areas	Increase	Moderate reduction	Major reduction
Fish resources	• Significant resource stress and depletion of open water resources	• Moderate improved protection of open water resources	• Effective conservation of open water capture fishery resources • Improved habitat quality

Factors	Low growth	Medium growth	High growth
	• Significant risk to intensive and even extensive inland aquaculture • Slight expansion of floodplain aquaculture (seasonal cultured water bodies)	• Gradual but slight stress on and depletion of wild fish resources due to urbanisation and industrialisation. • Increase in production inland intensive culture fisheries (though not species diversity) due to investment and technological innovations.	• Flourishing, high-intensive inland aquaculture • Expanded floodplain aquaculture (seasonal cultured water bodies) • High productivity shrimp/prawn and coastal aquaculture
Shrimp & fish breeding	Fragile condition of shrimp and fish breeding grounds	Moderate improvement	Improved
Fish brood stock	Decrease	Moderate increase	Large increase
Fish feed & inputs	Significant decrease in quality	Increased availability	Readily available
Pollution			
Water pollution (Dry season water quality)	Significant deterioration	Moderate deterioration	Considerable improvement (as result of increased freshwater flows due to dredging and interventions)
Air quality	No significant change	Increase – partially compensated by change to LPG and emission reduction measures in energy and industry	Increase – considerably compensated by change to LPG and emission reduction measures in energy and industry
Pollution management	• Existing pollution reduction measures and regulations not effectively implemented • Limited adoption of modern and upgraded technology and stringent air pollution mitigation measures including clean fuel. • Effluent treatment plants (ETP) in limited number of industries and economic zones • Limited sewage treatment capacity.	• Pollution reduction measures and regulations partially implemented • Moderate adoption of modern and upgraded technology and stringent air pollution mitigation measures including clean fuel. • Effluent treatment plants (ETP) in increased number of industries and economic zones • Increased sewage treatment capacity	• Pollution reduction measures and regulations fully and effectively implemented • Widespread adoption of modern and upgraded technology and stringent air pollution mitigation measures including clean fuel. • Effluent treatment plants (ETP) in all industries and economic zones • Sufficient sewage treatment capacity to deal with volume generated
Noise management in the Sundarbans	No change from baseline	Moderate decrease in the noise level of the protected areas of Sundarbans	Considerable decrease in the noise level of the protected areas of Sundarbans

Factors	Low growth	Medium growth	High growth
Noise in highly populated areas	High increase in noise in highly populated (accumulated periods in which noise exceeds Bangladesh standard in daytime) due to increase in traffic without technological improvements (traffic and industry) and high incidence of old vehicles in use	High to very high increase in noise in highly populated areas (accumulated periods in which noise exceeds Bangladesh standard in daytime) due to increased traffic intensity and industrial activity	Moderate to high increase in noise in highly populated area (accumulated periods in which noise exceeds Bangladesh standard in daytime) with introduction of technology (including vehicles) compensating for increased traffic and industrial intensity
Greenhouse gas emission	Moderate increase	Moderate increase, partially mitigated by energy efficiency measures and increased use of renewables	Major increase, largely mitigated by energy efficiency measures and increased use of renewables
Invasive alien species			
Management of water hyacinth	Poor or ineffective	Moderate improvement	Greatly improved
Land use change	No change	• Small increase in extent of land under shrimp & fish farming • Minor loss of agricultural land to urban/industrial use	• Large increase in extent of shrimp & fish farming • Moderate loss of agricultural land to urban/industrial use
Land degradation			
River bank erosion	Lack of adequate river protection measures	Moderate level of river bank protection and increased application of some SLM practices	Extensive river bank protection and widespread implementation of SLM
Soil salinity	Increase	Moderate reduction due to increased freshwater flow and introduction of some SLM practices	Greatly reduced due to increased freshwater flow and through SLM
Waste			
Waste (collection & treatment)	• Poor management of waste • Only the Khulna City Corporation is equipped with waste recycling plants • Traditional dumping continues with very limited recycling options	• Moderate improvement (50% of city corporations and municipalities are equipped with waste recycling plants)	• Major improvement • All city corporations and municipalities are equipped with waste recycling plants;
Capacity to convert waste to usable resources	Limited	Moderate increase	Large increase

Factors	Low growth	Medium growth	High growth
Vulnerability to climate change and natural disasters			
Extent of land liable to inundation	• Moderate increase • Inadequate warning system and shelters • Inadequate adaptation & mitigation measures implemented	• Little initial change but moderate improvement in later years (due to improvement to embankments), with an initially moderate - and later low - increase in the number of households affected • Improved warning system & number of shelters • Adaptation & mitigation measures implemented	• Moderate reduction due to improvement to embankments, with a moderate reduction in the number of households affected • Improved warning system, more shelters. • Adequate adaptation & mitigation measures implemented
Social			
Population			
Total population	High population growth due to higher total fertility rate	Marginally higher than baseline	Marginally increased over baseline, but lower than the medium growth scenario
Population growth rate	High	Reduced (due to lower TFR)	Reduced (due to lower TFR)
Total fertility rate	High		Declines after 2026
Land			
Land acquisition / grabbing	• Increase in unplanned development • Small increase in land acquisition due limited urbanization, industrialization and infrastructure development	• Small and marginal landholders forced to sell land to enable increase in industrial enterprises. • Moderate increase in land acquisition due to medium urbanization, industrialization and infrastructure development	• Large increase in land acquisition due high rate of urbanization, industrialization and infrastructure development
Land disputes	• Small increase in number of disputes/conflicts • High number of incidents of land grabbing due to poor land administration & inadequate governance	• Moderate increase in number of disputes/conflicts • Moderate number of incidents of land grabbing due to improved land administration and governance	• Considerable decrease in number of disputes/conflicts • Minimal incidents of land grabbing due to Good land administration governance
Large landowners	Remain same	Slightly increase	Increase
Medium-sized land holders	Remain same	Become smallholders	Some made small and marginal holders
Smallholders	Become landless/marginal	Become landless/marginal	Increase in landless

Factors	Low growth	Medium growth	High growth
Leasing and providing access for fishers to public water bodies	Lack of transparency & accountability	Improved transparency & accountability	Improved transparency & accountability
Landless and marginal people engaged in development activities	Modest improvement	Moderate improvement	Moderate improvement
Land use change			
Extent of land converted to shrimp cultivation and fish farming	No change	Moderate increase	Large increase
Poverty & inequality	No reduction	Moderately reduced	Considerably reduced
Education system	No change (possible a deterioration)	Moderate improvement	Major improvement
Health and sanitation	No change	Moderate improvement	Major improvement
Health care	No change with little increase in the number of physicians	Moderately improved with a moderate increase in the number of physicians	Considerably improved (eg big increase in the number of physicians and in well-equipped health care services affordable for most of the population)
Life expectancy	Small increase	Modest increase	Moderate increase
Connection to water supply and sanitation services	No change	Moderate improvement	Major improvement
Migration (rural to urban)	Large reduction	Large reduction	Very large reduction
Women's empowerment			
Women in employment	Low level	Slight increase	Moderate increase
Women participating in decision-making	Poor level	Good level	Very good level
Participation of women in formal education & skill development	Good level	Very good level	Extremely good level
Cultural and Natural Heritage Sites			
Management of cultural and natural heritage sites	Poor	Moderate improvement	Improved

5.4 Range of Developments under Growth Scenarios

Developments taken into account in elaborating each scenario include, for example, the extent of new/upgraded infrastructure (e.g. kilometres of new railways and roads, numbers of new ports and airports), new industrial facilities (e.g. types/numbers of new plants and sites), changed environmental and social management regimes, changes to agricultural and fisheries activities (e.g. altered cropping patterns, expansion of shrimp farms).

For each growth scenario, the developments and situations likely to arise will differ (possibly in type and nature, possibly in 'volume' or location/extent, etc.). Developments will arise as a result of continuing to implement existing PPPs (or as revised) and when new PPPs are introduced, and will include projects, new/expanded/modernised infrastructure, other initiatives by the private sector, and social change, etc. Developments will also be influenced by 'drivers of change' (see Box 5.1) and uncertain external factors (see section 5.2.1) such as transboundary water, climate change, trade dynamics, global economic factors, war, pandemics, etc. The baseline theme papers examine the influence of such external factors and our understanding of how they might influence future development. The factors that are being considered are, therefore, things that have a reasonable chance of occurring, but not mere speculation.

6. Assessment of Growth Scenarios

The assessments of the three growth scenarios have been undertaken on a 'broad-scale' basis. They provide a comparative picture of the likely combined impacts of overall development across all sectors in the SW region over the next 20 years under each scenario - reflected in terms of whether they will enhance or impede achieving objectives to address the key environmental and socio-economic issues discussed in Chapter 3.

The separate assessments for the high, medium and low growth scenarios are presented in annexes 3.1, 3.2 and 3.3 respectively, with associated comments providing an explanation to justify or explain the scores, or illustrate how objectives will be enhanced/impaired, or indicate how score can be improved by mitigation.

Scores are assigned as follows:

(a) The scenario will impede achieving an objective (negative score):
- Very significant and significant negative scores: '-5' and '-4', respectively.
- Very negative score: '-3'.
- Moderately and slightly negative scores '-2' and '-1', respectively.

(b) No overall influence on achieving the objective:
- Neutral [0].

(c) The scenario will enhance achieving an objective (positive score)
- Very significant and significant positive scores: '+5' and '+4', respectively.
- Very positive score: '+3'
- Moderately and slightly positive scores: '+2' and '+1' respectively.

The assessments allocated scores for two different situations:

R: Risk score: where existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced, and/or where no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory.

M: Mitigated score: where existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced, and the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

6.1 Comparison of Scenarios

Tables 6.1 and 6.2 compare the scores for the low, medium and high growth scenarios, for the risk and mitigated situations, respectively (see annexes 3.1, 3.2 and 3.3 for explanations underpinning the scores).

Table 6.1: Comparative Table of Risk Scores for Scenario Assessments

R: Risk score: where existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced, and/or where no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory.

			Low growth	Medium growth	High growth
Environmental Objectives					
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	-3	-2	-4
	2	Reduce illegal activities related to protected areas and biodiversity	-3	-2	-3
	3	Reduce introduction and spread of Invasive Alien Species	-3	-2	-3
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	-4	-2	-3
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	-4	-2	-3
	6	Minimise emissions of greenhouse gases	-3	-3	-3
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity intrusion, floods, storm surges, etc.)	-4	-3	-4
Water	8	Increase dry season freshwater flow in rivers	-3	-2	-3
	9	Reduce high/peak flows in rivers during monsoon season	0	0	-2
Land degradation	10	Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion, etc)	-3	-2	-3
Land use change	11	Minimise conversion of agricultural land (e.g. conversion to shrimp ponds)	-2	-3	-3
Socio-Economic					
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	-2	-2	-3
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	-2	-2	-3
Health and sanitation	14	Improve health services and health of society (eg. by reducing vulnerability to diseases)	-2	-1	-1
	15	Improve and extend water supply and sanitation services	-2	-3	-3
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	-2	-1	-1
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	-2	-2	-2
Women and children	18	Improve gender equality and empowerment of women	-1	0	0

			Low growth	**Medium growth**	**High growth**
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities in SW region	-3	-2	-2
Conflicts and security	20	Reduce conflicts over use of land	-3	-2	-3
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.) and also Sundarbans 0natural heritage sites	-3	-1	-2
Food	22	Improve food security	-2	0	0
Ag+1riculture and fisheries	23	Increase agricultural and fish production	-1	0	0
Power and energy	24	Increase uptake of renewable energy	-2	-1	-1
	25	Increase efficiency in production and consumption of energy	-2	0	0
	26	Increase access to affordable energy	-1	0	0
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts; and to remain within the carrying capacity of the Sundarbans for tourism.	-2	-1	-1
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	-2	-1	-1
	29	Optimise the existing and future physical footprint of transport services (rail, road, waterways)	-2	-1	-1

Table 6.2: Comparative Table of Mitigation Scores for Scenario Assessments

M: Mitigated score: where existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced, and the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

Environmental Objectives			**Low growth**	**Medium growth**	**High growth**
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	0	+2	+4
	2	Reduce illegal activities related to protected areas and biodiversity	0	+2	+4
	3	Reduce introduction and spread of Invasive Alien Species	0	+2	+4
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	0	+2	+4
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	+1	+3	+4
	6	Minimise emissions of greenhouse gases	0	+2	+1
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity intrusion, floods, storm surges, etc.)	+1	+2	+4
Water	8	Increase dry season freshwater flow in rivers	0	+2	+4
	9	Reduce high/peak flows in rivers during monsoon season	0	0	+2
Land degradation	10	Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion, etc)	0	+2	+3
Land use change	11	Minimise conversion of agricultural land (e.g. conversion to shrimp ponds)	0	0	0
Socio-economic			**Low growth**	**Medium growth**	**High growth**
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	+1	+3	+4
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	0	+2	+3
Health and sanitation	14	Improve health services and health of society (eg. by reducing vulnerability to diseases)	0	+2	+3
	15	Improve and extend water supply and sanitation services	0	+2	+4
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	0	+2	+4
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	+1	+2	+4
Women and children	18	Improve gender equality and empowerment of women	+1	+2	+4
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities in SW region	+1	+2	+3

Environmental Objectives			**Low growth**	**Medium growth**	**High growth**
Conflicts and security	20	Reduce conflicts over use of land	0	+2	+2
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.) and also Sundarbans natural heritage sites	0	+1	+3
Food	22	Improve food security	0	+3	+4
Agriculture and fisheries	23	Increase agricultural and fish production	+1	+2	+4
Power and energy	24	Increase uptake of renewable energy	0	+2	+3
	25	Increase efficiency in production and consumption of energy	+1	+3	+4
	26	Increase access to affordable energy	+1	+3	+4
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts; and to remain within the carrying capacity of the Sundarbans for tourism.	0	+1	+3
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	+1	+2	+3
	29	Optimise the existing and future physical footprint of transport services (rail, road, waterways)	+1	+2	+4

To provide a generic overall comparison of the three scenario assessments, the scores for the 29 objectives – for both the risk ('R') and mitigated ('M') situations - are summed for each scenario in Table 6.3. Whilst this depiction provides a helpful overall picture for decision-makers, the comparison must be treated with some care since such summation is not strictly scientific. This is because the objectives all concern very different issues/factors which cannot strictly be computed, and also because the number of objectives are not equal (there are 11 environmental and 18 socio-economic objectives).

Table 6.3: Summation of Scores from Assessment Tables

	Low growth		**Medium growth**		**High growth**	
	R	**M**	**R**	**M**	**R**	**M**
Environmental objectives	-32	+2	-23	+19	-34	+34
Socio-economic objectives	-36	+9	-20	+38	-24	+63
Total	-68	+11	-43	+57	-58	+97

From Table 6.3, the following conclusions can be made:

(a) Summed 'R' column (risk) scores

These show that both high growth and low growth will impede environmental objectives to a similar degree, with medium growth impeding environmental objectives less.

Low growth will very significantly impede socio-economic objectives; medium and high much less.

(b) Summed 'M' column (mitigated) scores

These show a predictable pattern for both environmental and socio-economic objectives, correlated to the level of growth – reflecting that, from low to medium to high growth, there is progressively more investment in environmental management, cleaner technology, socio-economic improvement, and increasingly effective implementation/enforcement of regulations.

High growth will enhance environmental objectives to a significant extent, almost double medium growth, whereas under low growth the outcome is almost neutral.

High growth will enhance socio-economic objectives to a very significant extent, almost 1.7 times medium growth and seven times more than low growth.

6.2 Distribution of Scores

Table 6.4 shows how the scores allocated for the 29 environmental and socio-economic objectives are distributed across the three growth scenarios.

Table 6.4: Distribution of Assessment Scores for Growth Scenarios

R: Risk score: where existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced, and/or where no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory – thus impeding realising the environmental and socio-economic objectives.

M: Mitigated score: where existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced, and the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies – thus enhancing realizing the environmental and socio-economic objectives.

Score level		(R) RISK Total number of objectives allocated indicated score				(M) MITIGATED Total number of objectives allocated indicated score		
		Low	Medium	High		Low	Medium	High
Environmental objectives								
-5	Very significantly negative							
-4	Significantly negative	3		2				
-3	Very negative	6	3	8				
-2	Moderately negative	1	7	1				
-1	Slightly negative							
0	Neutral	1	1			9	2	1
+1	Slightly positive					2		1
+2	Moderately positive						8	1
+3	Very positive						1	1
+4	Significantly positive							7
+5	Very significantly positive							
Socio-economic objectives								
-5	Very significantly negative							
-4	Significantly negative							
-3	Very negative	3	1	4				
-2	Moderately negative	12	5	3				
-1	Slightly negative	3	7	6				
0	Neutral		5	5		9		
+1	Slightly positive					9	2	
+2	Moderately positive						12	1
+3	Very positive						4	7
+4	Significantly positive							10
+5	Very significantly positive							
	Total	29	29	29		29	29	29

Some comment is required regarding the assumptions for the mitigated ('M') situation. Medium growth is broadly equivalent to the current situation and projected developments over the next 10 years – the country having reached lower middle income country status in 2015 and aiming to achieve upper middle income country status by 2031. The discussion in Chapter 3 describes a wide range of serious environmental and socio-economic concerns that currently challenge the SW region. These concerns are discussed in literature, and/or have been identified by experts and stakeholders consulted during the SEA They are the consequence of the combined actions and practices of government, the private sector and society, and they indicate that the assumptions for the 'M' situation are currently not being met. For the outcomes of the three scenarios under the 'M' situation to be realised, it will be critical that the government, private sector and society collaborate effectively and commit fully to implementing the SEMP. This imperative is even greater for the high growth scenario under which there will be even more negative impacts if mitigatory actions are not implemented and regulations are not effectively implemented.

The low growth scenario is obviously not a policy choice, nor is it a prediction. But it does indicate a possible future if unforeseen and unexpected circumstances conspire to undermine development. At best, this could delay progress towards the country's goals to achieve upper MIC status by 2031 and HIC status by 2041. At worst, if low growth is protracted, it could derail achieving these aims for a considerable period. This scenario is presented to enable government to consider response/contingency planning; and this includes implementing the measures in the SEMP just as much as it does for the medium and high growth scenarios.

The accompanying SEMP recommends a coordinated set of measures and procedures to address the environmental and socio-economic issues described in Chapter 3.

6.3 Outcomes of Scenarios

Table 6.5 compares the outcomes under the three scenarios as influenced by the above assumptions being met ('mitigated' situation) or not met ('risk' situation).

Table 6.5: Outcomes of Scenarios Compared

Scenario	Risk outcome (R)	Mitigated outcome (M)
High growth	• ***Mainly very negative environmental impacts*** – severely impeding realising the environmental objectives. • Rather than delivering anticipated socio-economic benefits, high growth would instead result in ***either no change*** in achieving about a third of the listed socio-economic objectives ***or in slightly to very negative*** effects which would significantly impede achieving two thirds of the socio-economic objectives. • The implication of this outcome would be that ***many of the current environmental and socio-economic challenges would continue or become worse.***	• ***Mainly significantly positive*** effect on achieving the majority of the environmental objectives, with ***some very positive, slightly and moderately positive*** effects on achieving a few of the objectives • ***Very and significantly positive*** effects on enhancing achieving socio-economic objectives
Medium growth	• ***Mainly moderately and very negative*** effects on achieving the environmental objectives. • Rather than delivering anticipated socio-economic benefits, medium growth would	• ***Dominantly moderately positive environmental*** effects on achieving environmental objectives • ***Dominantly moderately positive effects*** on achieving two thirds of

Scenario	Risk outcome (R)	Mitigated outcome (M)
	instead result in ***either no change*** in achieving about a third of the listed socio-economic objectives ***or in a slightly to moderately negative*** effect on achieving the other socio-economic objectives	the socio-economic objectives, with either slightly or ***very positive effects*** for the remaining socio-economic objectives.
Low growth	• ***Dominantly very and significantly negative*** effects on achieving environmental objectives • ***Moderately negative effects*** on achieving two thirds of the socio-economic objectives; with either slightly or very negative effects on achieving the remaining socio-economic objectives	• ***Dominantly neutral*** effects on achieving environmental objectives, with some slightly positive and slightly negative effects. • ***Slightly positive effects*** on achieving half of the socio-economic objectives, and no change as regards achieving the other half of the socio-economic objectives

The overall picture is that the medium and high growth scenarios will flow seamlessly from one to the other as government policy under the Second Perspectives Plan (2021-2041) progressively unfolds. Along this trajectory, there will be progressively more positive impacts and more beneficial outcomes if the 'M' column assumptions are fully met; but progressively more risks and negative environmental and socio-economic impacts if those assumptions are not met. For both situations, the SEMP will be a key instrument to enhance benefits and promote synergies, and to avoid or mitigate negative outcomes and counteract antagonisms. Similarly, for the possibility (even if remote) that low growth will ensue, the SEMP can play a similar response and mitigation role.

The assessment of the three growth scenarios fulfilled the function of a 'learning step' for the main assessment, prompting necessary refinements to the scenario narratives and adjustments to some of the objectives and indicators, so that all became more fully integrated. This step paved the way to the next phase of the assessment work which involved a deeper and more detailed assessment - on a sector-by-sector basis - of the developments that can be expected under the high growth scenario (discussed in Chapter 7). This initial assessment of the three growth scenarios underlined critical issues which the deeper assessment has paid particular attention to.

7. Deeper Assessment of High Growth Scenario

The deeper assessment builds on the initial assessments of the three growth strategies discussed in the previous chapter. But it focuses specifically on the high growth scenario as this accords with the government's policy to achieve high income country (HIC) status by 2041.

Whilst the initial assessments were on a 'whole scenario' basis, this deeper assessment has been undertaken on a sectoral basis. Assessments are made of nine key sectors: industry, transport[65], urban, power and energy, forestry, fisheries, water, tourism and agriculture. They follow the same procedure described in Chapter 6, i.e. assessing whether each individual sector will enhance or impede achieving the objectives which address the key environmental and socio-economic issues discussed in Chapter 3.

The nine sector assessments are presented in annexes 4.1 – 4.9. Tables 7.1 and 7.2 compare the scores for the nine sectors, for the mitigated and risk situations, respectively. In addition, these tables provide an overall score achieved by summing the sector scores for each objective. The overall summed scores are not scientific. But they provide a broad indication of the issues which are likely to be subject to the highest burden of cumulative impacts as a result of the combined implementation of development activities under the nine sectors. As such, they provide a basic means to compare the overall positive and negative cumulative impacts of each sector.

[65] Includes transport by road, rail, water (including shipping, tourist and fishing boats) and air. These modes are assessed together as they are part of an integrated system with distinct links between them.

Table 7.1: Comparison of Sector Assessments – Mitigated Scores

Scoring reflects whether the suite of developments likely to arise under each sector under a high growth scenario will enhance (+ scores) or impede (-ve scores) achieving the objectives

Range of scores

Very significant and significant negative scores: **'-5' and '-4'** respectively. Very negative score: **'-3'**. Moderately and slightly negative scores: **'-2' and '-1'** respectively.
Neutral [0]
Very significant and significant positive scores: **'+5' and '+4'**, respectively. Very positive score: **'+3'.** Moderately and slightly positive scores: **'+2' and '+1'**, respectively.

Total scores: **15-20** ; 7-14 ; 1-6

			Industry	Transport	Urban	Power & Energy	Forestry	Fisheries	Water	Tourism	Agriculture	Total
Environmental												
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	+4	+1	+1	+3	+4	+3	+4	+1	0	+21
	2	Reduce illegal activities related to protected areas and biodiversity	+2	0	0	+2	+4	+4	0	0	0	+12
	3	Reduce introduction and spread of Invasive Alien Species	+1	0	0	+1	0	+2	0	0	+3	+7
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	+2	+3	+4	+4	0	+3	0	+1	0	+17
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	+3	+3	+3	+4	0	+1	+4	+1	+1	+20
	6	Minimise emissions of greenhouse gases	+1	+2	+1	+2	+2	0	0	0	+1	+9
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity intrusion in rivers, floods, storm surges, etc.)	0	+2	+1	0	+2	0	+3	0	0	+8
Water	8	Increase dry season freshwater flow in rivers	0	0	0	0	+1	0	+4	0	0	+5
	9	Reduce high/peak flows in rivers during monsoon season	0	0	0	0	+1	0	+3	0	0	+4
Land degradation	10	Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion, etc)	0	+1	0	0	+1	+2	+3	0	0	+7

			Industry	Transport	Urban	Power & Energy	Forestry	Fisheries	Water	Tourism	Agriculture	Total
Land use change	11	Minimise conversion of agricultural land (e.g. conversion to shrimp ponds)	+1	0	0	0	0	0	0	0	0	+1
		Cumulative score	***14***	***12***	***10***	***16***	***15***	***15***	***21***	***3***	***5***	
Socio-economic												
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	+4	+4	+4	+4	+2	+4	+4	+3	+3	+32
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	+2	+2	+2	+1	+1	+2	+4	+2	0	+16
Health and sanitation	14	Improve health services and health of society (eg by reducing vulnerability to diseases)	+2	+1	+3	+1	+3	0	+3	+1	0	+14
	15	Improve and extend water supply and sanitation services	+2	+1	+3	+1	0	0	+4	0	0	+11
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	+1	+1	+3	+1	+1	+1	0	+2	+1	+11
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	+3	0	+3	0	0	0	0	0	0	+6
Women and children	18	Improve gender equality and empowerment of women	+3	0	0	0	+1	0	0	+2	0	+6
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities in SW region	+2	0	+2	+1	+2	0	0	0	0	+7
Conflicts and security	20	Reduce conflicts over use of land	+2	0	0	+2	0	+3	0	0	0	+7
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.) and also Sundarbans natural heritage sites	+1	0	+2	+1	+3	0	+3	+3	0	+13
Food security	22	Improve food security	+2	+2	+1	+1	+1	+4	+4	+1	+3	+19
Agriculture and fisheries	23	Increase agricultural and fish production	+1	+1	0	+1	+2	+4	+4	0	+3	+16

			Industry	Transport	Urban	Power & Energy	Forestry	Fisheries	Water	Tourism	Agriculture	Total
Power and energy	24	Increase uptake of renewable energy	+1	0	+3	+3	0	0	0	0	0	+7
	25	Increase efficiency in production and consumption of energy	+2	+1	+2	+4	+1	0	0	0	0	+10
	26	Increase access to affordable energy	+2	0	+2	+4	+1	0	0	0	0	+9
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts	0	+1	0	0	+3	0	0	+3	0	+7
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	0	+3	+2	+3	0	0	0	0	0	+8
	29	Optimise the existing and future physical footprint of transport services (rail, road, waterways)	0	+4	+2	+4	0	0	+2	0	0	+12
		Cumulative score	***30***	***21***	***34***	***32***	***21***	***18***	***28***	***17***	***10***	
		Overall cumulative score	***44***	***33***	***44***	***48***	***36***	***33***	***49***	***20***	***15***	

Table 7.2: Comparison of Sector Assessments – Risk Scores

Scoring reflects whether the suite of developments likely to arise under each sector under a high growth scenario will enhance (+ scores) or impede (-ve scores) achieving the objectives

Range of scores

Very significant and significant negative scores: '-5' and '-4' respectively. Very negative score: '-3'. Moderately and slightly negative scores: '-2' and '-1' respectively.
Neutral [0]
Very significant and significant positive scores: '+5' and '+4', respectively. Very positive score: '+3'. Moderately and slightly positive scores: '+2' and '+1', respectively.

Total scores: 14-20+ ; 7-13 ; 1-6 .

			Industry	Transport	Urban	Power & energy	Forestry	Fisheries	Water	Tourism	Agriculture	Total
Environmental												
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	-3	-2	-1	-3	-3	-3	-3	-2	0	-20
	2	Reduce illegal activities related to protected areas and biodiversity	0	0	0	0	-3	-3	0	0	0	-6
	3	Reduce introduction and spread of Invasive Alien Species	0	0	0	0	0	-3	0	0	-3	-6
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	-3	-3	-3	-3	0	-2	0	0	0	-14
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	-3	-3	-3	-3	0	-1	0	0	-1	-14
	6	Minimise emissions of greenhouse gases	-2	-2	-1	-3	-3	0	0	0	-1	-12
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity intrusion in rivers, floods, storm surges, etc.)	0	-2	-1	0	-2	0	-3	0	0	-8
Water	8	Increase dry season freshwater flow in rivers	0	0	0	-1	-1	0	-4	0	0	-6
	9	Reduce high/peak flows in rivers during monsoon season	0	0	0	0	-1	0	-3	0	0	-4
Land degradation	10	Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion, etc)	0	-1	0	0	-1	-3	-3	0	0	-8
Land use change	11	Minimise conversion of agricultural land (e.g. conversion to shrimp ponds)	-1	0	0	0	-1	-4	0	0	0	-6
		Cumulative score	***12***	***13***	***9***	***13***	***15***	***19***	***16***	***2***	***5***	

			Industry	Transport	Urban	Power & energy	Forestry	Fisheries	Water	Tourism	Agriculture	Total
Socio-Economic												
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	-2	-3	-3	-2	-1	-4	-4	-2	-2	-23
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	-1	0	-1	-1	-1	-1	-4	-1	-1	-11
Health and sanitation	14	Improve health services and health of society (eg by reducing vulnerability to diseases)	-1	-1	0	0	-3	0	-3	-2	0	-10
	15	Improve and extend water supply and sanitation services	-1	-1	-1	0	0	0	-3	0	0	-6
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	0	-1	-1	0	0	0	0	-1	0	-3
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	-2	0	-1	0	0	0	0	0	0	-3
Women and children	18	Improve gender equality and empowerment of women	-1	0	0	0	-1	0	0	-1	0	-3
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities in SW region	0	0	0	0	-2	0	0	0	0	-2
Conflicts and security	20	Reduce conflicts over use of land	-2	0	0	-2	0	-3	0	0	0	-7
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.) and also Sundarbans natural heritage sites	-1	0	0	-1	-3	0	-2	-2	0	-9
Food	22	Improve food security	-1	-1	0	-1	-1	-2	-4	0	-2	-12
Agriculture and fisheries	23	Increase agricultural and fish production	-1	-1	0	-1	-1	-1	-4	0	-2	-11
Power and energy	24	Increase uptake of renewable energy	0	0	-1	-1	0	0	0	0	0	-2
	25	Increase efficiency in production and consumption of energy	0	0	0	0	-1	0	0	0	0	-1

			Industry	Transport	Urban	Power & energy	Forestry	Fisheries	Water	Tourism	Agriculture	Total
	26	Increase access to affordable energy	0	0	0	0	-1	0	0	0	0	-1
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts	0	-1	0	0	-2	0	0	-2	0	-5
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	0	-2	0	-1	0	0	0	0	0	-3
	29	Optimise the existing and future physical footprint of transport services (rail, road, waterways)	0	-2	-1	-2	0	0	-2	0	0	-7
		Cumulative score	***13***	***13***	***9***	***9***	***15***	***11***	***26***	***11***	***7***	
		Overall cumulative score	***25***	***26***	***18***	***22***	***30***	***30***	***42***	***13***	***12***	

7.1 Analysis of Sector Assessments

7.1.1 Mitigated Situation

Table 7.1 shows how development arising from the implementation of PPPs under high growth can result in positive benefits under all of the key sectors through enhancing achievement of the objectives for the key environmental and socio-economic issues that face the SW region. However, this is dependent on two fundamental assumptions:

- Existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced,
- Government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

The cumulative negative scores for each sector (environmental, socio-economic and overall are broadly distributed across all sectors (Table 7.1). No sectors stand out as being more important in terms of generating negative environmental, or socio-economic outcomes, although the highest cumulative scores are attributed to four particular sectors: water, power and energy, industry and urban.

Table 7.1 contains a total of 261 score cells (excluding the totals) (9 sectors x 29 objectives). Analysis in Table 7.3 shows that the scores (and thus positive impacts) are not distributed evenly across either sectors or objectives. Overall, a positive score was achieved for 54% of all possible scores (142 out of 261 score cells), whilst in 46% of possible scores there was no influence on enhancing achievement of the objectives (neutral score: 0). The percentages are only slightly different when environmental and socio-economic scores are disaggregated: environmental objectives (50% positive, 50% neutral) and socio-economic objectives (57% positive, 43% neutral).

Table 7.3: Mitigated Score Distribution for Deeper Assessment

	Mitigated Scores						Total
	+5	**+4**	**+3**	**+2**	**+1**	**0**	
Environmental objectives	0	10	11	10	18	50	99
Socio-economic objectives	0	16	22	26	29	69	162
Total		**26**	**33**	**36**	**47**	**119**	**261**

The greatest total positive scores (thus the highest benefits) (aggregate score of 15 or more) were found for three environmental objectives and four socio-economic objectives, concerning:

- Biodiversity, habitats and ecosystem services (objective 1);
- Waste and pollution (objectives 4 and 5);
- Economic growth (objective 12);
- Employment (objective 13);
- Food security (objective 22);
- Agricultural and fish production (objective 23).

7.1.2 Risk Situation

Table 7.2 shows how development arising from the implementation of PPPs under high growth could result in negative outcomes under all of the key sectors through impeding achievement of the objectives for the key environmental and socio-economic issues that face the SW region. However, this is dependent on two fundamental assumptions:

- Existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced;
- No or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory.

The cumulative scores for each sector (environmental, socio-economic and overall are broadly distributed across all sectors (Table 7.2). No sectors stand out as being more important in terms of generating negative environmental, or socio-economic outcomes, although the highest cumulative scores are attributed to five particular sectors: water, forestry, transport, industry and fisheries.

Analysis in Table 7.4 shows that the scores (and thus negative impacts) are not distributed evenly across either sectors or objectives. Overall, a negative score resulted for 44% of all possible scores (115 out of 261 score cells), whilst in 56% of possible scores there was no influence on impeding achievement of the objectives (neutral score: 0). The percentages are only slightly different when environmental and socio-economic scores are disaggregated: environmental objectives (45% positive, 55% neutral) and socio-economic objectives (43% positive, 57% neutral).

Table 7.4: Risk Score Distribution for Deeper Assessment

	Risk Scores						Total
	-5	**-4**	**-3**	**-2**	**-1**	**0**	
Environmental objectives	0	2	23	7	13	54	99
Socio-economic objectives	0	5	7	20	38	92	162
Total	**0**	**7**	**30**	**27**	**51**	**146**	**261**

The greatest total negative scores (thus the highest negative impacts) (aggregate score of 14 or more) were found in respect of three environmental objectives and one socio-economic objective concerning:

- Biodiversity, habitats and ecosystem services (objective 1);
- Waste disposal and pollution (objectives 4 and 5);
- Economic growth (objective 12);
- Employment (objective 13);

But large number of total scores (7 to 13) – indicating issues of concern were also found for ten other objectives:

- Greenhouse gases (objective 6);
- Vulnerability to climate change and disasters (objective 7);
- Land degradation (objective 10);
- Employment (objective 13);
- Health (objective 14);
- Conflicts over land (objective 20);
- Natural and cultural heritage sites (objective 21);
- Food security (objective 22);
- Agricultural and fish production (objective 23);
- Footprint of transport services (objective 29).

The SEMP also covers all the other objectives to ensure negative impacts are effectively avoided, mitigated, or appropriately addressed.

8. Key Impacts of the High Growth Scenario

Chapter 7 presents the results of the deeper assessment of the high growth scenario indicating how developments under this scenario will influence (positively or negatively as shown in Tables 7.1 and 7.2, respectively) achieving 29 environmental and socio-economic objectives. These objectives were established as a response to key issues identified by experts and through stakeholder consultations. The scores provided in Tables 7.1 and 7.2 and in annexes 4.1 – 4.9 are a reflection of the impacts that development activities are likely to have under high growth in the SW region over the next 20 years. The impacts could be positive or negative depending on whether appropriate mitigatory actions are fully and effectively implemented to address identified issues.

The discussion below considers mainly the potential negative environmental and socio-economic impacts (i.e. the risk) if adequate mitigatory measures are not followed:

- Existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced;
- No or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development; and/or
- The use of clean and sustainable technologies is not compulsory and not adopted.

But, if mitigatory measures are put in place, then, in most cases, the negative impacts will be considerably reduced or eliminated and, often, they will be turned into positive impacts so that beneficial outcomes are achieved for the environment, society and the economy. The next chapter discusses how cumulative impacts could arise from multiple development activities across different sectors.

Background details to the issues discussed in the following sections are presented in Chapter 3, and a more thorough analysis is presented in the Final Scoping Report (January 2021) and the thematic baselines papers available on the SEA website (www.seasw-sundarbansbd.org).

8.1 Environmental Impacts

8.1.1 Degradation of Habitats, Loss of Biodiversity and Ecosystems Integrity and Services

A major concern for maintaining the outstanding universal value (OUV) of the Sundarbans including its wildlife sanctuaries (UNESCO World Heritage Sites) is the preservation of its unique mangrove ecosystem and habitats and their rich diversity of aquatic and terrestrial flora and fauna. The latter include rare or endangered species such as Bengal Tigers, aquatic mammals, birds and reptiles. Outside the Sundarbans, there are two ecologically critical areas (ECA): one lies adjacent to the Sundarbans on its inland side; the other, the Marjat Baor, is in Jhenaidah District. Both areas support a wide range of flora and fauna. There is also an offshore marine protected area (MPA) and six riverine brackish water dolphin conservation sanctuaries.

The analysis in the preceding chapters shows that there is a potential risk of degradation of habitats (including habitat isolation), loss of biodiversity and ecosystems integrity and services in the above areas from developments and activities in all nine key sectors assessed in Chapter 8.

The most critical risks will be due to:

- The major expansion of ***industrial development*** which will result in increased air and water pollution and an increased footprint of industrial infrastructure – particularly in areas surrounding the Sundarbans. Such pollution is likely to result in diseases, impaired breeding and mortalities amongst aquatic and terrestrial animal species.
- Increase in ***power and energy generation*** to meet the demand of an increasing population and expanding industry which will lead to increased air pollution – emissions of SO_2 and NOx

and particulate matter. The latter, as well as ash and fly ash, may contain mercury, lead, cadmium, toxic heavy metals, arsenic, and other harmful elements and compounds. The substances are particularly harmful to human health and can also pollute surface water, fish habitats (depleting fish diversity) and lead to consumption of fish containing levels of these substances which are dangerous for humans (IUCN 2014). Coal-fired power plant(s) will lead to large emissions of CO_2.

- Continued ***reduction in freshwater flows*** through the river system (if there is inadequate investment in water management) which will lead to increased salinity in the lower reaches of the distributary rivers in the Sundarbans and result in loss of floral and faunal habitats and impaired rejuvenation of important other plant species (e.g. *Heriterea fomes*).
- Increased ***anthropogenic pressure***. Thousands of people in the areas surrounding the Sundarbans and ECAs are highly dependent on the ecosystem services that these are as provide for their livelihoods. Increasing population growth and density will increase the demand to access these ecosystem services, particularly if alternative livelihood opportunities do not become available by the effective implementation of appropriate development policies. Furthermore, there will be an increasing demand for residential and agricultural expansion, infrastructural development and industrialisation in the ECAs and adjacent areas. All of these factors will increase the pressure on the protected areas. In addition, illegal activities such as cutting of trees and poaching will be likely to increase if there is inadequate forest protection/management and poor implementation of co-management (particularly if there is inadequate budget provision for management).
- ***Ships and boats***. Increased disturbance to forest wild animals and riverine fauna due to noise and light (at night) from the increasing number of ships that can be expected with the expansion of Mongla port, as well from transporting coal to Rampal power plant and from tourism boats (e.g. shouting, loud music) and other vessels. The movement of ships and boats are expected to increase considerably after the Padma Bridge becomes operational – thus enabling increased transport of goods to Mongla port. Noise and the physical presence of vessels and visitors can distress and interrupt the natural behaviour of wildlife, disturbing prey-predator relationships, feeding and breeding. There is also a risk of pollution from fuel and oil leaks/spills from poorly maintained boats, accidents (which can never be totally eliminated) and discarded materials (e.g. polythene bags and bottles).
- ***Inappropriate fishing***. Excessive and indiscriminate harvesting of shrimp fry and wild fish larvae, use of illegal fishing gear, poison fishing and fishing during the 'ban' period[66], all of which will severely diminish wild fish populations, impact on breeding grounds and threaten fish and shrimp cultivation. There is a risk of continued, or even increased, poison fishing if there are no controls on the indiscriminate sale of pesticides around the Sundarbans without regard to the actual demand for agricultural purposes.
- ***Fish and shrimp ponds***. Pollution (antibiotics and inorganic fertilisers) from expanded production in fish and shrimp ponds is likely to be flushed into surrounding waters by tides and floods, increasing eutrophication – which can lead to algal growths which outcompete aquatic plants, and reducing available oxygen which can lead to mortality of fish and other aquatic fauna such as amphibians. In addition, there is a risk that of further acidification and salinization of soil through extensive shrimp farming - leading to further reductions in crop productivity.
- ***Invasive alien species (IAS):*** Water hyacinth (*Echhornia crassipes)* is the most important IAS found in the SW region. It is well established in rivers, beels, baors and ponds. But this species cannot survive in the Sundarbans due to salinity. It spreads over the surface and prevents sunlight and oxygen from reaching below. It also hampers crop production, fishing and the

[66] Currently three months, 01 June – 31 August for Sundarbans

water transport system. This species is likely to spread further in the region if serious efforts are not made to control it and ensure regular clearance. Using water hyacinth as a bio-fertiliser, as cattle feed, for making paper, decorative items and toys, and for seeds beds will only partially control its spread. Poorly maintained ponds could result in the spread of this IAS as well as the spread of alien fish species that could displace (outcompete) native fish species.

Sedimentation of water courses: If there is inadequate dredging of rivers, there will be a risk that the sedimentation of river beds will continue - particularly in channels confined by polder embankments, where there will be a reduction of deposition on the forest floor. The northern boundary of the Sundarbans is marked by small rivers and narrow channels which have already been considerably sedimented. The process of sedimentation gradually raises the riverbeds and can lead to overtooping during tidal inflows and inundation of the forest floor. This can lead to a loss of mangroves and change of floristic composition, with mangroves replaced by 'mainland' tree species (e.g. Rain tree (*Samania saman*) and Karoi (*Albegia spp*.)). Such changes in these northern boundary areas of the Sundarbans will also make them vulnerable to encroachment. But timely dredging of the riverbed will increase the conveyance capacity of the river and mitigate the problem. Additionally, in shallow coastal waters, tidal asymmetry[67] developed in the tidal rivers can supply sediment to river reaches where there are depositional conditions. The reduction of adequate dry season flow in the distributaries of the SW region has enabled the tidal asymmetry to transport the sediment upstream.

8.1.2 Solid and Liquid Waste

The SW region already faces considerable challenges in managing solid and liquid waste from urban areas, industries, transport, the energy and other sectors. Despite there being waste collection and disposal systems[68], over half of daily generated waste in Khulna city is left discarded (Ahsan *et al.,* 2009) and waste in rural areas is mainly dumped in the open. The challenge will only increase as the government pursues development in these sectors and as the population increases.

The main risks regarding solid waste will be due to poor management (e.g. inadequate collection and removal to disposal sites) and inadequate treatment and recycling (see section 3.2.4). Solid waste is generated from many sources, including: street sweepings (including dead animals); pumped sludge from septic tanks and cesspits; refuse collected from residential establishments, commercial enterprises, and institutions; pharmaceutical and surgical wastes [69] from medical clinics and hospitals; refuse and processing wastes from industrial manufacturing facilities; and waste from livestock, especially poultry (particularly broiler excrement), containing organic and inorganic nutrients and pathogens. Solid waste

[67] Discrepancies in the. duration of the falling and rising tides of water elevation.

[68] In Khulna, waste deposited in community bins and secondary disposal sites (SDS) by citizens, community-based organizations or NGOs through their door-to-door collection systems, is collected by the City Corporation and sorted for recycling (9.1%), composting (4.4%) and landfilling (86.5%). Waste destined for landfilling is transported to the final disposal site in Rajbandh. In other municipal areas of the region, there are mixed approaches to solid waste management, with some collection systems and transfer to dump sites/landfills, an integrated landfill and resource recovery centre in Jessore District. But there is no systematic waste management system in the rural areas where waste is dumped indiscriminately in the open, and/or burned, or discarded into water bodies or landfills, and also disposed directly onto agricultural land. However, a significant amount of waste generated from domestic animals, especially cow dung, is used as manure and for fuel. In addition, household kitchen waste and feedstuff waste is used to generate biogas and produce electricity.

[69] Including face masks. Globally, due to COVID-19, there has been a massive increase in the use of face masks. A large number of face masks are ending up in landfills or are just being discarded, presenting both an environmental and health hazard. If such medical waste finds it way into waterways, it will be washed downstream and eventually will enter the ocean. As it breaks down will be consumed by marine wildlife. Face masks have already been detected washed up on coral reefs, e.g. in the Philippines. In Bangladesh, the use of face masks in publicly-owned places and offices has been made compulsory, but they are very little used in markets and not in rural areas. There is no evidence yet that this is a problem in the SW region, but it may become one as the pandemic continues and could lead to problems in the Sundarbans and offshore.

can contain putrescible organic matter (e.g. kitchen and market wastes, faecal matter, septage); combustible organic matter (e.g. paper, textiles and bone); and plastics, metals, glass, oil and grease, and inerts (e.g. soil and ash) (World Bank, 1991).

Overall, plastic waste management in the region is poor, largely due to inadequate facilities and infrastructure, and insufficient budget for waste management. The situation is likely to get worse with a large increase in discarded plastic containers and packaging unless there are major improvements in the collection, grading and separation of plastic waste, recycling and the extraction of dyes, fillers and other additives.

Solid waste left uncollected or dumped in the open in residential and industrial areas or dumped in or close to waterways can cause considerable problems. It can contain pathogenic microorganisms (e.g. bacteria and parasites) and toxic chemicals (e.g. pesticides, heavy metals, volatile organics and solvents) which can contaminate soil and seep into groundwater or be blown in dust. There is a considerable risk to public health and domestic animals and the potential for spread of disease and chemical contaminants through the food chain. Solid waste also leads to windblown litter and clogs sewers and open drains, encroaches on roadways, diminishes landscape aesthetics, and causes unpleasant odours and irritating dust.

Waste collection and disposal workers can be at risk where they have inadequate equipment or facilities (e.g. gloves, boots, masks, uniforms and changing/washing facilities). Biodegradation of openly dumped waste can generate gases which may include toxic and potentially carcinogenic volatile organics (e.g. benzene and vinyl chloride), as well as methane, hydrogen sulphide and carbon dioxide. Smoke from burning wastes at open dumps is a major respiratory irritant and can cause affected populations to have a much increased susceptibility to respiratory illness.

Where solid waste landfills and disposal sites are poorly designed, there can be seepage (leachate) containing pathogenic microorganisms, heavy metals, salts and chlorinated hydrocarbons, fine particulates and dissolved solids which can pass through the soil beneath and enter groundwater. Surface water can be contaminated by surface runoff directly from solid waste deposits.

Liquid waste covers several different waste products, including wastewater, oil, grease, sludge or hazardous household or industrial chemicals. Such wastes can be produced by residential, commercial and industrial areas and may be treated by either a mains sewage system or an alternative such a septic tank.

There is a major risk of pollution where liquid waste is improperly handled. Surface water will be polluted if liquid waste is released untreated to contaminate a water supply, changing its chemical composition, causing a major hazard to human and animal health and disrupting aquatic ecosystems. Liquid waste can also contaminate soil if it disposed improperly allowing chemicals to infiltrate, disrupt plant growth and enter the food chain - harming humans and animals that eat contaminated products.

Poorly handled solid waste (for example incineration when another method would have been suitable) can generate fumes which contribute to greenhouse gases.

The direct impacts of poorly managed solid and liquid waste will be concentrated in industrial and more densely populated (mainly urban) areas.

New coal-fired power plants will become an additional source of solid waste which will require careful treatment to minimize risk to the environment.

8.1.3 Pollution

The main sources of pollution (particularly air, land and water) in the region are industry, transport (including port activities – particularly at Mongla - and navigation in water channels), the power and energy sector, rapid and unplanned urbanisation (especially in Khulna, Bagerhat and Satkhira districts), agriculture and fisheries (particularly shrimp cultivation). With considerable expansion in the first three of these sectors, an increase in the extent of urban areas due to organic growth and population increase,

and projected increased production in agriculture and fisheries, there is a considerable risk of increased pollution levels.

This will particularly arise if there is:

- Inadequate adoption of pollution control measures (e.g. treatment of increasing industrial and municipal water-based discharges or air emission reduction measures in the energy and industry sectors), and inadequate investment in clean technologies;
- Poor enforcement of regulations and monitoring for transporting industrial raw materials by water, rail and road; and poor rate of convictions for pollution-related crimes;
- Inadequate investment in municipal and industrial waste treatment; poor waste management in cities and other urban areas; inadequate control of the use and disposal of plastics;
- A high increase in road infrastructure and traffic (in both urban and rural areas) along with an ageing and inefficient (and thus more polluting) vehicle fleet; and traffic congestion (which increases emissions) due to poor urban planning;
- A large increase in and poor regulation of shipping (cargo and passenger vessels) and poorly managed landing facilities and cargoes; and establishment of ship-breaking yards in the region;
- No instant oil spill management system that follows international standards and includes compensation arrangements;
- Pollution from fish ponds (see section 9.1.2);
- Inadequate control of pesticide and fertiliser use, continued use of inorganic fertilisers and low uptake of integrated pest management;
- Inadequate investment in interventions to increase freshwater flows in the main rivers (e.g. dredging, flow enhancement infrastructure).

Air pollution

The main airborne pollutants are: (a) sulphur dioxide and nitrogen oxides - particularly from fossil fuel-fired power plants, industrial combustion (brick and cement kilns), vehicular combustion and agriculture; and (b) particulate matter (PM_{10} and $PM_{2.5}$) from residential cooking, agriculture, brick and cement plants, and industrial processes) - Bangladesh is considered one of the most polluted countries for $PM_{2.5}$ exposures.

Chapter 4 presents the results of modelling for air and water pollution in the SW region to 2031 and 2041. Of particular concern are the impacts of particulate matter ($PM_{2.5}$) and Nitrogen dioxide (NO_2) for which Mongla area is, and is predicted to remain, the most polluted part of the SW region, requiring the implementation of emission reduction measures. The modelling shows a field of already raised levels of PM and NO_2 in the baseline year (2019) in the Khulna area, moving south over time with the occurrence, by 2031 and 2041, of a field of more elevated PM and NO_2 concentrations (approximately 2,000 km^2) occupying a 30 km wide band (west to east) and 65 km long (north to south) - from Khulna to the Mongla area.

This has major significance for the health of vegetation in that zone as well as for human health in the vicinity of Mongla.

Air pollution by $PM_{2.5}$, (both ambient and indoor) is by far the most significant environmental risk, causing about 21% of all deaths in Bangladesh. Studies since 2014 at several sites in the SW region show that concentrations of $PM_{2.5}$ and PM_{10} already significantly exceed national standards[70]. Increased pollution by

[70] For a note on international standards, see Annex 9.

particulate matter will lead to an increased risk of respiratory and coronary diseases (e.g. chronic obstructive pulmonary disease (COPD), heart attacks and strokes) and lung cancer.

Concerns have been raised that air pollution, particularly as a result of the construction of the new Rampal coal-fired power plant, presents a major current or near-future challenge to the outstanding universal value of the Sundarbans. However, as noted in section 3.7.1 of the Final Scoping Report (January 2021), available data indicates that additional air pollution by dust, sulphur dioxide and nitrogen oxides from the Rampal power plant is not expected to have high impact on Sundarbans as this plant is being equipped with modern emission reduction technologies. However, this plant and the newly constructed Rupsha gas-based combined cycle power plant and upcoming Goalpara duel fuel combined cycle power plant will emit considerable amounts of CO_2 (see section 3.3.1 of the Final Scoping Report (January 2021) for details).

The north-western regions of India, neighbouring West Bengal and Nepal are the most probable transboundary sources of particulate matter pollution likely to affect the SW region of Bangladesh – a matter of considerable concern. Prevailing wind direction in November to January suggests that this period is likely to be when the highest concentration of fine particles from these sources will reach Bangladesh. In West-Bengal (India), there are 15 coal-fired power plants with total installed capacity of 12 750 MW[71].

Water pollution

Water pollution (including chemicals, fuels, oil and grease, and heavy metals) from industries in the SW region is found in both the lacustrine (standing) water bodies and flowing river systems. The most common heavy metal pollutants found in the Sundarbans mangrove ecosystem include cadmium, chromium, copper, nickel, lead, mercury and arsenic (Ahmed *et al*., 2002).

Mercury and cadmium are of greatest concern for living organisms (accumulating in the food chain), including mangrove wetland species which concentrate heavy metals in their tissues, affecting their health. Heavy metals are carried in the drainage waters of the River Ganges and its distributaries and could derive from a mix of sources, both within and beyond the borders of Bangladesh. They accumulate in sediments over time. High concentrations of heavy metals have been found in water and sediment and some macro benthos in the Sundarbans mangroves (Rahman *et al.*, 2009). There is a risk that heavy metal concentration in coastal areas is likely to rise with the proposed expansion of industrial activities in the SW region (particularly where inadequate treatment and recycling measures are not in place or are poorly managed and/or maintained) and from continued and increasing industrial activity in upstream countries. Such an increase will lead to a greater risk to marine life. Similarly, industrial expansion is likely to lead to an increase in other water-borne pollutants without adequate mitigation measures and good management/regulation.

A major portion of the oil imported to Bangladesh through the SW region is transported by lighters from the outer anchorage and to inland areas by smaller tankers. A certain portion of the oil leaks into the sea. There have been numerous incidents of oil pollution, including major accidents (which can never be totally eliminated). The expansion of Mongla port and intention to increase trade as well as transportation of coal for Rampal power plant will lead to a large increase in shipping which will increase the risk of pollution in the riverine ecosystem, e.g. from the discharge of ballast and bilge water, oil spills[72] and waste thrown overboard, and escapes following collisions between vessels. This, in turn, will affect the economic output of the region that relies partly on aquaculture. For instance, high levels of metals may affect reproductive capabilities of fauna or contaminate fish making them unfit for human consumption (posing risks of developing cancer, suffering kidney failure or various forms of metal poisoning). There is also a possibility that fish will migrate away from toxic areas and threaten the livelihoods of fishermen. In addition, it is likely

[71] https://en.wikipedia.org/wiki/List_of_power_stations_in_West_Bengal

[72] Oil contamination changes river water quality and leads to decreased productivity and decreased abundance of phytoplankton and zooplankton, and can lead to a depletion of fisheries resources.

that there will be an increase in indiscriminate discharging of bilge water (oil and grease mixed water) by mechanized boats (particularly during seasonal fishing at sea) if they are not regulated effectively.

Shrimp farming is increasingly accompanied by excessive feeding, the presence of high biomass due to high stocking density, the application of drugs, antibiotics and chemicals, and the production of effluents, all of which pollute the polders and adjacent rivers and canals - especially in Satkhira, Bagerhat and Khulna Districts. Government policy to encourage increased production from shrimp farms will lead to a considerable increase in such pollution.

Similarly, the policy to increase agricultural production will mean an increase in applications of agro-chemicals (nitrate and phosphate fertilisers, pesticides, fungicides and herbicides – some of which are toxic to fauna and can also accumulate in food chains), particularly in the cultivation of paddy rice and mixed vegetables. Residues of these chemicals will increasingly be flushed into surface water bodies. Accumulation of excess fertilisers and discharges of sewage into water bodies can result in eutrophication, causing algal blooms, reducing oxygen levels which can lead to deaths of fish and other aquatic animals, obstruct the growth of mangrove pneumatophores, and ultimately hinder seedling growth.

Surface, brackish and sea waters will receive increasing amounts of pollutants from the above sources that may pose a threat to the riverine ecosystems and biodiversity. The risk in the dry season will increase if there is insufficient freshwater flowing through rivers as a result of inadequate water flow interventions (eg. dredging and diversion structures).

Groundwater in certain areas of the SW region is naturally contaminated by arsenic (on average, in the range of <50 µg/L to 200 µg/L), exceeding the recommended WHO allowable limit (≤10 µg/L) and the Bangladesh standard for drinking water quality (≤50 µg/L[73]). Concentration will not be affected by development activities. However, where tube wells (particularly in inland and rural areas) penetrate into contaminated groundwater, there is a risk to human health.

The results of modelling of water pollution in the SW region to 2031 and 2041 are presented in Chapter 4. Levels of surface water pollution by nitrates are not a serious problem at present (based on international standards, rivers can be considered moderately polluted), and the modelling does not indicate any substantial increase in pollution up to 2041. While observed actual concentrations of phosphates during the wet season in the baseline year (2019) often exceeded the national standard, modelling shows that the standard should not be exceeded in 2031 and 2041. Both current and modelled (2031 and 2041) concentrations of phosphates in segments of rivers within the Sundarbans are (except at Harbaria) lower than those in the rest of the SW region,

Noise pollution

Noise levels across the SW region will increase considerably and progressively over the next 20 years as a result of the combined effects of a range of changes including, for example:

- Major expansion of industrial operations (e.g. in economic zones and urban centres);
- Improvements in and expansion of the road network;
- Projected increase in numbers of motorized vehicles on the roads (particularly lorries servicing industries and carrying cargo (for import or export) and materials and products) – including as a consequence of the expansion of the communication network following completion of the Padma bridge;
- Increased train lines and number of trains in operation;

[73] µg/L= Micrograms per Liter

- Increased numbers of ships, motorized trawlers and fishing boats, and tourist launches (particularly in the winter months) on the estuarine rivers and transporting materials and people from deep in the Sundarbans to Khulna and other cities. The expected increase in shipping will increase ambient riverine and ocean noise levels (above and below the water surface) which could affect riverine and marine mammals;
- Increased amount of construction works;
- Operation of a new airport near Mongla;
- Increased recreational activities.

Noise can disturb wildlife communication, behaviour, food and reproduction (engine noise, music and shouting) and is detrimental to human health and wellbeing for communities residing along the riverine system.

8.1.4 Climate Change and Disasters

Although variability in climatic patterns is a natural occurrence (e.g. ice ages, warmer/cooler and wetter/drier periods over millennia), the evidence is now clear that there has been considerable human-induced global warming and climate change since the industrial revolution in the 1700s and 1800s – driven mainly by exponential increases in the release of greenhouse gases from burning fossil fuels.

Updated climate change scenarios developed by CEGIS (2020) for the second phase of the Bangladesh Delta Plan 2100 suggest a rise of 1.4 – 2.3^{0}C in maximum temperature and a rise of 2.1 - 3.6°C in minimum temperature by the 2080s in the SW region. Models prepared by the Asian Development Bank suggest that the average temperature in Bangladesh could rise by between 2°C and 4°C by 2050 under different scenarios (ADB 2014) which would cause considerable damage and losses to the economy – depressing GDP by about 2% (MoEFCC, 2018). Modelling by Rahaman (2019) predicts 11% and 15% increase in annual rainfall, 1.3°C and 2.5°C increase in maximum temperature and 1.6°C and 3.1°C increase in minimum temperature by the end of century under RCP4.5 and RCP8.5 scenarios, respectively. Other models predict different ranges of anomalies with a wide range of uncertainties, but generally indicate high chances of a rise in temperature and increased rainfall variability.

IPCC (2013) predicts mean sea level rise between 0.2 and 1m for low to high emission scenarios by 2100 for the Bay of Bengal.

Momentum for such changes is now 'inbuilt' in the global climatic system and government PPPs and planned developments in the SW region will not directly make any difference in preventing medium-term changes. Whilst the proportional contribution of Bangladesh to the causes of climate change is almost negligible compared to those of major economies such as China and the USA, all countries need to collaborate in combatting the challenge of climate change by adopting appropriate policies and commitments. In this regard, Bangladesh is already moving away from coal as an energy source to less carbon-intensive fossil fuels (e.g. natural gas and LPG) as well as renewables.

Consequences of climate change

Climate change will place Bangladesh at ***increased risk of recurrent and intensive natural disasters*** such as riverine floods, recurrent and flash floods, tropical cyclones and storm surges, droughts, salinity intrusion, sea level rise, and riverbank and coastal erosion. According to Dasgupta *et al*. (2013), the areas vulnerable to inundation depths more than 1m and 3m would be flooded 14 and 69% higher, respectively, in an extreme scenario than under the baseline scenario. 10-year-return period cyclones in the extreme scenario will be more intense by 2050 and will cover 43% of the vulnerable area of the country – a 17% increase on the current coverage. However, most of the SW region lies in the moribund delta which is less flooded than the current floodplain areas.

People living along the exposed coast, especially in Satkhira, Khulna, Bagerhat, Barguna, Patuakhali, Jhalkhati, Pirojpur and Barisal, are ***very vulnerable to sea level rise and surge flooding***. It is estimated

that nearly 7 million and 13 million people will be at risk in coastal zones alone (25,504 km^2) by 2025 and 2050, respectively, if the population growth continues at a rate of 1.4% (Karim and Mimura, 2008).

About 10% of the land area of the coastal belt of Bangladesh currently has salinity of 1 ppt, whilst 16% has 5 ppt salinity (IWM & CEGIS, 2007). By 2050, ***salinity levels are predicted to increase*** by up to 17.5% in the former areas and by up to 24% in the latter areas under extreme climate change scenarios. Increased salinity due to sea level rise will cause ***changes in the mangrove ecosystem*** (e.g. loss of less salt tolerant species and displacement of brackish water fish species) and may reduce the availability of many traditional medicines and food sources on which very many poor and rural people are dependent.

Brammer (2014b) suggests that the direct impacts of a rising sea-level will be to aggravate or accelerate some of the adverse effects of natural and human-induced environmental changes. For example, it will ***draw further inland the salt-water front*** in the western parts of the Ganges tidal floodplain, affecting river and soil salinity in the coastal area and increasing salinity levels particularly in the far SW aquifer. It will also further impede drainage from individual basins.

If monsoon rainfall increases by the predicted 11-15% (Rahaman, 2019), the frequency and severity of floods would be likely to increase and keep some basin land wet longer into the dry season than at present. Higher temperatures could reduce the suitability of the climate for wheat, potato and other temperate crops grown in the rabi season, but might benefit boro paddy. There has been no specific research on agricultural production and food security under climate change in the SW region. Rahman *et al.* (2017) examined the poor yield potential and crop failure in Bangladesh under the threat of a change of climate. They found that, if rainfall increases during the post-monsoon season but remains unchanged during other seasons, ***rice production, especially rain fed rice, will be at risk*** due to frequent droughts and decreasing diurnal temperature range. They suggest that stress-tolerant rice varieties requiring less irrigation water and able to survive at high temperatures should be introduced. Research on rescheduling crop calendar and cropping pattern will be necessary to mitigate the adverse climatic conditions.

Climate change ***might affect the production of tiger shrimp*** under alternating shrimp-rice and shrimp-only farming systems in the region (Ahmed and Diana, 2015):

- Coastal flooding due to elevated tide level and sea level rise might inundate shrimp farms and create prolonged waterlogging and pose an economic threat;
- Future intensified cyclones may increase the associated short-term decline in abundance of post larvae and stocking rate. This may affect shrimp harvests and cause economic loss;
- Increased salinity may lead to crop failure;
- Exceptional freshwater flooding may occur due to heavy rain in the upstream areas of the SW region and catchment of the Ganges basin, and due to lack of drainage infrastructure and high tidal flow.

Shahid (2012) predicts that rising temperature will ***elevate total power consumption and peak power demand***, especially during the pre-monsoon hot summer season, reduce power plant efficiency and transformer lifetime, and increase the transmission loss. More frequent and severe extreme weather events may cause more disruption in power generation and distribution, and more damage to power infrastructure. Lower river flow in the dry season may cause water scarcity in power plants and hamper generation. Increased salinity in river water due to sea level rise may lead to corrosion and leakages in power plants located in the coastal region.

Hossain et al. (2012) conclude that climate change will reduce availability and deteriorate quality of water for domestic use, and will increase the prevalence and infection of vector- and water-borne diseases such as malaria and dengue fever, cholera and dysentery, etc.

The ***economic costs of climate change*** are considerable. A World Bank Study (World Bank, 2009) estimated that, under the baseline scenario, the damages and losses stand at $4.6 billion from a single cyclone/storm surge of a ten-year return period. With climate change, the damages and losses are likely to

increase to $9.16 billion. Damages and losses due to tropical cyclones and storm surges that accounted for 0.3% of the GDP under the baseline scenario would rise to 0.6% of GDP in 2050.

Sector impacts

As indicated above, climate change is a phenomenon that is already set in train, although there is debate and uncertainty about the severity or extent of likely changes, particularly over the next 20 years. And there is nothing Bangladesh can do to prevent it. But there is a real need to take steps to adopt adaptation and mitigatory measures in order to reduce vulnerability to the impacts of climate change. The deeper assessment discussed in Chapter 7 (Table 7.2) shows that unplanned developments in several sectors (e.g. water, transport and urban) could undermine reducing vulnerability to climate change and natural disasters such as salinity intrusion, floods and storm surges.

If interventions to regulate freshwater flows (e.g. dredging and construction of diversion and water control structures) are inadequate or lacking, then dry season flows of freshwater through the distributary rivers will continue to be low allowing unrestricted and increasing (with sea level rise) saline intrusion, and there will be an increased risk of flooding.

Poorly planned roads will exacerbate localized flooding by impeding drainage, and poorly maintained embankments-cum-roads may fail during storm surges permitting flooding.

If climate change adaptation and mitigation measures (e.g. enhanced measures to protect the Sundarbans such as coastal afforestation and promotion/uptake of social forestry, alternative income generation livelihood activities for people dependent on natural resources) are inadequate, coastal areas and communities will be more vulnerable and at increased risk from storm surges and other natural disasters.

In urban areas, inadequately provision of embankments, poorly functioning warning systems and inadequate adoption of climate change adaptation measures would leave people at increasing risk from climate change and natural disasters.

8.1.5 Low and Excessive River Flows

A critical issue for the SW region is water flow in the distributary rivers of the Ganges that traverse the floodplains. Low levels of dry season flow have become a real problem. It is the result of human interventions such as upstream dams, diversions, water offtake (for domestic, industrial and irrigation use), bridges and embankments (causing restricted flow, cutting off inter-connected branches and creeks and leading to siltation), and natural morphological changes. On the other hand, excessive flooding due to high peak flows after heavy rain is also a concern in the monsoon season. These issues are discussed in Chapter 3 and in more detail in section 3.3.2 of the Final Scoping Report (January 2021).

The off-take of the Mathabhanga River has become closed and currently there is no supply of fresh water flow to the Sundarbans through this system. On the other hand, the Gorai River dries up during low-flow dry season periods, but it receives freshwater from Ganges River during the monsoon period and provides the main supply of freshwater flow in the region to the Sundarbans.

In the coastal areas, there is a zone of continuous transition between fresh water and open-sea salt water, and the ecology and land use pattern of the coastal areas is adapted to the normal movement of the saline front. However, the low dry season flows in the rivers means that there is reduced flushing of saline seawater towards the Bay of Bengal and salinity levels become elevated further upstream, particularly along the Passur-Rupsha-Nabagnaga-Gorai river system. There is a risk that continued low dry season flows will gradually lead to a change in the ecology of the Sundarbans, with mangrove and other species that are more tolerant of higher salinity levels displacing/replacing those that are less tolerant. Sundri (*Herteria fomes*) - the dominant mangrove species - has already been adversely affected. The excess salinity is likely to affect the diversity and abundance of fishery resources. The problem will be aggravated as a result of sea level rise. The greater levels of salinity will be an increasing concern for paddy rice production and cause already diminished yields to reduce further, even for more salt-tolerant varieties. They will also

present a challenge for industries (that require freshwater for their processes) and for domestic consumption.

Increasing salinity levels are a risk to public health. Salt intake by people in the coastal parts of the SW region already exceeds the recommended limit (1500 milligram/day), increasing risk of (pre)-eclampsia and gestational hypertension.

The power supply industry has also encountered problems due to increased salinity, with increased costs as a result of having to import fresh water for cooling.

Large parts of the country are subjected to freshwater flooding – to different depths - every year. The most affected parts of the SW region are to the north east of Khulna. It is a normal occurrence to which rural people have adapted their traditional settlements and agricultural practices. But abnormal and sometimes catastrophic floods (the result of particularly heavy rain – usually a combination of severe rainfall in Bangladesh and upstream in Nepal and India) occur every few years and cause damage to or destruction of crops and property. Areas in the south of the region are prone to tidal surge flooding, exacerbated by silted river beds and poorly maintained embankments (which sometimes fail) and poorly maintained drainage infrastructure in the polder areas (e.g. sluice gates/regulators).

If dredging programmes and investing in diversion infrastructure to increase dry season flows and water control infrastructure to regulate monsoon flows are not undertaken or are poorly planned and implemented, then the risks discussed above will continue or become worse.

8.1.6 Land Degradation

The main types of land degradation in the SW region are the erosion of river banks and water channels and increasing soil salinity.

River bank erosion and river course change is a natural phenomenon in few rivers in the active parts of the Ganges delta in the SW region, especially during rising and receding water levels (when flows are high) in the monsoon season. It can be due to a range of factors, e.g. stream bed lowering or infilling, flooding of bank soils followed by rapid drops in flow, redirection and acceleration of flow within channels, poor soil drainage, wave action, excessive sand/gravel extraction, and intense rain and flood waters. The Madhumati River is the most at risk, but erosion also occurs in the Shibsa, Passur, Baleshwar, Bhairab, Garai, Kholpetua, Kapotaksha (downstream), and Nabaganga (downstream) rivers. The width of these rivers has increased a little due to the continuous erosion. But none of the rivers has widened much since erosion has been balanced due to accretion.

Riverbank erosion is a natural hazard that adds a lot of sediment to the rivers that is deposited downstream (siltation) along their course and distributaries or is carried into the Bay of Bengal. The erosion destroys the socio-economic life of affected people, e.g. through loss of homes, croplands and infrastructure (e.g. roads and bridges). Important structures like schools, colleges, markets, hospitals and banks need to be replaced. The homeless and jobless suffer greatly. Many segments of narrow creeks have experienced severe bank erosion due to regular cargo movements between India and Bangladesh.

Bank erosion (with loss of mangroves) is a particular concern in the Sundarbans due to bow-waves from fast-moving ships. The increased number of ships expected to use an expanded Mongla port in the future is likely to lead to increase rates of such river bank erosion. The latter will also cause increased river bed siltation, contribute to the formation of new islands and result in changes in river courses as well as enabling increased sea water inflow in the SW region.

Storms and cyclones cause a considerable amount of coastal erosion and, through tidal surges, bring saline water onto a large area of farm land, destroying its fertility.

Increasing soil salinity is another form of land degradation in the SW region, causing considerable reductions in agricultural productivity (particularly paddy rice). Its causes are discussed in sections 8.1.4.1 and 8.1.5.

Rates of river bank erosion and levels of soil salinity are likely to increase considerably if programmes to regulate/control water flows in peak flow periods, dredge rivers and construct diversion infrastructure to increase dry season flows are not pursued or are poorly planned and inadequately implemented. New power generation facilities that are dependent on freshwater abstraction for cooling purposes will further deplete dry season water flows and cause increased salinity levels.

8.1.7 Loss of Agricultural Land

Over the last half-century, coastal land uses of Bangladesh have gone through major changes. Since the 1950s natural disasters like cyclones and tidal flooding, salinity intrusion, large-scale polderization, and intensive shrimp farming have changed the whole coastal area of the SW region. Some of the agricultural lands have also been converted to forestry to increase incomes. These factors have induced considerable impacts on agriculture, crop production, food and water supply, and livelihoods of the coastal community.

Urban and industrial expansion are the main reasons for the loss of agricultural land in the SW region. The amount of land under urban areas and industrial use expanded by about 6% per year between 1976 and 2010 (Hasan *et a*l., 2013). This is now the major cause of loss of agricultural land. Apart from such conversion, the most important form of land use change in the SW region has been the conversion in recent decades of agricultural land to shrimp farms and aquaculture ponds – enabled by extensive polderisation, mainly in Bagerhat, Satkhira, and Khulna Districts. Shrimp cultivation areas and pond aquaculture areas are shown in Figure 3.10 and now extend over 2,292 km^2 (11% of the region). Analysis by CEGIS (2020) shows that agricultural crop land reduced by 7.5% between 2000 and 2019, whilst shrimp cultivation and fish farming increased by 6.8%.

The negative impacts of shrimp farming have become apparent over the years. They include restricting rice production in favour of high-value shrimps, increased soil salinity which has severely reduced crop productivity and aggravated a potable water crisis, changed cultivation practices, a major reduction in the amount of available land (already in short supply) for the increasing population (most of who live in rural areas and are dependent on the land for their livelihoods), decreased employment and reduced incomes for rural people, increased marginalisation of poor and landless people, and migration to urban areas.

Government policy (National Shrimp Policy 2014, Second Perspectives Plan, 2021-2041) is to increase shrimp production and intensity of aquaculture. This will make these activities much more profitable and is likely to encourage more investment in shrimp farming, with considerably more land converted from agriculture (exacerbating the impacts mentioned above) – especially if there is inadequate implementation of land zoning to demarcate and fix the areas allowed for shrimp cultivation, with enforcement of associated legal and regulatory measures.

8.2 Socio-economic Impacts

Government social and economic policies are, by design, aimed to deliver benefits and improvements for the growing population of Bangladesh. However, there are risks of not achieving these outcomes, and indeed a risk of a deterioration in socio-economic conditions, if the necessary support measures, investments, controls and regulations are not fully and effectively implemented.

8.2.1 Impeded Economic Growth

It is a key government policy goal to greatly increase economic development and to diversify and increase economic growth (Second Perspectives Plan, 2021-2041), aiming to achieve upper middle income country (MIC) status by 2031 and high income country (HIC) by 2041. Economic growth is, of course, the engine that drives investment in all sectors by government as well as budgetary allocations.

The envisaged high economic growth will be achieved by, for example, major industrial and manufacturing expansion linked to increased exports, extended and improved transport networks (road, rail, water and air), further urban development, increased power generation (to meet the needs of industry and an

increasing population), new and improved infrastructure, and increased agricultural and aquaculture production.

All of these activities have potential environmental risks (as elaborated in the previous sections) if appropriate and necessary mitigatory measures are not fully implemented. But the envisaged socio-economic benefits of economic growth (and all that it will support/enable) are unlikely to be achieved:

- unless the required investments are made, either by government or investment partners (domestic or international);
- if there is poor competitiveness in Bangladesh compared to other countries as a result of a failure to develop the necessary skills and provide for the required training or support services needed for industrial development;
- or if efforts to diversify the economy do not materialize.

Indeed, if these requirements are not met, then the goal of increasing economic growth and employment is likely to be greatly impeded.

Other possible impediments to economic growth include:

- Poor maintenance and continued under-development (in some areas) of the transport network would restrict the connectivity required for economic development.
- If there is poor processing and hygiene and/or contamination in food processing plants from outside sources (e.g. pollutants and microbial infections), this could lead to products being banned in international markets, undermining exports.
- A continued lack of sufficient and good quality water will undermine key productive sectors.
- Continued poorly planned and ad hoc urban development will limit the efficiency of economic activities.
- If power generation to meet the needs of industry and the growing population is inadequate, then productivity will decline.
- Climate change (an uncontrollable 'external' factor) is likely to lead to increased salinity and flooding, increased pest problems, and reduce agricultural productivity – which will have a depressive effect on economic growth.
- Tourism is a minor contributor to the economy but that contribution is likely to be undermined if there is an increase in leakage linked to 'high-end' foreign tourism (i.e. a major proportion of fees are likely to accrue to overseas tourist operators rather than to Bangladesh). The benefits to local communities of tourism will not be realized if measures are not implemented to enable their prominent involvement. Weak local participation in the value chain would mean inadequate capture of the multiplier effects of tourism.

8.2.2 Impeded Employment and Livelihood Opportunities

The Bangladesh Bureau of Statistics (BBS) categorises livelihoods within three broad groups: agriculture (including fishing and forestry), industry and service (including salaried jobs). Many people fall within marginal livelihood groups (forest extractors (*bawals, mouals*), farmers, fisherman, dry fishers and fry collectors, fish nursery raisers) and wage labourers who mostly work for others and do not have work all year round. They do not have cultivable land other than homesteads and an increasing number are becoming landless.

The enhancement of opportunities for employment and creation of new and improved livelihood opportunities will be closely dependent on increased economic growth and diversification, and all of the investments and developments in different sectors that are likely to flow from growth and diversification; and, in turn, any failure to achieve economic growth or any economic downturn will, respectively, limit or undermine new employment and livelihood opportunities.

The deeper assessment reported in Chapter 7 (see Table 7.2) shows that a major impediment to achieving improved employment opportunities is likely to be if there are insufficient supplies of good quality water which will limit economic growth. Increasing salinity (due to sea level rise and reduced freshwater flows) and pollution will be the main drivers of worsening water quality, combined with high arsenic levels in groundwater in certain areas (a serious health hazard that will undermine ability to work and productivity).

In the fisheries sector, there is likely to be a slight reduction in jobs if climate change results in a stagnation or decline in production (as a result of temperature changes, changed freshwater water flows), or if there are inadequate investments or subsidies in technologies and varieties.

Loss of agricultural land due mainly to conversion to shrimp farming and aquaculture, industrial expansion and transport network developments and improvements, and increased farm mechanization will lead to change in available job types.

Inadequate investment and incentives in the forestry sector could lead to a reduction in forestry-related activities (e.g. logging, sawmilling, timber production, plantations, nurseries, silvicultural operations, non-wood forest product collection and forest-related industries) – all resulting in job losses.

Continued ad hoc and poor urban planning would have negative impacts on the efficiency of economic activities (e.g. by restricting traffic flows, resulting in poor access to facilities and services, impeding law enforcement, limiting the availability of land for business, and perpetuating poor communication infrastructure) - thus leading to inadequate job opportunities for the growing population.

There would also be fewer job opportunities in the power and energy sector if there is contraction in energy distribution businesses (e.g. LPG).

A failure to adequately market tourism opportunities in the SW region would limit growth in jobs in this sector, and failure to capture the multiplier effect of tourism would mean limited job opportunities in other sectors.

8.2.3 Poor Health and Sanitation

Human health in Bangladesh is at a risk from a wide array of challenges, e.g.

- Increase and spread of diseases (communicable and non-communicable);
- Poor diet which leads to malnutrition;
- Increased pollution, e.g. from industries (e.g. chemicals), power and energy plants (e.g. particulates) transport (fuel and oil), urban discharges, inadequate sanitation, poorly managed and treated solid and liquid waste, etc;
- Inadequate and unsafe management of medical waste (e.g. infectious materials, sharps, pharmaceuticals, radioactive materials);
- Insufficient and poor water quality (including increasingly saline water and water contaminated with arsenic). Children and elderly people are particularly susceptible to water–borne, respiratory and saline-related skin diseases;
- Poverty and over-crowded settlements and living conditions which foster the spread of diseases;
- Inadequate and poorly maintained transport networks – particularly poor connectivity to rural communities, which impedes access to health services and facilities;
- Accidents in the work place, due to poorly maintained vehicles, and as a result of poorly enforced traffic regulations, etc;
- Reduced long-term availability (access) to medicinal plants and reduced availability of species that provide raw materials for medicines if, respectively, there is over-exploitation due to poor management and degradation of the Sundarbans;

- Inadequate control of wildlife trafficking (illegal trade in tigers, deer, birds, turtle, sharks, rays, etc.) also cause the spread of zoonotic diseases;
- Introduction and spread of communicable diseases by local and foreign tourists, and inappropriate interactions between tourists and local people (e.g. spreading STDs);
- Reluctance to consult physicians and inaccessibility of medical facilities due to economic and cultural factors. Poor village people still depend largely on traditional healing and practice self-medication using indigenous knowledge. Only where such treatment fails, do they consider to consult physicians for modern treatment. (Haque *et al*., 2018);
- Poor diet causes malnutrition.

Many of these challenges will only increase as the population grows. Health care services and facilities are provided mainly by government but are often inadequate or poorly managed, fragile and function poorly – especially in emergencies. There are also private services, but they are available only to those who can afford them. As a mainly government-funded service, improvements in the provision and delivery of health care is very much linked to the performance of the economy (governing budgetary allocations and investment in facilities and staff training etc.). So any factors which impede economic growth will have a negative impact on the nation's health. Equally, poor management and weak implementation/enforcement of environmental and social safeguard laws, policies, rules and regulations in individual sectors (which give rise to the challenges listed above) will have a negative impact on health.

Sanitation is intimately linked with public and domestic health. There remains only moderate access to sanitation (56%) with a high proportion of shared toilets particularly in urban slums and only about 60% people practicing hand washing with water and soap at critical times[74]. More than 40% of all latrines are still unimproved, and sanitation facilities for children with disabilities are still generally lacking. Conventional sewerage systems are absent in all urban areas in the SW region. The safe disposal of faecal matter generated in rural and urban areas remains a major challenge, despite Bangladesh having made considerable progress in eliminating the practice of open defecation.

Planning and service delivery of improved sanitation are often supply driven, and government agencies have overlapping functions and pay insufficient attention to operation and maintenance issues. As a consequence, waterborne diseases are widespread, which fuels rapid transmission of gastro-intestinal pathogens that can have disastrous impact on health and nutrition. Over 40% of improved water sources are contaminated with *E. coli*. Without increased investment in the provision of potable water supplies and sanitation facilities and improved managed of such facilities, then problems will persist and even deteriorate as the population grows.

8.2.4 Inadequate Education

The quality of primary schools is generally inadequate. CEGIS (2012) found that most primary schools in the area surrounding the Sundarbans are constructed with poor quality materials and lack furniture and equipment, most schools (of all types) lack electricity and many lack drinking water facilities, are dirty and unhygienic. There is a lack of qualified teachers.

In the rainy season, the roads become submerged and very muddy which makes it hazardous for students to travel to school. In addition, low income in rural areas often hinders school attendance. As a result, a large percentage of students (40%) stay away from school, repeat years and eventually drop out.

There is a risk that the poor transport network and inadequate performance in the transport sector will retard achieving improved access to education, will undermine attendance and exacerbate the drop-out

[74] https://www.unicef.org/bangladesh/en/better-access-safe-drinking-water/safer-sanitation-and-hygiene#:~:text=Access%20to%20sanitation%20remains%20moderate,said%20the%202013%20MICS%20survey.&text=The%20safe%20disposal%20of%20faecal,challenge%20by%20the%20Bangladesh%20government.

rate and limit skills development and training, e.g. if remote areas remain unconnected (i.e. lack of roads) and if the road network is poorly maintained so that access to education facilities is hindered.

As with health, the adequacy and quality of government-funded education provision and delivery is very much linked to the performance of the economy. Thus, the above problems will continue and probably deteriorate (as population grows) if there is inability or failure to invest adequately in education services (despite the private sector continuing to increase services).

8.2.5 Migration Problems

In the SW region, rural to urban migration (mainly men) is common. It is driven mainly by poverty caused by frequent cyclones, food insecurity, closure of industries (e.g. hardboard, newsprint and jute mills), scarcity of potable water (i.e due to increased salinity) and associated health risks and treatment costs. Migrants move to urban areas in search of employment and to seek a chance to remit money back home. But they often end up in over-crowded slums and squatter areas, particularly in Khulna City, placing increased pressure on amenities such as clean drinking water, hygiene services and health facilities (which are already severely lacking in such areas), and face risks (e.g. from diseases). Ultimately, they may end up in deeper poverty, although the incidence of poverty in urban areas is lower than in rural areas[75].

It is government policy to expand 'urban facilities' and industries in rural areas under the My Village My Town Programme - to provide job opportunities. But if this programme is inadequately implemented, migration is likely to continue or increase, especially because of the 'pull factor' of perceived urban-based industrial jobs. Furthermore, climate change, sea level rise, and the associated impacts of these trends may soon lead to further migration.

8.2.6 Gender Discrimination and Lack of Empowerment

The majority of women are involved in home management and activities such as raising cattle and poultry, vegetable production, gardening, post-harvest activities, agro-forestry and importantly, micro-credit schemes (particularly women from poor households) and income-raising and expenditure-saving activities. Women are increasingly becoming involved in the main labour force, notably in garment manufacturing. But they still tend to be paid less than men. Discrimination against women is deeply embedded in social and cultural norms: patriarchy that enables men to dominate women; and purdah that still restricts many women's engagement in economic activities outside of their homes.

Women and girls are disadvantaged by multiple gender-based inequalities, including: wage discrimination; limited mobility; limited decision-making authority within the household; risks of exploitation; abuse and violence; limited access to basic services and social and legal protections; and limited visibility in society.

Empowerment of women and improvement in gender equality will not happen, and indeed the situation might deteriorate, if there is no deliberative effort to overcome restrictive social norms and to purposefully enable their greater engagement in industrial activities and other sectors. Poor implementation of the Gender Policy limits opportunities for women to participate in tourism-related income-generating activities (cultural activities, crafts, hotel management, guiding, etc.). Equally, empowerment and improved gender equality will not be realized unless opportunities are fostered for them to assume managerial positions in key development sectors.

8.2.7 Social Exclusion of Landless and Marginal Land Owners

Landlessness in the SW region has resulted from river erosion, land fragmentation and land grabbing – particularly by outside powerful elites and investors in shrimp farming. Lack of employment and poverty

[75] The Household Income and Expenditure Survey 2016 (BBS, 2019) found that the incidence of poverty at the upper poverty line (CBN Method) was 26.4% and 18.9%, respectively, in rural and urban areas in Bangladesh.

due to the closure of certain industries (e.g. hardboard, newsprint and jute mills), as a consequence of poor management, has also contributed to landlessness The agricultural census showed that about 7% of households in Khulna Division are landless. Some landless people take to living on chars which puts them at risk from floods and storm surges.

Landless people and marginal land holders have limited opportunities to engage in and benefit from development activities in the region. They are largely dependent on working for others as labourers and are often exploited, and frequently do not have work the year round. Many face poverty, indebtedness and powerlessness, and are forced to migrate to urban centres (particularly Khulna City) to find livelihood opportunities, where they suffer worse poverty and risks (see section 8.2.5).

Unless there is a serious effort by government to effectively implement policies across all relevant sectors to provide livelihood and income-earning opportunities for the landless and marginal land owners, they will slide further into poverty and exploitation. One example of a positive government response to this issue is social forestry programmes under which it is a legal requirement to engage such people. The Forest Department is also promoting a co-management system to involve the landless and marginal land owners in forest management in the Sundarbans. This aims to enable them to better access forest resources on a sustainable basis to support their livelihood needs. But these programmes will not succeed or will be ineffective if they are inadequately implemented.

8.2.8 Conflicts Over Land

The main area of conflict over land in the SW region concerns land control and land transformation to shrimp farms. Farmers have been dispossessed, displaced and marginalised, made poor and landless, lost their livelihoods and faced unemployment, suffered health hazards (e.g. from increased salinity and lack of potable water). There have been numerous, contestations, court cases (many still unresolved) and demonstrations by anti-shrimp dissidents (see section 3.4.8 of the Final Scoping Report, January 2021). As long as these disputes between farmers and fishers remain unresolved and/or not diffused (whether by formal or informal processes), and if governance regarding land management is poor (inadequate legal provisions, ineffectively functioning courts), tensions will persist. There have also been conflicts over the implementation of social forestry on marginal lands - between social forestry practitioners and the government agencies controlling marginal land besides roads and railway lines and on embankments. Under the high growth scenario, demand for land is likely to increase which may lead to further conflicts.

8.2.9 Deterioration and Poor Management of Cultural and Natural Heritage Sites

Very limited budget is allocated to preserve, monitor and maintain archaeological and heritage sites, contributing to a decline in their aesthetic, historical and cultural value. Pollution from industry and power plants contributes to structural deterioration of buildings. If there is a continuation of this situation, then the sites will continue to deteriorate.

The main risk to World Heritage Sites (WHS) in the Sundarbans would be if policy-makers do not understand and recognise the values of ecosystem services provided by the Sundarbans (worth US $ 456 to 1194 per hectare per year according to IUCN 2014). This is likely to lead to:

- Inadequate budget provision and investment in the proper and effective management of the Sundarbans and particularly the WHS;
- Lack of coordination among agencies respnsible for sectors that cause impacts on the Sundarbans;
- Inadequate efforts to raise and maintain public awareness about the importance and outstanding value of the Sundarbans (including the WHS).

There is also a risk that the ecological integrity of the Sundarbans will change and ecosystem functioning will deteriorate if there is inadequate investment in measures to enhance dry season water flows in the distributary rivers that pass through the forests (e.g. dredging and diversion structures). Such flows are

necessary to prevent further increases in salinity which will have a serious adverse impact on the mangroves and the biodiversity they support.

Deterioration in cultural and natural heritage sites could adversesely impact on tourism – fewer visitors would be interested to journey to the SW region if the sites decline.

8.2.10 Reduced Agricultural and Fisheries Production, and Reduced Food Security

Millions of poor rural people in the SW region are peasant farmers who are totally dependent on agriculture, fishing and forest resources for their survival. But increased soil salinity has led to considerably reduced crop productivity.

The coastal areas have been subjected to extensive polderisation and conversion to shrimp farming. Extensive shrimp ponds (*ghers*) were constructed with saline water brought from surrounding rivers via canals. In the dry season, the salinity of brackish water in the rivers in the coastal areas in and around Satkhira, Khulna, and Bagerhat districts has increased. This is due to very low flows (the result of siltation and increased damming and offtake for irrigation and industrial/domestic use, and diversion of rivers in upstream countries) which allow saline seawater to carry further inland. Saline water has also been admitted to polders and shrimp ponds through:

- the breaching of embankments;
- illegally introducing pipes through embankments;
- due to poor management of outlet gates;
- via seepage through soils or embankments;
- when storm surges lead to embankment overtopping and inundation of polders.

These factors have all led to increased soil salinity. But the latter is also subject to seasonal variation. Top soil salinity gradually increases from January, reaches a maximum usually in April or May. It then starts to gradually decrease with the onset of monsoon and reaches the seasonal low usually in September or October when salts are sufficiently flushed out by monsoon rainfall. However, at some places, greater accumulation of salts has occurred due to a combination of the factors:

- Climate variability - irregular rainfall (less rainfall not being able to flush out salts in monsoon and forcing more irrigation in the dry season) (there is a major risk that climate change will make this an increasing problem);
- Groundwater salinity - accumulation of salts from capillary rise of the saline groundwater table;
- Tidal inundation in unprotected areas;
- Lateral seepage of saline water through soil/embankments.

With poor dry season surface water resources, groundwater is the primary source of irrigation water in many areas. However, shallow aquifers in most of the SW region are affected by different levels of salinity due to seawater intrusion and interaction with saline surface water. This has resulted in the extraction of groundwater from deeper aquifers using deep tube wells. Shallow aquifers in some parts of the SW region are also naturally contaminated with arsenic which poses a health risk when such water is imbibed, and particularly when bio-accumulated in crops following irrigation.

The result of soil salinization has been a considerable decline in agricultural productivity, particularly reduced yields of rice (the staple crop), undermining food security, particularly for poor people.

If there is deteriorating sufficiency of good quality water, due to continued, or even lower, dry season flows as a result of inadequate interventions to augment flows (e.g. dredging, diversion infrastructure), then there will be a considerable risk of further decline in agricultural productivity. This will affect food security and low dry season flows will also undermine key economic sectors (e.g. industry, power generation) and reduce the country's ability to import food to make up for production shortfalls. Agricultural land lost to

expanding industrial development, urban expansion and transport development will also undermine food production. And if the transport network is poorly maintained, this will limit access to agricultural and aquaculture inputs, whilst inadequacy in the availability of power will also undermine agricultural and fish production and processing.

Declining fish resources due to pollution, loss of habitat and spawning grounds and reduced opportunities to harvest fry (e.g. particularly if the Sundarbans is poorly managed) will directly reduce food security, but will also undermine the contribution of the fisheries sector to the economy which would limit food purchases and imports.

There is a considerable risk that climate change (changes in rainfall and temperatures) will affect agricultural productivity and undermine food security. Productivity would also be affected if subsidies are insufficient to allow the purchase of fertilisers and equipment.

8.2.11 Energy

As part of the government's response to the challenges of climate change, it is critical to both increase uptakes of renewable energy and increase efficiency in the production and consumption of energy.

The first of these goals will be undermined if there is inadequate investment in green technologies (low/zero carbon, low/zero air and water pollution, low waste), insufficient subsidies to promote change (from fossil fuels to renewables or from coal to gas), and/or poor maintenance of equipment. Continued use of wood in brick manufacturing kilns and inefficient cooking stoves will be likely to lead to over-exploitation of fuelwood.

Given the high levels of poverty in Bangladesh, it is essential to ensure that energy is affordable. For most rural households, there is a reliance on fuelwood (for cooking) derived from homestead plantations and through social forestry programmes. But if such programmes are inadequately promoted and/or managed, this will undermine the availability of affordable energy.

8.2.12 Poorly Managed Tourism

The environmental impacts associated with tourism are discussed in section 3.4.10. It puts pressure on water, land, air and ecosystems. Increasing tourism leads to an increased demand for fresh water - for personal use and to maintain facilities (hotels, swimming pools, etc.), decreasing the amount of water available to local people and increasing the generation of sewage and waste, and thus pollution. New tourism facilities can also result in land clearing and the conversion of agricultural land and wetlands, and disturbance to habitats (e.g. through fuelwood collection). But the main concern is the disturbance that tourism can cause to habitats and ecosystems. The transport of tourists (e.g. by boat both inside and outside in the Sundarbans) can cause considerable disturbance to wildlife (e.g. noise such as loud music and the physical presence of visitors can distress and interrupt the natural behaviour of wildlife, disturbing their hunting, feeding and breeding). Tourism can also be a vector for the spread of infectious diseases.

There is a risk that such problems will increase if tourist numbers grow and there is poor management of tourists and operators, and/or if the services and facilities provided by the tourism sector are inadequate and poorly managed. If tourist launches and forest and security patrol boats are not renewed and/or are poorly maintained, there is also a risk of pollution, excessive engine noise and disturbance.

8.2.13 Inadequate Connectivity and Access to Infrastructure, Services and Facilities

Economic and social development in the SW region and lifting large numbers of people out of poverty will be held back if there is inadequate connectivity – particularly between rural communities and development centres - so that they cannot access infrastructure and critical services and facilities (e.g. schools, hospitals, commercial centres, etc.).

Such connectivity will not improve if there is poor management and maintenance of transport infrastructure (particularly roads, railways and water transport). And the provision of infrastructural

development, services and facilities will be impeded if there is inadequate generation and distribution of power and energy.

8.2.14 Footprint of Transport Services

Transport infrastructure (roads, railways, airports, water-based transport) is associated with a wide range of potential negative impacts. A few examples include:

- Pollution (fuel and oil spills, airborne emissions);
- Noise and dust;
- Land acquisition and foreclosure of other land uses (particularly agricultural land);
- Displacement of people (homes);
- Interference with movement of livestock and residents;
- Destruction of cultural sites;
- Problems arising during construction (e.g. due to presence of non-resident workforce), maintenance, and traffic use;
- Accidents;
- Spills of hazardous materials during transport;
- Interference with customary transportation methods (e.g. animal-drawn vehicles);
- Inappropriate/improper disposal of dredged materials – which can affect the regeneration of trees and survival of existing forests as well as benthic aquatic biodiversity;
- Disturbance and injuries to aquatic organisms;
- River bank erosion and sedimentation;
- Leaks of stored chemicals and hazardous materials (at ports/airports, landing sites);
- Wastage of time and resources due to delays in transport services

Government policies and plans aim to optimize the footprint of existing and future transport services (which it aims to improve and expand). But if there is inadequate investment in these policies and plans, and poor implementation, management and maintenance, and weak enforcement of regulations, then there is a risk that many of the above concerns will arise, and cumulatively, they are likely to be significant. Inadequate generation and distribution of power and energy will impede the goal to optimize the footprint.

9. Cumulative Impacts of the High Growth Scenario

9.1 Introduction

Section 2.4.2 describes what cumulative impacts are and how they have been assessed using linkage diagrams.

The comparative tables of the deeper assessments undertaken for nine key sectors depicted in Tables 7.1 and 7.2) show in a 'crude' but illustrative way how positive and negative cumulative effects, respectively, will be likely to arise (and their likely level of significance[76]) as a result of the developments likely to be implemented under the high growth scenario.

This chapter provides linkage diagrams indicating the pathways through which particular types of impacts resulting from implementing the principal development activities under each key sector (Table 9.1 and Figures 9.1 – 9.13.) will become cumulative (eg pollution, deforestation, deteriorating health, migration).

Table 9.1: Principal Development Activities for Key Sectors

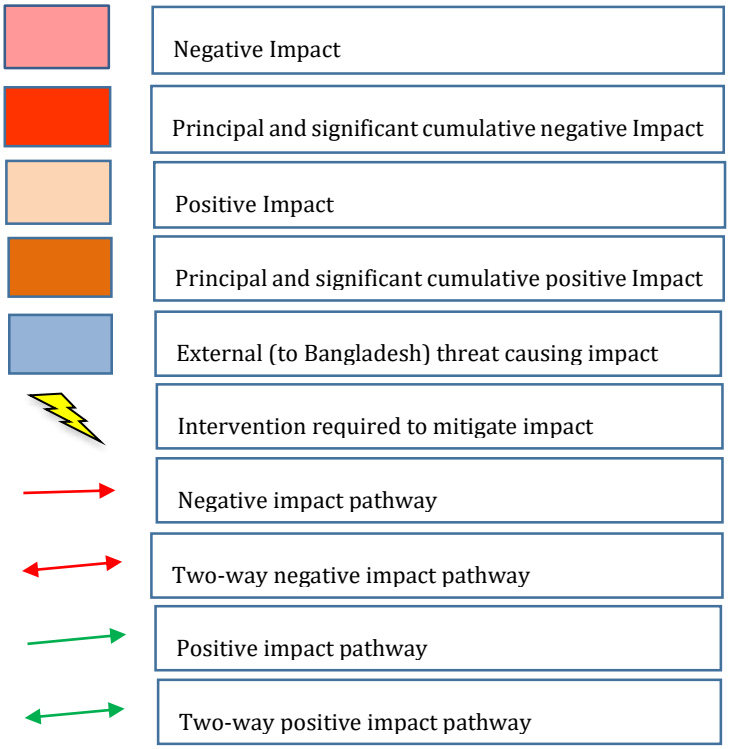
Sector	Key activities during 2021-2041	Linkage diagram
Industry	Rapidly expanding industrialization in an efficient way	Fig 9.1
Transport	Expansion and or upgrading of the road and rail network	Fig 9.2
	Upgrading, maintenance and re-instatement of the river transport network	Fig 9.3
Urban	Expansion and modernisation of cities and towns	Fig 9.4
Power and Energy	New or upgradation of power plants and transmission and distribution systems	Fig 9.5
	Technology investment for increased energy efficiency	Fig 9.6
Forestry	Conservation of Sundarbans forests	Fig 9.7
	Promotion of social forestry on homestead and marginal land in the SW region	Fig 9.8
Fisheries	Increased shrimp and fish production (capture and cultured)	Fig 9.9
Water	Dredging of rivers and construction of diversion structures (to enhance dry season flow and control floods)	Fig 9.10
Tourism	Development of eco-tourism inside Sundarbans	Fig 9.11
	Diversified tourism activities outside Sundarbans	Fig 9.12
Agriculture	Industrialisation of agriculture and increased production	Fig 9.13

9.2 Linkage Diagrams for Key Sectors

Linkage diagrams for the principal activities for key sectors are presented in Figure 9.1 – 9.13. Box 9.1 explains the colours, shading and symbols used in the figures.

[76] The higher the cumulative scores in the tables, the greater the likely cumulative impact.

Box 9.1: Explanation of Linkage Diagrams



Notes:

1. The darker shaded boxes in the diagrams indicate the principal and most significant cumulative impacts (dark green for positive impacts, dark red for negative impacts) that will occur where different impact pathways result in the same final outcome, thus increasing its intensity or significance. Other cumulative impacts arise along the pathways, but to a lower intensity or significance. The justification for a darker rather than light shade is not only determined by the number of arrows leading to the box, but also by expert opinion and a judgement of significance.

2. The yellow "lightening bolts" indicate where interventions are needed to avoid or reduce unintended consequences. In some cases, even positive impacts can inadvertently lead to unintended negative impacts. For example, an increase in industrial activities will generate economic growth but can also lead to an increase in pollution during construction and operations as well as increased emissions of greenhouse gases (see Figure 9.5).

3. The positive impacts of an activity can also result in mutually reinforcing positive feedback loops. For example, in Figure 9.2, where economic growth leads to more money being available for investment in social and physical infrastructure, that investment then creates further economic growth which, in turn can create more money for investment.

The SEMP begins the process of suggesting what is needed to address the lightening bolts shown in Figures 9.1 – 9.13, but it is expected that the proposed SEMP Coordinating Unit will build on these initial suggestions (see SEMP report).

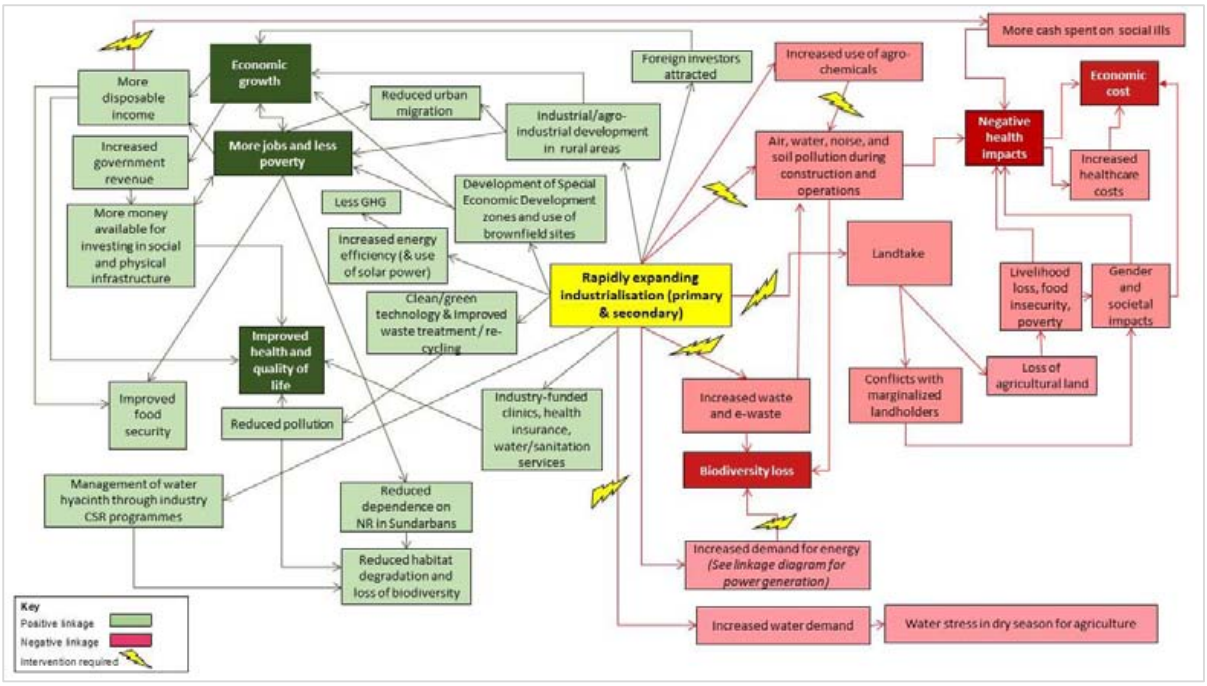


Figure 9.1: Industry: Rapidly Expanding Industrialisation

Main cumulative impacts
Positive: Economic growth; more jobs and less poverty; and improved health and quality of life;
Negative: Economic costs; negative health impacts; loss of biodiversity.

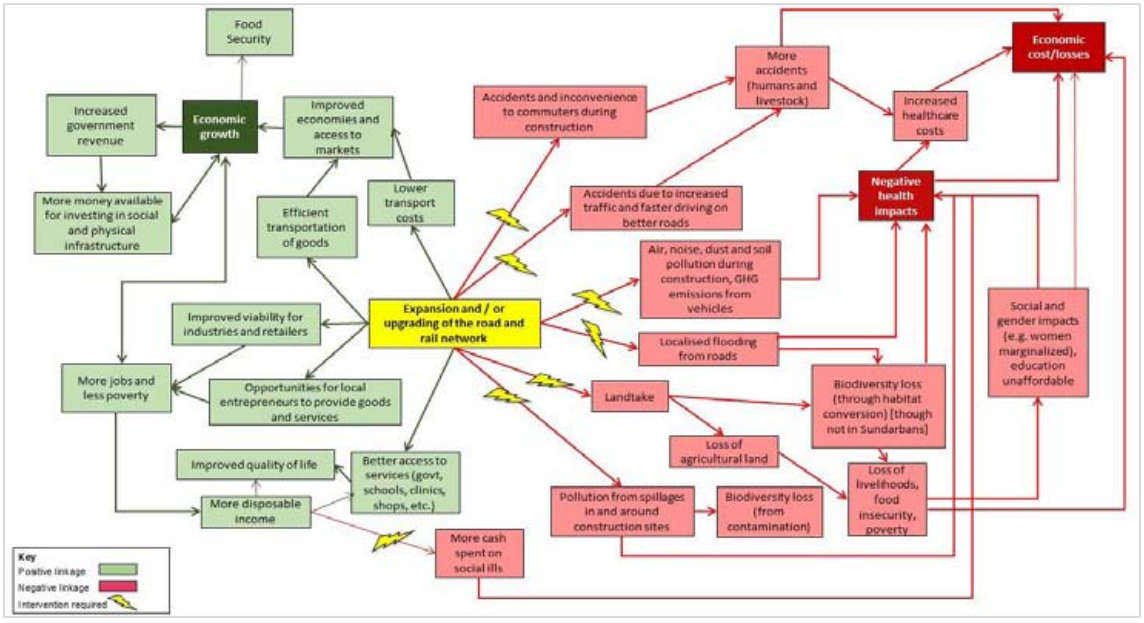


Figure 9.2: Transport: Expansion and /or Upgrading of the Road and Rail Network

Main cumulative impacts
Positive: Economic growth
Negative: Economic costs/losses; negative health impacts.

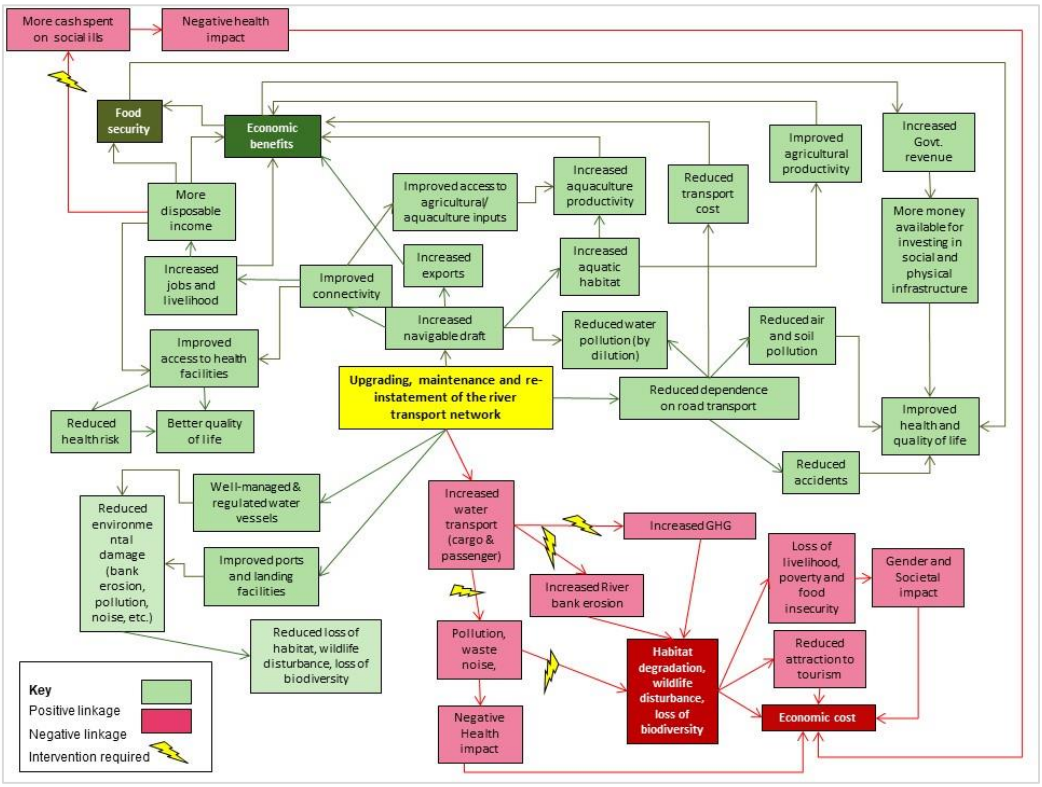


Figure 9.3: Transport: Upgrading, Maintenance and Re-instatement of the River Transport Network

Main cumulative impacts
Positive: Economic benefits; food security.
Negative: Economic costs; habitat degradation; wildlife disturbance and loss of biodiversity.

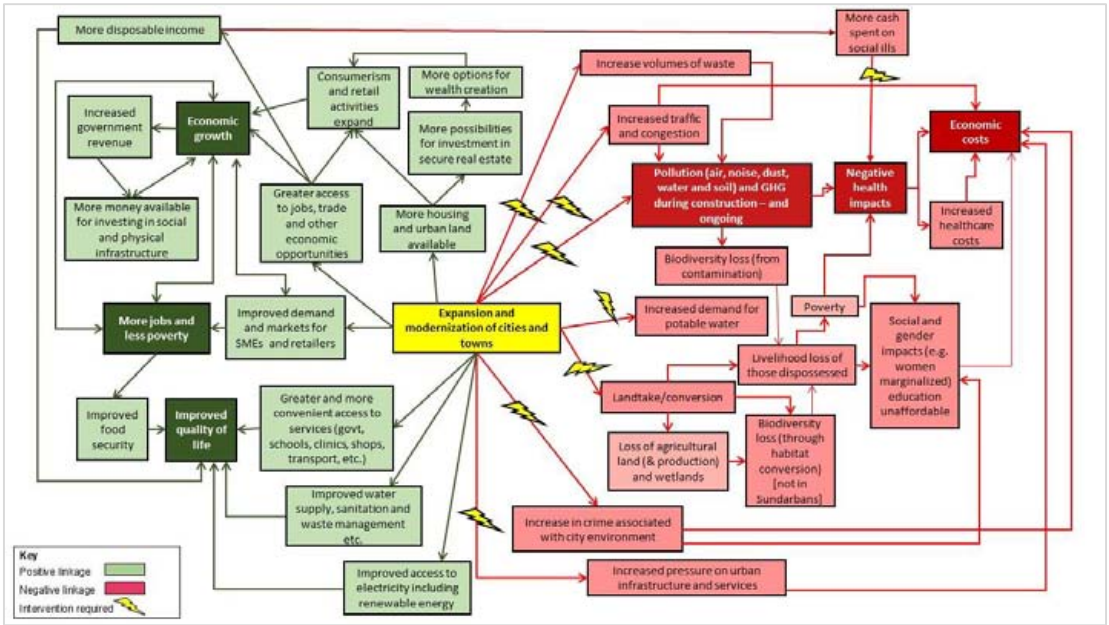


Figure 9.4: Urban: Expansion and Modernisation of Cities and Towns

Main cumulative impacts
Positive: Economic growth; more jobs and less poverty; and improved health and quality of life;
Negative: Economic costs; negative health impacts; pollution (air, noise, dust, water and soil) and greenhouse gases during construction and ongoing

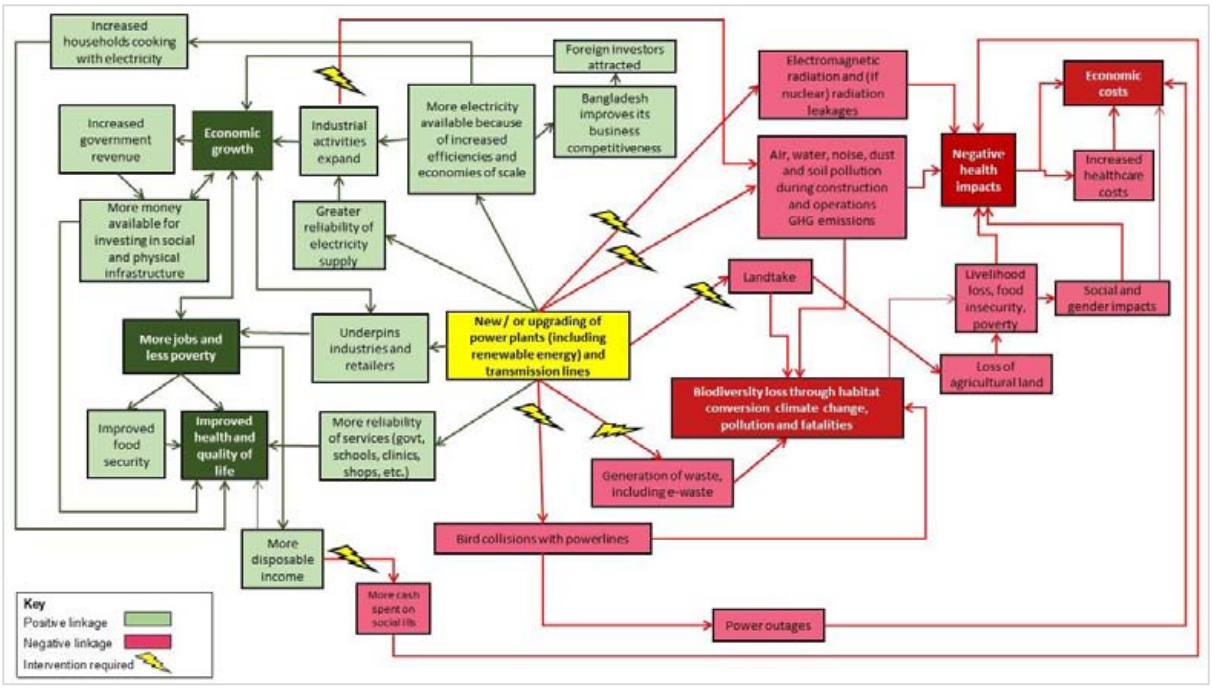


Figure 9.5: Power and Energy: New or Upgrading of Powerplants and Transmission Lines

Main cumulative impacts
Positive: Economic growth; more jobs and less poverty; and improved health and quality of life;
Negative: Economic costs, negative health impacts, loss of biodiversity through habitat conversion, climate change, pollution and fatalities.

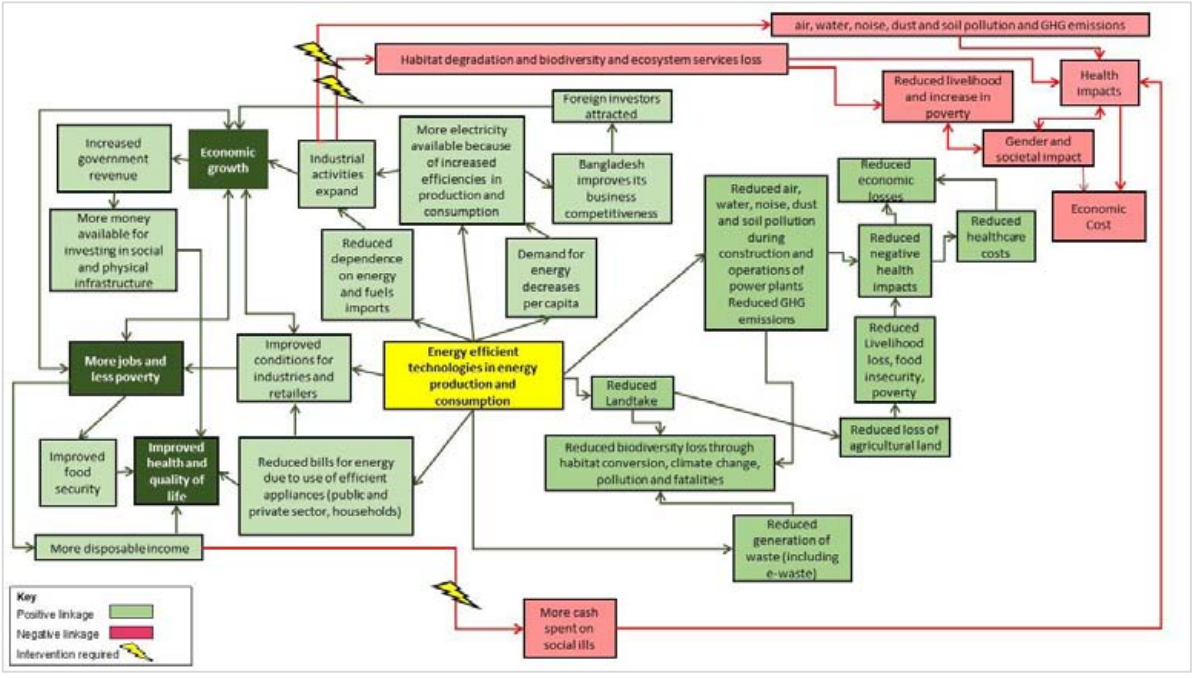


Figure 9.6: Power and Energy: Technology Investment for Increased Energy Efficiency

Main cumulative impacts
Positive: Economic growth; more jobs and less poverty; and improved health and quality of life;
Negative: None significant.

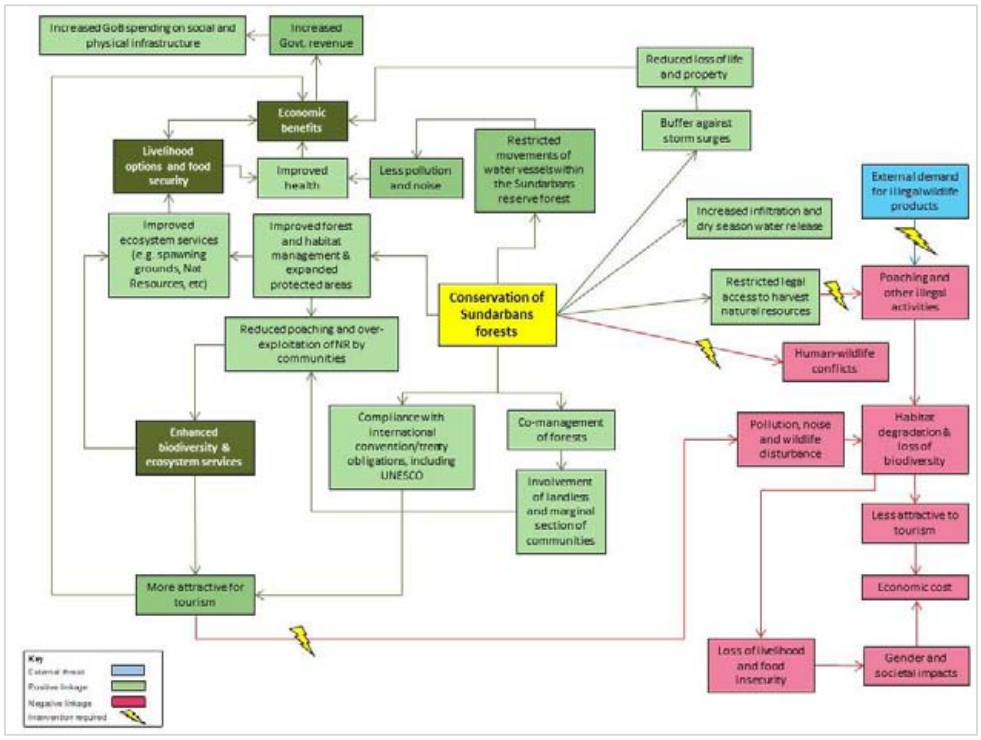


Figure 9.7: Forestry: Conservation of Sundarbans Forests

Main cumulative impacts
Positive: Economic benefits; livelihood options and food security; enhanced biodiversity and ecosystem services.
Negative: None significant.

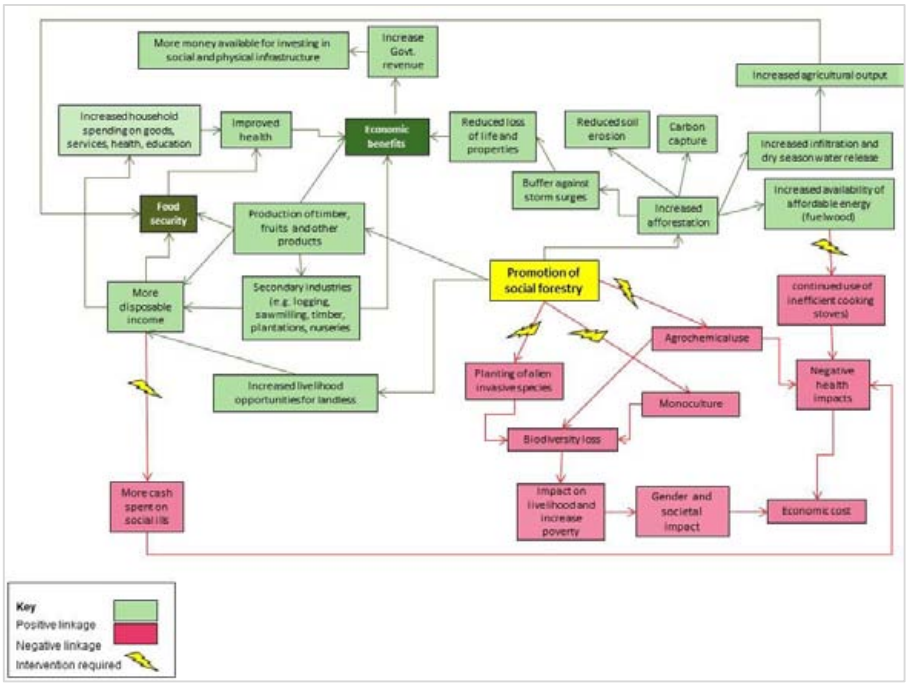


Figure 9.8: Forestry: Promotion of Social Forestry on Farmland in the SW Region

Main cumulative impacts
Positive: Economic benefits; food security.
Negative: None significant.

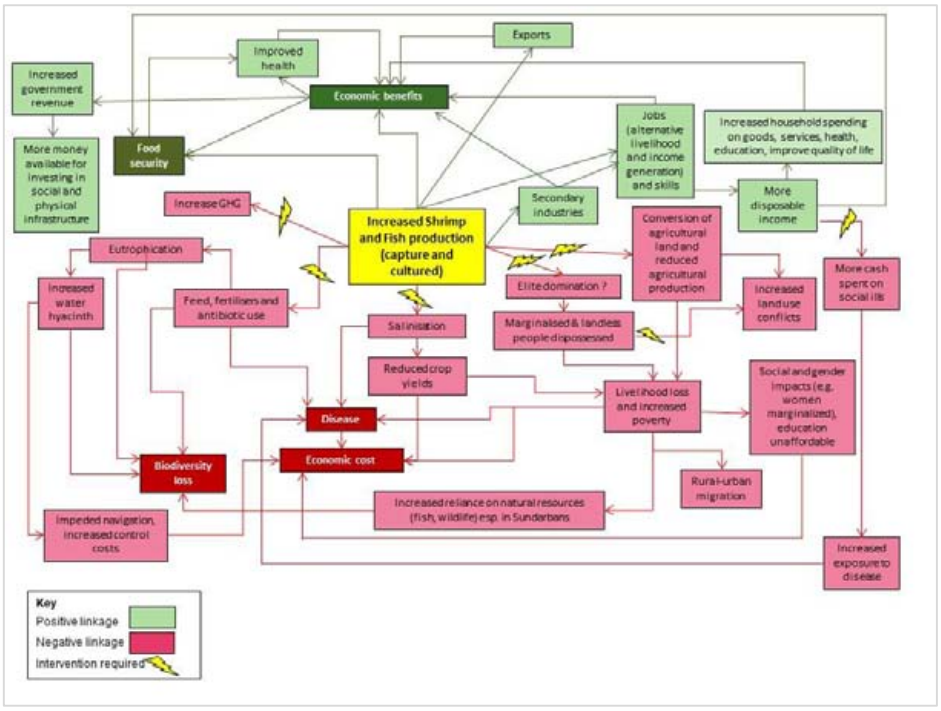


Figure 9.9: Fisheries: Increased Shrimp and Fish Production (Capture and Cultured)

Main cumulative impacts
Positive: Economic benefits; food security.
Negative: Economic costs; disease; loss of biodiversity.

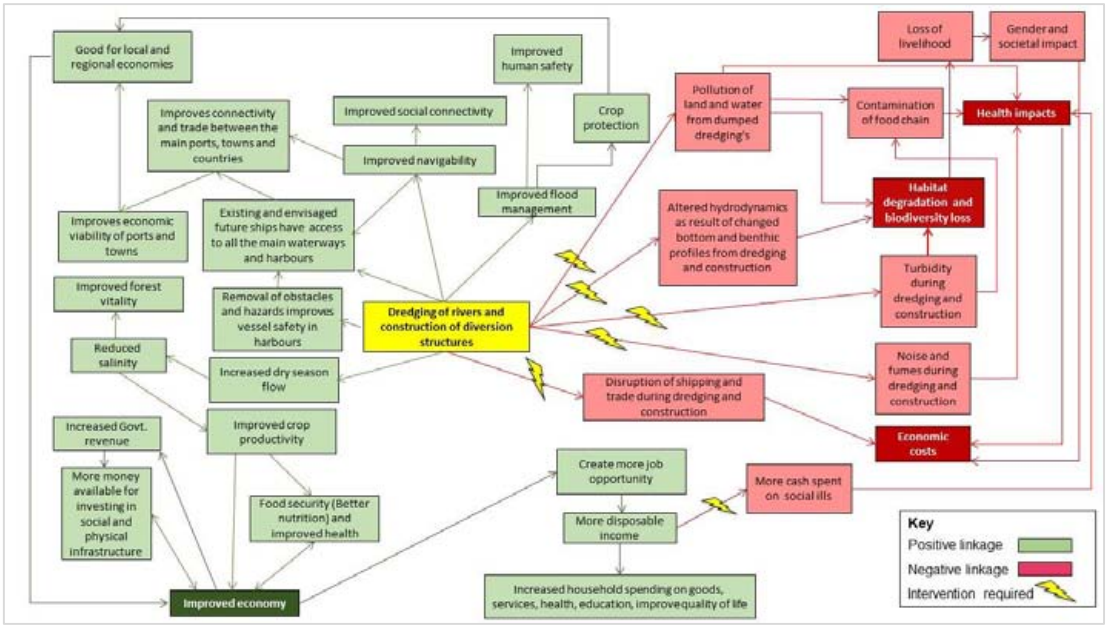


Figure 9.10: Water: Dredging of Rivers and Construction of Diversion Structures (to Enhance Dry Season Flow and Control Floods)

Main cumulative impacts
Positive: Improved economy.
Negative: Economic costs; habitat degradation and loss of biodiversity; negative health impacts

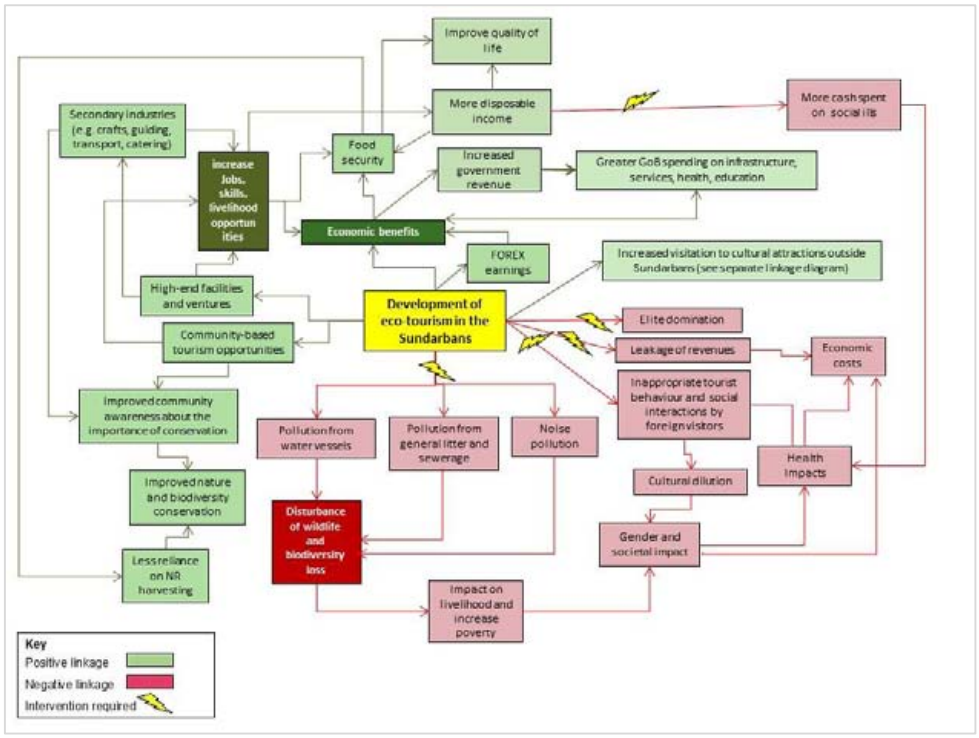


Figure 9.11: Tourism: Development of Eco-tourism Inside the Sundarbans

Main cumulative impacts
Positive: Economic benefits; increased jobs, skills and livelihood opportunities.
Negative: Disturbance of wildlife and loss of biodiversity.

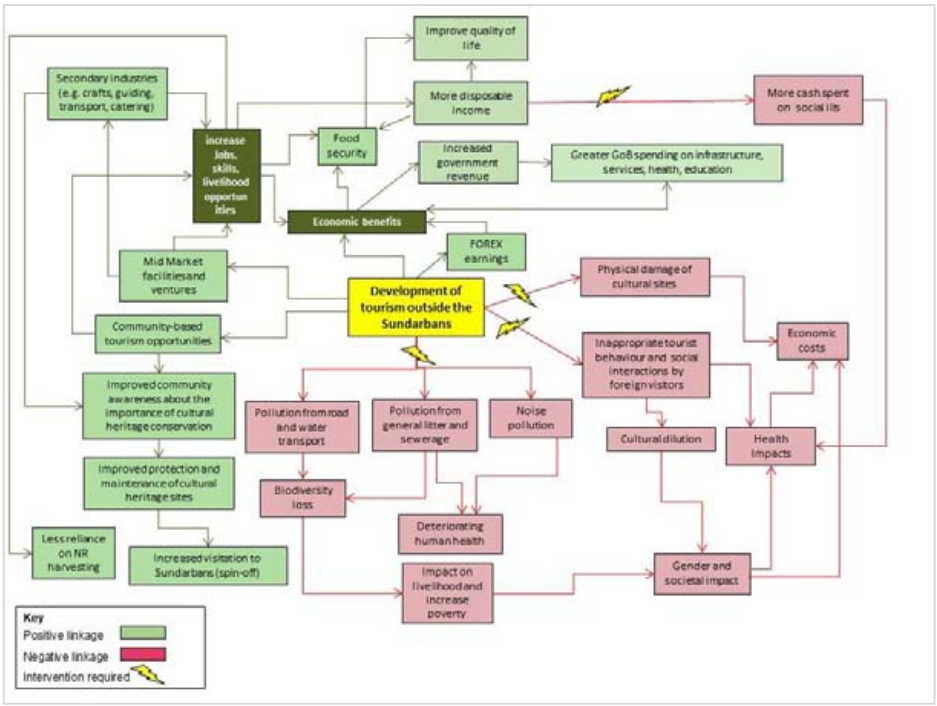


Figure 9.12: Tourism: Diversified Tourism Activities Outside the Sundarbans

Main cumulative impacts
Positive: Economic benefits; increased jobs, skills and livelihood opportunities.
Negative: None significant.

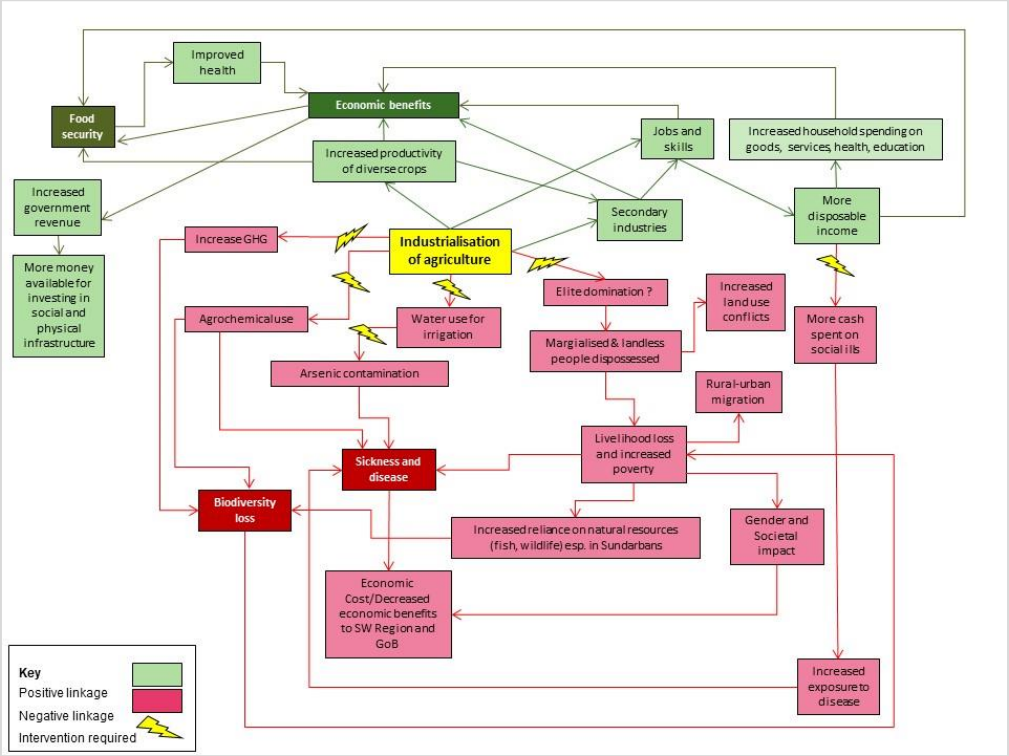


Figure 9.13: Agriculture: Industrialisation of Agriculture and Increased Production

Main cumulative impacts
Positive: Economic benefits; food security.
Negative: Sickness and disease; loss of biodiversity.

9.3 Conclusions

The linkage diagrams show that for each sector, the key activities result in a range of impact pathways that lead ultimately to a limited number (usually two or three per sectoral main activity) of 'end' cumulative impacts (either intended/positive or unintended/negative) (see also Table 9.2):

Principal positive cumulative impacts:

- Economic benefits;
- Increased jobs, skills and alternative livelihood opportunities;
- Food security;
- Improved health and quality of life;
- Enhance biodiversity and ecosystem services

Principal negative cumulative impacts:

- Economic costs;
- Degradation of habitat and loss of biodiversity and ecosystem services;
- Increased diseases, sickness and health impacts.

Other important cumulative impacts arise along the pathways (e.g. increased pollution) but then cause subsequent 'end' or principal cumulative impacts (e.g. pollution leads to health impacts or loss of biodiversity).

Table 9.2: Dominant Principal Cumulative Impacts of Development in the SW Region

Issue	Positive impact	Negative impact
Economy	Economic benefit	Economic cost
Habitats, biodiversity & ecosystem services	Enhance biodiversity and ecosystem services	Degradation of habitats, loss of biodiversity and/or ecosystem services
Health and quality of life	Improved health and quality of life	Increased diseases, sickness & health impacts
Food security	Improved food security	Deterioration of health and loss of livelihoods
Jobs	More jobs and improved skills	Deterioration of health and loss of livelihoods

This outcome provides a very clear signal of the logic and importance of ensuring that the Strategic Environmental Management Plan (SEMP) is pursued with determination and commitment across government; and is fully and effectively implemented – in order to avoid, minimise or mitigate these impacts arising. Indeed, investing in the SEMP will mean avoiding the economic costs of the risks involved – which are highly likely to be considerably greater than the costs of implementing the SEMP itself. In other words, implementing the SEMP will be a good investment.

10. Conclusions and Recommendations

This SEA was commissioned to assess the impacts of rapid growth and accompanying infrastructural and other developments (including industrialisation, expanded transport networks and urban growth) in the SW region over the next 20 years. The aim is to determine the risks of such developments to the environment, people and economy of the SW region and particularly the risks to the Sundarbans and the conservation of its outstanding universal value, and how such risks could be avoided or reduced. The nature of such potential risks and how they might arise are discussed in the preceding chapters.

Through stakeholder consultations at national, regional and local levels, expert analysis, review of research, published literature and official reports, a range of key environmental and socio-economic issues that affect the SW region and Sundarbans has been identified. These are discussed in Chapter 3 of this report, and in more detail in Chapter 3 of the Final Scoping Report (January 2021) and various thematic baselines reports (available on www.seasw-sundarbansbd.org). The SEA has focused on these key issues.

10.1 Growth Scenarios Compared

The initial assessment (see Chapter 6) examined the impacts of development under low, medium and high growth scenarios. The low growth scenario is obviously not a policy choice, nor is it a prediction. But it does indicate a possible future if unforeseen and unexpected circumstances conspire to undermine development. Medium growth is broadly equivalent to the current situation and projected developments over the next 10 years. High growth represents the growth path that will be required – through added stimulus (investment, innovation, etc.) to achieve high income country (HIC) status by 2041.

The overall picture is that the medium and high growth scenarios will flow seamlessly from one to the other as developments that are likely to arise under the Second Perspectives Plan (2021-2041) and other PPPs progressively unfold. Along this trajectory there will, progressively, be more positive impacts and more beneficial outcomes if two key assumptions are met:

- Existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced;
- Government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

But there will be progressively more risks and negative environmental and socio-economic impacts (some of which could, cumulatively, have an adverse impact on the Sundarbans) if the above assumptions are not met. For both situations, the SEMP will be a key instrument to enhance benefits and promote synergies, and to avoid or mitigate negative outcomes and counteract antagonisms. Similarly, for the possibility (even if remote) that low growth will ensue, the SEMP can play a similar response and mitigation role.

10.2 Maximising the Benefits of High Growth, and Reducing its Negative Impacts

The deeper assessment discussed in Chapter 7 (see in particular Table 7.1) shows how development arising from the implementation of PPPs for all key sectors under high growth can result in positive environmental and socio-economic benefits. However, this is also dependent on the two fundamental assumptions mentioned in section 10.1 being met.

The assessment equally shows that if these assumptions are not met, then high growth could result in significant negative cumulative impacts from the body of developments likely to arise in all of the key sectors (see Box 10.1).

However, should this be the case – for whatever reasons, then the risks need to be clearly understood. The SEMP specifically recommends the suite of measures required, and how they can be implemented, to ensure that the above assumptions are fully realized.

Box 10.1: Main potential negative impacts of high growth

The most serious potential cumulative negative impacts of high growth would arise as a consequence of inadequate implementation of safeguards and mitigation measures, and inadequate promotion of green technologies. These potential impacts include:

- Loss of biodiversity, degradation and loss of habitats and ecosystem services;
- Increased spread of invasive alien species (e.g. water hyacinth) due to increased use of fertilisers;
- Increased pollution of air (notably particulates), soil and water (chemicals, fuels. oil and grease, and heavy metals) from industries, power plants, transport (vehicles, shipping/boats and ports), agriculture (pesticides and fertilisers) and fisheries (particularly shrimp farms), urban areas (particularly due to rapid expansion and where unplanned), and transboundary sources;
- Inadequate collection, removal, disposal and treatment of solid and liquid wastes from energy (coal-fired power plants), industries, urban areas and households – leading to pollution and health hazards and risks to wildlife and livestock;
- Increased emissions of greenhouse gases, mainly CO_2 from power plants, industries and fuel combustion;
- Degradation of land (particularly due to increasing salinisation as a result of increasingly low freshwater flows and sea water intrusion);
- Conversion of agricultural land (for industrial development, transport network expansion (road and rail), urban expansion, etc);
- Increasing vulnerability to natural disasters (e.g. floods and storm surges), particularly due to increased emission of CO_2 (from power plants, industries, transport and other sources) which will influence climate change;
- Impeded economic growth and employment opportunities; consequent inability to improve health and education facilities/services and make other development investments; food insecurity.

10.3 Pollution

The types and sources of pollution (air, water, land, noise) are discussed in Chapter 3 (Box 10.1 indicates key sources). Most pollution is due to emissions/discharges from point sources that may not exceed statutory limits, but cumulatively it can be considerable.

10.3.1 Air Quality Assessment

The results of modelling of air for the high growth scenario till 2031 and 2041 are presented and discussed in detail in Chapter 4. The following conclusions can be made:

For the SW region in general:

- The most polluted sites as regards PM and NO_2 (predicted by 2031 and 2041) are in the Mongla–Rampal-Khulna and Khanjan-Ali bridge areas. The modelling shows a field of already raised PM and NO_2 levels in the Khulna in the baseline year (2019). It moves south with the occurrence, by 2031 and 204,1 of further elevated PM and NO_2 concentrations covering an area of approximately 2,000 km^2 - occupying a 30 km wide band (west to east) and 65 km long (north to south) - from Khulna to the Mongla area.

- Pollution by PM, especially $PM_{2.5}$, presents a very high risk for human health, and may also have an impact on fauna and flora.
- Pollution by NO_2 can be considered moderate from the point of view of both health impacts and impacts on vegetation/ecosystems.
- Pollution by SO_2 can be considered negligible from the point of view of both health impacts and impacts on vegetation/ecosystems.
- For PM and NO_2, the Mongla – Rampal- Khulna and Khanjan-Ali areas are, and most probably will remain, the most polluted localities.
- Available data indicates that additional air pollution by dust, SO_2 and NOx from the Rampal power plant is not expected to have a high impact on Sundarbans as this plant is being equipped with basic modern emission reduction technologies.

For the Sundarbans:

- The level of pollution by PM_{10}, $PM_{2.5}$, SO_2 and NO_2 is, and most probably will remain, lower (on average) in the mangrove forests than in the rest of SW region up to 2041.
- Pollution levels in the southern part (World Heritage Sites) are lower than those in the northern part.
- The impact of NO_2 pollution arising in the Mongla area on vegetation/ecosystems in that area can be considered moderate at present, but will increase over the next 20 years (but concentrations will remain within the Bangladesh standard).
- Pollution by SO_2 can be considered negligible.
- Pollution by PM, especially $PM_{2.5}$ is expected to remain stable or to decrease at six of nine key receptor points in the Sundarbans over the next 20 years, but will still mostly exceed national standards for the protection of human health.
- Available data indicates that additional air pollution by dust, SO_2 and NOx from the Rampal power plant is not expected to have a high impact on Sundarbans as this plant is being equipped with modern emission reduction technologies.

It is strongly recommended to implement PM emission reduction measures preferably in the Khulna-Mongla area. Having in mind the Precautionary Principle, efficient and cost-effective measure measures should also be implemented to reduce emissions of NOx[77].

It is also recommended that research on the impact of PM on fauna and flora in the Sundarbans is undertaken.

10.3.2 Water Pollution

The results of modelling of water pollution for the high growth scenario till 2031 and 2041 are presented and discussed in detail in Chapter 4. Major findings incude:

- The model was able to satisfactorily predict nitrate and phosphate concentrations in the rivers of the SW region in both wet and dry seasons
- There was little reduction in nitrate concentrations between the baseline year (2020), 2031 and 2041. In order to improve river water quality, heavy industrial development and waste water pipelines must be connected to efficient wastewater treatment facilities.
- There are comparatively high phosphate concentrations in the wet season which are due to agricultural run-off from crop fields and grazing lands. Discharges with high concentrations of

[77] Moreover, nitrogen oxides in addition to their direct negative impact on human health and vegetation also act as precursors of the formation of secondary particulate matter in the air.

dissolved phosphorous compounds urgently need to be reduced (by treatment). Stricter environmental regulations will need to be adopted and implemented effectively. Furthermore, technologies to remove phosphorus compounds from waste water need to be implemented along with balanced agricultural practices.

- The modelling of organic pollution (in terms of BOD_5,) was not carried out due to the lack of reliable data.

From the modelling, it can be concluded that for the SW region in general that:

- Nitrate concentrations will decline from the baseline year (2020) by 2031 and further by 2041. However, in order to avoid any deterioration of river water quality in future, heavy industrial development should be accompanied with installation of efficient wastewater treatment facilities. Large municipalities should also be equipped with wastewater treatment plants (STPs).
- Current phosphate concentrations (in 2020) are somewhat elevated at some points in the wet season. This could be due to agricultural run-off from crop fields and grazing lands as well as municipal and industrial discharges. Such run-off and discharges containing high concentrations of dissolved phosphorous compounds need to be reduced/treated immediately. However, the model predicts that by 2031 and 2041, phosphate levels will remain within the safe limit value of 0.5 mg/L set by the inland surface water quality standards of Bangladesh (Draft ECR '2017). Stringent environmental regulations should be adopted and implemented. Furthermore, technologies to remove phosphorus compounds from waste water need to be implemented along with nutrient-balanced agricultural practices.
- The BOD levels should be systematically monitored in all river systems of the SW region: river-specific monthly monitoring of vertical BOD profile, seasonal assessment of BOD levels of effluents from municipal sources, agricultural run-off and domestic discharges
- Water quality monitoring should be extended to cover other relevant pollutants (COD, hydrocarbons, AOX, metals).
- Overall, further research is needed to determine the possible level of risks for fauna, flora, habitats and ecosystem functioning within the Sundarbans from existing and projected water quality.

10.3.3 Other Pollution

Emissions of CO_2 are expected to increase dramatically as several fossil fuel-fired power plants are being constructed or planned. In order to mitigate this increase, implementation of energy efficiency measures, wherever possible and feasible, should be supported as well as the increased use of renewable energy.

There is a risk that heavy metal concentration in coastal areas will rise with expansion of industrial activities in the SW region (particularly if there are inadequate treatment and recycling measures in place or these are poorly managed and/or maintained) and from continued and increasing industrial activity in upstream countries. Such an increase will lead to a greater risk to marine life.

Exposure to excessive noise, particularly in urban and industrial areas and from vehicles, can cause problems (e.g. high blood pressure, heart disease, sleep disturbances, and stress.) for people in all age groups, especially vulnerable groups like children and the elderly. Such problems will increase following urban, industrial and transport network expansion if noise regulations are not adhered to. Noise from commercial and tourist boats causes disturbance to wildlife in the Sundarbans and underwater noise can have substantial impacts on aquatic mammals (see recommendations in section 10.11).

10.3.4 Conclusions and Recommendations on Pollution

Pollution of air (particularly particulate matter) and water presents a risk to the overall SW region, particularly the human population. The risks to biodiversity and ecosystem functioning within the Sundarbans need to be investigated by ecological monitoring and research. The risk is much greater for the northern part of the Mongla – Rampal- and Khanjan-Ali areas which are expected to be influenced by the

economic development in and around Mongla. This risk should be reduced by implementation of compensation measures – particularly to reduce emissions of air pollutants and discharges of water pollutants. Many PPPs include compensation measures (i.e. to reduce emissions of air pollutants and treat discharges of water pollutants) which should be implemented in a timely and efficient manner.

It is recommended that, under the SEMP, the modelling of both air and water quality is periodically re-run to incorporate up-dated and new data in order to provide revised information for the best management of pollution issues.

Box 10.2 presents further recommendations to address pollution.

Box 10.2: Recommendations to address pollution

Analyses of the current situation shows that the environment of the SW region is already under pressure from pollution. Modelling shows that implementation of the High Growth Scenario will likely to lead to additional negative impacts on the environment of the SW region in general, and particularly between Khulna and the Mongla area.

In order to achieve economic growth without compromising the environmental quality, compensation will be required to "neutralize" these additional negative impacts – particularly by measures to reduce emissions of air pollutants and discharges of water pollutants. Such measures can be introduced and applied through timely and efficient implementation of appropriate existing PPPs (listed below) and effective enforcement of existing regulatory instruments.

The following specific recommendations are made:

- Any further industrialization in the region needs to be assessed and decisions taken with a high priority given to the protection and conservation of aquatic ecosystems.
- The drainage network and system needs to extended and improved in all the major cities and sub-cities (pourashavas) with adequate waste water treatment facilities developed (e.g. individual sewage treatment plant (STP) or central-STP).
- Existing industries are scattered. They need to be clustered (following the national industrial policy) to enable the provision of more efficient waste water treatment facilities.
- Upgraded and/or advanced pollution abatement technologies (end-of-pipe) should be introduced in the industrial estates or zones.
- Modern highly efficient and low-waste technologies should be installed in the SW region.
- Consideration should be given to introducing stringent measures for the control of emissions of criteria pollutants[78] , and particularly to improve air quality so that it is closer to WHO air quality standards.
- Air quality monitoring network should be developed based on automated stations to generate 'near-to-real-time' information on actual air quality across the region and to make that information available to the public.
- An inventory of emissions of air pollutants should be developed and regularly updated in accordance with international standards.
- Air quality modelling should be periodically re-run to incorporate up-dated and new data in order to provide revised information for the best management of pollution issues
- Research is needed to ascertain critical air pollution loads for sensitive forest zones and ecosystems.

[78] Criteria pollutants are those which are controlled by either legislation or regulations.

- A transboundary air pollution management framework should be prepared after bi-lateral or multilateral dialogue with neighboring countries.
- Relocate the SEZ from Mongla region to the upper part of SW region, or limit the Mongla SEZ to containing only low polluting industries.
- Limit the growth of Mongla Port Authority beyond 2031 to prevent a major increase in the level of NOx and PM affecting the northern part of the Sundarbans close to the Mongla area.
- Institutional capacity should be enhanced to enforce regulations and undertake monitoring air pollution in the SW region – particularly through digitalisation.
- Investment is required in R&D for real-time monitoring of spatial air quality data through a monitoring and modelling network. Research should investigate cause-effect linkages between (a) air pollution and the status of mangrove ecosystem, and (b) air pollution and health cost in the SW region
- The recommendations of the DOE concerning "Air Pollution Reduction Strategies for Bangladesh" should be implemented, where applicable.
- Lower emitting vehicles, vessels or electric cars should be introduced in future in this area as well as incentives for private sector and citizens to switch to low/zero-emitting vehicles
- Pollution could be reduced by applying the Polluter Pays Principle, introducing emission taxes, encouraging green buildings and green technology, promoting green banking AND procurement, emission trading, and strictly enforcing legal requirements.
- A holistic environmental quality monitoring framework should be developed to monitor the air, water, soil and noise to enable better understanding of the spatial and temporal variation of pollution dispersion.
- The BOD levels should be systematically monitored in all river systems of the SW region: river-specific monthly monitoring of vertical BOD profile, seasonal assessment of BOD levels of effluents from municipal sources, agricultural run-off and domestic discharges.
- In future, BOD levels in rivers downstream of the big cities should be estimated by the model used in this SEA using systematically collected data.
- Scientific research is recommended to identify the major contributors to pollution causing raised BOD levels in the river systems.
- Monitoring of water quality and important water pollution point sources should be extended by including additional pollutants (COD[79], oil pollution, hydrocarbon pollution, dissolved organic carbon, AOX[80], heavy metals).

Relevant PPPs

- National Strategy for Water Supply and Sanitation, 2014 (establishing water quality monitoring system and protocols along with delineating roles and responsibilities of the consumers, service providers, local and central governments);
- National Urban Sector Policy, 2011 (protecting, preserving and enhancing the urban environment particularly water bodies);
- National Industrial Policy, 2016 (clustering of existing industries, inspiring and assisting environment-friendly sustainable industries);
- National Textile Policy, 2017 (industrial parks, RMG Parks, Knit Village, Textile parks and clustering art/fashion industries);

[79] Chemical Oxygen Demand

[80] Adsorbable Organic Halides

- Leather and Leather Products Development Policy, 2019 (increase production of leather and products using advanced and environmentally friendly and competitive one, revision of existing environmental protection laws and strengthening government's agency to enforce environmental protection laws);
- National Shipping Policy, 2000 (enforcing marine protection act, pollution management from ships);
- National Environment Policy, 2018 (follows of environmental protection in developing programs and plans, pollution control, sustainable resources management especially land, water, manpower etc);
- Bangladesh Country Investment Plan for Environment, Forest and Climate Change, 2016-2021 (establishment of waste reception facilities at ports);
- National Agriculture Policy, 2018 (balanced fertiliser application and pesticide management);
- National Integrated Livestock Manure Management, 2015 (reducing air and water pollution);
- National 3R strategy for Waste Management, 2010;

10.4 Power Generation

Energy and electric power consumption are expected to increase considerably in line with growth in GDP growth over the next 20 years. Under the Power and Energy System Master Plan 2016, it is expected to generate 24 GW of electricity by 2021, 40 GW by 2030, and 60 GW by 2041. About 35% of the country's power generation will be from renewable energy sources or power imports by 2041 (current level is 7%). It can be expected that power production in the SW region will increase 3 – 4 times during the next 20 years.

Bangladesh's total installed electricity generation capacity (including captive power) is 25,235 MW in August 2021. Total installed capacity of combustion power plants without captive power, renewable and imported power was 20,512 MW, of which gas-based plants accounted for 52%, whilst HSD- and HFO-based plants accounted for 32%, and coal-based plants accounted for 8%. The power sector has one national grid with an installed capacity of 52,679 MVA (42,143 MW) in August 2021. 99.5% of the population had access to electricity in August 2021. The gas distribution network is not sufficient and a part of the gas supply to final consumers is being provided through liquefied petroleum gas (LPG), compressed natural gas (CNG) and liquefied natural gas (LNG). Both power and gas distribution networks are being extended and/or reconstructed. By 2025, 2400 MW will be added from a nuclear power plant. Moreover, additional capacity (around 3000 MW) is expected by 2030 using non-combustion renewables (solar, wind).

The planned energy mix in Bangladesh includes natural gas, LNG, coal, renewables and nuclear energy, taking into account that known reserves of natural gas are expected to cover the growing demand for the next 10–12 years. Consumption of LPG is expected to increase 2.5 times by 2025 (compared to 2019 levels) and coal will also play a more important role (with the connection of newly built coal-fired power plants). Domestic coal reserves will not be able to cover expected demand. Nuclear electricity will enter the energy mix in 2023 (start of the first nuclear power plant) and its role will increase by 2040 (expected start of the second nuclear power plant). In addition to biomass (the dominant renewable), the share in energy mix is expected to increase in the case of solar and wind energy generation. Over the last decade, a large number of households have shifted their cooking fuel from biomass to cleaner fuels like LPG. This has been due to the improvement of international trade in petroleum products (LPG/LNG), petroleum industry development, supply chain improvement and improved quality of life.

Four new fossil fuel-fired power plants (total installed capacity 2550 MW) are being constructed in the SW region: one is the 1320 MW coal-fired Rampal Power Plant, one is a heavy fuel oil (HFO)-fired plant (IPP:

100 MW) and two are natural gas/ high-speed diesel (HSD)-fired plants (BPDB: 330 MW, and NWPGCL: 800 MW). Recently, the Government of Bangladesh has started reconsideration of its energy policy and decided so far to scrap certain planned coal-fired power plants and transform other such plants to natural gas (as of July 2021, five coal-fired plants are to be scrapped and a further five transformed). This means that further reduction of air pollution by PM, SO_2 and NOx can be expected as well as the reduction of carbon dioxide emissions, especially in the case that the reconsideration will include plants located in the SW region (included in Table 4.5).

At present, the energy sector has a limited direct impact on air pollution, GHG emissions and waste generation (given by the structure of energy mix). Cooking using biomass has a high impact on air quality, bringing serious negative health impacts (caused by fine particulate matter PM_5). But a step-by-step switch from the use of biomass for cooking to more environmentally-friendly LPG or electric stoves is expected to reduce these impacts. The construction of new coal- and gas-fired power plants will lead to a high increase in emissions of carbon dioxide (CO_2) and to a moderate increase in emissions of nitrogen oxides (NOx); and, in the case of coal, also to moderate emissions of dust ($PM_{2.5}$ and PM_{10}) and sulphur dioxide (SO_2), and to the generation of large volumes of solid waste.

Decisions on the spatial distribution of future power plants and their type and fuel used should take into account the sensitivity of the environment to pollution and community health.

Currently, power production is determined by seasonal and daily electricity demand and fuel costs. Therefore, the seasonal risks of pollution and the sensitivity of the local environment should be taken into account.

For both new and existing coal-fired power plants, technology to reduce emissions of mercury should be identified and used that is appropriate to the type of coal being used.

Solid waste from coal-fired power plants (ash) should be treated properly to minimize the risks to human health and the environment.

A framework for renewable energy production is required and should be integrated with future energy demand.

Use of renewable energy should be extended substantially with special attention paid to non-combustion renewables like solar energy.

The use only of energy efficient products and technologies and clean fuel should be emphasized

10.5 Rapid Urbanisation

Continued rapid urbanization in the 14 districts of the SW region as well as in the environmentally critical area around the Sundarbans, particularly where unplanned, will inevitably increase air and water pollution and lead to further loss of agricultural land. It can be expected that slums in the urban areas, with poor or no public services, will expand - particularly if diminished livelihood opportunities and climate change drive increased migration from rural areas to urban centres.

10.6 Industrialisation

The Second Perspectives Plan aims to pursue industrialization over the next 20 years with a focus on export-oriented manufacturing to drive structural transformation into the future. This will require extra power generation and an increase in cement and brick production (for buildings). If environmental safeguards and the SEMP are not adequately and effectively implemented, there is a risk of increased air and water pollution and impacts on biodiversity, human health and livelihoods in the SW region. Furthermore, increased industrialisation will require new developments and improvements in land and water-based transportation infrastructure and communication which will generate further risks: air, water and noise pollution; impacts on biodiversity; loss of agricultural lands and land degradation due to the expansion of transportation networks.

10.7 Land Use Change

Further land use changes in the SW region to the north of the Sundarbans can be expected due to population growth and as a result of high economic growth (urbanisation, expansion of industry and transport network).

Increased industrialisation, urbanisation and improvement/expansion of the transport network (road and rail) will inevitably result in further loss of agricultural land. There could be a continuing risk that highly profitable shrimp cultivation may drive further conversion of agricultural land to shrimp cultivation (leading to increased salinisation, reduced crop productivity and loss of livelihood opportunities). Land use zoning plan has been finalized and under the process of implementation. According to existing policies and plans, shrimp cultivation is not allowed beyond the designated areas. In future, shrimp production will be enhanced through the improved technology and aquaculture practice.

A land use survey and impact assessments should be undertaken of all coastal aquaculture to enable recommendations to be made to minimize negative impacts and increase their productive potential. The survey report should also consider optimum energy use so that these wetlands are fully utilized for productive fisheries.

10.8 Salinity

Due to reduced dry season flow of fresh water and channel siltation, and resultant sea water intrusion/inundation, soil and water salinity has increased and soil productivity has decreased as well as livelihood diversity. Remediation of this situation is dependent on government ensuring adequate and well managed dredging programmes in the main distributary rivers and investing in water flow diversion infrastructure on the Ganges-Padma river (in Bangladesh) and at the offtakes of the Gorai and other rivers.

The people living in the areas affected by soil salinity should continue and increase the use of sustainable land management (SLM) practices and rain water harvesting for drinking; and ground water recharge should also be pursued to minimise soil salinity.

Integrated water management and sustainable land management should be continued under the guidance of concerned agencies. Otherwise, the situation will deteriorate with increased negative consequences with further increases in salinity. The latter will lead to increased health problems (e.g. skin conditions), further reduction of drinking water quality – impairing people's ability to work and affecting crop production, etc.

10.9 Climate Change

Climate change scenarios predict rises in temperature and increased rainfall variability (increase in total annual rainfall – perhaps 10%, and longer dry spells). Climate change will put the SW region at increased risk of recurrent and intensive natural disasters such as riverine floods, recurrent floods, tropical cyclones and storm surges, droughts, salinity intrusion, riverbank and coastal erosion and sea level rise.

There is nothing that Bangladesh can do to prevent climate change or its severity, but it has already taken a range of measures to adapt to the threats of climate change (which should be continued), including, for example: enhancing the capacity of communities to increase their resilience, increasing the capacity of government agencies to respond to emergencies, strengthening river embankments and coastal polders, building emergency cyclone shelters and resilient homes, adapting rural households' farming systems, reducing saline water intrusion (especially in areas dependent upon agriculture), and implementing early warning and emergency management systems.

It is recommended that research be commissioned to determine how the crop calendar and cropping pattern may need to be rescheduled to mitigate the adverse climatic conditions.

10.10 Flooding

The SW region experiences periodic excessive freshwater flooding and water logging due to heavy monsoon rain in the region and upstream in Nepal and India. This flooding will continue to be exacerbated where there is inadequate or badly maintained drainage infrastructure and during high tidal flows. The problem will persist if there is no or inadequate investment if flood control infrastructure (e.g. appropriate interventions on the Ganges-Padma River (in Bangladesh) and at the offtakes of the distributary rivers). Additionally, erratic and extreme rainfall will induce localised flooding or water-logging problems.

Periodic and disastrous flooding due to storm surges frequently leads to loss of lives, and livestock and destruction of houses and inundation by saline water, especially when embankments are breached. It is not possible to predict the future pattern of cyclones and storm surges. However, climate change may lead to increasing sea surface temperature which could result in more intensive severe cyclones. Coupled with sea level rise, storm surges could be driven further inland and cause flooding over wider areas. The only response to such 'natural' sea water flood disasters is to ensure the implementation of a programme to properly maintain embankments and associated drainage infrastructure (these are measures that are well understood and have been identified as necessary many times), as well as improved and effective cyclone warning, an increased in and more accessible storm shelters.

10.11 Transboundary Issues

As discussed in Chapter 3, a number of issues are of concern due to policies, plans, developments and activities occurring beyond the international border of Bangladesh (notably in India and Nepal) – over which Bangladesh has little control. These include:

- Water management in the Ganges basin (notably dams and abstraction for irrigation, urban and industrial use) which reduce dry season flows in the Ganges-Padma River within Bangladesh and in the distributary rivers flowing through the SW region.

Overall, given population growth, expanding urbanisation and increasing demand for energy in India and Nepal, the likelihood is that the number of dams and hydropower installations on rivers in the Ganges basin will increase in the coming years. In addition, there is likely to be increased diversions and sand mining in the river courses, as well as groundwater withdrawals for irrigation (currently, about 90% of water demand in the Ganges basin is for irrigation with some of the lowest productivity levels in the world[81]). Consumption (drinking, cooking, bathing, etc.) and industrial use of water will also increase. It is estimated that water demand in India will increase by 30% by 2050[82]. Together, these demands are bound to have cumulative impacts on river flow and characteristics in the Ganges and Padma and their distributaries. In addition, climate changes may lead to changes in rates of warming and snow/glacier melt, and increased extreme events in the mountains, which may also affect flows. The Indian River Interlinking Project[83] would also have an impact on the availability of the Ganges. Whilst much data is reputed to be collected in the Indian

[81] Sharad Jain - https://www.ceh.ac.uk/sites/default/files/Future%20Ganga%20Workshop%20-%20Sharad%20Jain%20-%20NIH.pdf

for:

- Better protection of habitat and interest of people depending on Sundarbans;
- Scientific management of wildlife sanctuaries;
- Conservation of important endanger/threatened species (tiger, crocodile etc.);
- Enhanced ecosystem science.

[82] https://www.ceh.ac.uk/sites/default/files/Future%20Ganga%20Workshop%20-%20Sharad%20Jain%20-%20NIH.pdf

[83] A proposed large-scale civil engineering project that aims to effectively manage water resources in India by linking Indian rivers by a network of reservoirs and canals to enhance irrigation and groundwater recharge, reduce persistent floods in some parts and water shortages in other parts of India (https://en.wikipedia.org/wiki/Indian_Rivers_Inter-link#:~:text=The%20Indian%20Rivers%20Inter%2Dlink,and%20water%20shortages%20in%20other)

parts of the Ganges basin on water-related matters, it is largely inaccessible. This makes it very difficult to make deductions or predictions concerning the downstream impacts of changes and trends in upstream water use and offtake and the amount and quality of water entering the SW region of Bangladesh.

- Power stations and other industries in West Bengal are the source of pollutants which contribute to increased concentrations of air pollutants over the SW region, especially particulate matter.
- Other transboundary developments also have the potential to generate environmental and socio-economic impacts in the SW region such as cross-boundary transport and infrastructure (including road, rail and pipelines (e.g. gas). They will require careful planning, appropriate environmental/social assessments (some even cross-boundary SEAs) through regional and bilateral collaboration.

Bangladesh will need to make full use of existing bilateral and regional liaison fora (including the India-Bangladesh Joint Rivers Commission and Joint Working Group on Conservation of the Sundarbans) to ensure that issues of concern are discussed and resolved.

10.12 Management of the Sundarbans

The Sundarbans is managed under an Integrated Resource Management Plan (2011-2020)[84]. This includes a co-management approach and 10 strategic management programmes (see section 3.2.2). But stronger inter-agency coordination and cooperation is required to ensure its effective conservation. This might best be supported by establishing a national level Sundarbans Coordination Committee including all ministries/agencies (in addition to MOEFCC) that operate in or have an effect on the Sundarbans (e.g. agencies responsible for water, dredging, shipping and others). The next Sundarbans Resource Management Plan (may be for next10 years) should address the findings of SEA and incorporate the relevant indicators from the SEMP.

To raise awareness of the real value of the Sundarbans and to enable more informed management policy to be framed and decisions to be taken, it is recommended to undertake a thorough valuation of all aspects of ecosystem services in the Sundarbans. This should then inform the preparation of a new management plan for the Sundarbans which emphasises upholding its outstanding universal value.

Though BFD is doing SMART patrolling in the Sundarbans, it is recommended to develop an effective management information system that maintains information and data on poaching and wildlife trafficking in the Sundarbans.

The movement of large ships (which will increase over the coming years) and tourism causes interference with wildlife behaviour in the Sundarbans. Noise and light (at night) from the regular movement of ships (notably along major rivers of Sundarbans) and from tourist and fishing vessels is disruptive to wildlife, disturbs animal behaviour (e.g. feeding, breeding) (see section 8.1.1). Underwater noise from ship's engines and propellers can have substantial impacts on aquatic mammals (see Box 3.1). Whilst the speed of ships

[84] The plan provides for:

- Better protection of habitat and interest of people depending on Sundarbans;
- Scientific management of wildlife sanctuaries;
- Conservation of important endanger/threatened species (tiger, crocodile etc.);
- Enhanced ecosystem services through conservation of biodiversity;
- Promotes participation of local stakeholders in the governing system through strengthening co-management;
- Guides sustainable management of terrestrial and wetland resources;
- Addresses climate change issues and arrange conservation outreach;
- Development of infrastructures and facilities for eco-tourism and capacity buildings.
- Sustainable livelihood options for the Sundarbans dependent community.

and boats on the rivers is not officially restricted, pilots on larger ships navigating to Mongla port try to ensure a maximum speed of 10 knots. As noted above, bank erosion caused by bow waves, particularly from large ships, is a considerable problem. To address such issues, it is recommended to develop a protocol or guidelines (through agreement between all relevant agencies) (and perhaps a legal instrument to enable its enforcement) covering the operation of all vessels travelling in and through the Sundarbans (e.g. speed, noise emissions, crew/passenger behaviour). In the SEMP, it is further recommended that a baseline study of underwater noise levels is undertaken in the main rivers in the Sundarbans and in peripheral rivers and in sensitive areas (e.g. dolphin sanctuaries), and that underwater noise levels are monitored in the future as part of enforcing the proposed protocol/guidelines.

All tourism activities in the Sundarbans should be according a scientifically determined carrying capacity. It is recommended to introduce a moratorium on increasing and/or expanding tourism to Sundarbans beyond current levels until such a study is completed.

Poison fishing is another issue of concern which needs to be brought under control. It is recommended to establish a liaison mechanism with the Department of Agriculture, Department of Forests and other law enforcement agencies to investigate how to establish a means to limit the amount of pesticide sold. This might be based on identifying purchaser's legitimate needs for agricultural purposes. Effective SMART patrolling and strong co-ordination with co-management organisations can minimize the poison fishing in the Sundarbans.

There are potential threats to the distribution of mangrove trees (*Heritiera fomes*) in the Sundarbans due to limited supply of fresh water and consequent increase of salinity in the dry season within the area. Modelling suggests that neither air nor water pollution arising from the SW region beyond the Sundarbans will represent a serious threat to the mangrove ecosystem of the Sundarbans for the next 20 years (see Chapter 4). However, the northern part of the Mongla is likely to be influenced by increased emissions of PM and nitrogen oxides originating in the Mongla area. It must be recognised that models have high levels of uncertainty, especially over longer-time periods, and therefore the precautionary principle[85] should be applied and appropriate mitigation measures should be implemented - especially in the case of air pollution by particulate matter and nitrogen oxides, and water pollution by nitrate and phosphate in the wet season. The latter can be mitigated by measures such as expanding and improving the treatment of both industrial and municipal wastewater; and ensuring more efficient and targeted application of fertilisers by limiting sales to *bona fida* users and training/awareness-raising on appropriate levels of application.

Pollution from ships and boats passing through the Sundarbans is a problem.

Freshwater availability in the Sundarbans is discussed in section 10.11.

Sedimentation and siltation present a challenge to maintaining river flows through the Sundarbans. Improperly disposed dredged materials can affect the regeneration of trees and survival of existing forests as well as benthic biodiversity. Dredging issues are generally addressed through sight- and project- specific EIAs.

The above issues need to be addressed through effective implementation and policing of statutory regulations regarding ship/boat licensing, maintenance and operation; and effective implementing of tourism guidelines coupled with increased efforts to raise awareness of the sensitivity of the Sundarbans ecosystem to disturbance.

Effective forest management, based on sound ecological and sustainability principles, needs to be maintained to ensure there is no over-use (e.g. over fishing) or excessive abstraction of the natural

[85] The precautionary principle enables decision-makers to adopt precautionary measures when scientific evidence about an environmental or human health hazard is uncertain and the stakes are high. It first emerged during the 1970s and has since been enshrined in a number of international treaties on the environment. The principle is often used by policy-makers in situations where there is the possibility of harm from making a certain decision (e.g. taking a particular course of action) and conclusive evidence is not yet available.

resources of the Sundarbans and to control illegal activities (e.g. poaching, wildlife trafficking, poison fishing). Otherwise there is a serious risk of habitat degradation and loss of biodiversity (particularly keystone species) and ecosystem services. Habitat change and losses of biodiversity may occur due to climate change and natural dynamic changes in the ecosystem.

Ecosystem health indicators can be tracked to monitor the spatial and temporal changes. Those included in the SEMP include:

- The growth rate of main tree species (e.g *Heriteria fomes;)* in the different saline zone including germination and recruitment status.;
- Mud crab production and fish diversity;
- Tiger population.

It is also recommended that the SEMP coordination unit will monitor effective implementation of National Oil and Chemical Spill Contingency Plan (NOSCOP) to ensure immediate and coordinated efforts for mitigating impacts on the Sundarbans in case of emergencies.

10.13 Ecosystem Services Provided by the Sundarbans

As indicated in section 3.2.2, the real contribution of the Sundarbans Reserve Forest to the national economy has not been evaluated so far, although several studies have provided estimates of some of the range of services provided by the Sundarbans mangrove forests in Bangladesh. A comprehensive assessment of the full value of ecosystem services provided by the Sundarbans is recommended.

10.14 Invasive Alien Species

Water hyacinth has become a major problem in the SW region, clogging baors and ponds, and some water channels. A concerted effort through a coordinated government programme is required (led by the Departments of Agriculture and Fisheries) to reduce existing infestations and control the further spreading of this IAS. It is recommended that a baseline study is commissioned to generate a map of the extent and severity of water hyacinth infestation. Furthermore, it is recommended in the SEMP that regular monitoring is undertaken to track changes in the extent of the problem and whether control measures are working effectively.

Prosopis juliflora is also spreading on embankments although it is used as a fuelwood by local people. At present, there are no major issues with IAS within the Sundarbans. However, forest managers are concerned about their potential future spread and impacts.

10.15 Health, Gender and Education

Poor health particularly affects the poor, children and elderly people. Water-borne, respiratory and salinity-related skin diseases are common as well as malnutrition due to poor diet. A number of health issues are of critical concern:

- People use fuelwood, CNG, oil or a combination of any two for cooking purposes. But in the rural areas, the dominant way of cooking is still with fuelwood which, if indoors, can cause air pollution and can have a serious impact on human health.
- There are district/general hospitals in all the 14 districts of the region and some private medical facilities (i.e. hospitals, clinics, diagnostic centres, authorized dispensaries) in the Division/District/Upazila head-quarters. Moreover, there are community clinics and also some alternative medical treatment facilities in both urban and rural areas, i.e. homeopathic, unani-ayurvedic. However, the specialized hospitals are located mostly in the urban areas and cannot be easily accessed by those living in remote areas who require emergency treatment - due to poor communication networks;
- Health facilities located in the Upazila headquarters have limited equipment;

- Water supply and sanitation facilities in public places in urban and semi urban areas are either inadequate or in a poor condition.
- Arsenic contamination of drinking water is a serious issue in some parts of the region.
- There is some evidence from a study by Meharg and Rahman (2003) that paddy soils irrigated with groundwater in the north of the SW region had elevated arsenic levels. But the SEA has found no subsequent publications on studies on this issue. Research is needed to determine the situation and whether rice from such areas is contaminated to levels which would pose a health threat.

The quantity and quality of water supply and sanitation facilities (e.g. public toilets) needs to be improved to meet the population demand. Furthermore, it is recommended that the extent and severity of arsenic contamination of irrigated paddy fields in the SW region (and even across Bangladesh) is investigated through research. Also, arsenic levels in rice grown on arsenic-contaminated soils should be monitored through grain surveys to determine if there is a problem and its scale. Arsenic treatment plants need to be setup to ensure the availability of arsenic free water for domestic and other uses.

Women face socio-political exclusion in decision-making processes - both in the home and society. They are mostly responsible for collecting potable water, fuelwood (from homestead gardens, the Sundarbans and adjacent areas) together with the men. Women are often vulnerable while travelling alone to/from remote areas. The expansion of homestead vegetation and social forestry should be further encouraged to reduce the need for collection from further afield or from the Sundarbans. Access to safe water can be increased by promoting rainwater harvesting, the use of filters and construction of treatment facilities, etc. - thus reducing the pressure on women.

Bangladesh has made great progress in improving access to education as well as retention of students in education, along with gender parity in both primary and secondary education. But the country suffers from an inadequate number of teachers to meet the increasing demand, particularly as population grows. Many school buildings are of poor quality and have inadequate furniture and equipment, drinking water and hygienic sanitation facilities. Drop out, particularly from secondary schools, remains a major problem for poor households due to young people's involvement in livelihood activities, early marriage (especially women), poor communication network, etc.

The government introduced incentives such as scholarships for female students up to class eight, food for education, and these measures should be continued. Scholarship for male students should also be introduced for the poor to encourage them to send their children to schools. Vocational colleges should be established and skill development training programmes provided to create income opportunities for rural people.

10.16 Tourism, Cultural and Natural Heritage

The region is a prime attraction for tourists, drawn particularly to the Sundarbans and the many cultural heritage sites. But many cultural sites are poorly maintained and neglected due to low revenue return and inadequate budget allocation. This is an obvious area for government intervention. Consideration should be given to establishing a special committee and guidelines to ensure that commitments under the International Convention for the Protection and Promotion of Cultural Heritage, Historical Sites and Events are complied with, as well as to promote, maintaining respect for the cultural norms and properties and access by all peoples to cultural sites.

The Sundarbans is of global importance, as recognised by the declaration by UNESCO of three areas as World Heritage Sites. The problems generated by tourism in the Sundarbans (particularly noise and pollution) and recommendations are discussed in section 10.2.3.

It is recommended that a scientific study be undertaken during the first year of implementing the SEMP to determine the carrying capacity of the Sundarbans and the appropriate mix for tourism (low volume/high cost and high volume/low-cost). In general, there should be a preference for ecotourism.

Managing tourism will require a multi-sectoral coordinated approach. Projects to build tourist infrastructure (hotels and lodges, attractions, golf courses, access roads, associated sanitation and waste disposal facilities) should follow existing regulations with EIAs conducted and EMPs prepared and monitored. But such infrastructure should be prohibited in the Sundarbans Reserved Forest and protected areas. Rules are required setting out what developments and activities are permitted or restricted for different protected /restricted areas.

There is a need to ensure the tourism rules and guidelines are fully and effectively implemented, with greatly improved awareness-raising to ensure appropriate behaviour by tourists and tour operators, and the government departments/agencies of private sectors who control tourism activities in their respective areas.

10.17 Updating the Thematic Baseline Papers

13 thematic baseline papers were developed during the scoping phase (listed in Table 3.1) covering key issues that the SEA has addressed. Each presents information and trends based on latest available data. Collectively, they provide a baseline which will inform the monitoring proposed in the SEMP. The baseline papers are intended as rolling documents and it is recommended that the government give consideration to commissioning further work (through the proposed SEMP Coordinating Unit) to amplify these documents and regularly update them and, where necessary, to undertake and incorporate new analyses to expand the thematic papers to maximise their utility as a resource for implementing the SEMP.

10.18 Outstanding Universal Value of the Sundarbans

The SEA aims to assess the impacts of development in the SW region to ensure the sustainable development of the region and conservation of the Sundarbans, and to uphold its Outstanding Universal Value (OUV) – particularly within the three wildlife sactuaries that are designated as World Heritage Sites.

As Table 7.2 shows, under high growth over the next 20 years, and if the following 'factors' were to persist:

- existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced;
- no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development;
- the use of clean and sustainable technologies is not compulsory;
- the measures set out in the SEMP are not fully and effectively implemented.

then there are real risks that the cumulative impacts of projected developments in most of the key sectors would be likely to exacerbate exploitation and degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services in the Sundarbans. Furthermore, there will be increased volumes of liquid and solid waste from urban and industrial sources as well as noise and land degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion, etc.).

The pollution-related impacts would be felt more in the northern parts of the Sundarbans (closest to agricultural and aquaculture activities, urban and industrial areas) than in the southern parts where the World Heritage Sites are located, but it is not possible to give any weighting or scale to these impacts, nor to judge at this point just how they might affect the OUV of the WHS. But it is reasonable to assume that elevated levels of pollution may have some impact on flora and fauna. Research is recommended to assess the situation in detail.

The designation of the three wildlife sanctuaries in the coastal parts of the Sundarbans (East, West and South) was based on its Outstanding Universal Value (OUV) determined by two particular criteria:

> ***Criterion (ix):*** The Sundarbans provides a major example of on-going ecological processes as it represents the process of delta formation and the subsequent colonization of the newly formed deltaic islands and associated mangrove communities. These processes include monsoon rains,

flooding, delta formation, tidal influence and plant colonization. As part of the world's largest delta, formed from sediments deposited by three great rivers; the Ganges, Brahmaputra and Meghna, and covering the Bengal Basin, the land has been moulded by tidal action, resulting in a distinctive physiology.

Criterion (x): One of the largest remaining areas of mangroves in the world, the Sundarbans supports an exceptional level of biodiversity in both the terrestrial and marine environments, including important populations of globally endangered cat species, such as the Royal Bengal Tiger. Population censuses of Royal Bengal Tigers estimate a population of between 400 to 450 individuals , a higher density than any other population of tigers in the world.

Despite the difficulty mentioned above to draw precise conclusions on the scale of impacts on the WHS, Table 10.1 summarises the current and future likely status of the OUV of the WHS – as a result of human development in the SW region - under the two comparative situations used during the initial assessment of growth scenarios (Chapter 6) and the deeper assessment of high growth (Chapter 7): mitigated and risk (unmitigated) situations.

Table 10.1: Status of OUV of World Heritage Sites

Notes*:*

1.The risks indicated in the table are defined as follows:

Negligible:	*Highly unlikely to have an impact on OUV*
Low:	*Impacts are possible, but probably of low significance*
Moderate:	*Impacts are likely and will require mitigation to prevent degradation of the OUV*
Significant:	*Impacts are highly likely to occur and are expected compromise the OUV*

2. The influence of natural processes over which Bangladesh has no or little control (e.g. geological processes, climate change) are not considered. The table focuses on the influence on OUV of human development activities.

Criterion	Factors affecting the criterion	Current status	Future status (by 2041)	
			Mitigated situation (SEMP fully and effectively implemented)	**Risk situation (SEMP not fully and effectively implemented)**
(ix) Represents process of delta formation and the subsequent colonization of the newly formed deltaic islands and associated mangrove communities	Sedimentation *(affects delta formation)*	Sedimentation process is active but limited	Negligible risk of reduced delta formation.	Moderate risk of reduced delta formation *(if more upstream dams/barrages are constructed in neighbouring countries - trapping sediment)*
	Salinity *(affects colonization)*	Increased dry season salinity due to reduced freshwater flow in rivers.	Negligible risk of increased salinity *(due to increased dry season flow following dredging and intervention structures)*	Moderate risk of increased salinity *(as result of no dredging or intervention structures)*
(x) One of the largest remaining areas of	Loss of biodiversity	Increasing (for mega fauna)	Negligible risk	Low to moderate risk of loss

Criterion	Factors affecting the criterion	Current status	Future status (by 2041)	
mangroves in the world, with exceptional level of biodiversity in both the terrestrial and marine environments	Exploitation and degradation of habitats	Negligible	Negligible risk	Low risk
	Loss of ecosystem integrity and services	Negligible	Negligible risk	Low risk
	Pollution by liquid and solid wastes	Negligible	Negligible risk	Low to moderate risk
	Air pollution	Negligible	Negligible risk	Low risk
	Noise	Negligible	Negligible risk	Low to moderate risk
Conclusion			No change in OUV of WHS property	Low to moderate potential for degradation of OUV (scale unknown – requires research)

The SEMP sets out recommendations for research and continuous monitoring which will be necessary to determine changes in factors giving rise to negative impacts, and to determine if currently negligible or low-level impacts might be increasing due to cumulative trends.

10.19 Formalisation of SEA in Bangladesh

Stakeholder consultations (when the aims, modalities and benefits of SEA was presented) and discussions with key sector ministries revealed broad consensus that SEA should now be made a legal requirement in Bangladesh. It is recommended that the Ministry of Environment, Forestry and Climate Change (which has lead responsibilities for environmental matters), should initiate consultations within government in this regard. In addition, an SEA Regulation should be prepared to formally set out when SEA will be required, where responsibilities lie, procedures and formal requirements. The Regulation should be supported by guidelines (both generic and sector-based) on approach, methodological steps and available tools, etc.

Positive discussions along these lines have already been held between key sector ministries. The Department of Environment (Ministry of Environment, Forest and Climate Change) plans to make legislative changes to require sectoral SEAs and is preparing rules and a guideline for implementing SEA.

This SEA is the first such assessment of regional scope and multi-PPP complexity to have been undertaken in Bangladesh. It should provide useful lessons for the development of regulations and guidelines.

10.20 Follow-up SEAs for Key Sectors/Selected PPPs

Given the complexity and umbrella nature of this SEA, it has been conducted at a meta-level with a focus on growth scenarios and addressing 89 separate PPPs covering all key sectors. As a consequence, the SEA could not focus in detail on these sectors or individual PPPs. Nevertheless, even at a meta-level, the deeper assessment of the nine key sectors (Chapter 7), analysis of key impacts (Chapter 8) and cumulative impacts (Chapter 9) shows clearly that there is a risk of direct, indirect and cumulative impacts from developments over the next twenty years in the SW region – if appropriate and adequate mitigatory measures are not taken, as recommended in the accompanying SEMP. These impacts will arise from developments within the nine key sectors and as a result of interactions between them. Whilst the SEMP provides a mechanism to respond to the risks, there is also a remaining need to explore potential risks and impacts in much more detail on a sector-by-sector basis.

It is, therefore, recommended that a programme of more specific, sector-based SEAs be developed, building on the findings of this SEA, to be undertaken over the next 5-10 years. SEAs for the following are recommended - to be prioritised. Some are focused specifically on the SW region; others are national in scale (in italics) whilst also having relevance to the SW region:

- Mongla port and its further development, and shipping;
- *Power and energy generation and transmission;*
- *Industry;*
- Urban development in the SW region;
- *Transport (road, rail, water and air);*
- *Agriculture;*
- Fisheries (marine, freshwater and aquaculture);
- Water management infrastructure;
- Tourism.

Annex 8 outlines core issues that such SEAs should address.

10.21 Institutional Coordination

To ensure that the many interlinked possible negative impacts of high growth are effectively addressed (avoided, mitigated, monitored, regulated, managed, etc,) will require a significant improvement in institutional coordination, governance and supervisory oversight with adequate budgetary provisions. These issues are discussed in the accompanying SEMP.

10.22 Review and Revision of Existing Legal Instruments, Policies, Plans and Programmes

During the screening stage, 89 different PPPs were reviewed and details of their scope, objectives and main activities are provided in the Screening Report (March 2021). In addition, legal instruments (laws, regulations, rules, etc) relevant to all key sectors and areas of focus of the SEA are described in the Scoping Report (January 2021). Based on this analysis and review, a range of recommendations are made for many of these instruments regarding their possible revision or modification in order to address environmental and social issues of concern that have emerged during the SEA. These recommendations are set out in Annex 6.

10.23 Overall Conclusion

The SEA has responded to the concerns raised by UNESCO and others about the potential impacts on the Sundarbans of existing and planned developments in the SW Region. It has examined the impacts of current and planned future (over the next 20 years) developments in the SW region arising from implementing 89 policies, plans and programmes across multiple sectors. It has also taken into account transboundary pressures – those arising from neighbouring countries and elsewhere in Bangladesh. Bi-lateral and multi-lateral mechanisms will be required to address those issues of a trans-national nature. Example of such bodies that already exists are the Indo-Bangladesh Joint Rivers Commission (JRC) and the India Bangladesh Joint Working Group (JWG) on Conservation of the Sundarbans. These mechanisms can be used to raise and discuss transboundary impact issues and seek possible solutions.

The impacts have been addressed in terms of their significance for the region as a whole and its peoples, as well as for the Sundarbans. Clearly the government's development policies (particularly the Second Perspectives Plan: 2021-2041) will result in significant socio-economic benefits for the region. But this depends on various assumptions mentioned above (see section on Chapter 6) being fully met. But, if this is not the case, then there will be significant environmental and social risks which will generate significant environmental and socio-economic impacts – including significant economic costs.

The media, international and conservation organisations and others frequently assert that the Sundarbans is under threat from climate change and human development (particularly industrialisation). Some of the arguments advanced are somewhat emotive. This SEA has examined the available data and looked at the potential environmental and socio-economic risks of rapid development in the SW region (as a whole). These risks are particularly significant for the broader SW region and its peoples (particularly their health and livelihoods), but less so for the majority of the Sundarbans. The risks – for both the region and the Sundarbans - can be minimised and managed through implementing the SEMP and provided there is full and effective implementation of environmental and socio-economic safeguards, laws, regulations and guidelines, and the use of clean (green) and sustainable technologies for future developments.

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Note: The references below are those specifically cited in this report. A full list of all publications referenced during the SEA process is provided in the Final Scoping Report (January 2021).

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Annexes

1. Terms of Reference
2. The SEA Team
3. Initial Assessment of Growth Scenarios
4. Deeper Assessment of Key Sectors under High Growth Scenario
5. Members of SEMP Liaison Group
6. Recommendations for PPPs and Legal Instruments (Laws, Regulations, Rules)
7. Indicators and Projections for Scenarios
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Annex 1: Terms of Reference

Note: The Terms of Reference were revised during the Inception Phase and are contained as Appendix 1 of the approved Inception Report

1. Introduction

The Sundarbans is unique and has both local and global significance due to its diversity and rich ecosystems. The government's overall approach and vision is that the country's rapid growth and accompanying infrastructural and other developments must be eased-in and undertaken in a manner that safeguards natural resources and ecosystems, avoids negative environmental and socio-economic impacts and is sustainable; fulfilling both Vision 2021 and Vision 2041. In this context, the present government has commissioned a visionary initiative to undertake a comprehensive Strategic Environmental Assessment (SEA) for the sustainable conservation of the Sundarbans. This study aims to support striking a dynamic balance between the biodiversity and ecosystem services of the SW region and the Sundarbans and the current development drive to become a developed country by 2041.

Since independence in 1971, the nation has strived to pursue gradual and sustainable development. It culminated in the drive for the country's sustainable development agenda through striking a "right balance" between equitable national economic progress, human development and sound environmental management and protection. The present government initiated bold steps, widespread collaboration and unprecedented innovation to fast track the country's rate of development. To achieve developed country status, the nation has established new development paradigm through innovative approaches aimed at introducing a cohesive and integrated management system to ensure long-term sustainability, backed by integrated environmental strategies. Thus, an SEA is necessary for assessing the positive/negative, direct/indirect, domestic/transboundary and cumulative environmental and social impacts of development in the SW Region, including on the integrity and functioning of the Sundarbans and its Outstanding Universal Value, to inform future policies and decisions regarding development in the region.

Strategic Environmental Assessment (SEA) is a tool for assessing the environmental and socio-economic implications of policies, plans and programmes (PPPs) and ensuring the integration of these implications into their formulation and implementation. According to the Organization for Economic Cooperation and Development (OECD), **"***SEA comprises analytical and participatory approaches to strategic decision-making that aim to integrate environmental considerations into policies, plans and program, and evaluate the inter linkages with economic and social considerations."*

Thus, in line with this OECD guidance, the present government has prioritized the consideration of environmental and socio-economic considerations in planning for the overall development of the South West Region.

The SW region is blessed with the Sundarbans, the largest mangrove forest in the world. This vast forest is also a wildlife sanctuary located at the delta of the Ganges River on the Bay of Bengal. The Sundarbans has been declared as a Ramsar site in 1992 and parts of the Sundarbans were designated by UNESCO as World Heritage Sites in 1997. The Sundarbans has received recent global attention due to concern about the consequences of the current drive towards development and existing and future challenges. Subsequently, UNESCO WHC requested the State Party, Bangladesh, to undertake a comprehensive Strategic Environmental Assessment (SEA) (Decision 38 COM 7Bb.64 and 39 COM 7B.8) to assess the positive/negative, direct/indirect, domestic/transboundary and cumulative impacts at a landscape and regional scale and to uphold its Outstanding Universal Value (OUV).

The South West region is rapidly developing to achieve the national visions and goals and, subsequently, the government has formed policies, plans and programs (PPP) for development of the area through contributions from both the public and private sectors. An SEAis pivotal in assessing the environmental

and socio-economic impacts of development (current and planned) in the South West region and contribute to the formulation of PPP's and influence the decision-making process.

The SW region of Bangladesh has high prospects for development thrusts, but is lagging behind the rest of the country in achieving the present development trajectory. The present government has thus taken this SEA initiative to boost socio-economic development of the region and at same time to ensure balance between development and the conservation of natural resources on a priority basis.

This SEA will cover the PPPs related to nine sectors namely, forestry, fisheries, water, power and energy, tourism, urbanization, industry, transportation/ communication and shipping.

2. SEA Project Area

Bangladesh is situated at the tail-end of the mighty Ganges-Brahmaputra-Meghna (GBM) river basins and as such, drains the entirety of flow generated within these basins. Being part of a network this massive, the country holds contrasting hydrological features which prompted its division into eight unique hydrological regions during the formulation of the National Water Management Plan (NWMP) in 2001.

The SEA covers the South Western Region of Bangladesh (see Figure 1), It is a rich coastal region and is home to the Sundarbans, the largest contiguous natural mangrove forest in the world. The study region comprises the South West hydrological region, fed primarily through the Ganges River System. This region is crisscrossed by a complex network of rivers and streams of varying hydrological and morphological characteristics providing a lifeline to the ecosystems of the region including that of the Sundarbans. The downstream flow from Ganges is via several river systems: The Gorai-Madhumati, Kapatakshya, Mathabhanga, etc. The four major river systems flowing through the Sundarbans are the Raimangal, Arpangasia, Sibsa-Passur and the Baleshwar.

Being primarily dependent on the Ganges flow, temporal decrease of downstream freshwater flow combined with progressing salinity intrusion – argued to result from climate change induced sea level rise and decreased upstream freshwater flow – has rendered this region vulnerable to natural disasters and has also greatly affected the ecosystem as well as livelihood of the people. Any future development scheme for the region has to be implemented keeping in mind the possible long-term as well as short-term impacts it might exert on the biodiversity and ecological balance of the region, especially the Sundarbans, and socio-economic conditions. A strategic environmental management plan will therefore greatly help in reinforcing a secured future for the region.

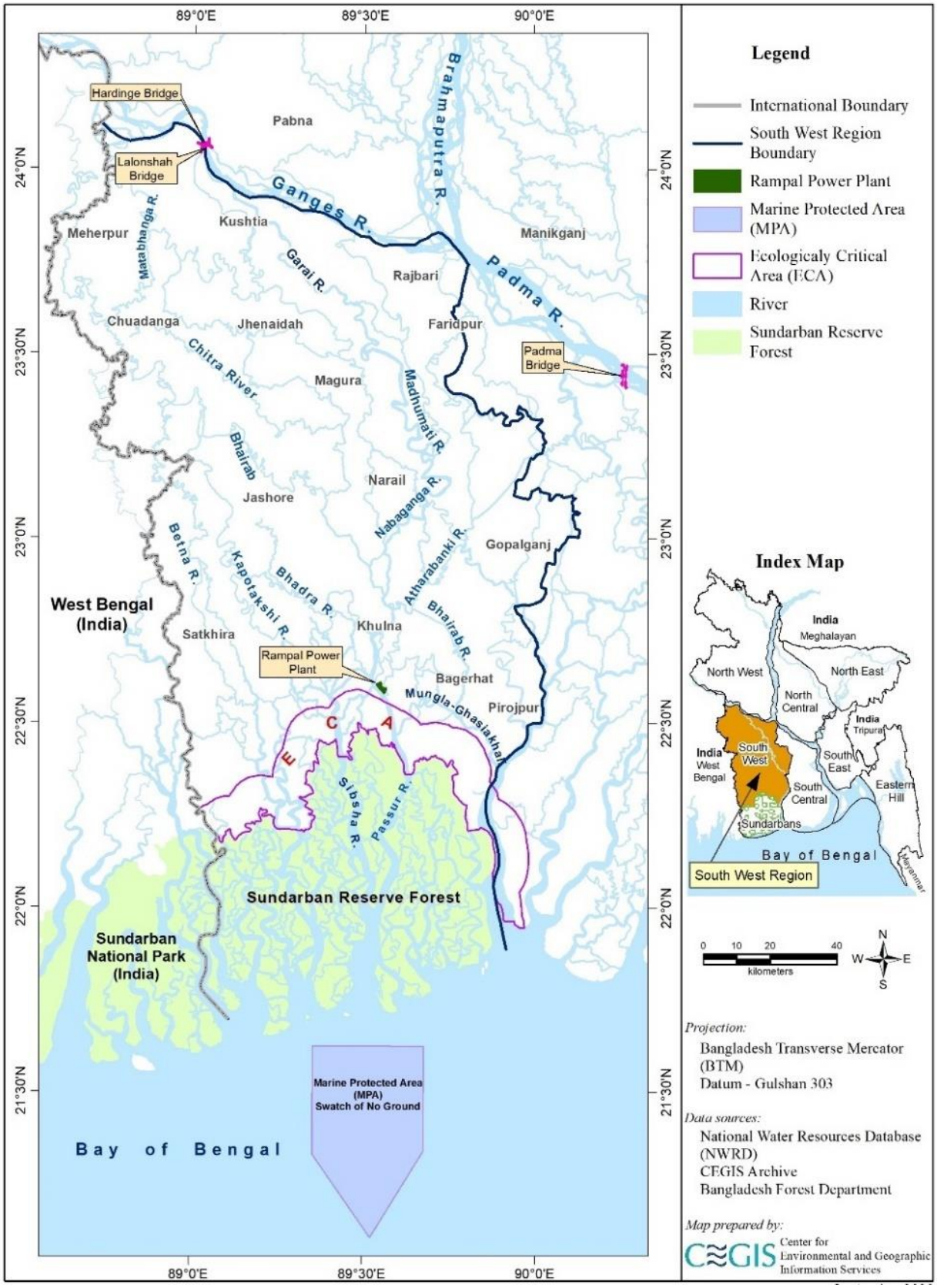

Figure 1: Map of the South-Western Region

3. Objectives

The following specific objectives have been for carrying out the SEA study:

- Consideration of environmental and socio-economic consequences of existing PPPs (national and SW region) that cover the SW Region and promoting that these issues be addressed when formulating and implementing future, as well as existing, PPPs with a view to promoting sustainable development in the region and conservation of the Sundarbans and its Outstanding Universal Value;
- Simultaneous assessment of the impacts of development initiatives on existing bio-physical settings and socio-economic conditions to facilitate informed decision-making regarding transitioning towards a sustainable, resilient and resource efficient economy;
- Identification of key stakeholders relevant to selected sectors and organizing consultation meetings to obtain knowledge on existing bio-physical settings and socio-economic conditions, impacts of current and proposed developments, and potential strategies for future development of the SW region;
- Development of alternative strategies to minimize the direct/ indirect, domestic/ transboundary and cumulative impacts of development on the Sundarbans and more widely in the South West Region;
- Make recommendations to improve environmental performance management in both the public and private sectors as regards future development activities; and
- Formulation of a comprehensive framework in the form of a Strategic Environmental Management Plan (SEMP) for the SW region to support decision making and monitoring of the implementation of policies, plans and programs that are likely to affect the environment and socio-economic conditions of the region and in particular the Sundarbans.

4. Scope of Works

4.1 Screening of relevant policies, plans and programmes (relevant to the period up to 2041) for both the public and private sectors - for key economic sectors, particularly: forest, fisheries, water, power and energy, industry, tourism, transportation and communication, urbanization and shipping - to identify those with potential to result in environmental and socio-economic impacts in the South West Region, including the Sundarbans, that will be addressed during the SEA.

4.2 Scoping to:

- Identify key sources of data and information – building on preliminary work undertake during the inception phases;
- Identify and summarize key laws, regulations, policies, strategies that concern environmental management and social conditions, and international commitments and conventions that Bangladesh is a signatory to;
- Review institutional roles, responsibilities and capacities as regards environmental management (national, SW regional and local levels);
- Review past regional, national and international studies, plans, reports and environmental/social assessments for relevant information that can support the SEA;
- Undertake stakeholder analysis (particularly as regards the nine key sectors) and prepare a participation strategy;
- Undertake key stakeholder consultations and organize workshops at national, regional and local levels – to:
    - explain the SEA (reason and process),
    - identify baseline data and development initiatives,

  - enable consultees to assist in scoping key issues and identifying SEA objectives; and record issues raised;
- Review of aims, objectives and key themes of selected PPPs;
- Initiate collection of baseline data and commission new research/field studies (where critically needed);
- Deepen identification of, and prioritize, key environmental and socio-economic issues that the SEA should take into consideration, including:
  - key environmental issues and challenges imposed by both natural and human interventions that significantly impact the region and the conservation of the Sundarbans (including those that are transboundary, i.e. arise from other regions of Bangladesh and from India);
  - current and potential sources of pollution as well as pollutant carriers that are important for human heath, ecosystem functioning, and for conservation of the Sundarbans;
- Based on key themes and issues identified in reviewed PPPs and raised during consultations, develop draft SEA objectives, targets and indicators (including those specific to the Sundarbans) to provide a framework for assessment and monitoring PPPs during SEMP implementation;
- Prepare a draft baseline environmental and socio-economic profile of the South West Region, including a baseline describing the current environmental and ecological status of the Sundarbans;
- Circulate/disclose the draft scoping report for stakeholder and public comment;
- Update of scoping report in response to comments.

4.3 The main assessment to:

- Undertake scenario analysis using key drivers of change to inform preliminary environmental and socio-economic assessment of possible economic growth trajectories (high, moderate, business-as-usual),
  - Undertake initial assessment of environmental and socio-economic impacts of alternative economic growth trajectories.
- Prepare an interim SEA report covering the assessment of these trajectories and circulate to stakeholders for comment.
- Workshop for national level committee/steering committee review findings and confirm the preferred economic growth trajectory for deeper assessment.
- Detailed assessment of environmental and socio-economic impacts of the preferred alternative trajectory (positive/negative, direct/indirect, domestic/transboundary, cumulative, synergistic or antagonistic) relevant to the nine key sectors, including
  - Analysing the available results of existing modelling of environmental and socio-economic factors (mainly those obtained using internationally recognized modelling tools);
  - Undertaking new modelling, where appropriate, of key environmental factors (e.g. water quality, air quality, energy generation and use, energy and transport-related emissions, etc.) to estimate probable future pollution levels and subsequent impacts;
- Identify options to enhance positive impacts and minimize/mitigate negative ones
- Continue throughout this stage to marshal and analyse available baseline data and new data from any commissioned studies;
- Continue engagement with stakeholders;

4.4 Prepare draft final SEA report - covering:

- Methodology used
- Overview of public/stakeholder engagement activities undertaken
- Baseline profile
- Key issues addressed, including summary of stakeholder concerns and expectations, and how these have been addressed
- Description of authorities, jurisdictions and key institutions – their roles and responsibilities.
- Policy, legal and administrative framework.
- Development scenarios
- Initial assessment of significant environmental and socio-economic impacts of scenarios
- Deeper assessment of significant environmental and social impacts of preferred scenario.
- Conclusions and recommendations, e.g.
    - For avoidance/mitigation of negative impacts and enhancement of synergies and positive impacts.
    - For how existing PPPs might need to be adjusted/revised to minimize/mitigate potential negative environmental and/or socio-economic impacts, and how planned PPPs will need to address such potential impacts.
    - Recommendations for the integration of environmental principles such as polluter pay principle and the precautionary principle in the development, appraisal, and selection of PPPs;
- References
- Appendices

4.5 Prepare a draft Strategic Environmental Management Plan (SEMP) for the SW Region, and Sundarbans, with

- identified measures for monitoring the implementation of PPPs
- identified institutional roles and responsibilities and
- an auditing procedure for compliance with the SEMP.

5. Documents to be submitted with the proposal

- Original copy of Joint venture signed agreement on non-judicial stamps.
- Certification from the implementing agency for completion/ongoing of SEA by the consulting firm (at least for those SEA works mentioned in the EOI proposal).
- Report of at least one completed SEA work by the firm mentioned in the EOI proposal.

6. Approach and Methodology

The methodology to be followed is largely implied in section 4 above.

6.1 SEA Conducting Approach

The SEA will evaluate environmental and socio-economic impacts of development in the SW Region and make recommendations to improve the management of existing as well as emerging risks to the SW Region and the Sundarbans. It will be carried out in accordance with the SEA international best practice and the OECD DAC SEA Guidelines, through a multi-tiered approach which will include conceptualization of the study, identification of policies, plans and programs to be assessed, as well as issues to be addressed,

consulting pertinent stakeholders, development of baseline environmental and socio-economic profile, and formulate alternative development economic development trajectories to be initially assessed.

The SEA will also be conducted in accordance with the eight UNESCO World Heritage Impact Assessment Principles that covers certain aspects such as ensuring rigorous environmental assessment of the multi-dimensional impacts of development programs and formulation of a Strategic Environmental Management Plan SEMP), that incorporates measures for monitoring the implementation of PPPs and auditing compliance.

6.2 Methodology

6.2.1 Screening

Screening will be carried out to identify relevant PPPs which should be assessed during the SEA. Screening will be based on criteria to determine whether the PPPs are likely to result in significant environmental or socio-economic impacts in SW Region and/or the Sundarbans, having regard to their probability, duration, frequency, reversibility, and cumulative nature etc.

6.2.2 Scoping

Scoping will be carried out to identify key elements of selected PPPs and environmental and socio-economic issues which will be the main focus of the SEA. This will be through a series of tasks stated below:

a. Determining key elements of PPPs

The key elements of PPPs such as goals, objectives and strategic aims of selected PPPs will be reviewed and activities that will be likely to follow from their implementation will be identified. Elements will be identified through processes such as review of relevant documents, brainstorming sessions between relevant government and non-government agencies as required. Strategic aims under individual PPP may include the development of projects, investment in new technologies etc.

b. Determination of key environmental and socio-economic issues

Key issues will be identified through: the review of PPPs and key documents; consultations with stakeholders (government, private sector, civil society/NGOs, experts and others) – at national-regional-local levels; interviews with key informants, focus group sessions, and workshops.

c. Literature Review for Secondary Information

The study will identify and review existing policies, laws, regulations and institutions (at national, regional and local levels) relevant to the study. The review of institutional arrangements, roles, responsibilities and capacities at all levels will include identifying those institutions whose activities may affect the SW Region and Sundarbans. A review of relevant research studies, reports and environmental assessments will also be carried out to determine useful information to inform the SEA.

d. Preparing an environmental and socio-economic baselines profile

An Environmental and Social Profile of SW Region will be prepared covering all relevant factors and including the current status of the nine selected sectors and the Sundarbans. To aid this process, necessary information will be collected from available sources. Where relevant, baseline data will be assigned to a suitable year/ period. Where relevant and of a priority nature, field surveys will be conducted to collect primary data.

e. Development of Objectives, Indicators and Targets

For each of the key environmental and socio-economic issues, objectives will be identified, drawn in part from those contained in existing national and regional policies, plans, strategies and international

commitments and associated memoranda of understanding. These objectives will provide a basis for impact assessment – assessing whether particular impacts will enhance or impede achieving individual objectives. For each objective, indicators will be identified (realistic indicators capable of being measured) to provide a qualitative or quantitative measurement (as appropriate) of progress towards achieving the objective, using internationally recognized indicators where appropriate. These will be used in implementing the SEMP.

f. Stakeholder Identification and Analysis

Stakeholder mapping will be done to identify pertinent stakeholders (including government institutions, private sector organizations, NGOs/CSOs and civil society) based on whether they will influence the implementation of proposed policies, plans and programs or in turn, be affected by or have a legitimate interest in them. Standard social tools (such as FGD, PCM) will be used for stakeholder analyses.

g. Consultation with stakeholders

The SEA scoping process will start through key informant interviews, focus group sessions and consultative meetings among the different stakeholders relevant to the nine sectors as well the Forest Department and Department of Environment. Such consultations will be carried out at national, SW regional and local levels. This will be done specifically to get a better understanding of the main objectives of the PPPs and stakeholder views, concerns and perspectives on them, and to identify key environmental, social, economic other issues to be addressed by the SEA and in the planning process.

h. Site visits

Field visits will be made to the study area for familiarization, consultative meetings and to observe conditions and features on the ground and identify issues/concerns that will need to be considered in the SEA. These include sensitive ecological features, industrial and manufacturing sites, urban areas, land use practices, areas vulnerable to climate change factors (eg sea level rise, increased salinity) and environmental and socio-economic challenges. The areas to be visited will be identified during the inception phase.

i. Key informant interviews

Key informants will be identified by the Team and experts of the MoEFCC. They will consist mainly of BFD and DoE officials, officials from the Local Government, Ministry of Forest officials, government officials from Power Development Board and Bangladesh Water Development Board and officials from the related public and private agencies, international NGOs. Public representatives and local leaders in SW Region will be also interviewed. Other officials from associations such as the Chamber of Commerce and domestic NGOs/CSO among others will also consulted.

6.2.3 Preparation of Scoping Report

A draft scoping report will be developed to inform pertinent stakeholders about key elements of the PPPs, key environmental and socio-economic issues to be addressed with the aim of generating interim feedback that will help in finalizing the focus of the SEA. Following stakeholder feedback, a final scoping report will be prepared.

6.2.4 The main assessment stage

a. Identification of alternative economic growth trajectories

Scenario analysis will be undertaken to identify inform analysis and an initial assessment of impacts for alternative macro-economic growth strategies. A preferred strategy will be confirmed by the Ministry of Environment, Forest and Climate Change in consultation with other government agencies and stakeholders. This preferred strategy will then be subjected to deeper assessment.

b. Assessing potential environmental and socio-economic impacts

This will involve an initial assessment of the likely impacts (positive/negative, direct/indirect, domestic/transboundary, cumulative, and synergistic/antagonistic) of activities likely to arise under the possible alternative macro-economic growth strategies, and a subsequent deeper assessment of the preferred strategy. The SEMP will recommend how any likely negative impacts will be addressed (minimized or mitigated) and how any likely positive impacts may be enhanced and maximized This SEA process will include the following tasks:

c. Predicting impacts of developments arising under the macro-economic growth strategies and assessing significance

Positive/negative, direct/indirect, domestic/transboundary, cumulative and synergistic/antagonistic environmental and socio-economic impacts of implementing PPPs under the macro-economic growth strategies will be assessed. Where appropriate, impacts will be assessed in respect to base condition using internationally accepted standard mathematical modeling tools and techniques. Where possible, this will identify significance based on, for example, the nature and extent of change, the frequency of impact and probability of recurrence.

d. Mitigation of impacts

Strategic measures will be recommended to minimize and mitigate impacts based on their level of significance. It will involve preventive measures as well as reduction of magnitude or probability of occurrence. Remedial measures will also be recommended where impacts have already occurred. The SEMP will focus first on avoiding potential negative impacts and secondly on reducing unavoidable residual impacts.

Finalization of SEA

Presentation of findings

The SEA Consultants team will synthesize and harmonize the study findings in a draft final SEA report and draft SEMP and present these at a multi-stakeholder validation workshop. Feedback will be incorporated as appropriate.

The provisional contents of the draft final SEA report are listed in section 4.4.

The draft SEMP will set out a framework for monitoring the impacts of implementing the selected PPPs and auditing compliance.

7. SEA Consultancy Outputs

- Inception, screening and scoping reports
- SEA report
- Strategic EMP for SW Region and Sundarbans including Monitoring and Auditing frameworks

Annex 2: The SEA Team

1. About CEGIS

The Centre for Environmental and Geographic Information Services (CEGIS) was established in 2002 as a national institution and a public Trust. It functions as a self earning, not for profit Trust under the aegis of the Ministry of Water Resources with a 15-member Board of Trustees.

CEGIS is the only scientifically independent organization in Bangladesh for integrated environmental analysis using GIS, Remote Sensing (RS), IT and databases. It provides solutions to issues and problems regarding water resources, land resources, agriculture, fisheries, engineering, transportation and environment, etc., and recommends technical options based on local realities that are feasible from the socio-economic and institutional point of view.

CEGIS is a multidisciplinary group of highly qualified scientists and technical professionals. 130 of the 200 staff are professional experts in different disciplines including:

- forms of integrated environmental and social analysis and assessment, baseline studies and monitoring studies;
- preparation of environmental guidelines and resettlement action plans;
- analytical framework for planning for integrated water resources management (IWRM);
- spatial analysis using GIS and RS for flood monitoring, drought assessment and monitoring, river plan-form changes, river erosion and accretion prediction, flood damage assessment;
- development of Digital Elevation Model (DEM),
- land-use planning, urban planning;
- database management and IT, and development of web based spatial database, MIS and decision support systems (DSS) for planning, designing, implementation and monitoring of water sector projects, etc.

https://www.cegisbd.com/

2. About Integra Consulting

Integra Consulting is based in Prague, Czech Republic. It has been providing expertise in strategic environmental assessment (SEA), environmental impact assessment (EIA), sustainable development, climate change adaptation and eco-innovations since 2006. By operating in many regions and countries (from Western Europe to South-East Asia), Integra's projects cover a large diversity of actions from policy advisory and strategic planning to field implementation including inventories.

https://www.integracons.com/

3. The team

The individual experts in the team are listed in Table A2.1.

Table A2.1: Team members

Name	Expertise/Responsibility	Organization
Prof. Barry Dalal-Clayton, PhD	Team Leader	Integra
Zahir Uddin Ahmed	Deputy Team Leader	CEGIS
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Dr Peter Tarr	Environmental assessment	Integra
Dr Vladislav Bizek	Environmental modelling	Integra

Name	Expertise/Responsibility	Organization
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Mir Sajjad Hossain	Transboundary water management	CEGIS
Motaleb Hossain Sarker	Tourism	CEGIS
Dr Mahmood Hossain	Mangrove ecology	CEGIS
Dr Dilruba Ahmed	Gender and stakeholder participation	CEGIS
Md. Shahidul Islam	Remote sensing	CEGIS
Dr Mohammad Zashim Uddin	Plant taxonomy	CEGIS
Jalal Ahmed Choudhury	Power and energy	CEGIS
Dr Kazi Md. Noor Newaz	Ecology and biodiversity; and legal and regulatory review	CEGIS
Dr Chowdhury Saleh Ahmed*	Policy and institutional affairs	CEGIS
Dr Moinul Hossain	Land transportation	CEGIS
Md. Tariqul Islam	Forest management	CEGIS
Apurba Kumar Sarker	Economic policy planning and investment	CEGIS
Capt. Md. Sayedul Hoque Khan	Water navigation	CEGIS
Md Mustafizur Rahman	Sociologist	CEGIS
Mohammad Abdur Rashid	Agriculture and land use	CEGIS
Kazi Kamrull Hassan	Environmental planning	CEGIS
Dr Farhana Ahmed	Transportation and infrastructure planning, and scenario development	CEGIS
Mohammed Mukteruzzaman	Fisheries	CEGIS
Sarazina Mumu	Urban development	CEGIS
Md. Firoz Alam	GIS data analysis and mapping	CEGIS
Sudipta Kumar Hore	River morphology	CEGIS
Laila Sanjida	Tourism	CEGIS
H. M. Nurul Islam	Water quality and pollution	CEGIS
Mushfiq Ahmed	Biodiversity and wildlife	CEGIS
Dr Md Shibly Sadik	Environment and disaster management	CEGIS
Md Shifuddin Mahmud	Livelihoods	CEGIS
Tanvir Ahmed	Flood modelling	CEGIS
Bhuiya Md Tarmin Al Hossain	Climate change modelling	CEGIS
Kushal Roy	Climate change	CEGIS
Pronab Kumar Halder	Industry and power	CEGIS
Md. Monowar-ul Haq	Water resources management	CEGIS
Ahmmed Zulfiqar Rahaman	Hydrology and climate change	CEGIS
Mohammad Kamruzzaman	Ecology and biodiversity	CEGIS
Abdul Halim Farhad Sikder	Soils and environment	CEGIS
Md. Ashis Mawla	Education	CEGIS
Faisal Ahmed	Security, conflict and power structure	CEGIS
Hifzur Rahman	Public health	CEGIS
Tanvir Ahmad Rifat	Population and demography	CEGIS
Amith Dutta	Ethnicity and culture	CEGIS
Md. Alamgir Hossain	Stakeholder engagement	CEGIS
Abul Kashem Md Hasan	Website development	CEGIS
Md Anisur Rahman	Website development	CEGIS

** Sadly Dr Mercier passed away on 5th July 2020 and Dr Chowdhury Saleh Ahmed passed away on14 December 2020.*

Annex 3: Initial Assessment of Growth Scenarios

Annex 3.1 Initial Assessment of High Growth Scenario

Annex 3.2 Initial Assessment of Medium Growth Scenario

Annex 3.3 Initial Assessment of Low Growth Scenario

Annex 3.1: Initial Assessment of High Growth Scenario

Scoring reflects whether the suite of developments likely to arise under each scenario will enhance (+ scores) or impede (-ve scores) achieving the objectives

Range of scores
Very significant and significant negative scores: '-5' and '-4' respectively. Very negative score: '-3'. Moderately and slightly negative scores: '-2' and '-1' respectively.
Neutral [0]
Very significant and significant positive scores: '+5' and '+4' respectively. Very positive score: '+3'. Moderately and slightly positive scores: '+2' and '+1' [add tone] respectively.

R: Risk score: where existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced, and/or where no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory.

M: Mitigated score: where existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced, and the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

			Score			Comments
				R	M	To justify or explain score, or illustrate how objective will be enhanced/impaired, or indicate how score can be improved by mitigation
Environmental						
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	R	-4		• Inadequate flow of freshwater will increase salinity resulting loss of Sundri habitat and impaired rejuvenation • High increase in pollution due to high increase in industrialization, power generation, transport (including coal) and urbanisation • Increase of anthropogenic pressure • Inadequate forest protection
			M		+4	• Significant increase of dry season fresh water flows due to appropriate government interventions • Significant reduction of anthropogenic pressure • Significant decrease of pollutants with strict enforcement of regulations and protection measures • Significant increase in prey base for Tiger and Dolphin habitat. • EMP and regulations are fully enforced including coal transportation.
	2		R	-3		• Very poor protection measures and co-management plan not effectively implemented

			Score			Comments
		Reduce illegal activities related to protected areas and biodiversity				• Reserved forest is more vulnerable when regulations not effectively implemented • WHS is deep in the reserved forest and not easily accessible (and only in dry season)
			M		+4	• Significant improvement in protection measures through strict enforcement of legal mandates using SMART tools • Strict implementation of co-management plan • Negligible dependence on forest due to alternative income opportunities
	3	Reduce introduction and spread of Invasive Alien Species	R	-3		• Very poor agricultural & aquaculture practices • Inadequate measures to manage spread of water hyacinth • Increased eutrophication due to increased use of chemical fertilisers
			M		+4	• Highly improved agricultural & aquaculture management practices • Significant increase in multipurpose use of water hyacinth as bio-fertiliser, cattle feed and for seed beds etc. • Appropriate measures to minimise the growth of water hyacinth adopted (e.g. plans and deployment of mechanical equipment) • Participatory approaches for management of water hyacinth applied
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	R	-3		• Very poor management of wastes; inadequate treatment & recycling facilities
			M		+4	• Significant improvement in waste collection, treatment and recycling
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	R	-3		• High increase in industrialization, power generation, urbanization and motorized transport • Inadequate implementation of pollution control and inadequate investment in control and clean technologies
			M		+4	• Significantly increased dry season flow resulting in reduced water pollution • Switch to LPG • Better eco-friendly transport and clean technology • Improved enforcement of regulations • Pollution control technologies applied in power plant and other industries • Improved ability to deal with impacts of transboundary pollution • Green technology applied in brick manufacturing
	6	Minimise emissions of greenhouse gases	R	-3		• Increased agricultural production (bio-wastes, increased livestock) • Increased emissions from power generation & industry

			Score			Comments
						• Limited measures for energy efficiency • Limited support for renewable energy
			M		+1	• Increased afforestation and reforestation in SW region • Switch to LPG • Use eco-friendly transport and clean air technology • Increased measures for energy efficiency • Increased support for renewable energy
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity intrusion in rivers, floods, storm surges, etc.)	R	-4		• Inadequate measures for adaptation & mitigation (e.g. embankments, cyclone shelters, warning system, announcements, etc.)
			M		+4	• Significant increase of dry season flow resulting decrease in extent of salinity intrusion. • Significant improvement warning system and increased number of shelters • Adequate adaptation & mitigation measures implemented (embankments strengthened, coastal afforestation)
Water	8	Increase dry season freshwater flow in rivers	R	-3		• Inadequate dredging • Increased extraction for industries & power plants
			M		+4	• Significant investment in augmentation intervention (dredging and diversion facilities) • Well managed forests enhances infiltration and dry season release of water
	9	Reduce high/peak flows in rivers during monsoon season	R	-2		• Inadequate investment in flow control measures
			M		+2	• Controlled flow due to government intervention
Land degradation	10	Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion, etc)	R	-3		• Inadequate implementation of SLM practices • Inadequate erosion control measures • Increase in shrimp farming may increase soil salinity
			M		+3	• Effective implementation of SLM practices. • Extensive erosion control measures in place.
Land use change	11	Minimise conversion of agricultural land (e.g. conversion to shrimp ponds)	R	-3		• Shrimp is high value – significantly more people investing in shrimp farming and significantly more land converted from agriculture to shrimp
			M		0	• Effective implementation of land zoning (designated use zones). New shrimp farms now not allowed on agricultural land

			Score			Comments
Socio-economic						
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	R	-3		• Inadequate investment and incentives (financial and fiscal) for industrial growth • Poor competitiveness compared to other countries due to inadequate skills and training and poor support services for industrial development • Inadequate product diversification
			M		+4	• Adequate availability of energy and other facility in place[86]. • Consistently good governance in place. • Complete transformation of the rural agrarian economy to a primarily industrial and digital economy. • All 7 economic zones are operational • Jute mills are fully functional • Substantially increased productivity due to new technologies/innovation/ intensification • Substantial investment and incentives (financial and fiscal) for industrial growth. • A significant increase in freight transport. • A significant increase in the volume of exports via Mongla sea port
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	R	-3		• Inadequate job opportunities due to partial operation of economic zones and jute mills etc. • Inadequate investment and incentives (financial and fiscal) for industrial growth • Poor competitiveness compared to other countries due to inadequate skills and training and poor support services for industrial development • Inadequate product diversification
			M		+3	• Strong economic growth (see Objective 12) boosts employment opportunities
Health and sanitation	14	Improve health services and health of society (eg by reducing vulnerability to diseases)	R	-1		• Even though there might be inadequate investment in health sector, a growing number of people can afford private health services
			M		+3	• Increased investment in health sector • Substantial increase in coverage of and access to health facilities

[86] Adequate refers to the demand for energy under this scenario in relation to population growth

			Score			Comments
	15	Improve and extend water supply and sanitation services	R	-3		• Inadequate investment in services, and existing facilities fail to cope with increased demand as population grows.
			M		+4	• Very high investment in services
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	R	-1		• Private sector will increase education services, but government investment is still inadequate. • Existing government tertiary level facilities fail to meet demand from growing population • Families must rely on private tertiary level institutions - but struggle to fund. • Poor transport/infrastructure hinders access to schools • Inadequate number of school level teachers.
			M		+4	• Education services and facilities are adequately available by both public and private sectors investment. • Public increasingly willing to pay for education • Government & private sector will increasingly provide financial support (e.g. bursaries, scholarships)
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	R	-2		• Inadequate provision of urban facilities in rural areas • My Village My Town' programme poorly implemented • Continuing strong 'pull factor' of urban centers • Migration may increase due to climate vulnerability.
			M		+4	• 'My Village My Town' programme (creating urban facilities in rural areas) will highly discourage out migration • Significant expansion of agro-based manufacturing in villages • Increased development of growth zones (providing job opportunities)
Women and children	18	Improve gender equality and empowerment of women	R	0		• Women's participation in income generation activities and jobs will continue to occur due to investment as well as their enhanced level of education and skills
			M		+4	• Significant number of women participate in income-generating activities and wide range of decision-making process • Highly significant number of women are involved in formal education and skill development under very good enabling environment created by the government
Social inclusion	19	Increase the inclusion of landless and marginal land holders in	R	-2		• Inadequate implementation of programs focused on poor/landless; and landless/poor are not prioritized or targeted • Inadequate micro credit support for small businesses

			Score			Comments
		development activities in SW region	M		+3	• High increase in job opportunities – targeting the vulnerable people • Implementation of programs targeted more at landless/poor • Micro credit support for small businesses
Conflicts and security	20	Reduce conflicts over use of land	R	-3		• Deficient governance regarding land management (e.g. very poor implementation of land use zoning, inefficient land administration and lack of transparency regarding land records and title deed filing system)
			M		+2	• Efficient governance regarding land management (e.g. greatly improved implementation of land use zoning, land administration and transparent land record and title deed filing system)
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.) and also Sundarbans natural heritage sites	R	-2		• Inadequate investment in management of heritage/cultural sites, with deterioration/degradation of sites
			M		+3	• More investment in management of heritage/cultural sites (including use of SMART tools) • Increased public awareness will help better manage and maintain the sites • Improved enforcement of environmental rules and regulations
Food	22	Improve food security	R	0		• Inadequate subsidies (for fertilisers, pesticides, seeds) • Food production will gradually improve because of new investments in technologies and varieties • Food supply may be ensured through import and distribution
			M		+4	• Food production will improve significantly because of increased investments and use of technologies and better varieties • People can afford better quality food • Increased economic growth allowing food imports • Government interventions when crises arise
Agriculture and fisheries	23	Increase agricultural and fish production	R	0		• Production will gradually improve because of new investments in technologies and varieties • Some investment in new technologies and improving management
			M		+4	• Production will improve significantly because of increased investments and use of technologies and better varieties • Significant investment in mechanization • Increased use of smart and new technologies • Improved management through increased community level participation resulting in sustainable fisheries resources.

			Score			Comments
Power and energy	24	Increase uptake of renewable energy	R	-1		• Inadequate investment in technologies, subsidies and maintenance
			M		+3	• Significant investment in technologies and increased subsidies
	25	Increase efficiency in production and consumption of energy	R	0		• Inadequate production compared to increased demand • Inadequate investment in technologies and inadequate improvement in management • Inefficient use of installed capacity
			M		+4	• Significant investment in technologies and improved management • Increased awareness and use of efficient energy
	26	Increase access to affordable energy	R	0		• Inadequate government subsidies for enhancing low-cost energy options
			M		+4	• Increased investment and subsidies for low-cost power generation • Expansion of energy trade
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts	R	-1		• Increased tourists with poor management • No improvement in quality of tourism experience • No improvement of services and facilities in tourism sector
			M		+3	• Very good management of tourism in place, and effort made to determine tourist carrying capacity • Very high value tourism (including eco-tourism) preferred over mass tourism • Highly improved quality of tourism experience enhanced • Highly improved services and facilities in tourism sector
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	R	-1		• Inadequate investment in infrastructure • Inadequate improvement in road network and mobile phone usage • Poor management of transport and traffic
			M		+3	• Major Investment in infrastructure and expansion • Highly improved road and rail network, inland waterways and mobile phone usage • Very good management of transport and traffic
	29	Optimise the existing and future physical footprint of transport services (rail, road, waterways)	R	-1		• Inadequate investment in implementation of government policies and plans to optimise footprint
			M		+4	• Significantly better implementation of government policies to optimise footprint (eg. Road and Rail Master Plans, and Dredging Plan)

Annex 3.2: Initial Assessment of Medium Growth Scenario

Scoring reflects whether the suite of developments likely to arise under each scenario will enhance (+ scores) or impede (-ve scores) achieving the objectives

Range of scores
Very significant and significant negative scores: '-5' and '-4' respectively. Very negative score: '-3'. Moderately and slightly negative scores: '-2' and '-1', respectively. Neutral [0].
Very significant and significant positive scores: '+5' and '+4' respectively. Very positive score: '+3'. Moderately and slightly positive scores: '+2' and '+1', respectively.

R: Risk score: where existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced, and/or where no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory.

M: Mitigated score: where existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced, and the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

			Score			Comments
				R	M	To justify or explain score, or illustrate how objective will be enhanced/impaired, or indicate how score can be improved by mitigation
Environmental						
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	R	-2		• Inadequate flow of freshwater will increase salinity resulting loss of Sundri habitat and impaired rejuvenation • Moderate increase in pollution due to moderate increase in industrialization, power generation, transport (including coal) and urbanisation • Moderate increase of anthropogenic pressure • Inadequate forest protection
			M		+2	• Moderate increase of dry season fresh water flows due to partial implementation of government interventions • Moderate reduction of anthropogenic pressure due to alternative income earning opportunities • Moderate decrease of pollutants with improved enforcement of regulations and protection measures • Prey-base for tiger and dolphin habitat remaining unchanged. • EMP and regulations are partially enforced including coal transportation

			Score			Comments
	2	Reduce illegal activities related to protected areas and biodiversity	R	-2		• Protection measures and co-management plan not effectively implemented • Reserved forest is more vulnerable when regulations not effectively implemented • WHS is deep in the reserved forest and not easily accessible (and only in dry season)
			M		+2	• Effective protection measures and co-management plan in place • Reduced dependence on forest due to alternative income opportunities
	3	Reduce introduction and spread of Invasive Alien Species	R	-2		• Poor agricultural & aquaculture practices • Inadequate measures to manage spread of water hyacinth (including limited collection and use of water hyacinth as bio-fertiliser, for cattle feed, and for seed beds, mechanical removal, etc.) • Some increase in eutrophication due to moderate increase in use of chemical fertilisers
			M		+2	• Moderately improved agricultural & aquaculture management practices • Improved implementation of measures to minimise the spread of water hyacinth (e.g. plans and deployment of mechanical removal equipment, collection and use of water hyacinth as bio-fertiliser, for cattle feed, and for seed beds)
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	R	-2		• Inadequate management of wastes; inadequate treatment & recycling facilities
			M		+2	• Moderate improvement in waste collection and treatment
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	R	-2		• Moderate increase in industrialization, power generation, urbanization and motorized transport • Inadequate implementation of pollution control and inadequate investment in control and clean technologies
			M		+3	• Moderately increased dry season flow resulting in reduced water pollution • Partial switch to LPG • Partial introduction of eco-friendly transport and clean technology • Partial improvement in enforcement of regulations • Partial improvement in pollution control technologies applied in power plant and other industries • Improved ability to deal with impacts of transboundary pollution • Green technology applied in brick manufacturing
	6	Minimise emissions of greenhouse gases	R	-3		• Increased agricultural production (bio-wastes, increased livestock) • Increased emissions from industry
			M		+2	• Limited use of eco-friendly industry-related transport and clean air technology

			Score			Comments
						• Limited use of measures for energy efficiency • Increased afforestation and reforestation in SW region
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity intrusion, floods, storm surges, etc.)	R	-3		• Inadequate measures for adaptation & mitigation(e.g. embankments, cyclone shelters, warning system, announcements, etc.)
			M		+2	• Moderate increase of dry season flow resulting in decreased extent of saline intrusion. • Improved warning system and increased number of shelters • Adaptation & mitigation measures implemented (embankments strengthened, coastal afforestation)
Water	8	Increase dry season freshwater flow in rivers	R	-2		• Inadequate dredging
			M		+2	• Investment in dredging
	9	Reduce high/peak flows in rivers during monsoon season	R	0		• No way to influence flow. No investment in control measures
			M		0	• No way to influence flow. Natural conditions will prevail • No investment in control measures
Land degradation	10	Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion etc)	R	-2		• Inadequate implementation of SLM practices • No erosion control measures
			M		+2	• Moderate implementation of SLM practices • Some erosion control measures in place
Land use change	11	Minimise conversion of agricultural land (e.g. conversion to shrimp ponds)	R	-3		• Shrimp is high value – more people investing in shrimp farming and more land converted from agriculture to shrimp
			M		0	• Effective implementation of land zoning (designated use zones). New shrimp farms now not allowed on agricultural land
Socio-Economic						
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	R	-2		• Inadequate investment and incentives (financial and fiscal) for industrial growth • Poor competitiveness compared to other countries due to inadequate skills and training and poor support services for industrial development • Inadequate product diversification

			Score			Comments
			M		+3	• Adequate availability of energy and other facility in place[87]. • Reasonably good governance in place. • Partial transformation of the rural agrarian economy to a primarily industrial and digital economy • Some economic zones operational • Jute mills start resuming operations • Moderately increased productivity due to new technologies/innovation/ intensification • Improved investment and incentives (financial and fiscal) for industrial growth • A moderate increase in freight transport. • A moderate increase in the volume of exports via Mongla sea port.
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	R	-2		• Fewer job opportunities due to failure to start operations of jute mills and economic zones • Limited investment and incentives (financial and fiscal) for industrial growth • Poor competitiveness compared to other countries due to inadequate skills and training and poor support services for industrial development • Inadequate product diversification
			M		+2	• Modest increase in job opportunities for reasons above (objective 12)
Health and sanitation	14	Improve health services and health of society (eg by reducing vulnerability to diseases)	R	-1		• Inadequate investment in health sector (not keeping pace with increasing demand as population grows)
			M		+2	• Moderate investment in health sector • Moderate increase in coverage of, and access to, health facilities
	15	Improve and extend water supply and sanitation services	R	-3		• Inadequate investment in services, and existing facilities fail to cope with increased demand as population grows
			M		+2	• Moderate investment in services
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates),	R	-1		• Inadequate investment in education sectors and inadequate facilities • Existing government tertiary level facilities fail to meet demand from growing population • Families must rely on private tertiary level institutions - but struggle to fund. • Poor transport/infrastructure hinders access to schools

[87] Adequate refers to the demand for energy under this scenario in relation to population growth

			Score			Comments
		and improve skills development and training	M		+2	• Increased investment in education sector, particularly in secondary education
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	R	-2		• Inadequate provision of urban facilities in rural areas • My Village My Town' programme poorly implemented • Continuing strong 'pull factor' of urban centres • Migration may increase due to climate vulnerability
			M		+2	• 'My Village My Town' programme (creating urban facilities in rural areas) partially implemented and will discourage migration • Moderate expansion of agro-based manufacturing in villages • Moderate development of growth centres (providing job opportunities)
Women and children	18	Improve gender equality and empowerment of women	R	0		• Gender gap remains the same in the absence of implementation of women-friendly policy or environment and investment.
			M		+2	• More women participate in income-generating activities and decision-making process • Initiatives by govt. and non-govt. agencies will create enabling environment for women's' development
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities in SW region	R	-2		• Inadequate implementation of programs focused on poor/landless; • Inadequate micro credit support for small businesses
			M		+2	• Increase in job opportunities – targeting the vulnerable • Modest implementation of programs targeted at landless/poor • Micro credit support for small businesses
Conflicts and security	20	Reduce conflicts over use of land	R	-2		• Inadequate governance regarding land management (e.g. poor implementation of land use zoning, inefficient land administration and lack of transparency regarding land records and title deed filing system)
			M		+2	• Improved governance regarding land management (e.g. improved implementation of land use zoning, land administration and transparent land record and title deed filing system)
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts,	R	-1		• Inadequate investment in management of heritage/cultural sites, with deterioration/degradation of sites
			M		+1	• Investment in management of heritage/cultural sites (including use of SMART tools)

			Score			Comments
		etc.), and also Sundarbans natural heritage sites				
Food	22	Improve food security	R	0		• Inadequate subsidies (for fertilisers, pesticides, seeds) even though ensured
			M		+3	• Increased agricultural production and affordability (including nutritional value) • Increased economic growth allowing food imports
Agriculture and fisheries	23	Increase agricultural and fish production	R	0		• Inadequate investment new technologies and in improving management
			M		+2	• Investment in mechanization and new technologies • Improved management through increased community level participation resulting in sustainable fisheries resources.
Power and energy	24	Increase uptake of renewable energy	R	-1		• Inadequate investment in technologies, subsidies and maintenance
			M		+2	• Investment in technologies and increased subsidies
	25	Increase efficiency in production and consumption of energy	R	0		• Inadequate production compared to increased demand • Inadequate investment in technologies and inadequate improvement in management • Inefficient use of installed capacity
			M		+3	• Investment in technologies and improved management
	26	Increase access to affordable energy	R	0		• Inadequate provision of subsidies for low-cost energy
			M		+3	• Provision of subsidies
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts; and to remain within the carrying capacity of the Sundarbans for tourism	R	-1		• Poor tourism management • No improvement in quality of tourism experience • No improvement of services and facilities in tourism sector
			M		+1	• Good management of tourism in place, and effort made to determine tourist carrying capacity • High value tourism (Including eco-tourism) preferred over mass tourism • Improved quality of tourism experience enhanced • Improved services and facilities in tourism sector
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	R	-1		• Inadequate investment in infrastructure • Inadequate improvement in road network • Moderate increase in mobile phone usage • Poor management of transport and traffic

			Score			Comments
			M		+2	• Investment in infrastructure • Improved road and rail network, inland waterways and mobile phone usage • Improved management of transport and traffic
	29	Optimise the existing and future physical footprint of transport services (rail, road, waterways)	R	-1		• Inadequate investment in implementation of government policies and plans to optimise footprint
			M		+2	• Moderately improved implementation of government policies to optimise footprint (eg Road and Rail Master Plans, and Dredging Plan)

Annex 3.3: Initial Assessment of Low Growth Scenario

Scoring reflects whether the suite of developments likely to arise under each scenario will enhance (+ scores) or impede (-ve scores) achieving the objectives

Range of scores
Very significant and significant negative scores: '-5' and '-4' respectively. Very negative score: '-3'. Moderately and slightly negative scores: '-2' and '-1' , respectively. Neutral [0].
Very significant and significant positive scores: '+5' and '+4' respectively. Very positive score: '+3'. Moderately and slightly positive scores: '+2' and '+1', respectively.

R: Risk score: where existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced, and/or where no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory.

M: Mitigated score: where existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced, and the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

			Score			Comments
				R	M	To justify or explain score, or illustrate how objective will be enhanced/impaired, or indicate how score can be improved by mitigation
Environmental						
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	R	-3		• Reduction of freshwater flow (due to inadequate or no dredging) will highly increase salinity causing deterioration of habitat condition and impaired rejuvenation of Sundri • Poor protection measures being implemented due to budget restrictions • Increased dependency on forest due to fewer alternative income opportunities and unemployment – due to lack of jobs under recession • Increase in all forms of pollution due to poor environmental management of industrial, agricultural, urbanization, transportation (including coal) activities, etc.
			M		0	• Some protection measures (e.g. patrolling) still being implemented (but with reduced efficacy) – due to budget restrictions • Limited investment in flow control measures (e.g. dredging), but inadequate to reduce salinity levels • Decrease of prey-base for tiger and dolphin habitat • EMP and regulations are poorly enforced including coal transportation
	2		R	-3		• Protection measures and co-management plan poorly implemented

			Score			Comments
		Reduce illegal activities related to protected areas and biodiversity				• Increased population will increase vulnerability to exploitation of reserve forest resources
			M		0	• Less protection measures being implemented and co-management plan inadequately implemented • Increased dependency on forest due to fewer alternative income opportunities
	3	Reduce introduction and spread of Invasive Alien Species	R	-3		• Very poor agricultural and aquaculture practices • Minimal use of water hyacinth as bio-fertiliser and cattle feed, and for seed beds • Very poor implementation of measures to minimise the spread of water hyacinth (e.g. plans and deployment of mechanical equipment)
			M		0	• Poor agricultural & aquaculture management practices • Less use of water hyacinth as bio-fertiliser and cattle feed, and for seed beds • Poor implementation of measures to minimise the spread of water hyacinth (e.g. plans and deployment of mechanical equipment)
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	R	-4		• Very poor management of wastes; inadequate treatment & recycling facilities
			M		0	• Poor management of waste collection and treatment
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	R	-4		• Very poor pollution control and less investment in control and clean technologies in industries and transport sector • Increased pollution due to reliance of use of fossil fuel-based transport • Lack of accessibility to LPG (less availability, cannot afford) • Poor pollution control due to use of traditional technologies applied in power plant and other industries • Insufficient enforcement of pollution control regulations • Inability to deal with impacts of transboundary emissions (due to restricted budget)
			M		+1	• Very limited improvement of dry season flow (due to inadequate dredging or other interventions) resulting in limited reduction of water pollution • Limited improvement in pollution levels due to restricted budget and limited investment in control and clean technologies in industries and transport sector • An increase in switch from existing fuels to LPG but limited due to affordability • Some but limited enforcement of pollution control regulations – due to budget restrictions

			Score			Comments
	6	Minimise emissions of greenhouse gases	R	-3		• Generation of bio-waste from agriculture and livestock • Significantly increased emissions from power generation and industry • No measures for energy efficiency • No support for renewable energy
			M		0	• Limited afforestation and reforestation • Some access to LPG
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity intrusion, floods, storm surges, etc.)	R	-4		• Poor measures for adaptation & mitigation (e.g. embankments, cyclone shelters, warning system, announcements, etc.). • Inadequate adaptation & mitigation measures implemented (embankments strengthened, coastal afforestation)
			M		+1	• Limited investment in flow control measures (e.g. dredging), but inadequate to reduce salinity levels • Limited improvement in measures for adaptation & mitigation (e.g. embankments, cyclone shelters, warning system, announcements, etc.).
Water	8	Increase dry season freshwater flow in rivers	R	-3		• No investment in dredging
			M		0	• Limited investment in flow control measures (e.g. dredging),
	9	Reduce high/peak flows in rivers during monsoon season	R	0		• No way to influence flow. Natural conditions will prevail • No investment in control measures
			M		0	• No way to influence flow. Natural conditions will prevail • No investment in control measures
Land degradation	10	Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion, etc)	R	-3		• Very poor implementation of SLM practices • Very poor erosion control measures in place.
			M		0	• Minimal implementation of SLM practices. • Less erosion control measures in place.
Land use change	11	Minimise conversion of agricultural land (e.g. conversion to shrimp ponds)	R	-2		• Shrimp is high value - people (with financial resources) may invest in shrimp farming with more land converted from agriculture to shrimp
			M		0	

			Score			Comments
Socio-economic						
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	R	-2		• Very limited investment and incentives (financial and fiscal) for industrial growth • Very poor competitiveness compared to other countries due to inadequate skills and training and poor support services for industrial development • Very poor product diversification
			M		+1	• Adequate availability of energy and other facilities in place88. • Inconsistent governance. • Transformation of the rural agrarian economy to a primarily industrial and digital economy is initiated • Few economic zones operational • No jute mills operating • Limited increased productivity due to limited introduction of new technologies/innovation/ intensification • Limited investment and incentives (financial and fiscal) for industrial growth • Amount of freight transported is below capacity • The volume of exports via Mongla sea port remain static
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	R	-2		• Fewer job opportunities due to failure to start operations of jute mills and economic zones • Very limited investment and incentives (financial and fiscal) for industrial growth • Very poor competitiveness compared to other countries due to inadequate skills and training and poor support services for industrial development • Very poor product diversification
			M		0	• Very limited increase in job opportunities for reasons above (objective 12)
Health and sanitation	14	Improve health services and health of society (eg. by reducing vulnerability to diseases)	R	-2		• Poor investment in health sector (not keeping pace with increasing demand as population grows)
			M		0	• Limited investment in health sector • Limited coverage of, and access to, health facilities
	15		R	-2		• Poor investment in services, and existing facilities fail to cope with increased demand as population grows

[88] Adequate refers to the demand for energy under this scenario in relation to population growth

			Score			Comments
		Improve and extend water supply and sanitation services	M		0	• Limited investment in services will remain unchanged
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	R	-2		• Poor investment in education sectors and inadequate facilities • Existing government tertiary level facilities fail to meet demand from growing population • Families must rely on private tertiary level institutions - but struggle to fund. • Poor transport/infrastructure hinders access to schools • Inadequate number of school level teachers.
			M		0	• Limited government investment in education sector
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	R	-2		• Inadequate provision of urban facilities in rural areas • My Village My Town' programme poorly implemented • Continuing strong 'pull factor' of urban centres • Migration may increase due to climate vulnerability
			M		+1	• 'My Village My Town' programme (creating urban facilities in rural areas) will discourage migration to a limited extent • Limited promotion of agro-based manufacturing in villages • Limited development of growth centres (providing limited job opportunities)
Women and children	18	Improve gender equality and empowerment of women	R	-1		• Gender gap will increase in the absence of implementation of women-friendly policy or environment and investment.
			M		+1	• Limited number of women participating in income-generating activities and decision-making process • Limited initiatives by govt. and non govt. agencies for creating enabling environment for women's' development
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities in SW region	R	-3		• Very limited implementation of programs focused on poor/landless; and landless/poor are not prioritized or targeted • Very limited micro credit support for small businesses
			M		+1	• Limited increase in job opportunities – targeting the vulnerable • Limited implementation of programs targeted at landless/poor • Some micro credit support for small businesses

			Score			Comments
Conflicts and security	20	Reduce conflicts over use of land	R	-3		• Very poor governance regarding land management (e.g. very poor implementation of land use zoning, inefficient land administration and lack of transparency regarding land records and title deed filing system)
			M		0	• Limited improvement in governance regarding land management (e.g. improved implementation of land use zoning, land administration and transparent land record and title deed filing system)
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.) and also Sundarbans natural heritage sites	R	-3		• Very poor investment in management of heritage/cultural sites, with deterioration/degradation of sites • Very poor enforcement of environmental rules and regulations
			M		0	• Very limited investment in maintenance or improvement of sites
Food	22	Improve food security	R	-2		• Limited subsidies (for fertilisers, pesticides, seeds) • Food market instability created by the traders
			M		0	• Food available (supply is just enough) but not affordable to many and/or has low nutritional value
Agriculture and fisheries	23	Increase agricultural and fish production	R	-1		• Inadequate investment new technologies and in improving management • Limited investment in intensification and diversification of agricultural production and coastal aquaculture • Inadequate implementation of co-management plan
			M		+1	• Limited investment in mechanization, new technologies and improved management • Limited investment in intensification and diversification of agricultural production and coastal aquaculture
Power and energy	24	Increase uptake of renewable energy	R	-2		• Poor investment in technologies, subsidies and maintenance
			M		0	• No additional investment in technologies, subsidies and maintenance
	25	Increase efficiency in production and consumption of energy	R	-2		• Inadequate production compared to increased demand • Inadequate investment in technologies and inadequate improvement in management • Inefficient use of installed capacity
			M		+1	• Limited investment in technologies and improved management
	26		R	-1		• Inadequate provision of subsidies for low-cost energy

			Score			Comments
		Increase access to affordable energy	M		+1	• Limited provision of subsidies
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts; and to remain within the carrying capacity of the Sundarbans for tourism.	R	-2		• Very poor tourism management • No improvement in quality of tourism experience • No improvement of services and facilities in tourism sector
			M		0	• Limited management of tourism in place, and effort made to determine tourist carrying capacity • High value tourism (Including eco-tourism) preferred over mass tourism • Inadequate services and facilities in tourism sector
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	R	-2		• Poor investment in infrastructure • No improvement in road and rail network, inland waterways and mobile phone usage • Very poor management of transport and traffic
			M		+1	• Limited investment in infrastructure • Limited improvement of road and rail network, inland waterways and mobile phone usage • Limited improvement in management of transport and traffic
	29	Optimise the existing and future physical footprint of transport services (rail, road, waterways)	R	-2		• Low investment in implementation of government policies and plans to optimise footprint
			M		+1	• Limited implementation of government policies and plans to optimise footprint (eg. Road and Rail Master Plans, and Dredging Plan)

Annex 4: Deeper Assessment of Key Sectors

Annex 4.1: Deeper Assessment of Industry Sector

Scoring reflects whether the suite of developments likely to arise under each scenario will enhance (+ scores) or impede (-ve scores) achieving the objectives

Range of scores

Very significant and significant negative scores: '-5' and '-4' respectively. Very negative score: '-3'. Moderately and slightly negative scores: '-2' and '-1' respectively.
Neutral [0]
Very significant and significant positive scores: '+5' and '+4' respectively. Very positive score: '+3'. Moderately and slightly positive scores: '+2' and '+1' [add tone] respectively.

R: Risk score: where existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced, and/or where no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory.

M: Mitigated score: where existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced, and the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

			Score			Comments
				R	M	To justify or explain score, or illustrate how objective will be enhanced/impaired, or indicate how score can be improved by mitigation
Environmental						
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	R	-3		• High increase in pollution due to high increase in industrialisation • Increased industrial infrastructure leads to increased footprint in areas surrounding the Sundarbans • Inadequate adoption of modern technologies for environmental management and forest protection
			M		+4	• More efficient use of existing industrial areas (eg industrial zones) without increasing footprint in green field sites • Significant decrease of pollutants with strict enforcement of regulations and protection measures
	2	Reduce illegal activities related to protected areas and biodiversity	R	0		
			M		+2	• Significant improvement in protection measures through partnerships with industries (corporate social responsibility) and conservation bodies, including using SMART tools

			Score			Comments
						• Negligible dependence on forest due to increased alternative employment and income opportunities in industry
	3	Reduce introduction and spread of Invasive Alien Species	R	0		
			M		+1	Management of water hyacinth through industry CSR programmes.
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	R	-3		Poor management of wastes; inadequate treatment & recycling facilities
			M		+3	Substantial improvement in waste treatment and recycling by industry
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	R	-3		• High increase in industrialization and industry-related motorized and water transport • Lack of adequate pollution control technologies and inadequate investment in control and clean technologies • Poor enforcement of regulations for transporting industrial raw material by water and road
			M		+3	• Better clean technology • Pollution control technologies applied in power plant and other industries • Green technology applied in brick manufacturing • Strict enforcement of regulations for transporting industrial raw material by water and road
	6	Minimise emissions of greenhouse gases	R	-2		• Increased emissions from industry • Limited measures for energy efficiency
			M		+1	• Use eco-friendly industry-related transport and clean air technology • Increased measures for energy efficiency
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity intrusion in rivers, floods, storm surges, etc.)	R	0		
			M		0	
Water	8	Increase dry season freshwater flow in rivers	R	0		
			M		0	
	9	Reduce high/peak flows in rivers during monsoon season	R	0		
			M		0	
	10		R	0		

			Score			Comments
Land degradation		Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion, etc)	M		0	
Land use change	11	Minimise conversion of agricultural land (e.g. conversion to shrimp ponds)	R	-1		Failure to effectively implement policy and regulations on not using agricultural land for industries
			M		+1	Focusing industrial development on 'brownfield' sites to limit agricultural land loss
Socio-economic						
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	R	-2		• Inadequate investment and incentives (financial and fiscal) for industrial growth • Poor competitiveness compared to other countries due to inadequate skills and training and poor support services for industrial development • Inadequate product diversification
			M		+4	• 7 economic zones are operational • Jute mills are fully functional • Increased productivity due to new technologies/innovation/ intensification • Substantial investment and incentives (financial and fiscal) for industrial growth • Improved competitiveness compared to other countries due to skills development and training and support services for industrial development • Product diversification
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	R	-1		Inadequate job opportunities due to partial operation of economic zones and jute mills etc.
			M		+2	Moderate increase in job opportunities for reasons above (objective 12)
Health and sanitation	14	Improve health services and health of society (eg by reducing vulnerability to diseases)	R	-1		Impact on people's health in the adjacent areas due to pollutants generated from industries
			M		+2	• Most industries provide own clinics and health insurance. • All industries provide occupational health services
	15	Improve and extend water supply and sanitation services	R	-1		• Inadequate investment in services within industrial establishments • No support by industries to local communities to provide water and sanitation services
			M		+2	• Adequate investment in services within industrial set up

			Score			Comments
						• Support by industries to local communities to provide water and sanitation services
Education, skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	R	0		
			M		+1	• Some industries operate their own schools • Industry CSR may provide some financial support (e.g. bursaries, scholarships, infrastructure) • Some industries will support development of educational facilities and provide training
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	R	-2		• Inadequate provision of urban facilities (including industries) in rural areas • 'My Village My Town' programme poorly implemented • Continuing strong 'pull factor' of urban-based industrial jobs
			M		+3	• 'My Village My Town' programme (creating urban facilities in rural areas) will highly discourageout migration • Significant expansion of agro-based manufacturing in villages • Increased development of industrial growth zones (providing job opportunities)
Women and children	18	Improve gender equality and empowerment of women	R	-1		Limited number of women's participating in income generation activities and jobs in industry.
			M		+3	Substantial number of women will find opportunities in the industrial sector
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities in SW region	R	0		
			M		+2	Moderate increase in job opportunities in industrial areas for the vulnerable people
Conflicts and security	20	Reduce conflicts over use of land	R	-2		Ineffective dispute resolution mechanisms lead to conflicts over land acquisition for industries
			M		+2	Effective dispute resolution mechanisms minimize conflicts over land take for industries
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.) and also Sundarbans natural heritage sites	R	-1		Industrial pollution will damage physical sites
			M		+1	• Technologies will reduce pollution from industries • Concern organization carryout maintenance works to reduce damage
Food	22	Improve food security	R	-1		• Lack of investment and incentives for industrial development (see Objective 12) leads to inadequate development of industries, undermines economic growth and impedes food imports

			Score			Comments
			M		+2	Increased industrialization leads to economic growth which allows food imports
Agriculture and fisheries	23	Increase agricultural and fish production	R	-1		Agricultural production will decline due to land lost to industry
			M		+1	• Focusing industrial development on 'brownfield' sites to limit agricultural land loss • Expansion of industries supplying agricultural appliances and fertilizers
Power and energy	24	Increase uptake of renewable energy	R	0		Limited investment in solar panels in industrial areas
			M		+1	Increased installation of solar panels on industrial buildings
	25	Increase efficiency in production and consumption of energy	R	0		Inadequate investment in technologies and inadequate improvement in management
			M		+2	• Significant investment in technologies and improved management • Increased awareness and use of efficient energy
	26	Increase access to affordable energy	R	0		
			M		+2	Increased investment and subsidies for low-cost power consumption
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts	R	0		
			M		0	
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	R	0		
			M		0	
	29	Optimise the existing and future physical footprint of transport services (rail, road, waterways)	R	0		
			M		0	

Annex 4.2: Deeper Assessment of Transport Sector

Scoring reflects whether the suite of developments likely to arise under each scenario will enhance (+ scores) or impede (-ve scores) achieving the objectives

Range of scores
Very significant and significant negative scores: '-5' and '-4' respectively. Very negative score: '-3'. Moderately and slightly negative scores: '-2' and '-1' respectively.
Neutral [0]
Very significant and significant positive scores: '+5' and '+4' respectively. Very positive score: '+3'. Moderately and slightly positive scores: '+2' and '+1' [add tone] respectively.

R: Risk score: where existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced, and/or where no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory.

M: Mitigated score: where existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced, and the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

			Score			Comments
				R	M	To justify or explain score, or illustrate how objective will be enhanced/impaired, or indicate how score can be improved by mitigation
Environmental						
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	R	-2		• Modest increase in environmental damage due to modest increase in road infrastructure and traffic surrounding Sundarbans. • Increased environmental damage and disturbance due to increased and poorly regulated shipping (movement of cargo and passenger vessels); and increased number of poorly managed landing facilities. • Ineffective implementation of transport plans (e.g. poor management of crossings in peripheral rivers leading to ecosystem damage) and poor enforcement of regulations.
			M		+1	• Reduced environmental damage due to well managed road infrastructure and traffic (eco-friendly transport and clean technology) surrounding Sundarbans. • Decreased environmental damage, noise and disturbance due to well-managed and regulated shipping; and properly managed landing facilities. • Effective implementation of transport plans (e.g. river crossings in peripheral rivers that avoid ecosystem damage) and strict enforcement of regulations
	2	Reduce illegal activities related to protected areas and biodiversity	R	0		
			M		0	

			Score			Comments
	3	Reduce introduction and spread of Invasive Alien Species	R	0		
			M		0	
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	R	-3		• Very poor management of transport-related wastes; inadequate treatment & recycling facilities
			M		+3	• Substantial improvement in transport-related waste collection, treatment and recycling
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	R	-3		• High increase in pollution due to high increase in road infrastructure and traffic and ageing vehicle fleet. • Increased pollution and disturbance (noise) due to increased and poorly regulated shipping (movement of cargo and passenger vessels, and increased number of poorly managed landing facilities) • Inadequate control of transport-related pollution and inadequate investment in control and clean technologies
			M		+3	• Substantial decrease of pollutants due to modernized vehicle fleet that is more fuel-efficient and less polluting; and an increase in rail cargo and passengers versus on roads; • Switch to LPG, CNG and battery-operated vehicles • Better eco-friendly transport and clean technology • Improved enforcement of regulations and traffic management
	6	Minimise emissions of greenhouse gases	R	-2		• Moderate increase in GHG due to high traffic and shipping, and an ageing vehicle and boat fleet. • Inadequate control of transport-related GHG emissions and inadequate investment in control and clean technologies
			M		+2	• Modest decrease of GHG due to modernized vehicle and boat fleet that is more fuel-efficient and less polluting; and an increase in rail cargo and passengers versus on roads; • Switch to battery operated vehicles • Introduction of SMART transport and clean technology • Improved enforcement of regulations and traffic management
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters	R	-2		• Poorly planned roads leading to localized flooding • Failure of poorly maintained embankment-cum-roads may cause flooding

			Score			Comments
		(salinity intrusion in rivers, floods, storm surges, etc.)	M		+2	• Well planned, designed and maintained (resilient) embankment-cum-roads would resist flood and storm surge
Water	8	Increase dry season freshwater flow in rivers	R	0		
			M		0	
	9	Reduce high/peak flows in rivers during monsoon season	R	0		
			M		0	
Land degradation	10	Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion, etc)	R	-1		• Failure of embankment-cum-road would cause intrusion of saline water in the land mass. • Poor regulation of vessel speed on waterways cause bank erosion
			M		+1	• Well planned, designed and maintained embankment cum roads resist saline water intrusion. • Compliance with vessel speed limits on waterways minimizes bank erosion.
Land use change	11	Minimise conversion of agricultural land (e.g. conversion to shrimp ponds)	R	0		
			M		0	
Socio-economic						
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	R	-3		• Poorly maintained and undeveloped (in some areas) transport network limits connectivity and economic development
			M		+4	• Significantly improved transport network facilitates connectivity and economic development
Employment	13	Enhance opportunities for employment and new/improved livelihoods (industry, transport, fisheries, agriculture, eco-tourism etc.)	R	0		
			M		+2	• Moderate increase in job opportunities due to improved connectivity and access to job centres • Job opportunities in transport sector
Health and sanitation	14	Improve health services and health of society (eg by reducing vulnerability to diseases)	R	-1		• Poorly maintained transport network limits access to health facilities • Poorly maintained vehicles increase risk of accidents • Poor enforcement of traffic regulations increases risk of accidents
			M		+1	• Improved transport network enhances access to health facilities • Enforcement of traffic regulations limits risk of accidents

			Score			Comments
	15	Improve and extend water supply and sanitation services	R	-1		• Poorly maintained transport fleet for water supply and sanitation may hinder services
			M		+1	• Well maintained transport fleet for water supply and sanitation facilitates services
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	R	-1		• Remaining unconnected areas and poorly maintained transport network hinders access to education facilities
			M		+1	• Improved transport network and maintenance enhances access to education facilities • Improved access to transport services
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	R	0		
			M		0	
Women and children	18	Improve gender equality and empowerment of women	R	0		
			M		0	
Social inclusion	19	Increase the inclusion of landless andmarginal land holders in development activities in SW region	R	0		
			M		0	
Conflicts and security	20	Reduce conflicts over use of land	R	0		
			M		0	
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.) and also Sundarbans natural heritage sites	R	0		
			M		0	
Food	22	Improve food security	R	-1		• Poorly maintained transport network inhibits (a) economic growth which limits access to food and food imports; and (b) distribution of food
			M		+2	• Improved transport network enables (a) increased economic growth allowing access to food and food imports; and (b) distribution of food
Agriculture and fisheries	23	Increase agricultural and fish production	R	-1		• Poorly maintained transport network limits access to agricultural/aquaculture inputs

			Score			Comments
			M		+1	• Improved transport network facilitates access to agricultural/aquaculture inputs
Power and energy	24	Increase uptake of renewable energy	R	0		
			M		0	
	25	Increase efficiency in production and consumption of energy	R	0		• Predominance of old and energy inefficient vehicles • Limited use of rail and river transportation for goods and passengers
			M		+1	• Significant investment in energy efficient vehicles • Shift from road to rail and river transportation (goods and passengers)
	26	Increase access to affordable energy	R	0		
			M		0	
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts	R	-1		• Old and poorly maintained tourist boats and patrol vessels causes pollution, noise and disturbance
			M		+1	• Improved quality of boats for tourists and patrolling reduces pollution, noise and disturbance
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	R	-2		• Poor management and maintenance of transport sector
			M		+3	• Very good management and maintenance of transport sector
	29	Optimise the existing and future physical footprint of transport services (rail, road, waterways)	R	-2		• Inadequate investment in implementation of government policies and plans to optimise footprint
			M		+4	• Significantly better implementation of government policies to optimise footprint (eg. Road and Rail Master Plans, and Dredging Plan)

Annex 4.3: Deeper Assessment of Urban Sector

Scoring reflects whether the suite of developments likely to arise under each scenario will enhance (+ scores) or impede (-ve scores) achieving the objectives

Range of scores

Very significant and significant negative scores: '-5' and '-4' respectively. Very negative score: '-3'. Moderately and slightly negative scores: '-2' and '-1' respectively.
Neutral [0]
Very significant and significant positive scores: '+5' and '+4' respectively. Very positive score: '+3'. Moderately and slightly positive scores: '+2' and '+1' [add tone] respectively.

R: Risk score: where existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced, and/or where no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory.

M: Mitigated score: where existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced, and the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

			Score			Comments
				R	M	To justify or explain score, or illustrate how objective will be enhanced/impaired, or indicate how score can be improved by mitigation
Environmental						
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	R	-1		• Moderate increase in environmental footprint (including pollution) due to significant expansion of urban area
			M		+1	• Slight decrease of environmental footprint (including pollution) with strict enforcement of regulations, urban plans and policy of densification.
	2	Reduce illegal activities related to protected areas and biodiversity	R	0		
			M		0	
	3	Reduce introduction and spread of Invasive Alien Species	R	0		
			M		0	
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	R	-3		• Poor management of wastes; inadequate treatment & recycling facilities
			M		+4	• Significant improvement in waste collection, treatment and recycling

			Score			Comments
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	R	-3		• High increase in urban traffic (with old and inefficient car fleet); • Traffic congestion due to poor urban planning (causes increased emissions); • Lack of adequate pollution control and inadequate investment in control and clean technologies • Construction of urban infrastructure leads to dust, noise and traffic congestion
			M		+3	• Eco-friendly urban traffic (efficient vehicles); good urban planning • Reduced traffic congestion due to good urban planning (reduced emissions); • Improved pollution control and investment in control and clean technologies • Shift to LPG and electric cooking stoves • Construction of urban infrastructure with green technologies
	6	Minimise emissions of greenhouse gases	R	-1		• Limited measures for energy efficiency in buildings, municipal transport etc • Limited support for renewable energy use in buildings
			M		+1	• Use eco-friendly transport and clean air technology • Increased measures for energy efficiency • Increased support for renewable energy
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity intrusion in rivers, floods, storm surges, etc.)	R	-1		• Urban areas inadequately protected by embankments • Poorly functioning warning system • Inadequate adaptation measures
			M		+1	• All urban areas protected by strengthened embankments • Significant improvement in warning system • Adequate adaptation measures • Implementation of 'low impact development' (aiding infiltration and reducing urban flooding)
Water	8	Increase dry season freshwater flow in rivers	R	0		
			M		0	

			Score			Comments
	9	Reduce high/peak flows in rivers during monsoon season	R	0		
			M		0	
Land degradation	10	Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion, etc)	R	0		
			M		0	
Land use change	11	Minimise conversion of agricultural land (e.g. conversion to shrimp ponds)	R	0		
			M		0	
Socio-economic						
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	R	-3		• Poor urban planning limits efficiency of economic activities
			M		+4	• Good urban planning enhances efficiency of economic activities (improved traffic flow, easy access to facilities and services, enabled law enforcement, availability of land for businesses, communication infrastructure, SMART cities, etc.)
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	R	-1		• Inadequate job opportunities for reasons above – poor urban planning (objective 12)
			M		+2	• Moderate increase in job opportunities for reasons above (objective 12)
Health and sanitation	14	Improve health services and health of society (eg by reducing vulnerability to diseases)	R	0		• Even though there is inadequate investment in health sector, a growing number of people can afford private health services
			M		+3	• Increased investment in health sector • Substantial increase in coverage of and access to health facilities in urban areas
	15	Improve and extend water supply and sanitation services	R	-1		• Inadequate investment in services, and existing facilities fail to cope with increased demand as population grows.
			M		+3	• High investment in services in urban areas
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	R	-1		• Private sector will increase education services, but government investment is still inadequate. • Existing government tertiary level facilities fail to meet demand from growing population

			Score			Comments
						• Poor transport/infrastructure hinders access to schools • Inadequate number of school level teachers.
			M		+3	• Education services and facilities are adequately available by both public and private sectors investment. • Public increasingly willing to pay for education • Government & private sector will increasingly provide financial support (e.g. bursaries, scholarships)
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	R	-1		• Inadequate provision of urban facilities in rural areas • My Village My Town' programme poorly implemented • Continuing strong ' pull factor' of urban centers
			M		+3	• 'My Village My Town' programme (creating urban facilities in rural areas) will highly discourage out migration • Increased development of growth zones in rural areas (providing job opportunities)
Women and children	18	Improve gender equality and empowerment of women	R	0		
			M		0	
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities in SW region	R	0		Limited job opportunities in urban areas for low-income and vulnerable people
			M		+2	• Moderate increase in job opportunities in urban areas – targeting the vulnerable people
Conflicts and security	20	Reduce conflicts over use of land	R	0		
			M		0	
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.) and also Sundarbans natural heritage sites	R	0		• Inadequate investment in management of heritage/cultural sites, with deterioration/degradation of sites
			M		+2	• More investment in management of heritage/cultural sites (including use of SMART tools) • Increased public awareness will help better manage and maintain the sites • Improved enforcement of environmental rules and regulations
Food	22	Improve food security	R	0		

			Score			Comments
			M		+1	• Urban people have better access to better quality food
Agriculture and fisheries	23	Increase agricultural and fish production	R	0		
			M		0	
Power and energy	24	Increase uptake of renewable energy	R	-1		• Inadequate investment in technologies in urban areas and subsidies
			M		+3	• Significant investment in technologies in urban areas and increased subsidies • Urbanization provides opportunity for mass installation of solar panels on rooves • Reduced unit costs of solar installations due to densification and easier access in urbans to service providers
	25	Increase efficiency in production and consumption of energy	R	0		• Inadequate investment in technologies and inadequate improvement in management in urban areas • Inefficient use of energy in urban areas
			M		+2	• Significant investment in technologies and improved management in urban areas • Increased awareness and efficient use of energy in urban areas
	26	Increase access to affordable energy	R	0		• Inadequate government subsidies for enhancing low-cost energy options in urban areas
			M		+2	• Increased investment and subsidies for low-cost power generation in urban areas
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts	**R**	0		
			M		0	
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	R	0		• Inadequate investment in urban infrastructure • Inadequate improvement in urban road network • Poor management of urban transport and traffic
			M		+2	• Major investment in, and expansion of, infrastructure in urban areas (e.g. mass rapid transport systems) • Highly improved urban road network

			Score			Comments
						• Very good management of urban transport and traffic
	29	Optimise the existing and future physical footprint of transport services (rail, road, waterways)	R	-1		• Inadequate investment in implementation in urban areas of government policies and plans to optimize footprint
			M		+2	• Significantly better implementation of government policies to optimize footprint (eg. Road and Rail Master Plans, municipal plans, Dredging Plan) in urban areas

Annex 4.4: Deeper Aasessment of Power and Energy Sector

Scoring reflects whether the suite of developments likely to arise under each scenario will enhance (+ scores) or impede (-ve scores) achieving the objectives

Range of scores
Very significant and significant negative scores: '-5' and '-4' respectively. Very negative score: '-3'. Moderately and slightly negative scores: '-2' and '-1' respectively.
Neutral [0]
Very significant and significant positive scores: '+5' and '+4' respectively. Very positive score: '+3'. Moderately and slightly positive scores: '+2' and '+1' [add tone] respectively.

R: Risk score: where existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced, and/or where no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory.

M: Mitigated score: where existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced, and the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

			Score			Comments
				R	M	To justify or explain score, or illustrate how objective will be enhanced/impaired, or indicate how score can be improved by mitigation
Environmental						
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	R	-3		• High increase in SO_2 and N0x due to high increase in power generation • Inadequate adoption of modern technologies for power generation • Inappropriately designed power lines cause mortalities to bird life
			M		+3	• Significant decrease of pollutants with strict enforcement of regulations and protection measures • Minimal increase in SO_2 and N0x due to clean technology used in power generation and adoption of ultra super critical technologies for coal-fired power generation and co-generation for other power plants • Impact avoidance mechanisms are incorporated in the design of power lines to reduce bird mortalities
	2	Reduce illegal activities related to protected areas and biodiversity	R	0		
			M		+2	• Temporary reduction of pressure on PA forests due to alternative job opportunities during power plant construction

			Score			Comments
						• Significant improvement in protection measures through partnerships with power and energy plants (corporate social responsibility) and conservation bodies, including using SMART tools
	3	Reduce introduction and spread of Invasive Alien Species	R	0		
			M		+1	• Management of water hyacinth through power and energy CSR programmes.
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	R	-3		• Poor management of wastes (ash, fly ash); inadequate treatment & recycling facilities
			M		+4	• Significant improvement in waste collection (ash, fly ash), treatment and recycling
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	R	-3		• High increase in power generation and motorized transport • Lack of adequate pollution control and inadequate investment in control and clean technologies
			M		+4	• Switch to LPG • Better eco-friendly transport and clean technology • Pollution control technologies applied in power plants
	6	Minimise emissions of greenhouse gases	R	-3		• Increased emissions from power generation • Limited measures for energy efficiency • Limited support for renewable energy
			M		+2	• Switch to LPG • Use eco-friendly transport and clean air technology • Additional use of nuclear energy (no direct emissions of GHG) • Increased measures for energy efficiency • Increased support for renewable energy
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity intrusion in rivers, floods, storm surges, etc.)	R	0		
			M		0	
Water	8		R	-1		• Increased extraction for power plants

			Score			Comments
		Increase dry season freshwater flow in rivers	M		0	
	9	Reduce high/peak flows in rivers during monsoon season	R	0		
			M		0	
Land degradation	10	Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion,etc)	R	0		
			M		0	
Land use change	11	Minimiseconversion of agricultural land (e.g. conversion to shrimp ponds)	R	-1		• Set up of power and energy industries will reduce agricultural land
			M		0	
Socio-economic						
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	R	-2		• Decreased productivity due to inadequate energy availability
			M		+4	• Increased productivity due to increased energy availability
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	R	-1		• Less job opportunities due to less energy generation and related generation and distribution businesses (e.g. LPG)
			M		+1	• Moderate increase in job opportunities in energy generation and related generation and distribution businesses (e.g. LPG)
Health and sanitation	14	Improve health services and health of society (eg by reducing vulnerability to diseases)	R	-1		• Impact on people's health in the adjacent areas due to pollutants generated from power and energy plant
			M		+1	• Most power plants provide own clinics and health insurance. • All power plants provide occupational health services
	15	Improve and extend water supply and sanitation services	R	0		
			M		+1	• Adequate investment in services in power plants • Support by power plants to local communities to provide water and sanitation services
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing	R	0		

			Score			Comments
		drop-out rates), and improve skills development and training	M		+1	• Some power plants operate their own schools • Power plant CSR may provide some financial support (e.g. bursaries, scholarships, infrastructure) • Some power plants will support development of educational facilities and provide training
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	R	0		
			M		0	
Women and children	18	Improve gender equality and empowerment of women	R	0		
			M		0	
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities in SW region	R	0		
			M		+1	• Slight and temporary increase in job opportunities for low-income and vulnerable people during power plant construction
Conflicts and security	20	Reduce conflicts over use of land	R	-2		• Ineffective dispute resolution mechanisms lead to conflicts over land acquisition for power plants and transmission lines
			M		+2	• Effective dispute resolution mechanisms minimize conflicts over land take for power plants and transmission lines
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.) and also Sundarbans natural heritage sites	R	-1		• Pollution from power plants will damage physical sites and WHS
			M		+1	• Technologies will reduce pollution from power plants • Concern organization carryout maintenance works to reduce damage
Food	22	Improve food security	R	-1		• Inadequate availability of power undermines food production
			M		+1	• Availability of power leads to economic growth which allows higher food production and imports
Agriculture and fisheries	23	Increase agricultural and fish production	R	-1		• Inadequate availability of power undermines agricultural and fish production
			M		+1	• Availability of power enhances agricultural and fish production
Power and energy	24		R	-1		• Inadequate investment in technologies, subsidies and maintenance

			Score			Comments
		Increase uptake of renewable energy	M		+3	• Significant investment in technologies and increased subsidies
	25	Increase efficiency in production and consumption of energy	R	0		• Inadequate production compared to increased demand • Inadequate investment in technologies and inadequate improvement in management • Inefficient use of installed capacity
			M		+4	• Significant investment in technologies and improved management • Increased awareness and efficient use of energy
	26	Increase access to affordable energy	R	0		• Inadequate government subsidies for enhancing low-cost energy options
			M		+4	• Increased investment and subsidies forlow-cost power generation • Expansion of energy trade
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts	R	0		
			M		0	
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	R	-1		• Inadequate power impedes infrastructural development which limits connectivity, services and facilities
			M		+3	• Availability of power promotes infrastructural development which improves connectivity, services and facilities
	29	Optimise the existing and future physical footprint of transport services (rail, road, waterways)	R	-2		• Inadequate power impedes efforts to optimize transport systems
			M		+4	• Availability of power promotes efforts to optimize transport systems

Annex 4.5: Deeper Assessment of Forestry Sector

Scoring reflects whether the suite of developments likely to arise under each scenario will enhance (+ scores) or impede (ve scores) achieving the objectives

Range of scores
Very significant and significant negative scores: '-5' and '-4' respectively. Very negative score: '-3'. Moderately and slightly negative scores: '-2' and '-1' respectively.
Neutral [0]
Very significant and significant positive scores: '+5' and '+4' respectively. Very positive score: '+3'. Moderately and slightly positive scores: '+2' and '+1' [add tone] respectively.

R: Risk score: where existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced, and/or where no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory.

M: Mitigated score: where existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced, and the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

			Score			Comments
				R	M	To justify or explain score, or illustrate how objective will be enhanced/impaired, or indicate how score can be improved by mitigation
Environmental						
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	R	-3		• Increase of anthropogenic pressure due to inadequate forest protection /management including poor implementation of co-management • Inadequate adoption of modern technologies for forest protection
			M		+4	• Improved forest management and expanded protected areas enhances biodiversity and ecosystem services • Reduced over-exploitation by dependent communities due to promoting alternative income/livelihood opportunities (e.g. cottage industries, poultry farming, bee keeping) • Restriction of passes to access resources • Improved co-management of the Sundarbans • Full compliance with international treaty/convention commitments, and partnerships with neighbouring countries and international actors
	2	Reduce illegal activities related to protected areas and biodiversity	R	-3		• Protection measures and co-management plan not effectively implemented

			Score			Comments
						• Reserved forest is more vulnerable when regulations not effectively implemented • WHS is deep in the reserved forest and not easily accessible (and only in dry season)
			M		+4	• Significant improvement in protection measures through strict enforcement of legal mandates using SMART tools • Strict implementation of co-management plan • Negligible dependence on forest due to alternative income opportunities
	3	Reduce introduction and spread of Invasive Alien Species	R	0		
			M		0	
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	R	0		
			M		0	
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	R	0		
			M		0	
	6	Minimise emissions of greenhouse gases	R	-3		• Degradation/over-harvesting of homestead forests • Poor implementation of social forestry • Limited ability to undertake social forestry due to land-owning agencies not providing land (scarcity of land) for this purpose (using for other purposes) • Limited capacity to control deliberate forest fires • Pressure to access fuelwood and timber might lead to moratorium on tree harvesting from Sundarbans being discontinued
			M		+2	• Increased afforestation and reforestation in SW region (including homestead forests) – as a sink for carbon • Moratorium on tree harvesting from Sundarbans is continued • Increased capacity to control deliberate forest fires
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity	R	-2		• Inadequate adaptation & mitigation measures (coastal afforestation and social forestry) leaves risk from storm surges

			Score			Comments
		intrusion in rivers, floods, storm surges, etc.)	M		+2	• Adequate adaptation & mitigation measures implemented (coastal afforestation and social forestry) acts as buffer against storm surges
Water	8	Increase dry season freshwater flow in rivers	R	-1		• Pressure to access fuelwood and timber might lead to tree cutting, reduced infiltration and less water retention for dry season release.
			M		+1	• Maintained forest cover enhances infiltration, thus increasing dry season release to rivers
	9	Reduce high/peak flows in rivers during monsoon season	R	-1		• Deforestation increases the velocity of surface runoff and enhance peak flow of rivers.
			M		+1	• Forest reduces the velocity of surface runoff and decreases peak flow of rivers.
Land degradation	10	Minimise loss of land due to degradation (e.g. erosion of river banks/water channels, soil salinity, soil erosion, etc.)	R	-1		• Inadequate implementation of afforestation • Deforestation on embankments and elsewhere leaves soil prone to erosion
			M		+1	• Afforestation (in coastal areas, on embankments and river sides, and beside irrigation canals) reduces soil erosion
Land use change	11	Minimize conversion of agricultural land (e.g. conversion to shrimp ponds)	R	-1		• Slight increase in forestry plantation on agricultural land.
			M		0	
Socio-economic						
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	R	-1		• Inadequate forest development and poor forest management limits contribution to economic growth (timber and other products)
			M		+2	• Forest development and well managed forestry activities stimulates economic growth (timber and other products, tourism revenues)
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	R	-1		• Inadequate investment and incentives lead to decrease in forestry-related activities (logging, sawmilling, timber, plantations, nurseries, including silvicultural operation etc) and thus reduced income-earning opportunities
			M		+1	• Moderate increase in job opportunities in forestry-related activities (logging, sawmilling, timber, plantations, nurseries, including silvicultural operations and forest related industries etc.)

			Score			Comments
Health and sanitation	14	Improve health services and health of society (e.g. by reducing vulnerability to diseases)	R	-3		• Poor management of Sundarbans results in over-exploitation and reduced long-term availability of medicinal plants • Depletion and degradation of forests and wildlife undermines availability of species that provide raw materials for medicines
			M		+3	• Good management of Sundarbans maintains the availability of the full range of ecosystem services (e.g. natural medicines) that benefit human health
	15	Improve and extend water supply and sanitation services	R	0		
			M		0	
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	R	0		
			M		+1	• Enhanced skills and training provided by forestry service schools and colleges
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	R	0		
			M		0	
Women and children	18	Improve gender equality and empowerment of women	R	-1		• Inadequate enforcement of the law requiring involvement of women in social forestry leads reduced earning for women
			M		+1	• Enforcement of the law requiring involvement of women in social forestry leads improved earnings for women
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities in SW region	R	-2		• Ineffective implementation of legal requirement to engage landless in social forestry programmes as beneficiaries. • Ineffective implementation of co-management system limits involvement of landless and marginal section of the community in forest management
			M		+2	• Effective implementation of legal requirement to engage landless in social forestry programmes as beneficiaries. • Effective implementation of co-management system provides for involvement of landless and marginal section of the community in forest management
Conflicts and security	20	Reduce conflicts over use of land	R	0		

			Score			Comments
			M		0	
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.) and also Sundarbans natural heritage sites	R	-3		• Inadequate investment in management of World Heritage Sites, with deterioration/degradation of sites. • Inadequate attention to raising public awareness about WHS.
			M		+3	• More investment in management of natural or World Heritage Sites (including use of SMART tools) • Increased public awareness will help better manage and maintain the sites • Improved enforcement of environmental rules and regulations
Food	22	Improve food security	R	-1		• Declining forestry sector activity will limit contribution to economic growth, thus slightly limiting food purchase and imports • Access to forest-based food sources will be restricted
			M		+1	• Strong forestry sector activity will slightly increase economic growth allowing food purchase and imports • Controlled access allowed to harvest forest-based food sources
Agriculture and fisheries	23	Increase agricultural and fish production	R	-2		• Poorly managed and declining Sundarbans leads to degraded habitat and spawning grounds for fish populations, and reduced opportunities to harvest fry
			M		+2	• Well managed and intact Sundarbans provides habitat and spawning grounds for fish populations, and for harvesting fry
Power and energy	24	Increase uptake of renewable energy	R	0		
			M		0	
	25	Increase efficiency in production and consumption of energy	R	-1		• Inefficient cooking stove leads to over exploitation of fuelwood
			M		+1	• Energy efficient cooking stove results in reduced use of fuel-wood.
	26	Increase access to affordable energy	R	-1		• Inadequate managed forestry limits sustainable availability of affordable energy (fuelwood).
			M		+1	• Well managed forestry (homestead and social) enables sustainable availability of affordable energy (fuelwood).
Tourism	27		**R**	-2		• Increased tourists with poor management

			Score			Comments
		Improve tourism management and behaviour to limit noise, pollution and other negative impacts				• No improvement in quality of tourism experience • No improvement of services and facilities in tourism sector
			M		+3	• Very good management of tourism in place, and effort made to determine tourist carrying capacity • Very high value tourism (including eco-tourism) preferred over mass tourism • Highly improved quality of tourism experience enhanced • Highly improved services and facilities in tourism sector
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	R	0		
			M		0	
	29	Optimise the existing and future physical footprint of transport services (rail, road, waterways)	R	0		
			M		0	

Annex 4.6: Deeper Assessment of Fisheries Sector

Scoring reflects whether the suite of developments likely to arise under each scenario will enhance (+ scores) or impede (-ve scores) achieving the objectives

Range of scores
Very significant and significant negative scores: '-5' and '-4' respectively. Very negative score: '-3'. Moderately and slightly negative scores: '-2' and '-1' respectively.
Neutral [0]
Very significant and significant positive scores: '+5' and '+4' respectively. Very positive score: '+3'. Moderately and slightly positive scores: '+2' and '+1' [add tone] respectively.

R: Risk score: where existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced, and/or where no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory.

M: Mitigated score: where existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced, and the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

			Score			Comments
				R	M	To justify or explain score, or illustrate how objective will be enhanced/impaired, or indicate how score can be improved by mitigation
Environmental						
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	R	-3		• Excessive and indiscriminate harvesting of wild fish larvae. • Use of illegal fishing gear (too small mesh), poison fishing, fishing in 'ban '(breeding/growth) season. • Weak enforcement of regulations allows pollution (antibiotics and fertilizers) from fish and shrimp ponds to be flushed into surrounding waters by tides
			M		+3	• Strong regulation limits excessive and indiscriminate harvesting of wild fish larvae. • Incentives (alternative livelihood opportunities) limit use of illegal fishing gear (too small mesh), poison fishing, and compliance with fishing 'ban '(breeding/growth) season. • Awareness-raising for sustainable fishing • Limited pollutants with strict enforcement of regulations and protection measures
	2	Reduce illegal activities related to protected areas and biodiversity	R	-3		• Protection measures and co-management plan not effectively implemented. • Wild fish resources are more vulnerable when regulations not effectively implemented.

			Score			Comments
			M		+4	• Significant improvement in protection measures through strict enforcement of legal mandates using SMART tools • Strict implementation of co-management plan • Negligible dependence on fisheries and forest due to alternative income opportunities
	3	Reduce introduction and spread of Invasive Alien Species	R	-3		• Excessive floods can allow existing alien fish species to spread from poorly maintained ponds • Unwitting release of alien fish species to wild • Increased eutrophication due to increased use of inorganic aquaculture fertilisers
			M		+2	• Highly improved aquaculture management practices • Awareness-raising limits unwitting release of alien fish species to wild
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	R	-2		• Poor management of wastes from fish processing plants; inadequate treatment & recycling facilities
			M		+3	• Significant improvement in fish waste collection, treatment and recycling (for fish and poultry feed)
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	R	-1		• Weak enforcement of regulations allows pollution (antibiotics and fertilisers) from fish and shrimp ponds to be flushed into surrounding waters by tides
			M		+1	• Limited pollutants with strict enforcement of regulations and protection measures
	6	Minimise emissions of greenhouse gases	R	0		
			M		0	
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity intrusion in rivers, floods, storm surges, etc.)	R	0		
			M		0	
Water	8	Increase dry season freshwater flow in rivers	R	0		
			M		0	
	9	Reduce high/peak flows in rivers during monsoon season	R	0		
			M		0	
	10		R	-3		• Uncontrolled shrimp farming will increase soil salinity

			Score			Comments
Land degradation		Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion, etc)	M		+2	• Promotion of alternating shrimp (saline) culture and freshwater fish and prawns may reduce soil salinity (by flushing) in transition areas (less saline)
Land use change	11	Minimise conversion of agricultural land (e.g. conversion to shrimp ponds)	R	-4		• Shrimp is high value – significantly more people investing in shrimp farming and significantly more land converted from agriculture to shrimp • Inadequate implementation of land zoning
			M		0	• Effective implementation of land zoning (designated use zones). New shrimp farms now not allowed on agricultural land
Socio-economic						
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	R	-4		• Poor processing and hygiene and/or contamination from outside sources (e.g. by pollutants and microbial infections) may lead to products being banned in international markets
			M		+4	• Significant increase in fisheries productivity due to new technologies/innovation/ intensification • Significant development of marine fisheries • Significant improved in fisheries products processing hygiene and management • Improved extension services • Increased exports of fish/shrimp and seafood products
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	R	-1		• Production will stagnate or decline because of climate change (temperature changes, changed freshwater flows), inadequate investments or subsidies in technologies and varieties – thus slightly reducing jobs in fisheries sector
			M		+2	• Moderate increase in job opportunities in fisheries sector • Incentives provided to fishermen in ban period (e.g. loans)
Health and sanitation	14	Improve health services and health of society (eg by reducing vulnerability to diseases)	R	0		
			M		0	
	15	Improve and extend water supply and sanitation services	R	0		
			M		0	
	16		R	0		·

			Score			Comments
Education. skills and training		Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	M		+1	• Enhanced skills and training provided in fisheries sector.
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	R	0		
			M		0	
Women and children	18	Improve gender equality and empowerment of women	R	0		
			M		0	
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities in SW region	R	0		
			M		0	
Conflicts and security	20	Reduce conflicts over use of land	R	-3		• Considerable increase in land disputes remaining unresolved either by formal or informal processes • Inadequate governance regarding land management
			M		+3	• Considerable decrease in land-related disputes due to good governance (e.g. potential disputes diffused by locally elected bodies and social system - shalish) • Significant reduction in farmer-fisher conflicts over land resolved by courts/informal measures
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.) and also Sundarbans natural heritage sites	R	0		
			M		0	
Food	22	Improve food security	R	-2		• Declining fisheries resources (due to pollution, habitat loss, economic factors, etc.) will limit contribution to economic growth, thus moderately limiting food purchase and imports.
			M		+4	• Strong fisheries sector activity will significantly increase production (balance nutrition) and economic growth allowing food purchase and imports • Controlled access to Sundarbans allowed to harvest wild fish

			Score			Comments
Agriculture and fisheries	23	Increase agricultural and fish production	R	-1		• Production will stagnate or decline because of climate change (temperature changes, changed freshwater flows), inadequate investments or subsidies in technologies and varieties
			M		+4	• Production will improve significantly because of increased investments and use of technologies and improved varieties • Significant investment in mechanization (e.g. wave machines) • Increased use of smart and new technologies • Improved management
Power and energy	24	Increase uptake of renewable energy	R	0		
			M		0	
	25	Increase efficiency in production and consumption of energy	R	0		
			M		0	
	26	Increase access to affordable energy	R	0		
			M		0	
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts	R	0		
			M		0	
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	R	0		
			M		0	
	29	Optimize the existing and future physical footprint of transport services (rail, road, waterways)	R	0		
			M		0	

Annex 4.7: Deeper Assessment of Water Sector

Scoring reflects whether the suite of developments likely to arise under each scenario will enhance (+ scores) or impede (-ve scores) achieving the objectives

Range of scores
Very significant and significant negative scores: '-5' and '-4' respectively. Very negative score: '-3'. Moderately and slightly negative scores: '-2' and '-1' respectively.
Neutral [0]
Very significant and significant positive scores: '+5' and '+4' respectively. Very positive score: '+3'. Moderately and slightly positive scores: '+2' and '+1' [add tone] respectively.

R: Risk score: where existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced, and/or where no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory.

M: Mitigated score: where existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced, and the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

R: *Risk score*: where no mitigatory action is taken, regulations are in place but not effectively implemented.

M: *Mitigated score*: score where the government implements avoidance, mitigation, minimization, restoration, offsetting, etc.

			Score			Comments
				R	M	To justify or explain score, or illustrate how objective will be enhanced/impaired, or indicate how score can be improved by mitigation
Environmental						
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	R	-3		• Inadequate flow of freshwater will increase salinity resulting loss of Sundri habitat and impaired rejuvenation
			M		+4	• Significant increase of dry season fresh water flows due to appropriate government interventions
	2	Reduce illegal activities related to protected areas and biodiversity	R	0		
			M		0	
	3	Reduce introduction and spread of Invasive Alien Species	R	0		
			M		0	
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	R	0		
			M		0	

			Score			Comments
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	R	-3		• Inadequate dry season flows (due to inadequate interventions) leads to inadequate dilution of pollution • Inadequate/improper treatment of increasing industrial and municipal (water-based) discharges
			M		+ 4	• Interventions (dredging, diversion structures) significantly enhance dry season flows and improve dilute of pollution in rivers • Transboundary water agreement maintains adequate dry season flow. • Effective treatment of increasing industrial and municipal (water-based) discharges
	6	Minimise emissions of greenhouse gases	R	0		
			M		0	
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity intrusion in rivers, floods, storm surges, etc.)	R	-3		• Lack of interventions to regulate flows (dredging, diversion structures) means continuing low dry season flows and unrestricted saline intrusion; and continuing flood risk
			M		+3	• Interventions to regulate flows (dredging, diversion structures) increase dry season flow which inhibits saline intrusion; and reduces flood intensity
Water	8	Increase dry season freshwater flow in rivers	R	-4		• Lack of flow augmentation interventions
			M		+4	• Significant investments in flow augmentation interventions
	9	Reduce high/peak flows in rivers during monsoon season	R	-3		• Uncontrolled flow due to no government investment in flow regulation interventions
			M		+3	• Controlled flow due to government investment in flow regulation interventions
Land degradation	10	Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion, etc)	R	-3		• Inadequate erosion control measures
			M		+3	• Extensive erosion control measures in place (e.g. river bank protection works)
Land use change	11	Minimise conversion of agricultural land (e.g. conversion to shrimp ponds)	R	0		
			M		0	
Socio-economic						
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	R	-4		• Insufficient and poor quality water undermines key productive sectors
			M		+4	• Improved supplies of good quality water underpins key productive sectors

			Score			Comments
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	R	-4		• Insufficient and poor-quality water undermines key economic sectors and thus limits job opportunities
			M		+4	• Improved supplies of good quality water underpins key economic sectors and thus job opportunities
Health and sanitation	14	Improve health services and health of society (e.g. by reducing vulnerability to diseases)	R	-3		• Insufficient and poor-quality water undermines public health and increases vulnerability to diseases
			M		+3	• Improved supplies of good quality water underpins public health and reduces vulnerability to diseases
	15	Improve and extend water supply and sanitation services	R	-3		• Poor investment in, and management of, water supply and sanitation infrastructure
			M		+4	• Significantly improved investment in, and management of, water supply and sanitation infrastructure
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	R	0		
			M		0	
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	R	0		
			M		0	
Women and children	18	Improve gender equality and empowerment of women	R	0		
			M		0	
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities in SW region	R	0		
			M		0	
Conflicts and security	20	Reduce conflicts over use of land	R	0		
			M		0	
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.) and also Sundarbans natural heritage sites	R	-2		• Inadequate dry season flows of freshwater due to inadequate water flow control interventions leads to deterioration of ecosystem functions in WHS
			M		+3	• Water flow control interventions improves dry season freshwater flow which helps to maintain ecosystem function in of WHS

			Score			Comments
Food	22	Improve food security	R	--4		• Insufficient and poor quality water undermines key economic sectors and economic growth, limiting food production and imports
			M		+4	• Improved supplies of good quality water underpins key economic sectors, increasing economic growth and food production and allowing food imports
Agriculture and fisheries	23	Increase agricultural and fish production	R	-4		• Insufficient and poor quality water undermines the agriculture and fisheries sectors
			M		+4	• Improved supplies of good quality water underpins the agriculture and fisheries sectors
Power and energy	24	Increase uptake of renewable energy	R	0		
			M		0	
	25	Increase efficiency in production and consumption of energy	R	0		
			M		0	
	26	Increase access to affordable energy	R	0		
			M		0	
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts	R	0		
			M		0	
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	R	0		
			M		0	
	29	Optimise the existing and future physical footprint of transport services (rail, road, waterways)	R	-2		• Inadequate investment in implementation of government policies and plans to optimise footprint of waterways
			M		+2	• Improved implementation of government policies to optimise footprint of waterways (e.g. Khulna Development Plan, dredging programmes)

Annex 4.8: Deeper Assessment of Tourism Sector

Scoring reflects whether the suite of developments likely to arise under each scenario will enhance (+ scores) or impede (-ve scores) achieving the objectives

Range of scores
Very significant and significant negative scores: '-5' and '-4' respectively. Very negative score: '-3'. Moderately and slightly negative scores: '-2' and '-1' respectively.
Neutral [0]
Very significant and significant positive scores: '+5' and '+4' respectively. Very positive score: '+3'. Moderately and slightly positive scores: '+2' and '+1' [add tone] respectively.

R: Risk score: where existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced, and/or where no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory.

M: Mitigated score: where existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced, and the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

			Score			Comments
				R	M	To justify or explain score, or illustrate how objective will be enhanced/impaired, or indicate how score can be improved by mitigation
Environmental						
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	R	-2		• Moderate increase in pollution due to discharges/leaks of fuel/oil and liquid waste from tourist boats and discarded plastic bottles/containers
			M		+1	• Minimal pollution due to discharges/leaks and liquid waste from tourist boats and discarded plastic bottles/containers because of improved implementation of tourist guidelines, controls and increased awareness.
	2	Reduce illegal activities related to protected areas and biodiversity	R	0		
			M		0	
	3	Reduce introduction and spread of Invasive Alien Species	R	0		
			M		0	
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	R	-2		• Moderate increase in pollution due to discharges of liquid waste from tourist boats and discarded plastic bottles/containers • Slight increase in unsafe sewage disposal from tourist facilities in departure/landing stations (e.g. jetties)

			Score			Comments
			M		+1	• Minimal pollution due to discharges/leaks of liquid waste from tourist boats and discarded plastic bottles/containers because of improved implementation of tourist guidelines, controls and increased awareness. • Improved collection, treatment and disposal of sewage from departure/landing stations (e.g. jetties)
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	R	-2		• Moderate increase in noise due to increased numbers of tourists and tourist boats • Moderate increase in pollution due to discharges/leaks of fuel/oil and liquid waste from tourist boats and discarded plastic bottles/containers • Moderate increase in unsafe sewage disposal from tourist facilities in departure/landing stations (e.g. jetties)
			M		+1	• Minimal increase in noise due to implementation of regulations, guidelines and increased awareness. • Minimal pollution due to discharges/leaks and liquid waste from tourist boats and discarded plastic bottles/containers because of improved implementation of tourist guidelines, controls and increased awareness. • Improved collection, treatment and disposal of sewage from departure/landing stations (e.g. jetties)
	6	Minimise emissions of greenhouse gases	R	0		
			M		0	
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity intrusion in rivers, floods, storm surges, etc.)	R	0		
			M		0	
Water	8	Increase dry season freshwater flow in rivers	R	0		
			M		0	
	9	Reduce high/peak flows in rivers during monsoon season	R	0		
			M		0	
Land degradation	10	Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion, etc)	R	0		
			M		0	
Land use change	11		R	0		

			Score			Comments
		Minimise conversion of agricultural land (e.g. conversion to shrimp ponds)	M		0	
Socio-economic						
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	R	-2		• Increase in high-end foreign tourism may lead to 'leakage' as not all fees accrue to Bangladesh but are paid overseas • Poor involvement of local communities and service providers in the tourism industry • Inadequate capture of the multiplier effect of tourism (e.g. weak local participation in value chain)
			M		+3	• Moderate increase in revenue from increased nature-based and cultural tourism (various forms including high-value packages) • Local share of tourism revenue safeguarded by ensuring dominant local ownership of tourism infrastructure and services. • Expanded involvement of communities and service providers in tourism industry • Tourism has a multiplier effect (maximized local participation in value chain) that increases revenue in other sectors
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	R	-1		• Limited job opportunities in tourism sector and other sectors through multiplier effect through failure to market tourism and/or capture multiplier affect • Poor involvement of communities and service providers in tourism
			M		+2	• Moderate increase in job opportunities in expanded tourism sector and in other sectors through good marketing and multiplier effect • Expanded involvement of communities and service providers in tourism
Health and sanitation	14	Improve health services and health of society (e.g. by reducing vulnerability to diseases)	R	-2		• Introduction/spread of communicable diseases by local and foreign tourists • Inappropriate interactions between tourists and locals (e.g. re: STDs)
			M		+1	• Reduced introduction/spread of communicable diseases by local and foreign tourists through implementation of health safety and disease control measures • Implementation of guidelines on inappropriate interactions between tourists and locals (e.g. re: STDs)
	15	Improve and extend water supply and sanitation services	R	0		
			M		0	

			Score			Comments
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	R	-1		• Inadequate skills and training provided by tourism training institutes • Poor involvement of local people in tourism sector and inadequate skills transfer
			M		+2	• Enhanced skills and training provided by tourism training institutes and through courses (e.g. hotel management, tourism and related courses) and practical on-the-job training • Improved involvement of local people in tourism sector and skills transfer
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	R	0		
			M		0	
Women and children	18	Improve gender equality and empowerment of women	R	-1		• Poor implementation of Gender Policy limits opportunities for women to participate in tourism-related income-generating activities (cultural activities, crafts, hotel management, guiding, etc.)
			M		+2	• Implementation of Gender Policy to promote opportunities for women to participate in tourism-related income-generating activities (cultural activities, crafts, hotel management, guiding, etc.)
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities in SW region	R	0		
			M		0	
Conflicts and security	20	Reduce conflicts over use of land	R	0		
			M		0	
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.) and also Sundarbans natural heritage sites	R	-2		• Inadequate investment in management of heritage/cultural sites, with deterioration/degradation of sites
			M		+3	• Strong and expanding tourism sector encourages more investment in, and good management and maintenance of, heritage/cultural sites
Food	22	Improve food security	R	0		
			M		+1	• Tourism slightly contributes to increased economic growth and enable food imports
Agriculture and fisheries	23	Increase agricultural and fish production	R	0		
			M		0	

			Score			Comments
Power and energy	24	Increase uptake of renewable energy	R	0		
			M		0	
	25	Increase efficiency in production and consumption of energy	R	0		
			M		0	
	26	Increase access to affordable energy	R	0		
			M		0	
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts	R	-2		Increased tourists with poor management No improvement in quality of tourism experience No improvement of services and facilities in tourism sector
			M		+3	• Very good management of tourism in place, and effort made to determine tourist carrying capacity • Very high value tourism (including eco-tourism) preferred over mass tourism • Highly improved quality of tourism experience enhanced • Highly improved services and facilities in tourism sector
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	R	0		
			M		0	
	29	Optimise the existing and future physical footprint of transport services (rail, road, waterways)	R	0		
			M		0	

Annex 4.9: Deeper Assessment of Agriculture Sector

Scoring reflects whether the suite of developments likely to arise under each scenario will enhance (+ scores) or impede (-ve scores) achieving the objectives

Range of scores
Very significant and significant negative scores: '-5' and '-4' respectively. Very negative score: '-3'. Moderately and slightly negative scores: '-2' and '-1' respectively.
Neutral [0]
Very significant and significant positive scores: '+5' and '+4' respectively. Very positive score: '+3'. Moderately and slightly positive scores: '+2' and '+1' [add tone] respectively.

R: Risk score: where existing environmental and social safeguard policies, regulations and guidelines are not fully or effectively implemented or enforced, and/or where no or ineffective mitigatory action is taken to avoid, minimise, restore, mitigate or offset potential impacts of development, and/or the use of clean and sustainable technologies is not compulsory.

M: Mitigated score: where existing environmental and social safeguard policies, regulations and guidelines are fully and effectively implemented and enforced, and the government implements effective measures to avoid, mitigate, minimise, restore or offset potential impacts of development, and ensures the use of clean and sustainable technologies.

			Score			Comments
				R	M	To justify or explain score, or illustrate how objective will be enhanced/impaired, or indicate how score can be improved by mitigation
Environmental						
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/degradation of habitats, loss of biodiversity and ecosystem(s) integrity and services	R	0		
			M		0	
	2	Reduce illegal activities related to protected areas and biodiversity	R	0		
			M		0	
	3	Reduce introduction and spread of Invasive Alien Species	R	-3		• Very poor agricultural practices • Inadequate measures to manage spread of water hyacinth • Increased eutrophication due to increased use of chemical fertilisers
			M		+3	• Highly improved agricultural management practices • Significant increase in multipurpose use of water hyacinth as bio-fertiliser, cattle feed and for seed beds etc.
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	R	0		
			M		0	

			Score			Comments
	5	Reduce all forms of pollution (air, land, water, noise, light, etc.)	R	-1		• Inadequate pollution control for pesticides and fertilisers, continued use of inorganic fertilizers, and low uptake of integrated pest management • Poor management of manure (from poultry and cattle) leads to emissions of ammonia
			M		+1	• Improved management of pesticides and fertilisers, reduced use of inorganic fertilizers (in favour of organic fertilizers) and increased use of integrated pest management • Improved management and maximum use of manure as a resource
	6	Minimise emissions of greenhouse gases	R	-1		• Increased rice production (emits methane) • No conversion to organic agriculture • Increase of flatulent cattle kept in feedlots (where feed other than grass is consumed)
			M		+1	• Increased use of organic agriculture • Promoting free-range cattle keeping and reducing size of feedlots
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (salinity intrusion in rivers, floods, storm surges, etc.)	R	0		
			M		0	
Water	8	Increase dry season freshwater flow in rivers	R	0		
			M		0	
	9	Reduce high/peak flows in rivers during monsoon season	R	0		
			M		0	
Land degradation	10	Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity, soil erosion, etc)	R	0		
			M		0	
Land use change	11	Minimise conversion of agricultural land (e.g. conversion to shrimp ponds)	R	0		
			M		0	
Socio-economic						
Economic growth	12		R	-2		• Diminished agricultural production due to climate change (increased salinity and inundation areas, increased pests)

			Score			Comments
		Ensure significant economic development and diversification, and increase in economic growth	M		+3	• Increased agricultural productivity due to new climate adaptation and other technologies (e.g. saline tolerant rice)/innovation/ intensification/ expanded agriculture service sector
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	R	-1		• Slight decrease in job opportunities in agriculture due to reduced cultivated land and increased mechanisation
			M		0	
Health and sanitation	14	Improve health services and health of society (eg by reducing vulnerability to diseases)	R	0		
			M		0	
	15	Improve and extend water supply and sanitation services	R	0		
			M		0	
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	R	0		
			M		+1	• Increased availability of education, training and extension services and facilities for agriculture
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	R	0		
			M		0	
Women and children	18	Improve gender equality and empowerment of women	R	0		
			M		0	
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities in SW region	R	0		
			M		0	
Conflicts and security	20	Reduce conflicts over use of land	R	0		
			M		0	
Cultural and natural heritage sites	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.) and also Sundarbans natural heritage sites	R	0		
			M		0	
Food	22	Improve food security	R	-2		• Climate change may reduce agricultural productivity • Inadequate subsidies for agriculture (e.g. for fertilisers and equipment)

			Score			Comments
			M		+3	• Food production will improve significantly because of increased investments and use of technologies and better varieties • Increased economic growth (due to agricultural contribution) allowing food imports
Agriculture and fisheries	23	Increase agricultural and fish production	R	-2		• Climate change may reduce agricultural productivity • Inadequate subsidies for agriculture (e.g. for fertilisers and equipment)
			M		+3	• Production will improve significantly because of increased investments and use of SMART and new technologies and better varieties • Significant investment in mechanization • Improved management
Power and energy	24	Increase uptake of renewable energy	R	0		
			M		0	
	25	Increase efficiency in production and consumption of energy	R	0		
			M		0	
	26	Increase access to affordable energy	R	0		
			M		0	
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts	R	0		
			M		0	
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	R	0		
			M		0	
	29	Optimise the existing and future physical footprint of transport services (rail, road, waterways)	R	0		
			M		0	

Annex 5: Members of SEMP Liaison Group

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Annex 6: Recommendations for PPPs and Legal Instruments (Laws, Regulations, Rules)

***Note**: Blank cells in the fourth column indicates no specific recommendations*

Sector	PPPs and legal instruments	Main elements	Recommended changes
Forestry	National Forestry Policy 2016 (draft)	• Guidance on increasing tree cover, stopping deforestation and forest degradation; • Encourage gainful participation of forest dependent communities in the protection and development of forests resources; • Promotes conservation-oriented forestry to improve ecosystem services and address climate change issues; • Integration of the values of forest ecosystem services in the processes of national planning; • Promotes research, education and capacity-building to meet the challenges of forest management.	• Address all climate change issues. • Need national-level body to address interagency issues regarding Sundarbans conservation. • The transfer of forest land for the purposes of other than forestry activity should not be allowed. • Encourage land-owning agencies to prioritise accommodating social forestry plantation. • Timely distribution of benefit shares to participants in social forestry programmes required to avoid conflict and mistrust. • Free seedling distribution and planting in vacant forest plots and fallow lands to promote social forestry • Undertake valuation of all aspects of ecosystem services in the Sundarbans • Prepare a new management plan for the Sundarbans which emphasises upholding its outstanding universal value. • Forests should be considered as important natural infrastructure and their conservation needs should be considered when preparing development plans. • More emphasis is needed at both national and local levels regarding compliance with international conventions and treaties. • Re-organization of the department and posts of estate and law officers, etc. is urgently needed in order to achieve more effective management of forests.
	Bangladesh Forestry Master Plan, 2017-2036	• Promotes the impact of forests on society in the form of ecosystem goods and services and also possibilities of earning foreign exchange through carbon trading;	• In order to improve the understanding of policy-makers, the Master Plan should include a statement that 'national land zoning policy should clearly indicate forest land to avoid use of forest land other than forestry practices'.

Sector	PPPs and legal instruments	Main elements	Recommended changes
		• Emphasizes the strongest natural defensive capacity of Sundarbans and coastal plantations against frequent natural disasters in the context of climate change impacts; • Indicates a very significant contribution of forestry sector to employment generation.	• The Master Plan should include the collaborative forest management approach in order to to maintain a sustainable continuous green belt through coastal plantation. • The Master Plan should commit to attaining, within the next 20 years, at least 25% tree cover for the entire country and 20% of forest cover with 50% canopy coverage for forest land. • The plan should recommend the branding and exporting of forest products for the creation of job opportunity in the sector.
	Legal instruments		
	The Forest Act, 1927 (amended in 1982, 1989 and 2000)	• Protects forest resources & provides for reserving forests over which the Government has an acquired property right. • Enables the restriction of many activities that may cause damage to forests and wildlife resources within forest areas and the imposition of punishment for violation. • Relevant people are bound to inform and assist Forest or Police Officers to prevent crime in the forests.	• Update the Act to emphasise biodiversity and ecosystem conservation, and engagement of local communities. • Increase the punishment for forest crimes/offences. • Strict enforcement and instant prosecution of offences is required. • Include fish and fish products as forest produce. • Include punishment for activities which threaten biodiversity conservation, natural heritage and ecosystems e.g. noise pollution during tourism in the Sundarbans, as well as for any illegal activity (fishing) in the World Heritage Sites, etc. • Introduce levies for enjoying/using major forest ecosystem services (e.g. water, natural beauty)
	The Social Forestry Rule 2004	• Regulates plantation on marginal lands besides roads, canals, embankments and railways with the involvement of local residence as beneficiaries. • The latter are given the majority of the harvested crops in return for their contribution to protect the seedlings planted. • Allows tree firming funds from the sale proceeds of harvested plantation for replanting.	• Provide for free distribution of quality indigenous seedlings to promote social forestry. • Include forest officers as members of the Tree Farming Fund Management Committee. • Increase the percentage of benefit share given to participants in social forestry activities. • Prioritise making government fallow/marginal land available for social forestry.
	Saw Mills Rule 2012	• Prohibits establishment of sawmill without license from the forest department	• Amend to benefit local people as well as for forest conservation.

Sector	PPPs and legal instruments	Main elements	Recommended changes
		• Allows maintenance of forest produce in prescribed form which is verifiable by forest officials • Restricts establishment of sawmills within 10 km of reserved forests and 5 km of international borders.	
Wildlife	Bangladesh Wildlife Master Plan, 2015-35	Covers: • Protection of important endangered/threatened species, • Management of natural habitat for wildlife • Planning of ecological network and land-uses, • Scientific management of protected areas, • Building institutional capacity • Policy and legal framework development, • Combating wildlife trafficking, • Supporting communities in wildlife zone, • International and regional cooperation, • Developing nature based eco-tourism • Communications awareness and education, • Wildlife Research	• Incorporate capacity-building programmer for law enforcement agencies to improve combating wildlife trafficking. • Provide for strict compliance with wildlife-related conventions, treaties and protocols. • Expand and enhance the management of protected areas. • Tourism in the Sundarbans should be strictly water based • Need to address habitat fragmentation and isolation through controlled ship movement in the Sundarbans Reserved Forest • Include development of a management information system for poaching and wildlife trafficking.
	Wildlife (Conservation and Security) Act-2012-	• Repeals the Bangladesh Wildlife (Preservation) Order 1973 relating to conservation and management of wildlife of Bangladesh. • Hunting, trapping, killing, driving or damaging of wildlife are strictly prohibited.	• Include power to arrest suspects of wildlife crimes. • Empower all forest officers and various designated personnel to enforce the Act. • Require the presence of witness at trials. • Explain the schedules. • Expand cognizable offences (beyond tigers and elephants). • Empower the Coast Guard, BGB, Navy and Fisheries officers to combat wildlife crimes. • Remove conflicts between sections (e.g. like Section 35 and 43). • Require strict enforcement of regulations and instant prosecution of offences.

Sector	PPPs and legal instruments	Main elements	Recommended changes
	The Protected Area Rule 2017	• Provides for the formation of Co-Management Committees for the management of Protected Areas. • Committees involve stakeholders including the resources users and especially ethnic people. • Empowers the Committee to act as official actor for the protection of forests and collect revenue • Provides for sharing of revenue to cover the recurrent costs of co-management. • Recently introduced in Sundarbans	• Include auditing of Co-Management Committees (CMC) to ensure proper financial functioning. • Restructure CMC Executive Committee with clear responsibilities to ensure smooth functioning. • Ensure democratic selection of CMC Executive Committee members to avoid bias. • Introduce monitoring of CMC Executive Committees to ensure proper discharge of duties and responsibilities of agencies and groups. • Ensure regular revenue-sharing and capacity-building for CMC members.
Sundarbans	Integrated Resource Management Plan of Sundarbans, 2011-2020	• Presents management situation and recommendation for 2010-20 - provides: • Better protection of habitat and interest of people depending on Sundarbans; • Scientific management of wildlife sanctuaries; • Conservation of important endanger/threatened species (tiger, crocodile etc.); • Enhanced ecosystem services through conservation of biodiversity; • Promotes participation of local stakeholders in the governing system through strengthening co-management; • Guides sustainable management of terrestrial and wetland resources; • Addresses climate change issues and arrange conservation outreach; • Development of infrastructures and facilities for eco-tourism and capacity buildings.	• Include stronger coordination and cooperation through a national level Sundarbans Coordination Committee amongst the agencies governing water, dredging, shipping & others; • Include guidelines to address cross-cutting issues (e.g. marine species, national parks and MPA) among agencies governing ecosystem components. • A liaison mechanism is required with the Department of Agriculture to establish a means to limit the amount of pesticide sold by basing this on legitimate agricultural needs - in order to limit their use for poison fishing in the Sundarbans. • Define responsibilities arising under the oil-pollution response regulation and compensation mechanism prepared through NOSCOP. • Indicate the number of trained staff required to implement the plan effectively. • All tourism activities in the Sundarbans should be according a scientifically determined carrying capacity. It is recommended that a moratorium on increasing and/or expanding tourism to Sundarbans beyond current levels until finalization of this study
	Tiger Action Plan (2018-2027)	• Raising awareness for tiger conservation, monitoring tiger population through bi-annual tiger, prey and habitat assessment	• All tourism activities in the Sundarbans should be according A scientifically determined carrying capacity • There should be regular monitoring and review of the implementation of the plan.

Sector	PPPs and legal instruments	Main elements	Recommended changes
		• Human-tiger conflict management through compensation • Strengthening BFD capacity for tiger conservation through training, education and research. • Controlling boat traffic in Sundarbans to allow free movement of tigers and prey • Assessing economic benefits of Sundarbans ecosystem to raise awareness of policy maker for Tiger conservation. • Collaboration and Coordination with regional, national and international agencies for tiger conservation • Promoting alternate income generation of Sundarbans dependent community	• Tiger behaviour should be undisturbed during frequent camera trapping. • The Wildlife and Nature Conservation Division, Khulna should be well equipped with adequate manpower to combat illegal activity (e.g. tiger poaching) and undertake wildlife management. • There should be regular monitoring of tiger habitat and their prey base, and effective protection measures should be ensured.
Fisheries	***PPPs***		
	Chingri (Shrimp) Mohal Management Policy, 1992	Covers selection of land for shrimp cultivation, survey, distribution and favourable management for shrimp cultivable land by reviewing production related rules and regulations	• Zoning regulations should be developed and implemented that are appropriated for each region. • A clear cultivation method should be defined, based on stocking densities, input usage, nutrient recycling and discharge. • Cluster shrimp farming (several shrimp farmers cooperating) should be promoted and mobilized together with the development of a farmer database, introduction of ID cards, introduction of an integrated e-traceability system for shrimp seed, feed, products, etc. and related business plan • Provision should be made to enable fry-catchers to switch to other economic activities such as feed production, operation of shrimp fry nurseries, shrimp fry trading, artisanal production of fishing traps and gear, operation of fish feed mills, shrimp de-heading for processing, crab-fattening, hogla- and mat- making, bee-keeping, coir industry, tree plantation, horticulture, tailoring and knitting, etc. • Align the policy with international best practice guidelines for shrimp production (to promote exports)
	National Fisheries Policy, 1998	Covers marine and freshwater fisheries management, culture, conservation, processing, marketing and transportation. Objectives:	• Participation, accountability, coherence and effectiveness are the hallmarks of good fisheries governance. The present policy was prepared in a mainly 'top down' manner. It emphasise 'good

Sector	PPPs and legal instruments	Main elements	Recommended changes
		• To enhance fisheries production; • To maintain ecological balance and conserve biodiversity; • To fulfil the demand for animal protein; • To achieve economic growth through exporting fish and fisheries products; • To alleviate poverty of the fishers.	governance' to ensure the sustainability of fisheries and underpin dependent livelihoods. • Being a climate-vulnerable country, climate change (CC) issues should be fully addressed by policy, clearly indicating the roles and responsibilities of the line agencies. • The policy should be aligned with Bangladesh's Climate Change Strategic and Action Plan (2008) or subsequent instruments in order to improve the resilience of the fisheries sector. • The policy should provide guidance on raising funds for CC-related research work by relevant research organizations (e.g., Bangladesh Fisheries Research Institute, etc.). • The Policy should indicate how the line agencies will interact with the aligned agencies/ministries (e.g. Bangladesh Water Development Board (BWDB)/Ministry of Water Resources (MoWR); Bangladesh Inland Water Transport Authority (BIWTA)/Ministry of Shipping (MoS); Local Government and Engineering Department (LGED)/Ministry of Local Government and Rural Development (MoLGRD), etc.) in order to better and efficiently manage the fisheries production system and post-harvest activities. • A liaison mechanism is required with the Department of Agriculture/BFD to establish a means to limit the amount of pesticide sold by basing this on legitimate agricultural needs - in order to limit their use for poison fishing in the Sundarbans.
	The National Fisheries Strategy, 2006	• Measures to implement the National Fisheries Policy • Redress the current imbalances in allocation of resources to ensure a balanced approach to development; • Change from annual development funding to revenue-based activities; • Ensure that staff technical skills and knowledge are retained in key core areas; • Develop staff capacity to address new areas of interventions e.g., community-based management, enhancing the legal capacity to develop regulatory frameworks for the sector; • Develop long-term monitoring and evaluation capacity.	
	National Shrimp Policy, 2014	• Emphasises promoting environment-friendly shrimp mixed cultivation. Covers: • Preserving, controlling quality, processing and facilitating export-import; • Facilitating shrimp producers, fishers, institutions, researchers and managers associated with shrimp culture, transportation and marketing; • Creating employment opportunities; • Improving the socio-economic conditions of shrimp-culture associated communities;	• Include the development of zoning regulations appropriate for each region. • Provide clear definition of a cultivation method based on stocking density, input usage, nutrient recycling and discharge. • Cluster shrimp farming should be operated in an equitable manner (i.e. sharing benefits/losses based on the share of land, investment and labour, and by adopting an eco-friendly management approach to promote a more sustainable farming system. • Provision should be made to enable fry-catchers to switch to other economic activities such as feed production, operation of shrimp fry nurseries, shrimp fry trading, artisanal production of fishing traps and

Sector	PPPs and legal instruments	Main elements	Recommended changes
		• Ensuring women participation and empowerment; • Ensuring enforcement of national and international labour laws; • Compliance with regulations for culturing, processing and exporting shrimp; • Shrimp culture associated education, training, extension and research.	gear, operation of fish feed mills, shrimp de-heading for processing, crab fattening, hogla- and mat-making, bee-keeping, coir industry, tree plantation, horticulture, tailoring and knitting, etc.
	Public Water Body (Jalmahal) Management Policy (PWBMP), 2009	Covers: • Wetlands under open access or leased out for private individual use - including beels (wetland depressions) and haors (oxbow lakes). • Gives priority and opportunities for revenue collection, in addition to conserving fisheries resources and increasing production whilst conserving biodiversity - when allowing genuine fishermen to settle in public water bodies and Jalmohals. • Sustainable and environment friendly management of lakes, floodplains, canals, ditches and coastal areas (estuary) with the participation of core fishermen; • Haors located at Jessore, Jhenaidah, Kushtia of SW region; • Beels and haors in NE region for conservation of biodiversity.	• All identified beels, baors and haors should be notified and defined in the Bangladesh Gazette, and in all of them except those are earmarked solely for conservation of biodiversity, the primary development aim should be the improvement of fisheries in terms of species composition and production. • A land- and water-sharing scheme should be developed for each beel, baor and haor - to enable the optimum development of fisheries whilst allowing some use for grazing and crops. • The categories of water courses in the policy should be reassessed and reclassified to reflect the ecosystem services they provide, their capacity for fish production and fishing portfolios for the effective and sustainable management of public water bodies and efficient handling of the leasing system. • A Panel of Experts should be formed, under the Ministry of Planning, to carry out the above-mentioned classification and to recommend proper land and water use. This Panel should contain experts recommended by the Ministries of Water Resources, Land, Environmental and Forest, Industries and Communications. • Ownership of all types of khas ponds/tanks should be placed under the Ministry of Fisheries and Livestock (MoFL) so that the ministry can develop all khas ponds/tanks to optimize their potential for fisheries. • The Non-Government Organizations (NGOs) should be encouraged by the MoFL to manage derelict ponds (tanks) so that their fishery potential can be realized. • A land use survey should be undertaken of all coastal aquaculture to enable recommendations to be made to minimize negative impacts

Sector	PPPs and legal instruments	Main elements	Recommended changes
			and increase their productive potential. The survey report should also consider optimum energy use so that these wetlands are fully utilized for productive fisheries.
	Bhabadah Area Fish Gher Establishment Policy, 2019	Covers registration of Ghers (ponds dug into rice fields) with conditions, removal of water logging and establishing techniques for planned fish Gher.	• Include the development of zoning regulations appropriate for each region. • Provide a clear definition of a cultivation method based on stocking densities, input usage, nutrient recycling and discharge. • Cluster shrimp farming should be operated in an equitable manner (meaning sharing benefit/loss based on the share of land or in-kind or others) and by adopting an eco-friendly management approach for the sustainability of the farming system. • Provision should be made to enable fry-catchers to switch to other economic activities such as feed production, operation of shrimp fry nursery, shrimp fry trading, artisanal production of fishing traps and gear, operation of fish feed mills, shrimp de-heading for processing, crab fattening, hogla- and mat-making, bee-keeping, coir industry, tree plantation, horticulture, tailoring and knitting, etc. • Provide credit facilities and training to enable fish farmers and fishermen to diversify into other activities. • Provide for seed certification for hatchery production to ensure the continued production and supply of quality hatchery-bred shrimp seeds. Such certification requires the screening of shrimp brooders and seed lots for viruses and deformities using quick and reliable diagnostic techniques.
	Legal instruments		
	The Protection and Conservation of Fish Act 1950 (amended 1973, 1982, 1995, 2002)	• Sets requirements to protect and conserve fish. • Defines fish as "all cartilaginous, bony fishes, prawn, shrimp, amphibians, tortoise, turtles, crustacean animals, molluscs, echinoderms and frogs at all stages in their life history."	• Clear definitions need to be developed for Maximum Sustainable Yield (MSY), fishing effort-MSY per type of 'Fishing Net', • Clear definitions need to be developed for Illegal Unreported and Unregulated (IUU) fishing. • Provision is needed for ecosystem based management.

Sector	PPPs and legal instruments	Main elements	Recommended changes
	The Protection and Conservation of Fish Rules-1985	Focus on the protection of fisheries/fishes and aim to prevent the destruction of fish in the natural waters and killing of fish by poisoning.	
	Private Fisheries Protection Act 1889	Provides for the protection of private fishing rights.	• Clear definitions need to be developed for extensive and semi-intensive production; and zoning regulations should be developed and implemented that are appropriate for each region. • Extensive and semi-intensive methods of cultivation should be based on stocking densities, input usage, nutrient recycling and discharge.
	Marine Fisheries Act, 2020	Contains 12 chapters and 63 clauses which will replace the Marine Fisheries Ordinance (1983), and defines the shape of the fishing boat or trawlers. The license period is extended from 1 to 2 years to reduce the bureaucracy and harassment of vessel owners. The act has also defines the import of commercial trawlers, and sets specification and safety requirements. The law enables magistrates or mobile courts to punish violators. For obstructing any official job, damaging fishing trawlers and destroying proof, the punishment is now a maximum two years of imprisonment or Tk 10 lakh fine depending on the nature of the crime. Fishing during a restricted period or area, and fishing without approval for going to sea, are punishable offences. In addition, the Law provides for a maximum three-year imprisonment or Tk 5 crore fine, or both, for fishing illegally within Bangladesh's maritime boundary by any foreign national.	
	Marine Fish and Fish products (Inspection and quality control) Act, 2020	Replaced the Fish and Fish Products (Inspection and Quality Control) Ordinance (1983), introducing tougher punishment for marketing and exporting fish or fish products with harmful chemicals. The punishment for violation of the law is maximum seven years imprisonment, Tk 5 lakh fine, or both. A license is required to export fish and fish products, set up or run a factory or any establishment in this regard. Such	

Sector	PPPs and legal instruments	Main elements	Recommended changes
		licenses can be revoked on different grounds, including violation of conditions, providing false information or concealing information, failure to renew a license for three consecutive years, and handing over and selling a license. A maximum fine of Tk 5 lakh fine may be imposed if inspection finds an unhygienic environment in factories or establishment or sub-standard quality of processing	
Water Resources	***PPPs***		
	National Water Policy, 1999	• Provides guidance to ensure optimal development and management of water. • All agencies and departments entrusted with water resource management responsibilities (regulation, planning, construction, operation, and maintenance) are required to enhance environmental amenities and ensure that environmental resources are protected and restored in executing their tasks.	
	National Water Management Plan, 2001	• Aims to achieve integrated development, management and use of water resources in Bangladesh over a period of 25 years. • The Water Resources Planning Organization (WARPO) has been assigned to monitor the plan. • Major programmes are organized under eight sub-sectoral clusters: i) Institutional Development, ii) Enabling Environment, iii) Main River, iv) Towns and Rural Areas, v) Major Cities; vi) Disaster Management; vii) Agriculture and Water Management, and viii) Environment and Aquatic Resources.	• The plan discusses flow augmentation, but needs to clearly specify how this is to be achieved. • It mentions establishing linkage through developing both regional and local river distributary systems as part of the overall ensuring of water availability in GDA. But it needs to clearly how this is to done. • A framework is needed to monitor plan implementation.
	National Strategy for Water Supply and Sanitation, 2014	A single synchronized strategy incorporating outstanding issues in existing sector documents and emerging issues, and seeks to translate the SDGs into action including providing guidelines for the sector.	
	Legal instruments		

Sector	PPPs and legal instruments	Main elements	Recommended changes
	Bangladesh Water Act- 2013	Makes provisions for integrated development, management, abstraction, distribution, use, protection and conservation of water resources.	
	Bangladesh Water Rules 2018	Formulated for the conduct basic and applied research on river basin management, flood control water logging and development of haor and wetland areas.	
	National River Protection Commission Act-2013	Created and sets the composition, duties and responsibilities the National River Protection Commission to: • Prevent irregularities and restore the normal flow of rivers, to control floods and drainage • Monitor hydrology and use of surface and ground water; and • Examine equipment.	
	The National River Conservation Commission Act, 2013	Established the Commission to prevent illegal occupation of rivers, pollution of water and environment, pollution of rivers caused by industrial factories, illegal construction and various irregularities and ensuring multidimensional use of rivers for socio-economic development including restoration of the normal flow of rivers, proper maintenance thereof and making them navigable.	
	Natural Water Bodies Protection Act 2000	Requires the approval of the concerned ministry to change the character of water bodies (i.e. rivers, canals, tanks, or floodplains identified as water bodies in the master plans or in the master plans formulated under the laws establishing the municipalities in division and district towns).	
	The Ground Water Management Ordinance (1985)	Describes the management of ground water resources and licensing of tube wells.	
	The Water Supply and Sanitation Act (1996)	Regulates the management and control of water supply and sanitation in urban areas.	

Sector	PPPs and legal instruments	Main elements	Recommended changes
	Irrigation Act 1876	Makes provision for the construction, maintenance and regulation of canals, for the supply of water therefrom, and for the levy of rates for water so supplied.	
Power and Energy	***PPPs***		
	Power & Energy System Master Plan , 2016	Focuses mainly on: • the enhancement of imported energy infrastructure and its flexible operation; • efficient development and utilization of domestic natural resources (gas and coal); • construction of a robust, high-quality power network; • maximisation of green energy and promotion of its introduction; • improvement of human resources and mechanisms related to the stable supply of energy	• The demand estimation for the SW region should be revised and related to the regional growth trend and transmission facilities. • Decisions on the spatial distribution of the power plants and their type and fuel used should take into account the sensitivity of the environment to pollution and community health. • Currently, power production is determined by seasonal and daily electricity loads and fuel costs. But it should also take into account seasonal risks of pollution and the sensitivity of the local environment. For example, during the evening in the winter, highly polluting power plants or power plants located nearby the sensitive places should be shut down so as to minimise emissions of pollutants. To compensate, where there is a demand for power, production should be switched to other less polluting power plants which are far away from sensitive places. • A framework for renewable energy production is required and should be integrated with future energy demand.
	Draft National Energy policy, 2006	Deals with: • Exploration (survey of natural gas), • Production (coal in northern part of Bangladesh), • Establishment of refineries and power plants, • Network transmission, • Distribution of power and rational use of energy sources to meet the growing demand on a sustainable basis. • Guidance to enhance renewable energy development activity to meet future challenges.	• The use only of energy efficient products and technologies and clean fuel should be emphasized, especially in SW region.
	Renewable Energy Policy of Bangladesh, 2008	• Aims to promote renewable energy generation: biomass, solar, hydro, wind, and tidal power.	• Include promotion of non-grid or small scale grid facilities to the remote areas with substantial incentives and capacity building.

Sector	PPPs and legal instruments	Main elements	Recommended changes
		• National level: aims to bring the entire country under electricity service. • Major transition of energy sector • Renewable energy usage considered essential. (solar, wind, biomass, hydro, geothermal, tidal, etc.)	• Include promotion of biomass or waste-to-energy production technologies, especially in the SW region • Include investment in research and development focusing on how to successfully operate and maintain solar power plants in the SW region.
	Energy Efficiency and Conservation Master Plan up to 2030, (2015)	Provides a Roadmap up to 2030 with Action Plan, consisting of the outlines of legal, institutional and operational framework for implementation of Energy Efficiency and Conservation initiative of Bangladesh.	• The Master Plan should promote plant efficiency without compromising effective pollution mitigation measures • The policy should promote Life Cycle Assessment (LCA) to assess new technologies or equipment, including new electronic equipment.
	Gas Sector Master Plan 2018	Focuses on demand-supply projections, assessment of oil and gas exploration possibilities and development of road map to enhance gas reserve.	• Updated technologies should be required during exploration works for better environmental protection. • Investors should be required to ensure adequate safety measures are incorporated in gas-related developments to minimize accidental risks from constructing gas transmission lines, importing LNG and using LNG in industrial activities.
	Policy Guideline for Small Power Plant (SPP) in Private Sector, 2008	Focuses on: • National level: Small power plants in private sector. • The SPPs will be developed on a Build-Own-Operate basis. The plant size could be 10 MW or higher size plant.	• The potential cumulative environmental and social risks of new small power plants developed by independent power procures should be assessed. • Incentives, fuel and electricity prices should be revised according to national demand, priority, supply facilities and environmental pollution risks.
	Power and Energy Sector Strategy Paper (PESSP), 2018	The main objective of this paper is the development of the energy and power sector to be able to ensure intended economic growth • Sector Outcome 1: Reliable, affordable, and efficient energy supply achieved and sustained; • Sector Outcome 2: Reliable, affordable, efficient, and quality power supply achieved and sustained; and • Sector Outcome 3: Well-articulated Demand Side Management (DSM) policy adopted and implemented.	• The use economic and market-based pollution control tools should be considered, e.g. pollution taxes for the power industries, incentives for energy efficiency power projects, encouraging procurement facilities for renewable and sustainable energy infrastructure - along with existing command and control tools. • Limit importation of vehicles to those which satisfy the upper EURO-4 standard for pollution, and which incorporate modern technologies for reducing pollution and increased efficiency. • Increase the capacity of power transmission and distribution lines in the SW region to more easily supply power from plants in other parts of Bangladesh other countries.

Sector	PPPs and legal instruments	Main elements	Recommended changes
	National Action Plan for Clean Cooking, 2020-2030	Focuses on household use of clean cooking technologies • To save energy, • To improve quality of life of consumers by reducing indoor air pollution (particulate matter, carbon monoxide); • To reduce the wood biomass harvest and reduce Green House Gas (GHG) emissions.	• Modern technologies (e.g. SCADA system[89]) should be adopted to reduce risks related to fuel transportation leakage and storage. • Subsidies and incentives should be introduced for using clean cooking in the SW region. • Provide financial support for local NGOs to raise awareness about the benefits of using clean cooking systems
	Private Sector Power Generation Policy 1996 (amended 2004)	• Aims to promote private sector participation in the generation of electricity in order to attain higher economic efficiency. • Government is strongly committed to attract private investment for installing new power generation capacity on a build-own-operate (BOO) basis. • The Power Cell was created in 1995 under the Ministry of Energy & Mineral Resources (MEMR) with a mandate to lead private power development, recommend power sector reforms and restructuring, conduct studies on tariffs, and to formulate a regulatory framework for the power sector.	• Include environmental performance in the security package of the agreement between GOB and investor. • Environmental and social sensitivity (ecological habitat, endangered species human health, aboriginals etc.) Should be adopted cumulatively during site allocation by the GOB to the investor. • Tax exemption may applicable for updated pollution mitigation measures like FGD, ESP, ETP, STP etc. • Investment on R&D and incentives for the local entrepreneur for producing or supplying of Pollution control tools and technologies for the Power Plant Project.
	Legal instruments		
	Electricity Act, 2018	• Repealed a 2010 law relating to the supply and use of electrical energy. • Specifies conditions of distribution, sale and use of electricity, including related generation and transmission infrastructure, and obligations regarding the need for preservation of the environment, and associated protection and safety clauses	

[89] The supervisory control and data acquisition (SCADA) is a control system architecture comprising computers, networked data communications and graphical user interfaces (GUI) for high-level process supervisory management, while also comprising other peripheral devices like programmable logic controllers (PLC) and discrete proportional-integral-derivative (PID) controllers to interface with process plant or machinery.

Sector	PPPs and legal instruments	Main elements	Recommended changes
	Bangladesh Energy Regulatory Commission Act-2003	Makes provisions for the establishment of an independent and impartial regulatory commission for the energy sector.	
	Speedy Increase of Electricity & Fuel (Special Provision) 2010	Makes provisions: • For enhancing the generation, transmission, transportation and marketing of electricity and energy - to ensure uninterrupted supply keeping pace with the demands of agricultural, industrial, commercial and domestic activities; • To import electricity and energy from abroad, if necessary, • To implement decisions on urgent extraction and utilization of minerals related to energy.	
	NG Safety Rules 1991 (amended 2003)	Provides guidelines on the materials, design and construction of gas transmission and pipeline industry. This Safety Rules were based on the American National Standard Codes for Gas Transmission and Piping System.	
	Bangladesh Petroleum Act 1974	Provides for the exploration, development, exploitation, production, processing, refining, and marketing of petroleum.	
	Petroleum Act 2016	• Consolidated and amended the law relating to the import, transport, storage, production, refining, blending, or reclaiming by recycling of petroleum and other inflammable substances. • Regulates petroleum import, transport, storage, distribution, refining, blending, testing, licensing and all aspects related to petroleum exploitation.	
	Bangladesh Gas Act 2010	Regulates the transmission, distribution, marketing, supply and storage of natural gas and liquid hydrocarbon.	

Sector	PPPs and legal instruments	Main elements	Recommended changes
	SREDA Act 2012, Renewable energy Act-2012	Established the Sustainable and Renewable Energy Development Authority (SREDA) as a nodal agency to promote, facilitate and disseminate sustainable energy (SE) and Energy Efficiency (EE) to ensure the energy security of the country.	
	Bangladesh Electricity & Energy Research Council Act 2015	• Established and prescribed the composition, duties and responsibilities of the Bangladesh Energy and Power Research Council. • Specifies the authorized use of electricity and fuel diversification for the identification, conservation and conversion of energy to ensure the safety of the power and energy sector.	
	Air Quality Standard (Schedule -2 & 6), 2005 (Amendment of ECR 1997)	• Standard for Ambient Air Quality Standard (Schedule -2)	• Separate (secondary) standards are needed for the Environmentally Critical Area and for declared degraded airsheds.
Tourism	***PPPs***		
	National Tourism Policy, 2010	Covers: • identification of tourist zones and attractions; development of the major tourist attractions and destinations; • involvement of other local government organizations; development and marketing of eco-tourism; and • Encouragement of private sector investment.	• The policy should address the extent of growth of mass tourism in the Sundarbans, and any restriction that might be required. There should be a preference for ecotourism. • A scientific study should be undertaken to determine the carrying capacity of the Sundarbans and the appropriate mix for tourism (low volume/high cost and high volume/low-cost), • A multi-sectoral coordinated approach for tourism sector development is needed • Hotels, lodges, parks and related tourism Infrastructural development in protected areas should be prohibited.
	Legal instruments		

Sector	PPPs and legal instruments	Main elements	Recommended changes
			• Rules are required setting out what developments and activities are permitted or restricted for different protected /restricted areas.
Urbanization	***PPPs***		
	National Urban Sector Policy, 2011 (draft)	Covers spatial, economic, social, cultural, aesthetic and environmental aspects of urban life directed towards. It is gender sensitive and friendly to children, the aged and the disadvantaged.	• Should emphasise transportation planning (e.g. planning/designing of road network) to reduce traffic load in cities
	Legal instruments		
Industry	***PPPs***		
	National Industrial Policy, 2016	• Aims to build the industrial sector and reduce unemployment, hunger and poverty through short-, medium- and long-term programmes to accelerate sustainable and inclusive economic growth of the country: • Achieve economic growth through industrialization by the combined effort of public and private investment, and improving socio-economic condition of people through generating large scale employment; • Increase the contribution of industrial sector from 29% to 35%, and the contribution of manpower 18% to 25%, aiming to achieve the government' Vision-2021; • Play a role in inclusive growth by means of generating quality and income generating employments through industrialization.	• The rates for industrial growth rate and employment need to be revised to be based on a pragmatic strategy for becoming a developed country. • Establishing a land bank and sand bank will be a challenge given the scarcity of available land. A mechanism and/or regional planning would help to implement these banks
	National Policy for the Management of Radioactive Waste and Spent	• Sets out the principles, goals and requirements to ensure the safe and efficient management of: • Radioactive Wastes (RW), • Spent nuclear fuel (SNF), • Disused sealed radioactive sources (DSRS) and	• Requirements for environmental and social impact assessment, mitigation and restoration requirements need to be specified • The policy needs to require the development of a programme to improving public confidence on using radioactive materials in Bangladesh

Sector	PPPs and legal instruments	Main elements	Recommended changes
	Nuclear Fuel, 2019	• Naturally occurring radioactive materials (NORM).	• The policy should state the need for monitoring radioactive waste and spent fuel to protect public health, food chains and sensitive ecosystems.
	National Textile Policy, 2017	Promotes expansion of textiles and clothing factories; employment generation; reduction of pollution from textile and clothing factories; and compliance with international requirements regarding textiles and clothing.	• Needs a target/plan setting out how to improve the quality and productivity of the weaving industries. • Needs a guideline for the technological development of wet processing industries.
	Leather and Leather Products Development Policy, 2019	Covers: • Transformation of leather and leather products industry into a sustainable, environmentally friendly and competitive one. • Priority is given to finished leather, footwear/shoes and leather goods/products	• Policy Implementation should be harmonized with necessary revisions to environmental protection laws to ensure the leather industry is environmentally friendly. • Requires a mechanism and phased activities to encourage domestic and foreign companies to undertake research and adopt eco-friendly technologies. • Requires a clear indication whether local and central industrial waste management facilities and refineries will be funded by government or the private sectors itself or on PPP basis. This is necessary to ensure enforcement of laws and regulations and effective management. Strategic planning for the leather industry should be in place before further leather businesses are proposed and permitted.
	Legal instruments		
	Brick Manufacturing and Brick Kiln Establishment (Amendment) Bill 2019	A modified version of the 2013 Act and will prohibit conventional technologies in the brick-making industry.	
	PPPs		

Sector	PPPs and legal instruments	Main elements	Recommended changes
Transportation and Communication	National Integrated Multi-Modal Transport Policy, 2013	Covers transport (road, rail, inland water and air), ports, urban and rural transport, transport safety, environmentally friendly efficient transport. Aims to: • Reduce cost of transporting goods; • Aid export competitiveness, through lower transport costs; • Improve safety and reduce accident rate; • Take advantages of Bangladesh's geographical position to trade through an efficient transport sector; • Reduce the worst environmental effects of transport; • Ensure that transport meets social needs in terms of cost accessibility to all sectors of society.	• The policy needs to be revised considering the strategies suggested in the BDP2100 and the Perspective Plan 2041. • The policy should be refocused to in developing resilient infrastructure to ensure sustainable development. • The policy should have included strategies to ensure that land for construction of roads and highways are acquired following LAP and RAP. • The policy should commit to preparing a management plan addressing adaptation and mitigation measures to minimise pollution due to roads and transport development. • The policy should be revised to avoid conflicts for ownership of land/properties in roadside area. • The policy should have given more guidance about navigational traffic management to avoid accidents due to night-time trips.
	National Land Transport Policy, 2004	• Provisions for safe and dependable transport services, and improvements to the regulatory and legal framework; • Introduces an integrated multimodal transport system, linking road, rail and water transport. • Describes a range of key issues.	• The policy would be updated to accord with Vision 2041 and to take account of the SDGs. • An electronic bus ticket system should be introduced. • Public bus service system should be modernized and well equipped with parts/machinery and seating facilities. • Land acquisition for roads in cities and peri-urban areas should be minimized as much as possible to prevent further loss of agricultural land in future. In lieu of this, elevated high way system across cities should be introduced in Bangladesh. • The policy should set out specificities for EIAs for new roads and extensions.
	Road Master Plan 2009	• A guiding document for the Road Sector Investment Priority Programme; • Provides a physical plan of new road construction, rehabilitation and maintenance of roads over the next 20 years.	• The plan should be updated to accord with Vision 2041 and to take account of the SDGs. • Traffic impact analysis (TIA) studies should be compulsory for road developments. • The planting of exotic trees and ornamental plants should be banned in road arboriculture. Instead, local plants should be used.

Sector	PPPs and legal instruments	Main elements	Recommended changes
		• Provides design standards considering future scenarios such as population growth, economic growth and vehicle growth.	• Cycle track systems should be introduced in urban areas to improve connectivity. • All road design standards should consider the implications of climate change.
	Railway Master Plan, 2016-2045	• Sets out measures to rehabilitate, modernize, improve and expand railway infrastructure, improve efficiency and operational capacity. Aims to: • Allow the railways to play a greater role in the overall transport sector with a view to contributing to economic and social development; • Prepare the railways for playing a transport role in regional and international context; • Integrate railway network though a multi-modal approach; • Increase railway efficiency with interventions to make best use of assets; • Obtain a greater share of the freight market, with more efficient management of railway assets and improved financial efficiency (all NLTP goals).	• The operational capacity of railways should be enhanced to relieve pressure on the roads and promote sustainable development. For example, timetables should *be strictly followed district-to-district trains*. • Electric trains should be introduced for rapid movement between regions. • Railway connectivity between the capitol city (Dhaka) and districts in the SW region should be implemented as early as possible.
	Legal instruments		
	Territorial Water and Marine Zone Act 1974 & Maritime Rules-1977	Provides guidelines for transportation through marine and inland water ways and control of pollution in the surrounding waterways, and for the conservation, management and development of marine fisheries.	
	The Vehicle Act (1927) and the Motor Vehicles Ordinance (1983)	Provides for the better control of horse-drawn vehicles in certain areas in Bangladesh. Consolidated and amended the law relating to motor vehicles in Bangladesh. These laws regulate vehicular exhaust emissions, air and noise pollution including road safety.	

Sector	PPPs and legal instruments	Main elements	Recommended changes
Shipping	***PPPs***		
	National Shipping Policy, 2000	Covers sea ports, marine transport, shipping services (both national and international), inland and coastal shipping services, logistic support. Aims to: • Develop a balanced and integrated transport network through adoption of strategies/programmes; • Integrate inland water transport sub-sector with the existing road transport system.	The policy needs revision to: • Take account of strategies set out in the Bangladesh Delta Plan; • Align with targets in the Second Perspective Plan 2021-2041. • Take account of the new extension of the maritime boundary. • Refocus on exploiting the benefits of the blue economy. • Address technologies for infrastructure development and improved, faster and cost effective transportation services • Ensure shipping developments follow environmental protection and management principles, safeguard the ecosystem and water quality. • Strengthen rules and regulations to protect waterways from soil and water pollution. • Ensure the policy helps to increase resilience to disasters and climate change especially in the coastal zone and shipping areas. • Incorporate development of an emergency management plan in order to mitigate pollution from oil leaks and spillages; • Make "flood damage-free" land available in coastal areas for shipyard and port construction; • Include measures for real time monitoring of the transport and handling dangerous cargo. • Include provisions for establishing waste and waste water reception facilities at river ports. • Require ecological riverbank protection. • Develop strategies to manage the environment of the extended coastal zone area (e.g. including the newly constructed sea port, deep water container hub ports, etc.). • The policy should include measures to control underwater noise to prevent disturbance to aquatic mammals.
	Legal instruments		

Sector	PPPs and legal instruments	Main elements	Recommended changes
	The Ship Breaking and Recycling Rules-2011	The Rules promulgated under the ECA of 1995 (amended) defines and classifies hazardous materials (hazmats) (including hazardous wastes) and provides for safe and environmentally sound ship recycling in Bangladesh.	
	Hazardous Wastes and Ship Breaking Waste Management Rules, 2011 (22 December, 2011; MoEF)	Based on the Basel Convention • Bars the import of wastes if ships are not certified by authorized agents of exporting countries as not containing hazardous wastes; • Provides regulations for safe disposal of hazardous waste. • Implementation through an emergency response plan. • Implementation is the responsibility of a National Technical Committee under MoEF.	
	The Removal of Wrecks and Obstructions in Inland Navigable Waterways Rules, 1973	• Provides for action against any obstruction created in the waterways. The wreck or obstruction can be required to be raised, removed or destroyed. • Applies to inland navigable waterways, including all rivers, canals, lakes, shores, inland river ports, piers and terminals (as per Section 2, clause I) • Deals with any kind of obstruction and all wrecks (as per Section 2, clause IV) impeding navigation. • The appointed Authority may dispose, remove or destroy obstructing items or even take possession of them and issue a public notice in this regard	• Should be updated to set clear time bound responsibilities for government and owners to remove wrecks and obstructions.
	Bangladesh Merchant Shipping Ordinance- 1983	Provides for the engagement of seaman during project activities.	
	The inland shipping Ordinance-1976	Provides for BIWTA to issue a permit for navigation.	• Should be updated setting out clear departmental/institutional responsibilities for BIWTA and related other organizations.

Sector	PPPs and legal instruments	Main elements	Recommended changes
	Coast Guard Act 2016	Provides for the control of pollution discharges and protection of the surrounding environment.	
	Canals Act 1864	Old law - covers the collection of tolls on canals and lines of navigation.	Needs amendment and consolidation to address: • Maintaining connectivity and navigability. • Canal bank protection. • Pollution control • Use of canal water.
	Mongla Port Authority Ordinance- 1976	• Enables the controlling, anchorage and sailing of ships • Provides guidelines for environmental pollution control in the surrounding sea and land environment.	• Should be updated to address environmental pollution and conservation of the Sundarbans including WHS.
	Ports Act- 1908	Provides guidelines for: • Controlling pollutant discharges (oil, grease, oily water, bilge and ballast water, rubbish etc.) • Creation of fires and obstacles for navigation and spread of infectious diseases in the surrounding environment or damage of shore/bank.	
Environment, Biodiversity and Climate	***PPPs***		
	National Environment Policy, 2018	• This update focuses on fulfilling the constitutional policy to conserve the environment and biodiversity as a priority in association with national economic development activities. • Considers environmental disasters, natural calamities, and climate change-induced impacts on natural resources with the target of sustainable development.	• The policy should include the adoption of an effective shared-benefit approach to enable the more sustainable management of the Sundarbans (e.g. through co-management – involving villagers - to ensure more stable economic conditions for communities).
	National Biodiversity Strategy and Action Plan for Bangladesh (NBSAP,B), 2016-2021	A comprehensive strategy to address climate change challenges in Bangladesh. Bangladesh Climate Change Strategy and Action Plan built on six themes: ▪ Food security, social protection and health ▪ Comprehensive disaster management ▪ Infrastructure ▪ Research and knowledge management	▪ Needs to address the conversion of forest to other land uses. ▪ Should address need to restrict the introduction of exotic species in plantation programmes (currently pursued as a climate change mitigation measure – to store carbon).

Sector	PPPs and legal instruments	Main elements	Recommended changes
		▪ Mitigation and low carbon development ▪ Capacity-building and institutional strengthening.	
	Country Investment Plan (CIP) for Environment Forestry and Climate Change, 2016-2021	• Provides a national roadmap to increase the contribution of environment, forest and climate change sectors to sustainable development of the country through the enhanced provision of ecosystem services- thereby helping to reduce poverty, improve environmental and human health benefits and increase resilience to climate change. The plan: • Identifies programmatic and sub-programmatic areas for Environment, Forest and Climate Change (EFCC) sectors; • Identifies the investment priority areas under each sub-programme; • Identifies responsible agencies for implementing the different programmes and sub-programmes of EFCC sectors; • Organizes projects to facilitate coherence and synergies among them and minimize duplication; • Estimates the financing needs over the next five years (2016-2021) and, by comparing them with current investments, quantifies the financing gap and identifies neglected areas	• Needs to discourage land use changes to protect natural vegetation and agricultural land during infrastructure development (roads, rail, industry, etc.) • Needs to address the loss or displacement of local and regional biodiversity through the introduction of exotic species (particularly invasive alien species) in large-scale plantations.
	National Adaptation Plan of Action (NAPA) – for Climate Change, 2005, updated 2009	Identifies many adaptation measures to be taken by different ministries and departments - in line with decisions of UNFCCC.	
	Bangladesh Climate Change Strategy and	Covers: • Climate change impacts, adaptation and mitigation; • 10-year action plan based on six pillars (with 44 programs):	• Needs to include a restriction on the introduction of the exotic species (particularly invasive alien species) in plantation programmes undertaken as a climate change mitigation measures (ie to store carbon).

Sector	PPPs and legal instruments	Main elements	Recommended changes
	Action Plan (BCCSAP), 2009	• Food security, social protection & health; • Comprehensive disaster management; • Infrastructure, especially in vulnerable regions; • Research & knowledge management; • Mitigation & low carbon development; • Adaptation capacity building and institutional strengthening.	
	Bangladesh Climate Change and Gender Action Plan (CCGAP), 2013	Integrates gender considerations into four of the six main pillars as identified in the action plan: • food security, social protection and health; • comprehensive disaster management; • infrastructure and • Mitigation and low carbon development.	
	National strategy for sustainable brick production in Bangladesh, 2017		• The policy should promote the use of 'environmentally-friendly materials' developed by HBRI[90] instead of soil bricks to prevent the loss of productive soil and enhance sustainable development.
	Legal instruments		
	Environment Conservation Act-1995 (with amendments till 2010)	• Covers environment conservation, standards development, pollution control and abatement, declaration of ecologically critical areas (ECAs) and imposing of restriction for operations within the jurisdiction of such areas, defining and conserving wetlands, hill cutting, ship breaking, and hazardous waste disposal.	

[90] The House Building Research Institute, Bangladesh has developed eco-friendly building materials made from soil dredged from the bottom of rivers, sand, cement, and iron netting, e.g. compressed stabilized earth blocks (CSEB), interlocking CSEB, concrete hollow blocks (CHB), thermal blocks (TB), aerated concrete, and ferro-cement sandwich panels (ACFSP).

Sector	PPPs and legal instruments	Main elements	Recommended changes
		• The 2010 amendment empowered the government to enforce more penalties than before. Affected persons were given provision for make objections or take legal actions against polluters or any entity creating a nuisance.	
	Environment Conservation Rules- 1997 (including all amendments)	Categories industries and projects and identify the types of environmental assessments needed for the categories, and established national environmental quality standards.	• Needs to include both general and sectoral environmental and health safety guidelines and standards.
	Environment Court Act 2010)	• Expedites trials concerning environmental crimes. • Allows government to take necessary legal action against any parties who create environmental hazards/ damage to environmentally sensitive areas as well as human society. • Government can take legal actions if any environmental problem occurs due to interventions of the River Management Improvement Programme.	
	Bangladesh Biodiversity Act 2017	• Fulfils the State's obligations under the Convention on Biodiversity in order to fulfil the State's international obligations. • Introduced an access and benefit-sharing (ABS) mechanism • Promotes research related to biotechnology and documentation of traditional knowledge.	
	Ecologically Critical Area Management Rules 2016	• Prohibit any change of land type within an ECA without permission of DoE. • Prohibit activities that could destroy or change the natural characteristics of soil and water. • Provide for penalties.	• The Rules should ban any change of land type within then ECA surrounding the Sundarbans. • Should promote greening the ECA with indigenous species.

Sector	PPPs and legal instruments	Main elements	Recommended changes
	Noise Pollution Control Rules, 2006	• Give a right to the respective authority to mark off the areas under their jurisdiction as silent, residential, mixed, commercial or industrial. • Describe the approved standard limit of sound for each area.	
	Bangladesh Climate Change Trust Act 2010	Established the trust to: • Redress the adverse impact of climate change on Bangladesh and to take measures on other matters relating thereto. • Use funds beyond the revenue and development budget to address vulnerability to climate change issues.	• The use of funds under this Act should be specific to addressing climate change issues. • The act should require that adequate funds are allocated for the activities of the Trust
	Biosafety Rules, 2012	• Provide regulations on the approval process for biotech products developed domestically or by a third country. • Requires all GE products to be approved before they can be imported or sold domestically within Bangladesh.	
	The Penal Code 1860	• Contains still valid provisions relating to pollution management, environment protection, and protection of health and safety.	
Agriculture	***PPPs***		
	National Agriculture Policy, 2018	• Overall objective is to make the nation self-sufficient in food through increasing production of all crops including cereals and ensure an environmental management framework (EMF) for the River Management Improvement Programme (RMIP) and a dependable food security system for all. • It stresses the need for research on the development of improved varieties and technologies for cultivation in water-logged and salinity affected areas.	• Only sustainable and optimal use of agro-chemicals are mentioned in the policy. The policy should promote technological improvement (e.g.; sowing, harvesting and processing methods, etc) to improve productivity • The policy needs to address the control of pollution by agro-chemicals and minimization of GHG emissions. • A liaison mechanism is required with the Department of Fisheries and Forestry to establish a means to limit the amount of pesticide sold by basing this on legitimate agricultural needs - in order to limit their use for poison fishing in the Sundarbans.
	National Organic Agriculture Policy, 2016	Covers: • Agricultural development and food security (special emphasis on southern region);	Needs to address waste management and control of pollution (especially BOD) from organic agriculture.

Sector	PPPs and legal instruments	Main elements	Recommended changes
		• Water management (especially irrigated agriculture); • Crop zoning; • Crop diversification, increasing cropping intensity and reducing yield gap; • Farm mechanization; • Pesticide management.	
	Agricultural Extension Policy, 2015 (draft)	Covers: • Improvement of agricultural productivity (both crop and non-crop) by ensuring proper management of water; • Emphasis on identifying different local/regional demands and then developing a targeted plan. • Food security, improved credit, marketing and agro-based industries, protecting small farmers interest.	• Needs to provide for remediation of agrochemical pollution, and should address minimization of GHG emissions.
	National Dairy Development Policy, 2016	Covers: • Dairy production; • Marketing; • Research and extension; • Development of human resources; • Protection of grazing lands; • Poverty alleviation; • Veterinary service and diseases control; • Preparation of national standardization organization; • Management of environment and accommodation; • Animal well-being; • Organic feed production and antibiotics avoidance; • Support to cooperative organizations.	• Should address manure management issues.
	National Livestock Extension Policy,	• Covers livestock extension, planning and research, involvement of private sector, supporting services,	

Sector	PPPs and legal instruments	Main elements	Recommended changes
	2013 (Final Draft)	• The policy priorities the coastal region under location specific planning, to realize the potential to rear dairy cattle and buffalo.	
	National Livestock Development Policy, 2007	Short-, medium- and long-term strategy for the development of livestock along with improvement, management, breeding, marketing, involvement of private sector, etc.	• Manure management at local-regional-national level should be emphasised. This could help to reduce GHG emissions and contribute to national power grid through small-medium-large bio gas plants.
	National Integrated Livestock Manure Management Policy, 2015 (draft)	Covers: • Management of livestock manure in agriculture, • Power generation from biogas in small and local scale and other related sectors to distribute it properly and reduce public health risk and greenhouse gas emission.	• Should encourage and subsidise the establishment of small-scale biogas plants.
	National Poultry Development Policy, 2008	• Formulated to encourage development of the poultry industry and to control quality of inputs for sustainable poultry development: • Improve poultry development extension; • Create new entrepreneurs in poultry farming; • Develop poultry sector including eggs, meat and related things; • Maintain standards for poultry feed, meat, eggs, medicine, etc.	
	National Integrated Pest Management Policy, 2002	Covers: • Maintaining ecological balance by reducing the use of chemical pesticides throughout the country; • Operating an effective system for implementing the national Integrated Pest Management (IPM) programme • Developing human resources as the core of IPM by encouraging research.	
	Integrated Minor Irrigation Policy, 2017	Covers: • Improvement of irrigation through the integrated management of water	• Should priorities energy efficiency for renewable energy production.

Sector	PPPs and legal instruments	Main elements	Recommended changes
		• Sustainable use of both surface and ground water.	
	Master Plan for Agricultural Development in the Southern Region of Bangladesh 2012	Covers: • Agricultural development. • Fish and livestock improvement. • Ensuring sustainable use of water. • Creating strong farmer-market linkage.	
	Bangladesh Second Country Investment Plan Nutrition-sensitive food system, 2016-2020	Focuses on ensuring food security and nutrition. Aims to: • Integrate multi-sectoral approach to tackle hunger and malnutrition and achieve the Sustainable Development Goals (SDGs). • Mobilise funds and align sectoral and cross-sectoral food and nutrition security (FNS) related programmes.	
	Legal instruments		
	Agricultural Pest Ordinance 1962	Provides for the prevention of the spread of agricultural pests in Bangladesh.	
	Agriculture and Sanitary Improvement Act 1920	Consolidated and amended the law relating to the construction of drainage and other works for the improvement of the agricultural and sanitary conditions.	
	Agricultural Pest Ordinance 1962	Provides for the prevention of the spread of agricultural pests in Bangladesh	
	Pesticide Act-2018 and Pesticide Rules, 1985 (Amendment) in 2010	Bans harmful toxic substance which were earlier imported and used for pest control.	• Should set out mechanism for pollution remediation.
Cultural affairs	National Cultural Policy, 2006	Covers: • Protection of cultural tangible and intangible heritage;	• A special committee should be appointed to ensure that commitments under the International Convention for the Protection and Promotion of Cultural Heritage, Historical Sites and events are complied with, as

Sector	PPPs and legal instruments	Main elements	Recommended changes
		• Uphold the cultural heritage of Bangladesh; • Promotion of diversity of cultural contents and artistic expression; • Strengthening institutional capacity and manpower; • Development of tourism sectors and improvement of livelihood options.	well as to promote, maintaining respect for the cultural norms and properties and access by all peoples to cultural sites. • Archives should be digitised and an inventory [of what?] prepared as a basis for monitoring and evaluation of cultural sites and assets. • A guideline should be prepared on making policy comply with the International Convention for the Protection and Promotion of Cultural Heritage, Hstorical Sites and Events.
	Legal instruments		
	Antiquities Act 1968	• Focuses on protection and preservation of archaeological and historical artefacts; • Restriction on use of protected immovable antiquity; • Prohibition of making copies of protected antiquities without licence; • Prohibition of destruction, damage etc, of antiquities; • Protection of place of worship from misuse; • Compulsory acquisition of protected immovable antiquity for the preservation and promotion	
	Bangladesh National Building Code, 1993	Before commencement of particular which may affect any structure having historical association and antiquity, the owner of that building should obtain special permission from the relevant authority;	
	Small Ethnic Groups Cultural Organisation Act 2010	• Recognize small ethnic groups with respect and separate identity; • Protect, preserve and promote the cultural expressions of small ethnic groups of Bangladesh at local, national and international level.	
	Mohanagar Imarat Nirman Bidhimala 2008	The section 8, sub-section 1 specify the requirement of special project clearance certificate for the development within the 250 m of radius. It is evident that a city may become famous all over the world for a single historical occurrence or a geographical phenomenon.	

Sector	PPPs and legal instruments	Main elements	Recommended changes
Disasters	***PPPs***		
	National Plan for Disaster Management, 2016-2020	• Promotes risk informed planning and implementation of investment initiatives for business continuity in disasters; • Focuses on effective integration of disaster management planning and programming, particularly risk reduction and resilience approach across agencies and sectors; • Functions as a guiding tool for the implementation of Disaster Management Act 2012, which aims at safer and more resilient communities. • Identifies priority actions to guide the implementation of DM; • Provides a roadmap for progress and implementation of at least 25 core investments;	• The plan's infrastructure development program should address land use change and vegetation cover impacts as well as local environmental pollution.
	Legal instruments		
	Embankment and Drainage Act 1952	• Consolidated the laws relating to embankment and drainage • Makes better provisions for the construction, maintenance, management, removal and control of embankments and water courses for the better drainage of lands and for their protection from floods, erosion or other damage by water.	• The Act should be amended to impose a stronger punishment for breaches of its requirements so that it is more effective.
Economy	***PPPs***		
	Export Policy of Bangladesh, 2018-2021	Covers: • Rules and regulations to control and diversify all exports of goods and services from Bangladesh except from Bangladesh Export Processing Zones and private export processing zones. May be reviewed and modified annually. • High priority sectors for export products:	• The policy should specify the development of a Free Trade Agreement at the sub-regional level in South Asia

Sector	PPPs and legal instruments	Main elements	Recommended changes
		• High value-added readymade garment (RMG) and garment accessories; • Software and tenable services, ICT products; • Pharmaceutical products; • Ship & ocean-going fishing trawlers; • Footwear & leather products; • Jute products; • Agro -products &agro-processed products; • Furniture; • Home textiles & terry towels; • Luggage.	
	Medium Term Macro Economic Policy Plan, 2019	Covers: • Assessment of government thrust in achievement of macro-economic goals of the country including those in Terminal year of 7th Five Year Plan • Identifies key issues:	• The policy should emphasise the development of at least one technical institution in each Upazila to develop skilled manpower for both home and overseas employment.
	Legal instruments		
	BEZA Act 2010	Makes provisions for: • the establishment of economic zones in all potential areas including backward and underdeveloped regions • Their development, operation, management and control with a view to encouraging rapid economic development through increase and diversification of industry, employment, production and export.	• The Act should acknowledge the need to follow the land zoning policy set out in the National Land Use Policy which requires that irrigable crop land with high cropping intensity should not be acquired for non-agricultural purposes.
Education	***PPPs***		
	National Education Policy, 2010	Covers: • Pre-primary and primary education; • Adult and non-formal education; • Vocational and Technical Education	• There should be a provision/guideline that limits or bans the use of wetlands for building educational institutions.

Sector	PPPs and legal instruments	Main elements	Recommended changes
		• Women's education; • Sports education.	
	Legal instruments		
Food	***PPPs***		
	National Food Policy, 2006	Covers: • Increasing agricultural productivity and regional crop diversification; • Food marketing; • Livelihood improvement and support after natural disasters; • Nutrition and diet diversification	• The policy should promote agriculture and forestry on newly formed char land to increase food production • Include provisions to create a greenbelt in the newly accreted char land of coastal areas through tree plantation to provide protection against cyclones/tidal surges and to enhance fish production. • The policy should require planning and the use of technology to avoid/minimize the impacts of increased agricultural production (i.e. increased GHG emissions and pollution from the use agro-chemicals).
	Food/Cash for Work (F/CFW) Program, 1974	Covers: • Rural employment generation • Income generation for rural poor people • Balanced distribution of food through the country	• The selection of the people and areas for the program should be un-biased and needs-based.
	Legal instruments		
Health & Family Welfare	***PPPs***		
	National Health Policy, 2011	Focuses on ensuring availability of primary health and emergency treatment facilities for all citizens and also extending easy and equitable access to quality health care facilities.	• The policy implementation mechanism should be updated with ICT based technology • Effective monitoring of health sector activities and transparency should be required • The penalty mechanism for crimes should be strengthened and effectively implemented

Sector	PPPs and legal instruments	Main elements	Recommended changes
	Occupational Health and Safety Policy, 2013	• Focuses on the improvement of OHS in all levels of the working environment. The policy also been developed in compliance with the ILO and WHO guidelines. • Provides for compensation packages and rehabilitation procedures for affected workers, and enables workers to take issues the Labor Court for decision.	
	Legal instruments		
	Drug Act 1940	Regulates the import, export, manufacture, distribution and sale of drugs.	• Technology should be introduced for ensure regulation can be effectively implemented. • The penalties for selling and using of illegal drugs should be increased and effective monitoring should be strengthened.
	Drug Control Order 1982	Controls the manufacture, import, distribution and sale of drugs.	• Same as previous above
	Poison Act, 1919	Consolidated and amended the law regulating the importation, possession and sale of poisons	• A technology-based monitoring and penalty mechanism should be developed
	Dangerous Cargoes Act 1953	Provides for guidelines for cargoes to avoid any discharges of hazardous materials in the surrounding water ways and adjacent land.	
Labour, Employment and Livelihoods	***PPPs***		
	National Labour Policy, 2012	Includes provisions to address wage discrimination along with assurance of equal wages and rights for women workers.	• Need a guideline/provision for the hiring/engagement of labour, especially in the informal sector (covering terms of contract, job description, working hours, etc. • Need a a guideline/provision for the lawful termination of labour (covering warnings, prior notice, compensation, etc.)
	My Home and My Farm (Amar Bari Amar Farm) Program, 2009	Covers: • Poverty alleviation and sustainable development • To develop each rural household as a sustainable an agro-based income generating unit through optimum utilization of human and economic resources (labour,	• Needs a provision for undertake monitoring to ensure that beneficiaries are actually poor people.

Sector	PPPs and legal instruments	Main elements	Recommended changes
		land, water etc.);through e-financial inclusion i.e. fund mobilization followed by family farming livelihood and income generation of the under privileged smallholders of the country.	
	Legal instruments		
	Bangladesh Labour Act 2006 and Bangladesh Labour (Amendment) Act, 2013.	• The 2013 amendment makes a large number of changes to the 2006 Act. • It provides regulations that aim to protect the interests and rights of the workers, provision for a comfortable working environment, reasonable working conditions, and to ensure workers' safety and wellbeing during project life cycles. • In addition, it stipulates that children under 18 years are not allowed to be employed during project life cycle.	• Needs provisions to undertake monitoring unit related to informal sector employment, a mechanmism to lodge and investigate grievances, and a requirement for transparent job descriptions.
	Bangladesh Labour Rules 2015	• Require that any establishments which want to employ labour must have service rules and must get permission from the Chief Inspector of Labour. • The Manpower Supply Agency is registered under the Labour Act. • Prescribed the process for investigating misconduct. • Cover festival bonuses, provident fund, holidays, health and fire safety, calculating wages, a form for use in labour court cases, and approval of factory plans and extensions.	• Needs provisions to undertake monitoring related to informal sector employment, a mechanmism to lodge and investigate grievances, and a requirement for transparent job descriptions.
Land	***PPPs***		
	National Land Use Policy, 2001	Identifies components for ensuring land use activities are aligned with environmental conservation and sustainability. Sets out mechanisms for land zoning in rural and urban areas.	• Should address the need for coastal char land (newly accreted lands) to be maintained as green belt (coastal plantations) and retained for environmental protection and fish production, • Need to address the need that, for any infrastructural development, the existing landscape and ecological functions should not be destroyed or changed.

Sector	PPPs and legal instruments	Main elements	Recommended changes
			• Needs a provision to ensure that land zoning does not impede natural ecosystem services.
	National Action Programme (NAP) for Combating Desertification, 2015-2024	• Strategy and measures to combat desertification. • Integrated and coordinated bottom-up approach to mitigate the effects of desertification and drought	• Should propose modalities to achieve the identified LDN (Land Degradation Neutrality) targets using proposed projects and a monitoring mechanism.
	National Road Map for Combating Land Degradation for 2025-2041 (Draft)	Covers: • Preparing land use maps for the entire country and for the hotspot regions. • Land degradation profiling of hotspot areas according to degradation status. • Identification and documentation of SLM practices and approaches focusing on degradation process (e.g. river bank erosion, drought, ecosystem vulnerability, salinization, deforestation, water logging, etc.). • Preparing National Road Map (action plan) for combating land degradation for each hotspot region. • Updating/ developing the action plan including both structural (e.g. flood protection embankments/polders, bank protection, water storage/control structures, buried pipelines for irrigation, solar power dugwells, submergible roads, land zoning, dredging/excavation of rivers/canals, agro-based industries, etc.) as well as non-structural (awareness-raising, capacity-building and research) measures.	• The roadmap is in draft stage. However, the final version should provide the process of attaining the LDN (Land Degradation Neutrality) status with the proposed programmes.
	Legal instruments		
	Acquisition and Requisition of Immovable	• Repealed the Acquisition and Requisition of Immovable Property Ordinance 1982	

Sector	PPPs and legal instruments	Main elements	Recommended changes
	Property Act, 2017	• Provides certain safeguards for the owners and has provision for payment of "fair value" for the property acquired. • Gives the right to the land owner to appeal against land acquisition.	
	Non-Agricultural Tenancy Act 1949-for land use	Makes provisions relating to the certain non-agricultural tenancies in Bangladesh.	
	State Acquisition and Tenancy Act 1950-land use	• Eradicates flaws and gaps in the provisions for collection and receiving of rents for land. • Declares forests and water bodies as non-retainable properties.	• The latest land survey should identify and register non-retainable properties and registered accordingly.
	Acquisition of Waste Land Act 1950	Authorizes the government to acquire private lands that have not been cultivated during last five years, for any public purposes including afforestation.	
	Land Reforms Ordinance 1984 Land use	Reformed the law relating to land tenure, land holding and land transfer with a view to maximising production and ensuring a better relationship between land owners and bargadars (people who cultivate the land for others).	
Local Government, Rural Development and Cooperatives	National Rural Development Policy, 2001	Aims: • To ensure the improvement of the socio-economic conditions of the rural people to increase their income and fulfil the basic needs; • To ensure the development of physical infrastructure, balanced distribution of resources among people and marketing of the products; • To make efforts to fulfil the needs of rural people through proper identification of the problems for socio-economic upliftment of the rural poor and disadvantaged people and producers, especially the small, marginal and the landless farmers; • To develop the local government systems including enhancing capacity and effectiveness of Union Parishads	

Sector	PPPs and legal instruments	Main elements	Recommended changes
		(smallest administrative unit in rural areas) to create a congenial atmosphere for formulating and implementing local level plans.	
Mining	***PPPs***		
	No PPP yet prepared		
	Legal instruments		
	Mines Act 1927	Focuses on mineral resources development and management.	Requires amending and consolidation regarding the regulation and inspection of mines – with addition of guidelines to ensure safety and environmental pollution control
	Balumahal and Soil Management Act 2010	• Provides for protection of uncontrolled mining of sand from water ways • Prohibits sand quarrying within a kilometre of bridges, culverts, dams, barrages, embankments, highways, rail tracks, residential areas and other important structures, as well as sand lifting without permission.	The act should be amended to take into consideration the protection (e.g. using artificial structures) of riverbank and prevention of soil erosion
Planning	***PPPs***		
	Khulna Development Authority (KDA) Master Plan 2001-2020	• Review of existing problems and proposed initiatives. • Determination of present and future functional structure of the city • Development of mechanism for improving and guiding urban development. • Formulation of bankable projects Construction of Rupsha Bridge Approach and Khulna City Bypass Road • Increase the Right of Way (ROW) of existing roads; • Reduce traffic congestion at critical junction points of Khulna city (e.g. Khan-E-Sabur Road at Daulatpur area and Fulbarigate level crossing); • Increasing the capacities of the urban development authorities, such as, KDA.	• The plan needs to be updated for the next 20 years. • The development needs to be adjusted to reflect changes in land use, morphological dynamics, physical system, climate change etc. • The plan needs to include adaptation and mitigation strategies in line with the recently approved BDP2100 and SDG, to cope with disaster and impacts of climate change.

Sector	PPPs and legal instruments	Main elements	Recommended changes
	Khulna Development Authority (KDA) Detailed Area Plan 2001-2020	The Detailed Area Plan (DAP) identifies 27 bankable, physical and socio-economic development cultural development projects for Khulna City, each requiring further detailing planning through feasibility studies. The top ten are: 1. Rehabilitation of water supply system 2. Rain water reservoirs 3. Surface water treatment plant 4. Dual water supply system 5. Piped water supply in Noapara, Fultala and Rupsa 6. Squatter Resettlement Project 7. Sonadanga Housing Project (Third Phase) 8. Mirerddanga Low-cost Housing Project 9. Land development for housing through public-private partnership 10. Khulna City bypass road / Development of Khulna Orbit	• The plan needs to be updated for the next 20 years • The development needs to be adjusted to reflect changes in land use, morphological dynamics, physical system, climate change etc. • The plan needs to include adaptation and mitigation strategies in line with the recently approved BDP2100 and SDG, to cope with disaster and impacts of climate change.
	Khulna Metropolitan Development Plan (Mongla) 2012-2031	• Rural, urban and conservable area-based development • High value agricultural area protection • Minimum conversion of agricultural land • Densification of existing urban areas • Mixed use development in the rural growth centers • Restrict industrial establishments strictly within permitted zones; • Securing alternative connectivity to Mongla Sea Port (proposed Mongla western and eastern bypass roads); • Railway track along the Khulna-Mongla Highway right of way; • Prevent saline water intrusion in agricultural fields	• The plan needs to be updated for 2021 to 2041. • The development needs to be adjusted to reflect changes in land use, morphological dynamics, physical system, climate change etc. • The plan needs to include adaptation and mitigation strategies in line with the recently approved BDP2100 and SDG, to cope with disaster and impacts of climate change. • The plan should also include management strategies specifically for Rampal, Mongla where the government has planned to build infrastructures. • Strict rules and regulations should be formulated for tourism within the Ecologically Critical Area (ECA) with annual/daily tourist numbers restricted according to requirements that may be set out in the management plan (currently under development) for the ECA.
	Legal instruments		

Sector	PPPs and legal instruments	Main elements	Recommended changes
Population	***PPPs***		
	Bangladesh Population Policy, 2012	Covers population control ensuring quality of reproductive health services to the nation	• The policy should aim to maintain effective percentage of young population as they provide the main working (force) manpower.
	Legal instruments		
Posts, telecommunications & Information	***PPPs***		
	National ICT Policy, 2009	Presents a vision, 10 broad objectives aligned with the general national goals, 56 strategic themes and 306 action items – all targeted to enhance the use of ICT.	
	Legal instruments		
Science & Technology	***PPPs***		
	National Science and Technology Policy, 2011	Aims to promote the effective application of science and technology (S&T) in all sectors of the economy including agriculture, industry, environment, and services for sustainable development.	
	Legal instruments		
Waste Management	***PPPs***		
	The National Sanitation Strategy, 2005	• Addresses issues related to unhygienic defecation only; • Defines the roles of various actors; • Provides guidance on the creation of enabling conditions for success in providing 100% coverage in hygiene sanitation.	

Sector	PPPs and legal instruments	Main elements	Recommended changes
	National 3R Strategy for Waste Management, 2010	The 3Rs concept concerns maximizing the reduction reuse and recycling of resources in the manufacture, distribution and use of products consumed by society.	
	Legal instruments		
	Bangladesh Standards and Guidelines for Sludge Management 2015	The guidelines support the mandatory requirements under the Environment Conservation Act, 1995 (amended 2010) for proper management of sludge and installation of effluent treatment plants (ETP). They provide extensive information and methods for all aspects of sludge management and operating effluent treatment plants, and disposal.	
Women and Children Affairs and Vulnerable Groups	***PPPs***		
	National Women Development Policy, 2011	Provides distinct guidelines on prevention of child marriage, removal of discrimination and protection against disabled girls, enhanced recreational and cultural facilities for female children, and removal of mental and physical abuse of women.	• The preventive and punishable measures should be Increased and enforced strictly. The policy needs to emphasize entrepreneurship by women, and the provision of supportive facilities.
	National Children Policy, 2011	Accords special priority to girl children. It emphasizes counselling for adolescent girls, provision of sanitation facilities for girls in educational institutions and workplaces, and special security arrangements for girls during disasters.	• The policy needs a clear framework for its implementation.
	National Action Plan on Women, Peace and Security, 2019-2022	Implements UN Security Council Resolution 1325 and provide an agenda for increasing women's participation in efforts to maintain peace and security and gender equality at the national and international level.	
	Vulnerable Group Development (VGD) Programme, 2011	VGD is one of the largest safety net programmes targeted at poor and vulnerable women in Bangladesh. It focuses on bringing sustainable improvement to the lives of ultra-poor households.	• For effective implementation of the program it is important to strictly follow the VGD beneficiary selection criteria and lessen political pressure. • The following issues need to be addressed with monitoring by MWCA\DWA:

Sector	PPPs and legal instruments	Main elements	Recommended changes
			○ There is a need to eliminate bribery in the process of VGD beneficiary selection. ○ There is a need to ensure that economically better-off households are not selected, and that the focus is on those that actually deserve support and are eligible poor households.
	Vulnerable Group Feeding (VGF) programme, 1974	Humanitarian program that provides food transfers	• Transparency and comprehensive monitoring is required in targeting eligible poor and vulnerable people, to ensure the provision of sufficient and weighed food grain. • Standard weighing equipment should be used.
	Legal instruments		
National and cross-sector plans	***PPPs***		
	Bangladesh Delta Plan. 2100	• Aims to ensure an optimum level of water safety and food security, as well as economic growth and a framework for its implementation based on effective governance. • An overall investment plan with individual sub-plans, programmes and projects aimed specifically at the development of 6 hotspot regions: ○ Coastal zone; Barind and drought prone areas; Haor and flash flood areas; Chittagong Hill tracts; River system and estuaries; and urban areas. • Provides an assessment of hotspot-specific strategies developed specifically to cater to pressing socio-environmental requirements of each individual region.	• Plan needs to be refocused to ensure agriculture production before reclaiming marginal lands for development of industries and economic zones. • The plan should be focused on the basin-wide management of resources considering the problems and issues of the hydrological regions of the country. • Plan need to ensure that the proposed development of transportation, shipping and navigation will not increase the vulnerability of ecosystem of the Sundarbans. • The investment plan of the BDP2100 should be revised to include eco-friendlier and adaptation-based projects - not only infrastructural development projects. • Plan implementation should ensure the adoption of environmental measures to minimize air, water and land pollution arising from infrastructural development projects.
	Seventh Five Year Plan FY 2016 – FY 2020: Accelerating	• Focuses on achieving Bangladesh's Vision 2021 and continuing the success of the 6th FYP including: • GDP growth acceleration, employment generation and rapid poverty reduction;	

Sector	PPPs and legal instruments	Main elements	Recommended changes
	Growth, Empowering Citizens	• A broad-based strategy of inclusiveness with a view to empowering every citizen to participate full and benefit from the development process. • A sustainable development pathway that is resilient to disaster and climate change; entails sustainable use of natural resources; and successfully manages the inevitable urbanization transition.	
	National Sustainable Development Strategy (2010-21), 2013	• Sets out five strategic priority areas and three cross-cutting areas to ensure economic, social and environmental sustainability of development; • Priority areas are: sustained economic growth, development of priority sectors, urban environment, social security and protection, environment and natural resources management; • Cross cutting areas are: disaster risk reduction and climate change, good governance and gender.	
	First Perspective Plan of Bangladesh: 2010-2021	• Provides the road map for accelerated growth and lays down broad approaches for eradication of poverty, inequality, and human deprivation; • Specific strategies and the task of implementation are articulated through the two five-year plans: Sixth Five Year Plan (2011-2015) and the Seventh Five Year Plan (2016-2020).	
	Coastal Zone Policy, 2005; and Coastal Development Strategy, 2006	• The policy provides for management and support to the coastal region in a manner so that the people of the region can lead their life and livelihoods within a secure and conducive environment. • These PPPs jointly promote socio-economic development, disaster safety, preventing deterioration of natural environment and enhancing potential of coastal region to contribute national development.	

Sector	PPPs and legal instruments	Main elements	Recommended changes
		• They cover 48 coastal upazilas of 19 districts including SW region and include the marine Exclusive Economic Zone. ***The PPPs include:*** o Code of conduct for sectoral development activities, and integrating and harmonizing development activities towards the common goal of poverty reduction, economic development, livelihood safety; o Institutional reform and build capacity of the WARPO to co-ordinate development activities under Plans ICZMPs. ***The strategy has nine priorities***: o Ensuring fresh and safe water availability (in the context of regional water resources management); o Safety from man-made and natural hazards; o Optimizing use of coastal lands o Promoting economic growth emphasizing non-farm rural employment; o Sustainable management of natural resources; o Improving livelihood conditions of the people specially women; o Environmental conservation; o Empowering through knowledge management; o Creating an enabling institutional environment.	
	Second Perspective Plan of Bangladesh: 2021-2041	Provides the road map for accelerated growth and lays down broad approaches for eradication of poverty, inequality, and human deprivation. Objectives: • Eradication of extreme poverty by 2031; reducing moderate poverty to less than 3% by 2041; • Achieve Upper Middle Income Country (UMIC) status by 2031 and High-Income Country (HIC) status by 2041; • Industrialization with export-oriented manufacturing will drive structural transformation into the future;	**Agricultural and Livestock** • The plan should include strategies to manage agro-based industries and minimize the use of pesticides (to avoid soil, water and air pollution). • Roads, dams and infrastructure should be designed sustainably to minimize water logging which hamper day-to-day activities and livelihoods.

Sector	PPPs and legal instruments	Main elements	Recommended changes
		• Paradigm shifts in agriculture will enhance productivity and ensure nutrition and food security for the future; • A service sector of the future will provide the bridge for the transformation of the rural agrarian economy to a primarily industrial and digital economy; • The urban transition will be an essential part of the strategy to move to a high-income economy; • Efficient energy and infrastructure will be essential components of the enabling environment that facilitates rapid, efficient and sustainable growth; • Building a country resilient to climate change and other environmental challenges; • Establishing Bangladesh as a knowledge hub country for promoting a skill-based society.	**Fisheries** • The plan should suggest adopting proper technological management methods to avoid salinization due to the development of shrimp culture. • Roadside plantation should be undertaken in a proper way that avoids road accidents. **Industry** • The plan should priorities maintaining habitats and agricultural land over industrial development. **ICT and Digital Bangladesh** • The plan should include strategies for management of e-waste due to expansion of digital technology. • The plan should include a zero tolerance policy against the cybercrimes. **Transportation and Communication** • The plan should require the use of advanced methods and technologies to minimize air and noise pollution due to the development of transport and communication infrastructure. **Urbanization** • A strategic plan should be developed for the sewage and drainage system to avoid surface run off in urban areas. **Power and Energy** • The plan needs to address the expansion on pipeline network required across the country to meet the growing demand for energy. • The plan should include waste management plan for nuclear power plant to avoid/minimise health hazard.
	Eighth Five Year Plan, (FY2021-FY2025)	Overall goal is to attain SDG targets and also eliminate extreme poverty by FY2031 and achieve High-Income Country (HIC) status by FY2041. Specific objectives are: • To achieve GDP growth acceleration, employment generation and rapid poverty reduction;	**Urbanization** • A structural plan and strategy is needed to minimise pollution as a consequence of increased infrastructure development. • A zero carbon emissions policy is needed since increased transport density will lead to a major increase in air pollution. **Transportation**

Sector	PPPs and legal instruments	Main elements	Recommended changes
		• To restore human health, confidence, employment, income and economic activities; • To empower every citizen to participate fully in, and benefit from, the development process; • To provide a sustainable development pathway that is resilient to disaster and climate change, entails sustainable use of natural resources and successfully manages the inevitable urbanization transition.	• The plan should include easy passenger traffic movement strategies for river routes, such as building river-based ports that facilitate river-based transport movement. • The plan should include waste management policies for ship repairing industries which cause serious pollution of water, soil and air. **Power and Energy** • No recommendation **Tourism** • Plan should include or refer to the fixed rules and regulations for tourists and local people to ensure that tourismn does not impact negatively on habitats and biodiversity. • The plan needs highloight that EIA is compulsory for existing and planned tourism infrastructure developments or projects. **Industry** • The plan should address the increasing industrial development which is likely to have negative impact on the environment. • The plan needs to indicate that power plants and industries (e.g. chemical and cement factories) should build their own water treatment plants. **Forestry** • The plan should indicate that whilst non-cultivated land can be transformed through afforestation, the conversion of cultivated lands to other use (e.g. infrastructures or afforestation) should be avoided.
	Legal instruments		

Annex 7: Indicators and Projections for Scenarios

Notes:
Baseline year is 2018-19 wherever possible.
Some baseline data is projected from an earlier year indicate the year.
Sources for all baseline data are indicated.

Themes	Objective		Indicator		Unit	Baseline figure	Year of baseline data	Source	Low growth		Medium growth		High growth	
									2031	2041	2031	2041	2031	2041
Environmental														
Forest, Protected areas and biodiversity	1	Reduce over-exploitation/ degradation of habitats, loss of biodiversity and ecosystem(s)	1	Status of suitable habitat for Tiger (in wildlife sanctuaries)	Poor Good Very Good [91]	Good	2017	BFD, 2017	Poor	Poor	Good	Good	Very good	Very good
			2	Status of suitable habitat for dolphin (in sanctuaries & hotspots)	Poor Good Very good [92]	Very good	2018-19	BFD, 2020	Good	Good	Very good	Very good	Very good	Very good

[91] Poor: Where Tiger cannot easily find basic life cycle requirements such as food, water, and cover (e.g. shelter, nesting, etc.) and disturbance is high.

Good: Where Tiger can find basic life cycle requirements such as food, water, and cover (e.g. shelter, nesting, etc.) adequately and disturbance is less (from resource collectors and boat movement)

Very good: Life cycle requirements such as food, water, and cover (e.g. shelter, nesting, etc.) is readily available/ plentiful for Tigers and there is no disturbance (from resource collectors and boat movement).

[92] Poor: Where the environmental factors and food accessibility for dolphins is not enough for basic life cycle requirements and where interference by fishermen and boat movement disturbance is high.

Good: Where the environmental factors and food accessibility for dolphins is enough for basic life cycle requirements, and interference by fishermen and boat movement disturbance is low.

Very good: Where the environmental factors and food accessibility for dolphins is abundant for basic life cycle requirements, and there is no interefernce by fishermen and boat disturbance.

Themes	Objective		Indicator		Unit	Baseline figure	Year of baseline data	Source	Low growth		Medium growth		High growth	
									2031	2041	2031	2041	2031	2041
		integrity and services	3	Status of suitable habitat for Heritiera fomes (Sundri) (less saline zone)	Poor Good Very good [93]	Good	2017	BFD, 2017	Poor	Poor	Good	Good	Very good	Very good
			4	Forest and tree coverage in Sundarbans	Ha	399,900 (approx)	2018-19	GoB, 2019	398,000	397,000	399,900	399,900	414,000	415,000
			5	Population size of Tiger in Sundarbans	No.	114	2018	Aziz et al, 2018	105	100	130	140	155	165
	2	Reduce illegal activities related to protected areas and biodiversity	6	No of reported cases of poaching & Illicit felling)	No.	772	2018-19	BFD, 2020	840	850	600	500	200	100
			7	Seized products (timber)	Cubic m	104.61	2018-19	BFD, 2020	150	160	90	80	50	30
	3	Reduce introduction and spread of	8	Extent of water hyacinth	Extensive Common Rare	Common	2018-19	BFD, 2020	Extensive	Extensive	Common	Common	Rare	Rare

[93] Poor: High saline and water influenced area of the Sundarbans [water salinity 18-30 ppt; water salinity influences the soil salinity up to > 4 dS/m and influence the vegetation growth and composition]

Good: Moderate saline and water influenced area of the Sundarbans [water salinity 5-18 ppt; water salinity influences the soil salinity up to 2 to 4 dS/m and influence the vegetation growth and composition]

Very good: Less saline and water influenced area of the Sundarbans. [water salinity 0-5 ppt; water salinity influences the soil salinity < 2 dS/m and influence the vegetation growth and composition]

Themes	Objective		Indicator		Unit	Baseline figure	Year of baseline data	Source	Low growth		Medium growth		High growth	
									2031	2041	2031	2041	2031	2041
		Invasive Alien Species												
Waste and pollution	4	Reduce poor management and unsafe disposal of solid and liquid waste (urban & industrial)	9	Capacity of recycling plants in SW region	Very good/Good/ Moderate/ Poor/ Very poor [94]	Poor	2020	MIA, 2020	Very poor	Poor	Moderate	Good	Good	Very good
			10	Plastic in collection sites recycled	%/yr	69	2012	Zaman et al., 2012	72	75	78	82	85	90
			11	Total volume waste per capita in Khulna City Corporation area	Kg/ person/ day	0.40	2018	Ahmed & Moniruzzaman, 2018	0.42	0.44	0.45	0.55	0.60	0.70
			12	Solid waste sent to Khulna city facilities	%	35	2018	Ahmed & Moniruzzaman, 2018	45	50	70	80	85	90
	5	Reduce all forms of pollution (air,	13	Dry season water quality (nitrate) at Passur-Mongla Confluence	mg/litre annual avg	3.30	2019	CEGIS 2019	6.0	7.0	4.0	5.0	2.5	2.0

[94] Very good = The state where all the municipal solid waste in urban areas of SW region is recycled and properly managed without posing any threats to environment, and 70-90%) of waste is converted into resources.

Good = The state where all the municipal solid waste in the urban areas of SW region is recycled and properly managed without posing any threats to environment, with 50-69% of waste converted into resources.

Moderate = The state where 50 –75% of the municipal solid waste in the urban areas of SW region is recycled and properly managed without posing any threats to environment, with 30-49% of waste converted into resources.

Poor = The state where around 25% of the municipal solid waste in the urban areas of SW region is recycled and properly managed only, with no waste comverted into resources.

Very Poor = The state where less than 25% of municipal solid waste in the urban areas of SW region is recycled and properly managed, with no waste converted into resources.

Themes	Objective		Indicator		Unit	Baseline figure	Year of baseline data	Source	Low growth		Medium growth		High growth	
									2031	2041	2031	2041	2031	2041
		water, noise etc.)	14	Dry season water quality (phosphate) at Passur-Mongla Confluence	mg/litre annual avg	0.30	2019	CEGIS 2019	2.0	3.0	1.0	1.5	0.2	0.15
			15	Dry season water quality (biochemical oxygen demand) at Passur-Mongla Confluence	mg/litre annual avg	3.00	2015	Rahman et al., 2015	5.0	8.0	3.5	4.0	1.5	1.0
			16	Dry season water quality (nitrate) at Harbaria, Sundarbans	mg/litre annual avg	2.10	2019	CEGIS 2019	5.0	6.0	3.0	4.0	2.0	1.5
			17	Dry season water quality (phosphate) at Harbaria, Sundarbans	mg/litre annual avg	0.30	2019	CEGIS 2019	1.2	2.0	0.5	0.3	0.2	0.1
			18	Dry season water quality (biochemical oxygen demand) at Harbaria, Sundarbans	mg/litre annual avg	2.00	2015	Rahman et al, 2015	3.5	5.0	2.5	3.0	1.5	1.0

Themes	Objective		Indicator		Unit	Baseline figure	Year of baseline data	Source	Low growth		Medium growth		High growth	
									2031	2041	2031	2041	2031	2041
			19	No hrs in which noise exceeds 45dBA in the 'Silent Zone' in the Sundarbans) [95]	Hrs/day	4-5 [96]	2018	CEGIS 2018	5	5	3	2	1	0
			20	No hrs in which noise exceeds 60dBA in the 'Mixed Zone' at Mongla) during daytime [97]	Hrs/day	6[98]	2018	CEGIS, 2018	8	8	8	9	7	8
			21	Average Day time noise in mixed zone area of Mongla [99]	dBA	55-56	2018	CEGIS 2018	58-60	63-65	58-60	63-65	63-65	58-60
			22	Ambient Concentration of $PM_{2.5}$ at Khulna during worst case situation	µg/m³ (Annual Average)	62	, 2019	http://case.doe.gov.bd	71	79	68	73	63	40

[95] Bangladesh standard (Environmental Conservation Rule-ECR-1997) for Silent zone (45 dBA)

[96] Discontinuously when Cargo and ships move and honk

[97] Bangladesh standard (Environmental Conservation Rule-ECR-1997) for Mixed zone (60 dBA) (Given projected values are the summation of discrete intervals)

[98] Discontinuous when cars, trucks, motorbikes, other heavy commercial vehicles and municipal activities occurs as well as noise from public gatherings.

[99] This is a mainly residential area, and also simultaneously used for commercial and industrial purposes.

Themes	Objective		Indicator		Unit	Baseline figure	Year of baseline data	Source	Low growth		Medium growth		High growth	
									2031	2041	2031	2041	2031	2041
			23	Ambient Concentration of NO_2 at Khulna during the worst-case situation	µg/m^3 (Annual average)	44	2019	http://case.doe.gov.bd	40	50	49	56	57	40
	6	Minimise emissions of greenhouse gases	24	Total emissions of CO2 from SW region	Million-ton CO2 eq/year	8.7	2019	Gains, 2020	13.6	16.4	14.3	17.3	38	72
			25	Total emissions of CH4 for SW region	Million-ton CO2 eq/year	12.8	2019	Gains, 2020	13.5	14.3	14.2	15.01	28	43
Climate change and disasters	7	Reduce vulnerability to climate change and natural disasters (floods, storm surges, etc.)	26	Storm surge inundation	% of SW region	Cyclone Sidr: 10	2007	WB, 2011	12	13	10	7	8	5
			27	SW Salinity intrusion	% of SW region: 1PPT	70	2011	CEGIS Bay of Bengal Model	80	85	75	80	75	50
					% of SW region: 5PPT	45			58	62	55	60	55	30
			28	Average Household affected due to climate change-induced disasters in SW region in extreme years	No.	129,266	2019	BBS, 2015a	162,400	169,400	151,300	133,400	127,200	92,500
			29	Length of embankment strengthened	Km (future values in % of total)	180 Km (out of 1821 Km	2018-19	(World Bank, CEIP & BWDB)	20%	40%	70%	85%	80%	100%

Themes	Objective		Indicator		Unit	Baseline figure	Year of baseline data	Source	Low growth		Medium growth		High growth	
									2031	2041	2031	2041	2031	2041
						in 41 polders) (9.88%)								
Water	8	Increase dry season freshwater flow in rivers	30	Average daily dry season (Jan-May) discharge on Gorai at Railway Bridge	Cumec	84	1997-2019	BWDB	65	65	91	91	220	220
	9	Reduce high/peak flows in rivers during monsoon season	31	Average daily monsoon (Jul-Aug-Sept) discharge in upstream river reaches Gorai at Railway Bridge	Cumec	8,880	1997-2006	BWDB	8,880	8,880	8,880	8,880	7,600	7,600
Land degradation	10	Minimise loss of land due to degradation (e.g erosion of river banks/water channels, soil salinity intrusion etc)	32	Eroded bank area	Ha / yr	350	2019	CEGIS	385.00	385.00	245.00	245.00	140.00	140.00
			33	Extent of soil salinity in SW region	Million Ha	0.465	2015	SRDI and CEGIS	0.490	0.510	0.490	0.510	0.425	0.400
Land use change	11	Minimise loss of agricultural land (e.g. conversion to shrimp ponds)	34	Extent of shrimp cultivation and fish farming in SW region	Km2	2,188	2019	CEGIS	2,190	2,190	2,220	2,270	3,060	3,130

Themes	Objective		Indicator		Unit	Baseline figure	Year of baseline data	Source	Low growth		Medium growth		High growth	
									2031	2041	2031	2041	2031	2041
Socio-Economic														
Economic growth	12	Ensure significant economic development and diversification, and increase in economic growth	35	Per capita GDP for SW region (in constant price of 2010)	PPP[100] international $	2096	2018-19	BBS, 2019	2,820	3,100	4,610	5,195	5,390	6,510
			36	GDP for SW region (in constant prices of 2010)	PPP international $ billion	44.29			70.7	79.8	110.2	126.2	120.2	143.2
			37	GDP in SW region as share of national GDP	%	14	2018-19	Est.	15	16	18	20	20	22
			38	Industry as share of GDP of SW region	%	24.08	2018-19	BBS, 2019	25	28	27	30	32	35
Employment	13	Enhance opportunities for employment and new/improved livelihoods (particularly for fisheries, agriculture, eco-tourism)	38	People employed in agriculture in SW region	% of total people employed	75	2012	BBS, 2012	72	70	70	66	63	61
			40	People employed in industry in SW region	% of total people employed	20	2012	BBS, 2012	22	23	23	25	26	27

[100] PPP: Purchasing Power Parity

Themes	Objective		Indicator		Unit	Baseline figure	Year of baseline data	Source	Low growth		Medium growth		High growth	
									2031	2041	2031	2041	2031	2041
Health and sanitation	14	Improve health services and health of society (eg by reducing vulnerability to diseases)	41	No doctors per 10,000population for SW region	No.	6.70	2018	DGHS	6.3	6.3	6.7	7.4	7.2	8.9
			42	Life expectancy	Yrs	72.10	2018	BBS, 2019	73.5	75.0	74.0	77.0	74.5	78.0
	15	Improve and extend water supply and sanitation services	43	Population connected to water supply in urban areas (Khulna)	%	95	2019	BBS, 2015a	95	95	98	99	100	100
			44	Population connected to sanitation in urban areas (Khulna)	%	90	2019	BBS, 2015a	90	90	97	98	100	100
Education. skills and training	16	Improve access to education for all, increase attendance (by reducing drop-out rates), and improve skills development and training	45	Literacy rate in SW region	% of population	74.5	2018	BBS, 2019	74.5	79	90	95	100	100
			46	Enrolment in primary education (6 -10 yrs)	%	97.34	2019	Banbeis	97	98	97	98	100	100
			47	Enrolment in secondary education (11 - to 15 yrs)	%	69.38	2019	Banbeis	69	72	80	86	90	100
			48	Enrolment in higher secondary	%	35.81	2019	Banbeis	36	38	39	50	75	80

Themes	Objective		Indicator		Unit	Baseline figure	Year of baseline data	Source	Low growth		Medium growth		High growth	
									2031	2041	2031	2041	2031	2041
				education (16+ years)										
			49	Enrolment in tertiary education (national level)	%	17.8	2018	GED	20	30	40	60	50	80
Population		No objective	50	Overall population of SW region	No. in million	21.13	2019	BBS,2012	25.1	25.7	23.9	24.3	22.3	22.0
Migration	17	Reduce migration from rural (including disaster-prone and risk-prone) areas to urban areas	51	Rate of migration to urban areas in SW region	%	14.4	2019	BBS, 2019	12	8	9	7	5	3
Women's empowerment	18	Improve gender equality and empowerment of women	52	Involvement in employment/income generating activity	Poor Good Very good [101]	Poor	2019	Expert Judgement	Poor	Poor	Good	Good	Very good	Very good
			53	Participation of women in decision-making	Low Good	Poor	2019	Expert Judgement	Poor	Poor	Good	Good	Very good	Very good

[101] Very good: 60-80% of women are involved in income generating activity (IGA) or independently employed in a women-friendly environment and have control over their income.

Good: 40-60% of women are involved in income generating activity (IGA) or independently employed and have control over their income (60%).

Poor: <40% of women are involved in income generating activity (IGA) or independently employmed,t and may or may not have control over their income (30%).

Themes	Objective		Indicator		Unit	Baseline figure	Year of baseline data	Source	Low growth		Medium growth		High growth	
									2031	2041	2031	2041	2031	2041
					Very good [102]									
			54	Participation of women in formal education & skill development	Good Very Good Extremely good [103]	Good	2019	Expert Judgement	Good	Good	Very good	Very good	Extremely good	Extremely good
Social inclusion	19	Increase the inclusion of landless and marginal land holders in development activities of SW region	55	Landless/marginal Landholders (0- 0.04 acre) in SW region	%	38.73	2008	BBS, 2011	41.8	44.3	43.7	45.0	45.8	46.2
Conflicts and security	20	Reduce conflicts over use of land	56	No of reported local land-related disputes / clashes	No.	30	2018-19	http://peaceobservatory-cgs.org/#/ division/district	35	40	40	35	15	10

[102] Very good: 60 – 80% of women are actively involved in a wide range of decision-making processes at household to national level.

Good 40 – 60% of women are involved in a wide range of decision-making processes at household to national level,

Poor: >40% of women are involved in in a wide range decision-making processes on at household to national level.

[103] Good: 50 - 60% of women are more involved in formal education and skill development etc.

Very Good: 60- 80% of women are y involved in formal education and skill development etc.

Extremely good: Above 80% of women are involved in formal education and skill development etc.

Themes	Objective		Indicator		Unit	Baseline figure	Year of baseline data	Source	Low growth		Medium growth		High growth	
									2031	2041	2031	2041	2031	2041
Cultural heritage	21	Preserve heritage sites (historic buildings, archaeological and cultural sites and enhance cultural diversity (eg language, arts, etc.)	57	Management status of Sundarban WHS	Poor Good Very good[104]	Good	2019	UNESCO, 1997	Poor	Poor	Good	Good	Very good	Very good
			58	Management status of Shat Gambuj mosque	Poor Good Very good[105]	Very good	2019	http://www.archaeology.gov.bd/	Poor	Poor	Good	Good	Very good	Very good
Food	22	Improve food security	59	Status of food security	Moderate [106]	Good	2018-19	Expert judgement	Good	Good	Very Good	Very Good	Very Good	Very Good

[104] Very good: Physical condition is stable, safe to visit, not fragile and no visible impact due to increased pressure or human mobilization. Adequate budget and manpower available for regular monitoring and maintenance. Management is very prompt and functional to sustain the historical and cultural value of the site.

Good: Physical condition is stable and not fragile. Visible impact is increasing due to increased pressure, human intervention or human mobilization. Budget and manpower is not adequate for regular monitoring and maintenance. Management body is functional but not manageable due to lack of proper budget and manpower.

Poor: Physical condition of the site is fragile and impact is visible due to increased pressure, intervention and human mobilization. No required budget and manpower for regular maintenance. Management is weak and not functional to retain or sustain the historical or cultural value of the site

[105] Very good: Physical condition is stable, safe to visit, not fragile and no visible impact due to increased pressure or human mobilization. Adequate budget and manpower available for regular monitoring and maintenance. Management is very prompt and functional to sustain the historical and cultural value of the site.

Good: Physical condition is stable and not fragile. Visible impact is increasing due to increased pressure, human intervention or human mobilization. Budget and manpower is not adequate for regular monitoring and maintenance. Management body is functional but not manageable due to lack of proper budget and manpower.

Poor: Physical condition of the site is fragile and impact is visible due to increased pressure, intervention and human mobilization. No required budget and manpower for regular maintenance. Management is weak and not functional to retain or sustain the historical or cultural value of the site.

[106] Very Good: Food production/supply is sufficient to feed the people and everyone has ample ability to afford it. Food utilization is ensured in terms of food quality and nutritional value.

Themes	Objective		Indicator		Unit	Baseline figure	Year of baseline data	Source	Low growth		Medium growth		High growth	
									2031	2041	2031	2041	2031	2041
					Good Very Good									
Agriculture and fisheries	23	Increase agricultural and fish production	60	Milk demand	Tons	0.21	2018	DLS, 2018	0.37	0.38	0.35	0.35	0.33	0.32
			61	Meat demand	Tons	0.20	2018	DLS, 2018	1.19	1.22	1.13	1.15	1.06	1.05
			62	Rice production in SW region	M M Ton/yr	6.15	2018-19	BBS, 2020	7.84	7.86	8.22	8.24	8.72	8.75
			63	Fish production in SW region being reviewed	Million MT	0.81	2018	DoF, 2019	0.84	0.92	0.92	1.56	1.56	1.60
			64	Extent of shrimp farms in SW region	Ha	218,828	2018	DoF, 2019	219,000	219,000	114,000	116,000	227,000	233,000
Power and energy	24	Increase efficiency in production and consumption of energy	65	Power production in SW region (installed capacity)	MW	2,575	2020	BPDB, 2020	8,500	8,700	9,100	9,300	9,600	9,900
	25	Increase production and	66	Power production per capita	W / capita	122	2020	Expert judgement	338.0	339	381	384	431	451

Good: Food production/supply is just enough to feeding the people. But instability is visible in food affordability due to price hiking. Nutritional security is not ensured in terms of balance diet.

Moderate: Food production/supply is insufficient to meet demand. Inadequate income leads lack of affordability which ultimately scale down accessibility to food for all level of people. Food quality AND nutritional value are well below the standard.

Themes	Objective		Indicator		Unit	Baseline figure	Year of baseline data	Source	Low growth		Medium growth		High growth	
									2031	2041	2031	2041	2031	2041
		consumption of energy		(installed capacity										
	26	Increase access to affordable energy	67	Power production per GDP (installed capacity)	W / 1000 $ international (PPP, constant prices of 2010)	58.1	2020	Expert judgement	120.2	109.3	82.6	74.0	80.0	69.2
Industries		No objective	68	No. of special economic zones in SW region	No.	0 (Area: 1496.29 for No.07 (land acquired)	2020	BEZA, 2020	No. <03	No.03	No. <05	No.05	No. <07	No.7
Tourism	27	Improve tourism management and behaviour to limit noise, pollution and other negative impacts and remain within the carrying capacity of	69	Visitors to Sundarbans	No.	189,570	2018-19	BFD, 2020	246,400	303,300	284,400	379,000	322,300	455,000

Themes	Objective		Indicator		Unit	Baseline figure	Year of baseline data	Source	Low growth		Medium growth		High growth	
									2031	2041	2031	2041	2031	2041
		the Sundarban[107]												
Infrastructure, transportation and communications	28	Improve connection of communities, and improve access to infrastructure, services and facilities	70	% of population (above 14 years) in SW region (Khulna Division) using mobile phones.	% / yr	84.2 (above 14 yrs)	2013	Expert judgement based on BBS, 2013	90%	95%	95%	97%	98%	99%
			71	Density of roads in SW region (national/regional highways and district roads only)	Km roads per 100 Km2	11.38	2019	RHD, 2020	12.0	12.1	12.2	12.7	12.5	13.6
	29	Optimise the existing and future physical footprint of transport services (rail, road, air, waterways)	72	Extent of roads and highways	Km2	16.054 (est.)	2019	RHD, 2020	17.20	17.80	17.90	19.60	19.10	21.20
			73	Motorised traffic as percent of all traffic in SW region	% / yr	71.97	2020	RHD, 2020	69.1	81.4	73.7	88.2	76.2	90.0
			74	Extent of railways in SW region	Km	467.05	2019	BR, 2019	510.1	583.1	514.0	590.2	529.9	621.3
			75	Ships sailed (cargo and passenger)	No. / yr	1,283 (Mongla port)	2018-19	MPA, 2019	1,720	2,100	1,830	2,330	1,940	2,590

[107] There is no current data or system for recording the status of tourism management. Recommendations for an appropriate indicator and system will be made in the SEMP.

Themes	Objective		Indicator		Unit	Baseline figure	Year of baseline data	Source	Low growth		Medium growth		High growth	
									2031	2041	2031	2041	2031	2041
				operating in SW region[108]										
			76	Annual cargo traffic movement in Khulna Port	Million metric tons-km	64	2018-19	Projected value based on baseline data of (BIWTA, 2015b)	81	87	92	99	103	109

[108]A ship is denoted as a motorized maritime vehicle which is used for carrying passengers using waterways.

Annex 8: Core Issues for Proposed SEAs

It is recommended that a programme of more specific, sector-based SEAs be developed, building on the findings of this SEA, to be undertaken over the next 5-10 years. SEAs for the following are recommended - to be prioritised. Some are focused specifically on the SW region; others are national in scale (in italics) whilst also having relevance to the SW region:

- Mongla port and its further development, and shipping;
- Power and energy generation and transmission;
- Industry;
- Urban development in the SW region;
- Transport (road, rail, water and air);
- Agriculture;
- Fisheries (marine, freshwater and aquaculture);
- Water management infrastructure;
- Tourism.

An illustrative list of key issues that each SEA should address is given below to indicate their potential scope. These should be incorporated when Terms of Reference prepared for these SEAs. However, they do not represent a full or exhaustive set of issues that should be addressed. Further consultation with experts and key stakeholders will be required when developing the TOR. In all cases, scenarios should be developed as well as comprehensive consideration of development and management alternatives bearing in mind the mitigation hierarchy (avoid, minimise, mitigate, compensate).

Mongla port and its further development, and shipping

- The volume of traffic (now and projected), the type of ships, and the type of loads they are carrying and the resultant risks of accidents, pollution, etc.
- The expected needs for dredging, where dredge materials will be dumped, and the extent to which muds are already polluted (e.g. heavy metals).
- The extent and growth of shipyards, especially where ship repairs and maintenance are done.
- The types of infrastructure used or required for loading and unloading of cargo, and the associated risks (e.g. spillages/pollution).
- Turnaround times for incoming ships (the longer they berth outside whilst in the queue, the more they discharge galley waste, etc.).
- Mechanisms to manage risky or undesirable social interactions between locals and incoming sailors or labour force (if from other countries/areas).
- Waste disposal facilities in and around the port.
- Separation of types of cargo stored in the port (e.g. food, medical, fuels, chemicals, etc.).
- Knock-on effects (e.g. incoming and outgoing road, river and rail traffic).
- Security considerations.
- Port expansion.
- Effects on the Sundarbans (e.g. bank erosion, surface and underwater noise, and light, pollution from ships, etc.).

Power and energy generation and transmission

- The type (fuel type) of power stations and transmission lines envisaged, their localities and lifespans and whether greenfield or brownfield land required.
- The type of technology and expected efficiency of conversion of fuel into energy.
- Potential risks of accidents / emergency situations (especially in the case of nuclear plants.
- Potential health and environmental impacts of operation.
- Involuntary resettlement requirements.
- The source of fuel for the power stations, transport and storage thereof (including treatment of spent fuels in the case of nuclear – both interim and final treatment).
- The need for other materials or resources (e.g. water for cooling).
- Likely emissions (air, noise, lights) or discharges.
- Likely emissions of GHG (carbon dioxide).
- Envisaged emission abatement technique/technology installed.
- Waste waters treatment (technology, recipient of treated waste water).
- The types of ancillary infrastructure required (e.g. roads, rail, water facilities, warehouses).
- Human resources required for construction and operation (and where they will likely come from and be accommodated).
- Waste disposal and use (e.g. use of ash and fly ash from coal fired plants) and facilities required in and around the power stations.
- Knock-on effects (e.g. incoming and outgoing road, rial or river traffic).
- Safety measures including emergency plans (especially in the case of nuclear power plants).
- Security considerations.

Industry

- The type of industries currently existing and new developments envisaged, their localities and lifespans, and whether greenfield or brownfield land is required.
- The type of technology installed and expected energy efficiency.
- Potential risks of accidents / emergency situations (especially in the case of nuclear plants.
- Potential health and environmental impacts of operation.
- Involuntary resettlement requirements.
- The types and sources of inputs for the industries (e.g. raw materials, water, fuel, etc.).
- Likely emissions (air, noise, lights) and discharges.
- Envisaged emission abatement technique/technology installed.
- Waste water treatment (technology, recipient of treated waste water).
- Likely emissions of GHG (carbon dioxide).
- The types of ancillary infrastructure required (e.g. roads, rail, river facilities, warehouses).
- Human resources required for construction and operation (and where they will likely come from and be accommodated).
- Waste disposal and treatment facilities in and around the industries (including reuse and / or recycling of waste).
- Knock-on effects (e.g. incoming and outgoing road, rail or river traffic).

- Safety measures including emergency plans (especially when high volumes of hazardous chemicals are in place).
- Safety issues in and around the industries.

Urban development in the SW region

- Expected areas to be expanded or densified (footprint) – and whether greenfield (agricultural or aquatic) or brownfield (industrial/already developed) land is required and what of environmental and/or cultural value will be destroyed/lost/converted.
- Involuntary resettlement requirements.
- What is the need for urban development? - who would be the likely beneficiaries (and why) and where they would be coming from.
- The type of housing areas envisaged, their localities and layouts, and envisaged services (e.g. mobility, sewerage, police, health, retail, schools, recreation).
- The types and sources of inputs for the expansions (e.g. building materials, water, electricity, etc.)
- Required energy infrastructure (electricity, gas) and water infrastructure (drinking water supply, sewerage, treatment plant).
- Likely emissions (air, noise, lights) or discharges and how these will be abated/treated.
- Likely emissions of GHG (carbon dioxide).
- The types of ancillary infrastructure required (e.g. roads, rail, river transport, airports, warehouses, parking, etc).
- Human resources required for construction (and where they will likely come from and be accommodated).
- Waste disposal and treatment facilities in and around the urban areas.
- Knock-on effects (e.g. incoming and outgoing road, rail, river and air traffic).

Transport (road, rail, water and air)

- Current and types of new transport expansions envisaged, and their extent and alignments/routes.
- Expected land required (footprint) – and whether greenfield (agricultural or aquatic) or brownfield (industrial/already developed) land required, and whether drainage might be affected.
- Involuntary resettlement requirements.
- The types and sources of inputs for the construction (e.g. raw materials, water, equipment, etc.).
- Likely emissions (air, soil, dust, noise, lights) and discharges.
- Likely emissions of GHG (carbon dioxide).
- Human resources required for construction (and where they will likely come from and how they will be accommodated during construction).
- Waste disposal and treatment during construction.
- Knock-on effects (e.g. deviations during construction)
- Health and safety issues in and around the construction sites.

Agriculture

- The type of agriculture development, changed management or new projects envisaged, their localities and whether greenfield or brownfield land is required (involuntary resettlement requirements).
- The types and source of inputs for the developments/projects (e.g. mechanisation, fodder, seeds, fertilizer, chemicals, water), transport and storage thereof.
- The types of crops, transportation and storage thereof, and marketing.
- Likely emissions (air, noise, lights) and discharges.
- Likely emissions of GHG (methane).
- The types of ancillary infrastructure required (e.g. roads, rail, river, warehouses).
- Human resources required for changes, construction and operation (and where they will likely come from and be accommodated).
- Waste generated by the changes, developments or projects.
- Pest control.
- Knock-on effects (e.g. incoming and outgoing road, rail or river traffic).
- Impacts of conversion of agricultural land to other uses.

Fisheries (marine, freshwater and aquaculture)

- The type of current fisheries activities (capture or farmed) and envisaged development/projects, their localities and whether greenfield or brownfield land required (involuntary resettlement requirements).
- The types and source of inputs for the development/projects (e.g. fry, chemicals, medicines), transport and storage thereof.
- The types of fish produced, processing activities, transportation and storage thereof, and marketing/export.
- The types of ancillary infrastructure and equipment required (e.g. roads, rail, warehouses, boats).
- Human resources required for construction and operation (and where they will likely come from and be accommodated).
- Waste generated by the activities/projects and its treatment.
- Pest control.
- Illegal activities (poison fishing, illegal capture, etc.).
- Knock-on effects (e.g. incoming and outgoing river, road and rail traffic).

Water management infrastructure

- Existing and planned/envisaged water management infrastructure developments (e.g. water diversion structures, barrages, flow control, embankments), their location and lifespans, and whether greenfield or brownfield land is required.
- The impacts likely to arise from water management infrastructure developments/projects, maintenance and improvement works such as water regulating structures (e.g. barrages, sluice gates, regulators), dredging activities, flood protection embankments, structures that can impede water flow (eg. bridges) and erosion control measures.
- The types of ancillary structures or infrastructure and equipment required (e.g. road, rail, warehouses, dredgers).

- The need for dredging, locations where dredged materials are dumped, and the extent to which such materials are already polluted (e.g. heavy metals) or having negative environmental impacts.
- Emissions (e.g. air pollutants), discharges (e.g. polluted water), waste and other pollutants/disturbances (e.g. soil erosion, dust created, noise, light) related to existing and planned water management infrastructure.
- Current and likely future emissions of GHG (carbon dioxide).
- Human resources required for changes, construction and operation (and where they will likely come from and be accommodated).

Tourism

- The type of current and envisaged tourism activities/developments/projects, their localities and whether greenfield or brownfield land required (involuntary resettlement requirements).
- How tourism activities are/will be managed.
- Attractions likely to be visited and what activities will be offered.
- Likely volume of tourists (domestic, international).
- The types and source of inputs for the activities/projects (e.g. boats, vehicles, fuel, food, drinks).
- Likely emissions (air, noise, lights) and discharges.
- The types of ancillary infrastructure required (e.g. roads, jetties, lodges, airports, customs and immigration).
- Human resources required for operation (and where they will likely come from and be accommodated).
- Waste generated by the projects and treatment.

Annex 9: A Note on National, Regional and International Standards for the Protection of Human Health, and for the Protection of Vegetation and Animals

Environmental standards are administrative regulations or civil law rules implemented for the treatment and maintenance of the environment. They are typically set by the government of a country and can include prohibition of specific activities, mandating the frequency and methods of monitoring, and requiring permits, e.g. for the use of land or water. The basis for the standards is determined by scientific opinions from varying disciplines, the views of the general population, and social context. As a result, the process of determining and implementing standards is complex and is usually set within legal, administrative or private contexts. Moreover, technical achievability and economic feasibility need to be taken into account.

Environmmental standards are also set by international organisations. For example, various UN bodies have developed standards for the subject areas they are responsible for such as human health standards set by the World Health Organisation. The International Organisation for Standardisation (ISO) has developed the ISO1400 series of standards for environmental management.

It is standard practice in SEA to make reference to national environmental standards for particular matters (e.g. health, biodiversity) as well as to the most relevant or appropriate UN/international body.

Member States of UN organisations commit to trying to improve their standards towards those set by those bodies, although often UN standards are set high as a goal to work towards. In practice, ambient levels of environmental qualities in most countries usually fall well below UN values.

The following table on human health standards is provided for comparison purposes

(a) Human health

	Air quality standard: annual average concentration (µg/m³)							
	Bangladesh	**USA[109]**	**EU[110]**	**WHO[111]**	**WHO-2021[112]**	**India[113]**	**Pakistan[114]**	**Myanmar[115]**
PM_{10}	50	-	40	20	15	60	120	20
$PM_{2.5}$	15	12	25	10	5	40	15	10
SO_2	80	-	-	-	-	50	80	
NO_2	100	100	40	40	10	40	40	40

Note: Figures are the average over the year

Across the world (except for South Asian countries), annual limit values for SO_2 are now considered obsolete.

(b) Vegtation and animals

The EU has issued a set special standards - critical levels for the protection of vegetation (in terms of annual average concentration): 20 µg/m³ for SO_2 and 30 µg/m³ for NO_2.

The USA has a secondary standard for the protection of vegetation and animals: for $PM_{2.5}$ 15 µg/m³.

[109] USEPA: https://www.epa.gov/criteria-air-pollutants/naaqs-table (secondary standards for protection against damage to animals, crops, vegetation, and buildings in brackets)
[110] Directive 2008/50/EC on ambient air quality and cleaner air for Europe: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0050&from=EN
[111] WHO: https://www.who.int/airpollution/guidelines/en/
[112] WHO: https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health
[113] https://cpcb.nic.in/upload/NAAQS_2019.pdf
[114] https://www3.opic.gov/environment/eia/pakistanpower/110711%20R1V08STR-A%20-%20Part%20III.pdf
[115] https://www.eanet.asia/wp-content/uploads/2020/04/8-Myanmar_Factsheet_compressed.pdf

Annex 10: Responses to Written Comments Received from Stakeholders

Comment	Response
From SM Zobaidal Kabir, Deputy Secretary, Ministry of Fisheries and Livestock (MoFL)	
General: This is a great job done by CEGIS Team and Team of Foreign Consultants. This is the first kind of SEA in Bangladesh undertaken by the Government of Bangladesh. In Bangladesh, where SEA is not mandatory by regulations and there is absence of a Guideline for SEA, the development of the SEA for SW region is a difficult task particularly when the SEA is undertaken in a non-regulatory context.	Thankyou
Chapter 1: Introduction • The guiding principles for SEA need to be included in the introduction (this can be from international literature) • Triggers are there in the introduction for example, Sundarbans is an UNESCO heritage, so the SW region need to be sustainable to protect the Sundarbans. However, legal obligations often work as triggers. While there is no Act or regulations incorporated the need for SEA for PPPs or sustainable region, the revised National Environmental Policy-2018 incorporated the need for SES and underscores the implementation of SEA of PPPs. This can be mentioned in this section as one of the triggers too. • Also, how the need for SEA in the region is aligned with other national and international conventions (e.g., Espoo and Arhus), plans and strategies such as Bangladesh Delta Plan-2100, Perspective Plan-2041 and SDGs can be mentioned to provide a strong basis for undertaking SEA • Under 1.2 subsection, identification of stakeholders is not the objective of SEA. This can be deleted or removed. • The sub-sections 1.3 and 1.4 can be included somewhere else under other chapters/sections • Overall, the introduction chapter need to be revised for more clarity and incorporating more relevant information	• Feedback on the Scoping Report was that readers found it too long (although difficult to avoid for such a complex SEA). So unnecessary materials have not been included. Principles of SEA are theory. A footnote is included to a good source. • The report addresses the principal triggers for the SEA. A full discussion of the legal and policy framework relevant to SEA is provided in Chapter 5 of the Final Scoping Report. • Commitment to international treaties, conventions and protocols are also set out in Chapter 5 of the Final Scoping Report. For brevity, they are not repeated in the SEA report. • Section 1.2 gives the objectives for the SEA set out in the TOR, which specifically include identification of stakeholders. • We believe these sub-sections are required in the Introduction. • We believe Chapter 1 is clear and contains the information relevant to an introduction. It is unclear what other ('more relevant') information is being referred to.
Chapter 2: Methodology • The list of stakeholders discussed with whom during scoping (appendix 2) should	

Comment	Response
be included with the SEA report. • Stakeholder analysis is a key part of the report, but this is absent. It is necessary to include a sub-section on stakeholder analysis using appropriate tools and techniques and identification of key stakeholders at local, regional, and national levels through the analysis. Gathering data to identify stakeholders is important and BBS in addition to fieldwork can help in the regard. • Similarly, Annexures 7 and 8 included in scoping reports can be included with the SEA report. • The initial plan for stakeholder consultations such as workshops at local, regional, and national level, interview, FGD were not possible to undertake adequately due to COVID-19. This is a limitation of the SEA and a separate sub-section titled L**imitation of the SEA report** can be added under introduction (at the end of introduction) including other procedural limitations if any. This is not the weakness of the report rather it will improve the clarity of the report. • On the other hand, what were done as alternative to these methods demands more elaboration and clarity. How many people were contacted by email and how many were responded? Who are they? A table can be added in this section including the stakeholders by category, profession etc. • Similarly, how many video conferences were undertaken, with NGOs (how many and who are they?). • Why not video conferencing with local stakeholders through DCs or UNOs? • Some national stakeholder consultation is a vague term. How many consultations at local, regional, and national levels were undertaken and with whom should be clearly specified? • It was possible to undertake in-depth telephone interview with key informants. • It was mentioned that SEMP was developed comprising focal points of sectoral ministries. As one of the key stakeholders of SEA, I am not sure if any focal point was contacted from the MoFL. • Overall, what were done as alternative to what were planned were good and served	• As indicated above, the team has been asked to keep the report as short as possible. We have not repeated many things contained in the Scoping Report. The latter is a companion to the Final SEA Report. • Agreed, stakeholder analysis is a key element of an SEA. Appendix 2 of the Final Scoping Report lists all stakeholders, categorised by: government institutions (at different levels), private and non-government institutions. • BBS data are included in the report where appropriate. • Those annexes are comments on the Scoping Report and belong in that document. • A new section 1.4 has been added to address this suggestion. • Emails were sent to all stakeholders listed in Appendix 2 of the Final Scoping Report initially requesting comments on (a) key issues of concern and(b) subsequently inviting comments on the draft Scoping Report. Only four people responded (listed in Revised Record of Consultations. A new Table 2.2 has been added analysing the stakeholder consultation actions taken during the SEA process. • Two video conferences (Skype & Zoom) were organised with 15 NGO and INGO. Those participating are listed in a Revised Record of Stakeholder Consultations • 11 video conferences were organised using the Zoom platform - with multilevel stakeholders (govt., non-govt. and international organizations). Section 2.3.2 has been adjusted to reflect this. Despite the COVID-19 outbreak, two district level consultations were conducted in Bagerhat and Khulna districts as well as three upazila level consultations in Mongla, Rampal and Sarankhola upazila. (details are provided in the Revised Record of Stakeholder Consultations). • Requests were made for in depth interviews with 30 key informants. Of these, 14 provided written comments and 10 gave verbal information. Details are provided in the Revised Record of Consultations. • Mr. Hasan Ahmmed Chowdhury, Director, Finance & Planning of Department of Fisheries was the focal person from the Ministry of Fisheries and Livestock (MoFL). The SEMP was compiled over a month through team meetings and video-based consultation workshops (due to COVID-19 restrictions) with the SEMP Liaison Group. The latter comprised representatives of key government ministries (of nine sectors) who consulted their

Comment	Response
the purpose I believe. *Section 2.3.3 Site visits* • Many of the Bangladeshi team members?? Instead, most of the team members can be included. *Section 2.3.4 Identification of key environmental and socio-economic issues* • (This is a part of SEA process/ also an objective). To identify these issues, we talked to people, collected secondary data are part of methodology) *Section 2.3.6: Preparation of SEA prospectus* • This can be removed as this is not a part of methodology. *Section 2.3.9: Setting environmental and socio-economic objectives for the key issues* • This is a bit confusing. The methods such as workshops, stakeholder consultations etc were conducted to identify objectives of SEA in the region. So, we can mention this is one of the key reasons for undertaking FGD, workshops etc. • Modelling can be added as part of Methodology and included what we have done, why and how and what are the tools and techniques used for modelling.	respective higher authorities before consenting to the SEMP organogram and responsibilities. • Thankyou. This comment is appreciated. Agreed. Changed. • But is still part of the methodology. • The prospectus was a methodological innovation, seldom undertaken in SEAs. It is important to mention • The objectives in this sub-section are specifically those to address/respond to key issues, and formed the basis for the subsequent initial and deeper assessments. We believe this section is clear, although it needs to be read carefully. • Modelling is introduced in section 2.4.3. of the methodology chapter. But the modelling is an important and detailed issue that is dealt with (and referred to) in its own dedicated chapter – where the method used is presented. It is important to keep the methodology for modelling together with the results.
Scoring: • Can go under scenario analysis as a tool to develop scenario and understand the extent of impacts. It is important to clarify how scoring were given for each of the issues (29 issues/objectives). Scoring is subjective although expert judgement is used for scoring in this report. However, the use of weightage could be used for each of the issues/objectives of sectors. The use of weightage would make the assessment more rigorous.	• The scoring approach is correctly mentioned in Table 2.4 as it is a part of methodology chapter. It is the basis for the work reported in Chapter 6 (assessment of scenarios) and Chapter 7 (deeper assessment of high growth scenario). The scoring is not a tool for actual scenario development. It was not appropriate of feasible to use weighting because of the strategic level at which expert judgements had to be made.
Cumulative impacts • Assessment of CIs but no method was used to understand the Cis in the region. It is to be noted that one of the key advantages of SEA is to identify and assess the Cis and it is not possible to assess the Cis by using EIA. A separate chapter can be added for	• We disagree. The team made extensive used of linkage diagramming (introduced in see section 2.4.2 of methodology chapter) as a proven method to show cumulative effects - with Chapter providing the outcomes. The linkage diagrams are essentially sector based,

Comment	Response
regional Cis. It is possible to identify and develop a matrix to understand the extent of Cis or potential impacts for each sector in the region.	so they have already provided a good understanding of how a sector causes impacts and how each type of impact contributes to onward impacts. A matrix can be developed but a matrix doesn't improve the understanding of HOW impacts progress and become cumulative. A matrix is in some cases useful, but its biggest weakness is that it doesn't show the dynamics of impact progression. Thus, we think linkage diagrams are the correct tool to show CI in this case.
Chapter 3 • In high growth scenario- RE [renewable energy] should be mentioned including sources (though added in Table 5.1) • Waste to Energy (WtE) should be added, recycling is not enough. WtE technology not only recycle the MSW but also generate Renewable Energy. • When we talk about **significance**. This word should be used carefully. If this is used for impacts or pollution or risk, the **criteria (temporal, intensity, area, frequency, quantity)** of significance should be used to understand whether the risks are very significant, significant, or not significant at all. • The **assumptions** should be related to the context of Bangladesh or the SEA undertaken here need to be contextualised given the socio-economic, political, and cultural conditions. There should be **justification** why we have taken these assumptions.	• Chapter 3 concerns the baseline profile and ley environmental and social issues. It is not clear what these comments refer to. We assume these comments refer to Chapter 5. • Renewables are mentioned in Box 5.1. • Accepted. Text has been amended in section 3.2.4. • We have reviewed the use of the word 'significant' throughout the report, and substituted other terms where appropriate. • We believe the assumptions to be relevant to Bangladesh. Most are specific to the country context. A few are global (e.g. climate change, pandemics) but likely to affect Bangladesh
Chapter 4: Modelling • This can be added as an annexure with the SEA report. This does not represent a Chapter indeed. Rather, modelling as a method can be described under Methodology including what we have modelled, what tools and techniques we have used and how.	• Modelling was required by the TOR and is so important and complex that we take the view it requires a dedicated chapter within the report. Modelling is indeed a methodology, but Chapter 4 presents the results and conclusions therefrom. In a similar way, Chapters 6 and 7 present the results of the assessment of scenarios (which is also a methodology).
Annex 4.6: Deeper Assessment of Fisheries Sector **Scoring** • Annex 4.6 is largely incomplete with the potential risks and mitigation as well as scoring for many issues associated with. • Water, Climate Change, Health and Sanitation, Migration, Women and Children, Cultural and Natural heritage, Power and energy, Tourism and infrastructure. It is possible to identify issues (risks and mitigation) and complete this matrix with a bit more exercise	• It is not clear what this comments refers to. How is it largely incomplete? It presents what the team did on this sectoral assessment. We cannot assume what risks or mitigation are being referred to. • It is difficult to respond to this comment. The team believes that it has identified the key risks from its expert perspectives. Mitigation is dealt with in the SEMP.

Comment	Response
Chapter 6: assessment of growth scenarios	
• Risk or negative impacts should be written or mentioned in a negative sense and Mitigation should be mentioned in positive sense.	• This is indeed how the chapter aims to present risk and mitigation. It is expressed in this way in the chapter.
Other comments	
• Livestock sector is totally absent in this SEA report. Given the importance of this sector in supply of food and nutrition nationally, this sector can be incorporated.	• This is not the case. Livestock are mentioned 25 times, cattle 18 times and poultry 15 time.
• It is important to clarify between SEA objectives, sectoral objectives, sectoral issues, impacts and factors. These words have been used in the report inconsistently and therefore difficult to understand.	• The report makes an effort to be clear what kind of objectives are being referred
• Executive Summary or Non-Technical Summary can be rewritten in simple language and may reflect key issues of the report only. A revision can be done if possible. One of the key purposes of Executive Summary is to provide information in simple language covering the key issues of the report so that the Executive Summary becomes understandable to a non-technical person.	• This SEA is very complex – arguably one of the most complex ever conducted in the world to date. It would be extremely difficult to 'dumb down' the Executive Summary in the main SEA Report without losing clarity and specificity. Key technical text can become rather misleading and vague if very simple and imprecise language is used. But the team will prepare a separate "flyer" that is a slimmed down version of the executive summary – for those who need an even simpler overview of the SEA.
Listing mammals and endangered species in Sundarbans	
• The mammals and animals in Sundarbans and in the SW region including endangered ones can be listed to understand how they will be affected by future activities of different sectors.	• The team is not convinced of the value or purpose of including a long list of all wildlife species in the Sundarbans, especially when this SEA is at such a meta level. For a project-level EIA, listing species (including endangered ones) is, of course, necessary and routine, they are listed in many books and reports and readily available on the internet. Key and affected species are mentioned where appropriate.
Overall comments on the SEA	
• This is a great job as the first SEA in Bangladesh undertaken by the Government of Bangladesh. In a non-regulatory context, the development of SEA is a difficult task particularly when the SEA is undertaken for a region. In the report, materials or information are there. A bit more reorganisation or restructuring with clarity and justification is required.	• Thank you for this comment. It is appreciated. But we do not feel that the report requires restructuring. The team believes that it is fit for purpose and clear. Without specificity of what elements of the text are unclear, it is difficult to make adjustments.

Comment	Response
From Mr. Md. Ashraf Uddin, Director General, Department of Environment, Ministry of Environment, Forest and Climate Change (MoEFCC)	Note: these comments related to the first Draft SEA Report submitted on 1st June but responses are included in this Final report
Page 4: The following issues and concerns could be added under the `Industrialization'- *Textile dyeing, Garments washing, Tannery, Chemicals and its potential impacts.*	We cannot find where on page 4, this comment would apply. We assume it refers to Table E.1 on page XX14 (14) which lists the major issues identified by stakeholders and experts which was used to focus the SEA. It is not appropriate to alter this table at this end-point in the SEA process. But the issues mentioned are discussed in the scoping report and in Chapter 3.
Page 5: Pollution from cooking could be rewritten as: *Pollution from cooking and Open Burning and* example of potential impacts should be mentioned clearly.	We assume this also refers to Table E.1. See comment above Accepted. Table E.1 has been amended.
The following Environmental issues and concerns should be added: • ***New Roads & Highway construction:*** *The new Roads & Highways construction is also a huge concern to the Sundarbans area-may cause sound and air pollution, increasing the development activities like housing, tourism etc.* • ***Ecologically Critical Area & Marine Protection Area:*** *According to the ECA & MPA-the prohibited activities should be well defined and maintained respectively.* • ***Port and Ship/Dockyard:*** *Port extension or establishment of ship dockyard are also the major concern in the Sundarbans, that may increase the shipping movement and causing the river pollution of Sundarbans area.*	The comment does not suggest where these issues should be added • Roads and highway construction is addressed consistently throughout the report • The ECA and MPA areas rules and activities are addressed in the SEA report (Annex 6). with recommendations. • This issue is also addressed consistently throughout the report
Page 37:*Health and Well-being* could be included as a topic under table 3.1 (scope of baseline theme papers).	The theme papers have been completed. They were not a required deliverable but provided background detail to the team to inform the assessment
Page37: In table 3.1, coastal polders (under Sl. 4: Land Resources) should be placed under the Sl. 8: Infrastructure.	The theme papers have been completed. They were not a required deliverable but provided background detail to the team to inform the assessment
Page 37: In table 3.1, Ecologically Critical Areas (ECAs) could be added under the Sl. 5: The Sundarbans, other ecosystems, and wildlife conservation	The theme papers have been completed. They were not a required deliverable but provided background detail to the team to inform the assessment
Page 40: *Figure 3.1 (Location of river embankments in SW Bangladesh and adjacent areas)* is not readable. Please use a higher resolution figure.	Figure 3.1 has been replaced with a new version.
Page 66: *Figure 3.10 (Map showing the location of dams in Nepal)* is not readable. Please use a higher resolution map if possible.	This was obtained from a source in Nepal. No higher resolution version is available.
Page 98: The last paragraph can be replaced by the following paragraph: "Naturally the canals and small rivers in Southwest regions are connected the Passur and Shibsa river system. Liquid wastewater generating industries in southwest regions the treated and untreated waters somehow fall into the big river. There are 71 industries producing liquid wastewater in the southwest regions under the Khulna Divisional office of DoE. Of these 16 establishments have their own active liquid wastewater treatment	Some industries have ETP facilities. However, of these, some are functional and others are not. According to the DoE, there are 71 industries (registered) producing moderate to huge liquid wastewater in the SW region under its Khulna Divisional Office. Of these, 16 establishments have their own active liquid wastewater treatment plants. 45 have their own treatment plants

Comment	Response
plants. 45 establishments have their own treatment plants but not active. 04 establishments have their own zero discharge treatment plants and 06 establishments have their no effluent treatment plants.	but are not active, 4 have their own zero discharge treatment plants, and 6 have no effluent treatment plants. This information has been incorporated in section 4.2.4.
Page 113: The following environmental drivers under climate change could be added- • Increase of flooding • Increase the intensity of cyclones and precipitation • Greenhouse Gas (GHG) emission • Increase of droughts	• These issues are mainly addressed under natural disasters • These all are not the drivers of climate change (except GHG), rather they are the impacts of climate change
Page 205: The references are not followed in uniformity. It is suggested to use a similar referencing system (e.g., APA 6th Edition).	The references are provided in the format in which they were sourced. As this is not an academic journal document, uniformity is not a critical issue
Strategic Environmental Assessment report should be concise, easily comprehensible and readable but the text in the table under annex is not clear enough to read and it should be laconic.	This SEA is one of the most complex ever undertaken in the world. The team has tried to limit the length of the report and has retained certain materials in companion volumes (eg the scoping report, record of stakeholder consultations, theme papers, etc). The team has strived to maintain clear language throughout. It is not clear which table in the several annexes is referred to.
All abbreviations could be rechecked whether it is appropriate or not, the correction of Forest Department, Bangladesh Environment Conservation Act 1995, Environment conservation Rules 1997, Bangladesh Biological diversity Act 2017, is just a few of many.	All abbreviations included appear in the text and therefore require to be listed. They list of abbreviations has been checked and corrected where needed.
Page number of ToC is not matched with the actual page number	This Final Report includes substantial updating, including aligning text with page number if the TOC
• Main objectives and other objectives could come under separate para.	• It is unclear to which section/page of the report this refers
• In Annex 6: National Forestry policy 2016 (Draft), Draft National energy policy, 2006, could be replaced with the final version. National Environment Policy 2018 should come in the legal instrument part.	• The PPPs listed in Annex 6 are the ones that were reviewed at the time. No final version of the mentioned policy has been released. • Policies are not legal instruments
Expected Health impact could focus as much as environmental and social impact (direct and indirect) that could be presented in a table against the sectors to make more organized and readable. This process could follow for listing the mitigation measures in a table.	This issue is addressed strategically in the Final SEMP (Table 4.2) and Annex B as regards monitoring.
From the document it is not clear what alternative strategies have been chalked out for attaining the aim of the SEA to ensure the sustainable development of the SW region whilst also ensuring the conservation of the Sundarbans. As of the draft reviewed by us,	• The SEMP is the document that sets out the proposed measures and alternative strategies to mitigate and manage impacts and key environmental and social issues – which might affect the SW region and the Sundarbans.

Comment	Response
it is confusing because of merging with other texts under Chapter 5. Alternative strategies or options should come under separate headings to make it clearer.	• The point made concerning Chapter 5 is not clear
Comments on Water Quality • In water quality report, there are two type of water as per ECR 1997 –Surface water, Industrial waste and Sewage water. • For three types of water, there are different STD in ECR 1997 (Waste Water STD Schedule-10 and 12, Sewage Water STD Schedule-9, and Surface Water STD Schedule-3 • There is no STD for Phosphate and Nitrate of Surface water STD existing ECR1997; For sewage water Nitrate STD- 250mg/L and Phosphate STD- 35mg/L, for General Waste Water Nitrate as elemental nitrogen STD- 10mg/L and Dissolved phosphorus(P) STD 8mg/L • The STD which is given in the report is for drinking water STD • phosphate data of Industrial Effluent should be check specially Phosphate because it is not too low specially sea food and sewage effluent	• Since the first draft of the SEA was submitted on 1st June, all data sources have been checked and updated, where necessary, and the modelling has been re-run, and revisions of the text of Chapter 4. The team is satisfied that Chapter 4 is robust. • The team is grateful for the details of the standards of water quality, Bangladesh. In the water modelling undertaken, standard nitrate (10 mg/L) and phosphate (5 mg/L) concentrations were used for generating the water quality scenario in 2041. The figure for nitrate proposed by the DoE has been used. However, a lower figure for phosphate than that proposed by the DoE has been used (5 mg/L instead of 8 mg/L as dissolved phosphorus). Initially, the modelling considered total orthophosphate in water, but this was subsequently replaced by dissolved phosphorous to conform with the DoE standard[116]. Therefore, in this final SEA report, the modelling team has adjusted the concentration of phosphate and updated the relevant section of Chapter 4. However, this correction does not significantly change the phosphate scenario for 2041 due to the implementation of environment-friendly policies, acts, rules, and regulations adopted by the government such as clustering of industries, effluent treatments through CETP, ETPs, STPs, etc. • Regarding the very low concentration of phosphate in effluent discharged by the seafood industry and sewage lines, the modelling team has cross-checked this issue again - collecting primary water quality samples and testing in a reputable laboratory. The results of the testing were in alignment with the original measurements. • It is recommended in Chapter 10 that, under the SEMP, the modelling is periodically re-run to incorporate up-dated and new data in order to provide revised information for the best management of pollution issues.] •
Comments on Air Quality • The results of the air pollution model usually depend on the data used in the model and also upon the 'quality/authenticity' of the data. If the collected data can reflect the actual scenario of the environment, the result of the model reveals the actual result. Data inadequacy is a major weakness of Bangladesh. In the absence of reliable data, the best expected results from any study cannot expected.	Since the first draft of the SEA was submitted on 1st June, all data sources have been checked and updated, where necessary, and the modelling has been re-run, and revisions of the text of Chapter 4. The team is satisfied that Chapter 4 is robust. But some explanations may be helpful, as follows:

[116] Standards for Waste from Industrial Units or Projects Waste: SCHEDULE-10, ECR-1997

Comment	Response
• The government's policy of using unbleached bricks instead of burnt bricks and increasing use of LPG instead of biofuels (firewood) in home cooking will greatly reduce the rate of air pollution by 2025. This issue was not addressed in the air pollution inventory and reporting model. At the same time many local sources of pollution did not come into the air pollution inventory. • The report mentioned that, for the analysis of PM10 and PM2.5 emissions primary data has been collected. A gap has been observed between the data used in this case and the actual data. The data of all sources of air pollution and the contribution of various sources of pollution (Source apportionment) were not used properly in the model and the results of the model were not accurately reflected. Proper use of data (authentic) in the model and proper use of PM10 and PM 2.5 sources of air pollution (Road and Soil Dust), could have resulted in different (higher) for PM10 and PM 2.5 projection of 2031 and 2041. • Contribution (Source apportionment) of PM10 and PM2.5 pollution sources has not been used properly in the data model. A major source of air pollution in Bangladesh (PM10 and PM2.5) is the transboundary effect which comes from 25-40% of neighboring countries. This transboundary effect and its impact does not address during the projection for 2031 and 2041. The report did not say what kind of pollution could occur if there was no transboundary effect. • A gap between actual data and inventory data on sulfur dioxide and nitrogen oxide used for air pollution model has been observed. Not all sulfur dioxide and nitrogen oxides pollution sources and data from these different sources were used in the model. The 2031 and 2041 projections of the report did not show what kind of pollution could be caused by the conversion of ongoing projects to clean technology and the use of modern clean technology in future projects. The government has plans to reduce the amount of sulfur in fuel oil and convert vehicles into electric vehicles in 2031 and 2041. In that case the amount of air pollution i.e. sulfur dioxide and nitrogen oxide will be reduced to a great extent. The use of renewable energy and some of the upcoming projects (that might have negative impact) if not implemented, in such cases the impact of air pollution should have been described in the report. But this issue was not reported. • Contributions to the contamination of sulfur dioxide and nitrogen oxides as a result of the activities of neighboring countries have not been shown and projected. The issue was not even discussed in the report.	The air quality modelling study has been conducted through a sources-oriented approach using an internationally recognised modelling system - Calpuff. The emission inventories were prepared in a standard way for the major sources by the top down procedure. The identification of sources was thorough, but source apportionment was not fully conducted due to the large modelling domain (300 x 300 km) and the high number of emission sources of different types therein (with high share of fugitive and area sources). Calpuff modelling included all the major point, line and area sources of emissions from within the modelling domain to generate the baseline (2019 for SO_2, NO_x, PM_{10} & $PM_{2.5}$). The unaccounted sources (e.g. pollution from outside the modelling domain - both from other parts of Bangladesh and transboundary, fugitive emissions from cooking, construction sites, unpaved roads, wind erosion or vegetation pollen) were included as background concentration (background emissions) during the calibration process (this is standard procedure in air modelling). After the calibration for baseline modelling (2019), the predictions for 2031 and 2041 were calculated. Explanations: 1. Emission inventory never includes all emissions from all emissions sources (fugitive emissions and emission from area sources are hardly measurable and must be estimated, obviously with high uncertainty). Emission inventory also cannot include emission sources from outside the modelling domain. The obvious way to solve this gap is calibration of the model. Available data on emissions from known individual emission sources are collected, concentration field is calculated and compared with the results of real air quality monitoring (measured concentration field). The difference in concentrations is attributed to resting emission sources which are not included individually in the inventory (fugitive and area emissions) but are included into the background emissions which generate background concentration field. 2. After calibration, it is considered that practically all existing emissions sources are covered, some of them explicitly (as individual sources in emission inventory), some of them implicitly (through background emissions and resulting background concentration) 3. The result of modelling is final concentration field which is the sum of background concentration field (generated by sources which cannot be included in the emission inventory) and incremental concentration field generated by sources included in the inventory. 4. The way this was done is described in detail in subchapters 4.1.2 – 4.1.4 5. Transboundary pollution represents a part of the difference between measured and calculated concentrations and was therefore implicitly taken into account during calibration. 6. Emission inventories for the future can only include those existing individual sources whose destiny is known and known future planned individual sources. As a result, a high

Comment	Response
	level of uncertainty must be expected. But this was compensated in background emissions through multiplying factors (1.5 for 2031 and 2.0 for 2041). 7. Certain positive effects of governmental policies were taken into account (e.g. the upgrade of 34 % of brick kilns), but not all (this would require additional studies resulting in some estimates). 8. The intent of the modelling was to describe the more "pessimistic" developments to be able to present a "real situation which will most probably be better" than that the one described in the report 9. The contribution of pollution from transboundary sources is a fact. So excluding transboundary pollution as a hypothetical exercise has no logic.
From Urban Development Department	
• Comments mainly provide a summary of the scope and content of the SEA but without raising any particular issues. • The following recommendations is made: "Since conducting SEA is a new practice process may be developed in Bangladesh, a handbook on SEA monitoring implementation as a strategic decision making tool for assessing and of PPPs.	• No action required • This is a matter for the Department of Environment to pursue.
From Ministry of Water Resources	
The Ministry provided comments, observations and information on a variety of river factors (eg siltation, rivers drying up, identification of various rivers, excavation requirements, protection measures, removal of congestion).	The comments refer mainly to individual rivers or sets of rivers. Their level of detail is not appropriate to the strategic level of an SEA, and would normally be addressed at the level of individual projects.
From Mongla Port Authority	
MPA listed a number of projects it is undertaking that focus on environmental issues.	No action required.
From Ministry of Industries: Maffara Tasnin, Senior Assistant Secretary; 13/09/2021	
Sector-wise STOT analysis is needed in the report	SWOT analysis is not appropriate to the SEA. The aim is to identify environmental and social risks and impacts.
According to findings, for implementation of suggestions, strategic plan and action plans are needed to include in the report.	This is specifically addressed in the SEMP
According to the suggestion of implementation of the report, a draft budget requirement is needed for resource allocation.	Provision for identifying required budget resources is made for each activity in Annex B of the SEMP. This will be finalised on an 'as needed' basis by the proposed SEMP Coordinating Unit during the first few months of SEMP implementation.

Comment	Response
In respect to the regional and international aspect of Bangladesh. a chapter can be included in the report on strategic environmental gap analysis.	It is not clear what 'strategic environmental gap analysis' specifically means. It is not a term or technique routinely used in SEA. Annex 6 is, in effect, a gap analysis, providing an analysis of current PPPs and legal instruments and recommending revisions to address significant environmental issues.
From Power Division, Ministry of Power, Energy and Mineral Resources	
Page xxxvi: Table E.1: List of priority environmental, social and economic issues (Industrialisation): Should include power transmission and distribution system	Table E.1 lists the major issues identified by stakeholders and experts which was used to focus the SEA. It is not appropriate to alter this table at this end-point in the SEA process. But the issues concerned with distribution of energy are discussed in the scoping report and in Chapter
Page xxxvi: Table E.5: Principal development activities for key sectors. It is suggested to change: • 'rapidly expanding industrialisation' to rapidly expanding industrialisation in an efficient way' • 'New or upgrading of powerplants and transmission lines' to 'new or upgradation of power plants, transmission and distribution systems'. • Technology investment for increased energy efficiency' to technology investment for increasing energy efficiency'	 • Accepted. Text of Table amended accordingly • Accepted. Text of table amended accordingly • This change means exactly the same thing. No change necessary
Page 14. Section 2.4 heading: should be edited to read 'December 2020 - February 202'1	This error has been corrected.
Section 3.2.9: Industries, power and energy (part of 2nd para). Should be amended to read: "At present, four new fossil fuel-fired power plants, with a total installed capacity of 2550 MW, are being constructed: one (Rampal) is a coal-fired plant (1320 MW), one is a heavy fuel oil-fired plant (100 MW), and two are natural gas/high-speed diesel plants (BPDB: 330 MW; and NWPGCL: 800 MW) in association with renewable projects"	The text has been amended accordingly.
Section 3.4.4: Activities in neighbouring regions of Bangladesh. It is suggested to bullet on Payra Power Plant to read: "1320 MW coal-fired power station in Kalapara Upazila of Patuakhali District in southern Bangladesh."	The text has been amended accordingly.
Box 5.2: High growth scenario, section on power and energy. • Second bullet: delete 'zero carbon' • Sixth bullet: Delete 'completed expansion of power grid network' and replace with 'Strengthening and enhancement of power grid network. • Seventh bullet: after 'conversion to renewable energy', add "as per the Renewable Energy Policy of Bangladesh – 2008"	 • Accepted. Text has been amended • Accepted. Text has been amended • Accepted. Text has been amended

Comment	Response
Box 5.3: Medium growth scenario: section on power and energy • Second bullet: Change LPG to LNG	Agreed
Table 5.1: Growth scenarios compared: • Section on power grid connection, high growth column – proposed to change from completion to 'strengthening and enhancing"	Agreed. Text amended
Chapter 10: Conclusions and recommendations, section 10.4: Power generation: • Para 1: suggested to delete 'clean power imports by 2041 (current level is 3%)' and replace with 'power imports by 2041 (current level is 7%) • Para 2: It is suggested to replace the text with the following which included updated data "Bangladesh's total installed electricity generation capacity (including captive power) is 25,235 MW in August 2021. Total installed capacity of combustion power plants without captive power, renewable and imported power was 20,512 MW, of which gas-based plants accounted for 52%, whilst HSD- and HFO-based plants accounted for 32%, and coal-based plants accounted for 8%. The power sector has one national grid with an installed capacity of 52,679 MVA (42,143 MW) in August 2021. 99.5% of the population had access to electricity in August 2021. The gas distribution network is not sufficient and a part of the gas supply to final consumers is being provided through liquefied petroleum gas (LPG), compressed natural gas (CNG) and liquefied natural gas (LNG). Both power and gas distribution networks are being extended and/or reconstructed. By 2025, 2400 MW will be added from a nuclear power plant. Moreover, additional capacity (around 3000 MW) is expected by 2030 using non-combustion renewables (solar, wind)." • Para 3: suggested edits to read as follows: "The planned energy mix in Bangladesh includes natural gas, LNG, coal, renewables and nuclear energy, taking into account that known reserves of natural gas are expected to cover the growing demand for the next 10–12 years." • Para 4: suggested edits to read as follows: "Four new fossil fuel-fired power plants (total installed capacity 2550 MW) are being constructed in the SW region: one is the 1320 MW coal-fired Rampal Power Plant, one is a heavy fuel oil (HFO)-fired plant (IPP: 100 MW) and two are natural gas/ high-speed diesel (HSD)-fired plants (BPDB: 330 MW, and NWPGCL: 800 MW)." • Para 6: suggested edits to read as follows: "A framework for renewable energy production is required and should be integrated with future energy demand. The government has taken an initiative to review and update the renewable Energy Policy of Bangladesh, 2008, to address present	• Accepted. Text amended accordingly • Suggestions accepted • Suggestions accepted • Suggestions accepted • Suggestions accepted

Comment	Response
scenarios. Also, steps have been taken to prepare a Solar Roadmap to implement solar-based power generation units in the country.	
From Professor Rezaur Rahman, Institute of Water and Flood Management Bangladesh University of Engineering and Technology (BUET)	
• Sundarbans is being repeatedly damaged by frequent cyclones. It needs a recovery strategy based on past experiences. Such a strategy needs to be aligned with the SEA findings and future threats of sea level rise and increased cyclonic activities due to climate change.	• Cyclones are a natural phenomenon. Nevertheless, efforts are needed to ensure that the Sundarbans can continue to provide buffering against the effects of cyclones. Hopefully the SEA will provide an input to a strategy for this purpose.
• It will be impossible to preserve the OUV of Sundarbans without adequate freshwater supply from upstream. Prime ministers of India and Bangladesh signed an MoU in 2011 recognizing Sundarbans as a unitary ecosystem. Accordingly, India can be expected to assign and release Ganges water for sustenance of Bangladesh part of Sundarbans. The report needs to strongly recommend that Bangladesh assess and demand this water for Sundarbans during the upcoming renegotiation of GWT in 2026/27 and also raise this important aspect with UNESCO during this SEA study so that they can help in GWT for sustenance of the Sundarbans.	• The SEA recognises the importance of enhanced freshwater flows to the SW region and Sundarbans and recommends implementation of appropriate measures in this regard.
• Different economic growth scenarios have been considered and the impact of such scenarios on Sundarbans have been depicted. However, the climate change scenario superimposed on the economic growth may severely compromise the OUVs of the Sundarbans. This has not been attempted in this study. A management plan for such imminent threat will be helpful.	• The SEA discussed in chapter 5 how the economic growth scenarios were developed, including the influence on these of drivers of change and uncertainties including climate change. Section 5.2.1 indicates that climate changes will unfold in the same way under all three economic scenarios, refers to the predictions and conclusions of Intergovernmental Panel on Climate Change (IPCC).Detailed discussion of current climate data, trends and studies of future climate change in Bangladesh (including their potential impacts) are presented in Section 3.3.6 of the Final Scoping Report (January 2021).
From Professor Dr. Mohammad Zashim Uddin Department of Botany, University of Dhaka	
I have gone through it and found it perfect. Please present it. I think there are no anomalies in the report.	Thankyou. This comment is much appreciated.
From Dr Mashura Shammi, Associate Professor, Department of Environmental Sciences Jahangirnagar University	
General comments • It's a good milestone reached that both SEA and SEMP is done by CEGIS+foreign consultation team.	• Thankyou

Comment	Response
• However, 400 pages of SEA is a weakness or a major limitation of any SEA and SEMP. What messages are the decision-makers going to receive from it? The report would not help them to get any guidelines. In fact, the message would be lost in translation. • The report has become an enlarged version of EIA/EMP more or less since there was no SEA principle found in it and working methodology was close to EMP. • For the decision-maker a shorter version can be provided	• This is one of the most complex SEAs ever undertaken in the world (89 PPPs covered). The SEA Report is the technical presentation of the process, methods, analyses, outcomes and conclusions. It provides the basis for the SEMP and is essential for those who will implement it. Unfortunately, it is therefore long, the team does not agree that this is a weakness. It cannot be avoided and cannot be condensed to reduce its length without cutting essential material and 'dumbing it down'. However, there is an Executive Summary, aimed at decision-makers, which describes the essential elements of the report and main conclusions. Consideration is also being given to issuing a shorter condensed version for lay readers who may not need or be interested in technical details. The report is not designed nor intended to provide guidelines. It is an assessment of potential impacts • The team also disagrees that the SEA is an enlarged version of EIA/EMP. It points out how EIA and SEA are very different processes and serve different purposes. The methodology is entirely different to that which would routinely be followed by an EIA. The report is not intended to be an academic text book and thus we did not include extra material of this nature (such as principles). The latter are referenced and can readily be looked up by interested individuals. Further, if extra material of this nature were to be added, it would increase the length of the document which has been criticised as a problem.
Introduction • Figure 1.1: The SEA Area of Focus, World Heritage Sites and Protected Areas. The map area (ECA which was left out from the SW region) should have been revised according to the inception workshop comments with the reviewer. Unfortunately, even after mid-term report it was not revised. And even in the Final report, it still was not changed. If the reviewers' comments are not addressed, what are the needs for sending comments? • Section "1.3 The SEA Study Area" should explain why it excluded part of ECA. • On which SEA principle is the SEA being carried out? A section can be provided here • A section can explain why it is essential for this region and other long-term perspective plans of government such as 2041 and Delta plan 2100, how these plans are aligned with this specific SEA for this region. • Similarly, it should also explain a section on the limitation of the SEA report.	• The Study Area for the SEA under the TOR is Bangladesh SW hydrological region. The SEA has addressed the impacts arising in and on this region - including from other areas in Bangladesh (including the part of the ECA lying beyond the SW hydrological region) and other countries. Figure 1.1 does show the ECA extending into the adjacent region. • The SEA has followed all of the 17 basic principles for SEA set out in section 4.1 of the OECD DAC Guidelines for SEA which is referenced in the SEA report. A new Annex 11 is added presenting these principles. • The rational for the SEA is set out in section 1.2 which provides the objectives set by the TOR. It addresses the impacts of development over the next 20 years in the SW region. It is not the aim or purpose of the SEA to be 'aligned' with the Delta Plan or other plans/programmes. It aims to assess their potential impacts. The second Perspectives Plan covers sectoral development for 2021-2041 (and is aligned with the Delta Plan. Both the Second. Both were reviewed and assessed along with 87 other PPPs during the screening phase and reported in the Mid-Term Screening Report (September 2020), Plus, recommendations are made in Annex regarding how all 89 PPPs and associated legal instruments need to be revised in order to address issue identified by the SEA.

Comment	Response
	• A new Section1.4 sets out the limitations of the SEA.
Chapter 2: Methodology • Figure 2.1: Steps in the SEA Process (methodology) should contain a step for selecting alternatives which is a significant part of SEA process. Here high growth scenario was used for alternative. • Section 2.4.3 Environmental modelling can be discussed here. o Air quality modelling method of model preparation, performance, calibration, data collection can be discussed here. Model results can be discussed in Chapter 3 o Section 4.2 Water quality modelling, model parameters can be mentioned in the method. Results can be mentioned in Chapter 4	• Selecting alternatives is part of the scoping step and is addressed in section 2.3.10. A separate step is not required. Three alternatives were selected (high, medium and low growth), not just high growth. • Section 2.4.3 is merely a reference point for modelling. The approach followed is described in Chapter 4. This is our preference because the methodology needs to sit alongside the results to make them understandable.
Chapter 4: Water quality • Considering salinity, BOD, NO3 and PO4 are significant parameters that have been covered here. However, some significant but foreseeable pollution such as oil pollution, hydrocarbon pollution etc. was not discussed. This part should be taken into consideration. Already comments were given in the online meeting. • Since a significant growth of industries will be developed in high growth scenario chemical oxygen demand (COD) should have been considered here for WQM. • Possible changes in organic carbon biogeochemistry of river systems were not considered. Dissolved Organic carbon (DOC) and Dissolved organic matter (DOM) are significant carbon sink in the soil and river water of Sundarbans that controls the ecosystem. It should be taken into consideration, at least from the secondary literature.	• The recommendations have been modified to include monitoring these factors • The recommendations have been modified to include monitoring these factors. • The recommendations have been modified to include monitoring these factors. • The team is content with the modelling as it stands.
Chapter 9: Cumulative impacts of high growth scenario • The cumulative impacts described in Figure 9.6: Power and energy: Technology investment for increased energy efficiency and Figure 9.7: Forestry: Conservation of Sundarbans forests are in conflict with each other. The report mentioned "Negative: Economic costs, negative health impacts, loss of biodiversity through habitat conversion, climate change, pollution and fatalities" for Fig. 9.6 while on Fig. 9.7 None significant. As a reviewer I find it contradictory. The same goes with Fig. 9.9. The description is self-contradictory. The team should explain on what basis there was no significant effect while the figure is showing significant negative linkages.	• Each linkage diagram is constructed as part of the analysis for that sector. The idea is not to try and match the various linkage diagrams against each other. There is no intention to try and achieve "consistency" between linkage diagrams because each one is specific to its own sector and the linkages are informed by an analysis of the dynamics of that sector and its impacts on coupled social-ecological-economic systems. There is considerable complexity in these interrelationships. So each diagram is "stand-alone" in that sense.
Chapter 10: Conclusions and recommendations • Page 181: "The construction of new coal- and gas-fired power plants will lead to a high increase in emissions of carbon dioxide (CO2) and to a moderate increase in	• This suggestion has been included in section 10.4.

Comment	Response
emissions of nitrogen oxides (NOx); and, in the case of coal, also to moderate emissions of dust (PM2.5 and PM10) and sulphur dioxide (SO2), and to the generation of large volumes of solid waste." The SEA report could suggest renewable energies here. GoB already has policies. Section 10.18: it was good suggestion to formalize SEA by DoE'.	
• Section "10.21 Review and revision of existing legal instruments, policies, plans and programmes" can be a sub-section of 10.18 Initial methodology contained DPSIR framework. The responses could have been suggested in the conclusion in line with the framework.	• We prefer to keep section 10.21 as a stand-alone subsection. The team does not see the logic of incorporating this text in section 10.18. It is not clear what this comment refers to. There are no 'responses' discussed in section 10.21. It introduces Annex 6 which provides a range of recommendations for the possible revision or modification of all of the 89 PPPs and associated legal instruments considered by the SEA.
National Committee for Saving the Sundarbans	
• The Draft SEA appears intent on promoting existing industrial plans and projects as the way to achieve high growth—which it claims is the only scenario that will improve conservation of the Sundarbans	• The SEA does not promote anything. It assesses the risk of impacts from developments in the SW region. It does not claim that high growth will improve conservation of the Sundarbans.
• NCSS has long argued that in order to protect the Outstanding Universal Value of the Sundarbans, we need stronger mechanisms to ensure the free, prior, and informed consent to protect local and indigenous communities from displacement and injustice. We need stronger commitment to the precautionary principle, and the principles of sustainable development, which include identifying and assessing alternatives. Finally, we need stronger legal mechanisms to prevent, identify and halt polluting industries, and hold them accountable. While the Draft SEA mentions some of these principles, it ignores how the pursuit of high growth can undermine or negate these principles entirely.	• The SEA does address the issues mentioned. It is not high growth *pers se* that would undermine the principles, but how it is managed, and the actions of government, companies, communities and individuals. The SEMP proposed a mechanism to manage risks and impacts.
• SW Bangladesh is threatened with many challenges, as identified in the SEA documents. However, insufficient attention has been paid to the land grabbing for industrial projects that displace local communities; use resources beyond sustainable levels; pollute air, water, soil and food; and degrade wildlife habitat. The proposed energy projects and associated infrastructure, including the Rampal, Barisal, Payra and Patuakhali coal and gas plants, will be the most polluting of the proposed industries, and threaten the OUV of the Sundarbans. These industries are the reason the World Heritage Committee has called for the SEA prior to projects moving forward.	• The team believes that the key issues mentioned have been addressed in appropriate detail consistent with a broad strategic assessment which covered 89 PPPs and over 30 sectors and key themes. The SEMP has recommended measures to address them. It is at the level of individual projects that more specific risks and impacts should be identified through EIAs and appropriate mitigation measures set out (in EMPs).
• The Draft SEA aims to address "policies, plans and programs" but states it will not address the "individual projects" that triggered the World Heritage Committee's request for SEA. The IUCN World Heritage Advice Note on Environmental Assessment defines SEA as "applying to policies, plans and programmes (i.e. multiple or very large projects)". We argue that SEA is indeed expected to assess multiple or very large projects, and not dismiss them as beyond its mandate. We	• The TOR require a strategic assessment covering PPPs of nine key sectors. In the event, the SEA was expanded to address 89 PPPs. Given the huge scope of this particular SEA, it was definitely not its purpose (not would it have been possible) to assess individual (even large) projects. It is not the aim of SEA to perform a function of 'court of last resort' and pass judgement on whether they should proceed or not. An SEA provides information to government at a strategic level to enable broad-based policy matters to be better considered and more informed decisions to be taken, We believe the SEA fully sets out the

Comment	Response
argue that the continued construction of the coal plants and their associated dredging, shipping and waste disposal are such "multiple or very large projects". The energy infrastructure plan for southwestern Bangladesh has potential to harm the OUV of the Sundarbans. Both the plan and the individual projects must be assessed cumulatively in the SEA. This must occur before the Environmental Impact Assessments of these projects can be done—or redone—with scientific integrity, data transparency, public consultation, and assessment of alternatives. Until that happens, none of the projects should move forward. • The Draft SEA, with its promotion of the highest possible level of industrial development for the region, fails to provide sufficient science and data to endorse the planned energy projects from moving forward. The Draft SEA effectively gives a green light to moving forward with nearly every possible industrial project.	risk of unfettered industrial and energy development and makes recommendations in the SEMP for their management and mitigation. • We do not accept the notion that the SEA promotes high industrial development. Rather it clearly identifies the risk of such development. As indicated above, it is not the purpose of SEA to prevent individual projects from proceeding.
• The boundary of the assessed area in the Draft SEA appears designed to evade assessment of industries east of the Sundarbans. The final SEA must also assess development and consult stakeholders in what the SEA labels "South Central" Bangladesh. • The SW region should be determined based on the hydrological, meteorological, and ecological characteristics of the region, not an arbitrary political boundary. It should include all land and rivers from the right bank of the Ganges/Padma/Meghna rivers, which carry water, sediment, and pollutants from the Himalayas to the Bay of Bengal. Where the Meghna river meets the Bay of Bengal, the current turns west towards the Sundarbans for several months of the year, bringing pollutants into the Sundarbans. • The IUCN World Heritage Advice Note: Environmental Assessment (2013) states that projects located outside World Heritage site boundaries should also be assessed • The April 2020 Prospectus of the SEA appeared to agree with this, stating: "Impacts arising across the SW Region will be assessed as well as those that impact upon the outstanding universal value (OUV) of the Sundarbans, including those that are transboundary in nature (ie arising across regional boundaries within Bangladesh and across international boundaries)." However, the Draft SEA failed to assess the transboundary impacts of industrial projects across regional boundaries within Bangladesh. (See, e.g., Figure 4.3 showing major air polluting industries, with no industries outside the assessment boundary.)	• We do not accept the notion that the SEA has set out to 'evade' anything or anybody. It has been as inclusive and participatory as possible within the restrictions imposed by COVID-19. The SEA has been conducted according to its TOR which set the area of study as the SW hydrological region. But section 3.4 covers transboundary issues - from other countries as well as from neighbouring regions of Bangladesh. • The SEA has been conducted to comply with the TOR. • Projects should be subjected to EIAs. It is not the function of SEA to do this. • Section 3.4 addresses transboundary issues. The impacts of transboundary industrial developments have been factored into the modelling of air and water quality.

Comment	Response
• The Draft SEA map of the assessed area shows a boundary that cuts off the Ecological Critical Area of the Sundarbans on the eastern border of the Sundarbans Reserve Forest. We argue that the final SEA must assess impacts of projects and consult stakeholders in what the SEA map below labels "South Central" Bangladesh.	• The Study Area for the SEA under the TOR is Bangladesh SW hydrological region. The SEA has addressed the impacts arising in and on this region - including from other areas in Bangladesh (including the part of the ECA lying beyond the SW hydrological region) and other countries.
• The following projects must be included in the cumulative assessments of the final SEA: 1. The SEA failed to assess pollution from the 300 MW Barisal coal plant, just 20km from the Sundarbans. (And we note this project is moving ahead without an EIA or environmental permit publicly available.) 2. The SEA failed to assess pollution from the Payra coal plant and deep seaport, less than 50 km from Sundarbans. 3. The SEA failed to assess pollution from the three proposed Patuakhali coal plants totaling 3690 MW, less than 50 km from Sundarbans. 4. The SEA failed to assess pollution from the newly announced 3600 MW LNG power plant at Payra.	• These projects have been factored into the modelling of air and water quality.
The Draft SEA air pollution modeling does not meet standards for scientific integrity or transparency	
• The Draft SEA fails to cite all sources of data or ensure that sources are publicly available. For example, the Draft SEA uses emissions rates for the Rampal power plant from uncited "design specifications" that are significantly less than emissions rates in the project EIA or tender documents. The tender documents appear to allow 633 g/s of NOx, roughly twice the rate of 328 g/s stated in the Draft SEA. (We also note that the Rampal project's EIA and tender documents with design specifications are no longer available on the project website).	• The Maitree Super Thermal Power Plant (Rampal) includes stringent initiatives to reduce the concentration of air pollutants emitted from the stacks and maintain World Bank standards (IFC emission standards for thermal power plant, 2007) rather than the previous DOE standards (ECR, 1997). The maximum emission rate of the criteria pollutants at the stack outlet will be: 50mg/Nm^3 for PM, 200mg/Nm^3 for SO_2, and 510mg/Nm^3 for NO_2 - as specified in the tender document. However, the project design documents state that actual emissions of air pollutants from Rampal power plant are expected to be lower than the emission rate predicted by the EIA.
• The Draft SEA states that "Available data indicates that additional air pollution by dust, SO2 and NOx from the Rampal power plant is not expected to have a high impact on the Sundarbans as this plant is being equipped with modern emission reduction technologies." However, it also recommends that PM and NOx be better controlled in the Khulna-Mongla area. The Rampal plant lacks technologies that have long been standard practice in China and India, including Selective Catalytic Reduction (SCR) to reduce NOx and Fabric Filters (FF) to reduce fine particulates (PM2.5). It is well established that the planned technologies of advanced low NOx burners and electrostatic precipitator (ESP) are not as effective at controlling emissions as SCR and FF.	• We agree that PM and NOx should be better controlled in the Khulna-Mongla area and the SEA make such a recommendation. According to experience from several European countries, electrostatic precipitators are able to achieve concentrations of dust below 10 mg/m3; and low NOx burner, in combination with combustion process optimisation, can achieve concentrations of NOx below 180 mg/m3. These values are not far from the EU emission levels associated with BAT. Of course, both fabric filter and SCR would lead to better results but the question is how to convince investors to accept the additional costs if current technologies are sufficient to comply with national emission standards.
• The plant also lacks best available technology of activated carbon injection to reduce mercury. It is disingenuous to pretend that mercury is well controlled by flue gas desulphurization and ESP—together those technologies reduce mercury emissions	• Appropriate technology to reduce mercury emissions depends on the type of coal and on the use of pollution control technologies. In the case of the Rampal Power Plant, 67% of mercury from flue gas is reduced through the combined operation of FGD and ESP. A recommendation has been added to select and introduce relevant technology.

Comment	Response
from coal fired power plants by only 60%. When SCR, FF and Activated Carbon Injection are added, airborne mercury can be reduced by 99%. • The greenhouse gas emissions of the Rampal plant are also not best practice for climate-- the plant boilers are not ultra-supercritical (highest efficiency), and the plant will not capture its carbon emissions. • The same technologies are planned at the coal plants at Barisal, Payra, and Patuakhali, and will pollute the air that reaches into the Sundarbans • The SEA must publish individual and cumulative air pollution dispersion maps to show affected areas and concentrations by pollutant, including PM2.5, SO2, NOx, acid, airborne fly ash, and mercury. It must also recommend truly state of the art air pollution control technologies for each pollutant type, and model how these technologies would reduce air emissions and impacts to public health in the South West Region as well as the main population center of Dhaka. • The Centre for Research on Energy and Clean Air (CREA) modelled the air pollutant and dispersion plumes from coal plants planned and under construction in Bangladesh. Its maps showing the pollutant loads to the Sundarbans and its catchment are provided below [in this commentator's submission] to show cumulative impacts. The final SEA should include such cumulative analyses.	• Recommendations to increase efficiency of energy production (and also consumption) are made several times in the SEA report. • See comment above • Cumulative dispersion maps are presented in Figures 4.8 to 4.11 for PM2.5, PM10, SO2 and NOx. Mercury cannot be modelled as there are limited emission data and no data on concentrations in ambient air which could enable model calibration. Technology assessment is beyond the scope of SEA report. Pollution control is based on legally binding parameters (air quality standards, emission limit values) while the choice of technology to achieve compliance with these binding parameters is in the hands of operator of polluting installation. Modelling of health and environmental impacts is possible but goes beyond the scope of the SEA report. Reference is made in the SEA report to the IIASA GAINS model results available for Bangladesh. • Cumulative dispersion maps are presented in Figures 4.8 to 4.11 for PM2.5, PM10, SO2 and NOx. They are based on the data on emissions from more than one thousand individual emission sources. Emissions from sources for which emission data is not available (fugitive emissions, sources outside the modelling area including transboundary pollution) are covered by "background concentration". For the baseline year (2019), background concentration (caused by background emissions) was assessed through model calibration. For future years, coefficients higher than one were used to "catch" additional emissions which are not known now (1.5 for 2021 and 2.0 for 2041).
The Draft SEA fails to assess the risks of coal ash disposal in the region. • The Draft SEA admits that coal ash "may contain mercury, lead, cadmium, toxic heavy metals, arsenic, and other harmful elements and compounds. The substances are particularly harmful to human health and can also pollute surface water, fish habitats (depleting fish diversity) and lead to consumption of fish containing levels of these substances which are dangerous for humans." • However, the Draft SEA fails to provide any evidence that creating 100+ acre ash ponds next to the Passur, Payra and Galachipa Rivers will not risk heavy metal contamination of water and aquatic food chains of the Sundarbans. These ash ponds can overflow or send large volumes of stormwater into waterways during storm surges or cyclones. They can also leach toxins into waterways through the eventual cracks in concrete walls and liners. Project proponents claim that high concentration	• Comment accepted: A recommendation on ash disposal and treatment has been be added to section 10.4. • A recommendation on ash disposal and treatment has been be added to section 10.4.

Comment	Response
ash slurry dries to create an inert, hard surface. Such claims were shattered in 2017 when type of ash system collapsed in Katikela, India, sending millions of tons of ash slurry over farmlands and into a river. • The SEA must independently assess market demand and likely reuse rates of coal ash in cement for the region. We note that encapsulation in cement is the only re-use of coal ash with low environmental and public health risks. Unencapsulated coal ash should be disposed of in engineered, dry, lined landfills with continuous water monitoring and treatment. We note with concern that the Rampal project website continues has been reissuing the tender for the use of fly ash between August and October 2021. With the Payra coal plant already generating ash, demand for coal ash in Bangladesh's cement industries may already be met. We also note with alarm that higherash coal from India has been shipped to the Rampal plant, when the plant was not designed to handle high ash coals. • The SEA must recommend ecologically protective safeguards for coal ash disposal in the region. We urge the SEA team to review independent science and recommendations on coal ash disposal, including the U.S. EPA's Human and Ecological Risk Assessment of Coal Combustion Wastes (2014), the US EPA's Final Coal Ash Rule (2015), the US EPA's Final Rule on Steam Power Generating Effluent Guidelines (2015), and the US EPA's Leaching Environmental Assessment Framework (LEAF) How-To Guide (2019). These studies and regulations make clear that leachate from coal ash, in fluctuating environmental conditions, poses a serious risk to downstream aquatic ecosystems and the people who eat organisms from these ecosystems. The policies for coal ash disposal in Bangladesh could have major impact on the OUV of the Sundarbans	• The role of SEA is not to assess market demands for particular commodities • A recommendation on ash disposal and treatment has been added to section 10.4. • The SEA was not able to undertake new research. It had to rely on available published information. • Comment accepted: A recommendation on ash disposal and treatment has been added to section 10.4. However, the role of SEA is not to propose concrete technologies.
The SEA must seriously assess and give detailed recommendations on clean and renewable energy alternatives for the region • The Draft SEA appears to take for granted that 3480 MW of new coal plants will be built by 2024. It appears to cave to the fossil fuel lobby that insists imported coal or domestic or imported gas is required for energy security and economic growth. • The SEA ignores the risk that all new gas and coal plants are likely to become stranded assets within the decade. This can become an economic drag as Bangladesh energy users will pay more for fossil fuel energy compared to solar, wind, or geothermal energy. • The SEA must assess the potential for, and costs of, non-fossil fuel-based energy in the region. This would enable the SEA to comply with World Heritage Operational Guideline 118bis wherein assessments, including SEAs, "identify development alternatives" and "recommend mitigation measures against degradation or other	• The SEA presents actual openly available data • It is not the role of SEA to assess the risk of investments. • The SEA has addressed alternatives in the form of growth scenarios which are appropriate to the high level and complexity of the SEA (covering 89 PPPs and 30 sectors and key themes). The expanded use of renewable energy is recommended several times throughout the document as well as the need to increase energy efficiency.

Comment	Response
negative impacts on the cultural or natural heritage within the property or its wider setting.	
• Public participation in the SEA process to date has been wholly insufficient.	• The SEA report states clearly that the extent of stakeholder engagement has been less satisfactory than was planned in the Inception Report. But this has been beyond the control of the team which has had to operate within restrictions demanding by COVID-19 safety.
• The SEA must provide many more consultations with affected communities, including women, as promised in the Prospectus. It appears that roughly 100 resource users were consulted in 10 focus group discussions in October 2020. It is unclear how these consultations were advertised or convened. Only two discussion groups were held for women, with a total of 19 participants, despite the Final Scoping Report noting that women are a key stakeholder group. Rather than finalizing the SEA without sufficient public participation, the SEA process must take the needed time to do so.	• 67 consultations have been completed with about 1200 experts from university professionals, NGOs, INGOs, UP-Zilla members, forest resources collectors, forest users, Upazilla Chairman, District level administrations, law enforcement and government agencies, elected representatives, and the media.
• Stakeholders that have been publicly critical of projects around the Sundarbans, including NCSS, were not informed of any stakeholder consultations, despite this being promised by the Additional Secretary to the Ministry of Environment, Forests and Climate Change during an IUCN Webinar presided over by the Chair of Bangladesh IUCN in 2020.	• All the documents have been available on the SEA website for all stakeholders to access and comment on. Responses have been received from different types of stakeholders including NCSS. A full account of all consultations, comments and responses is available in the Record of Stakeholder Consultations available on the website.
• Local and indigenous communities must receive meaningful data in their own language. Because of low levels of literacy in some communities, these mediums should include presentations with understandable infographics and open question and answer sessions. All SEA documents should be made available in Bangla before additional stakeholder consultations are held. Currently, only the Prospectus has been translated into Bangla, and yet it is not available on the website.	• The SEA report is long and technical and it is doubtful that it will be understandable to all people. But we agree that a Bangla version of the Executive Summary would be helpful, and perhaps presented in lay terms. The government will need to consider taking this step once the reports have been formally approved.
• Standards of stakeholder consultation for free, prior and informed consent of indigenous communities must be upheld in this process. There are many indigenous communities around the Sundarbans who hold customary land and resource use rights. They have not been adequately consulted and have not given their consent for the policies, programs, plans assessed in the SEA.	• All level stakeholder's consultation including local community, resource user, district and upazila level people were informed for free and prior consultation. However, due to the COVID situation and restrictions, all planned consultations were not possible. Even so, all issues and concerns raised have been addressed in the report.
• NCSS calls upon Integra and CEGIS to extend the public comment period on the Updated Final Draft SEA and Updated Final Draft Strategic Environmental Management Plan to allow for thorough open communication on the issues raised in this letter.	• The SEA team has sought and welcomed discussion throughout the SEA process, and has accepted advice to make the report acceptable at all levels. The contract for the SEA terminates on 15 December 2021. Unfortunately, it will not be possible for Integra or its international experts to continue beyond this date. The final reports will need to submitted to government within this timeframe. It is a matter for the government to consider if it wishes to engage in an extended period for public consultation on the findings of the SEA.

Annex 11: Principles of SEA

OECD DAC SEA principles

The following principles for SEA are given in the SEA Guidelines prepared by the Organisation for Economic Cooperation and Development (OOECD DAC 2006) which have been followed as a requirement of the Terms of Reference of this SEA.

To be influential and help improve policy-making, planning and decision-taking, an SEA should:

- Establish clear goals;
- Be integrated with existing policy and planning structures;
- Be flexible, iterative and customised to context;
- Analyse the potential effects and risks of the proposed PPP, and its alternatives, against a framework of sustainability objectives, principles and criteria;
- Provide explicit justification for the selection of preferred options and for the acceptance of significant trade-offs;
- Identify environmental and other opportunities and constraints;
- Address the linkages and trade-offs between environmental, social and economic considerations;
- Involve key stakeholders and encourage public involvement;
- Include an effective, preferably independent, quality assurance system;
- Be transparent throughout the process, and communicate the results;
- Be cost-effective;
- Encourage formal reviews of the SEA process after completion, and monitor PPP outputs;
- Build capacity for both undertaking and using SEA.

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SEA princplies in the literature

For comparison, the following principles derived from international literature are provided in Dalal-Clayton and Sadler (2005).

***(A) General*:** An SEA process should:

- fit the purpose and be customised for application at the policy level or at the level of plans and programmes;
- have integrity, so that it is applied in accordance with the objectives and provisions established for it; and be effective in meeting those objectives;
- be focused on delivering information necessary to the decisions to be made, and address the significant and key issues;
- be driven by sustainable development principles (taking into account environmental, social and economic considerations); and therefore
- be integrated with parallel analyses of economic and social dimensions and issues, and with other planning and assessment instruments and processes;
- relate to project EIA where appropriate – perhaps through tiering mechanisms;
- be transparent and open;
- be practical, easy to implement, oriented to problem-solving, and cost-effective;

- introduce new perspectives and creativity (it should "provide bonuses, not be a burden"); and
- be a learning process (thus it is essential to start 'doing SEA' to gain experience).

(B) SEA Steps: An SEA process should ensure that:

- *screening*: responsible agencies carry out an appropriate assessment of all strategic decisions with significant environmental consequences;
- *timing*: results of the assessment are available sufficiently early for use in the preparation of the strategic decision;
- *environmental scoping*: all relevant information is provided to judge whether: (i) an initiative should proceed; and (ii) objectives could be achieved in a more environmentally friendly way (i.e. through alternative initiatives or approaches);
- *other factors*: sufficient information is available on other factors, including socio-economic considerations, either parallel to or integrated in the assessment;
- *review*: the quality of the process and information is safeguarded by an effective review mechanism;
- *participation*: sufficient information on the views of all legitimate stakeholders (including the public affected) is available early enough to be used effectively in the preparation of the strategic decision;
- *documentation*: results are identifiable, understandable and available to all parties affected by the decision;
- *decision-making and accountability*: it is clear to all stakeholders and all parties affected how the results were taken into account in decision-making; and
- *post-decision*: sufficient information on the actual impacts of implementing the decision is gained to judge whether the decision should be amended.

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<u>UNESCO World Heritage Impact Assessment Principles</u>

The SEA has also taken account of the eight UNESCO World Heritage Impact Assessment Principles:

Principle 1: All proposals that may adversely affect a natural World Heritage Site must undergo a rigorous Environmental Assessment early on in the decision-making process, whether they are located within or outside its boundaries. This assessment should take place as early as possible in order to provide timely and effective input to decision-makers. Assessments that take place late in the decision-making process or after the decision has been made cannot adequately inform decision-makers.

Principle 2: Experts with World Heritage, protected area and biodiversity knowledge must be closely involved in the assessment process in order to identify the issues that will need to be assessed. These experts can also work together with developers and engineers to find alternative solutions to proposals that may adversely affect a World Heritage Site's Outstanding Universal Value.

Principle 3: The likely environmental and social impacts of the development proposal on the site's Outstanding Universal Value must be assessed, including direct, indirect and cumulative effects. This assessment should consider the site's values, integrity and protection and management, as well as its connection to the wider landscape, and should be based on adequate information and data.

Principle 4: Reasonable alternatives to the proposal must be identified and assessed with the aim of recommending the most sustainable option to decision-makers. The different options should be clearly communicated to decision-makers, and those that are least damaging in relation to the site's Outstanding Universal Value should be highlighted, including in some cases the 'no project' option. Very often, economically viable and feasible alternatives can be found to development proposals that may be damaging

to a World Heritage Site's Outstanding Universal Value. A detailed and early consideration of alternatives can also help to ensure that resources are not wasted in developing proposals that are incompatible with World Heritage status (for example extractive projects).

Principle 5: Mitigation measures should be identified in line with the mitigation hierarchy, which requires first avoiding potential negative impacts and secondly reducing unavoidable residual impacts through mitigation measures. The Environmental Assessment should outline how any minor residual negative impacts on Outstanding Universal Value that cannot be avoided will be mitigated and monitored through a budgeted Environmental Management Plan, indicating how the mitigation measures will be implemented, who will implement them within what timeframe, and what resources are secured for their implementation.

Principle 6: A separate chapter on World Heritage must be included in the Environmental Assessment. This chapter should present clear conclusions to decision-makers on the proposal's potential impacts on a site's Outstanding Universal Value, and should be reflected in the Executive Summary.

Principle 7: The assessment must be publically disclosed and subject to thorough public consultation at different stages. Consultation should take place at the scoping, draft Environmental Report, and monitoring report stages. All relevant stakeholders should be involved, including local communities, indigenous peoples, scientists, relevant government agencies, and non-governmental organizations. Feedback from consultation should be fully reflected and documented in the assessment.

Principle 8: An Environmental Management Plan must be proposed, implemented and independently audited. The plan should detail operating, monitoring and restoration conditions in relation to the site's Outstanding Universal Value. The developer must set aside funds from the outset to cover the costs of independent auditing of the implementation of the Environmental Management Plan at regular intervals.

Annex 12: Location of Dhaka City in Bangladesh