Ministry of Environment, Forest and Climate Change



Responses to Third Party's Positions 2023:

Assessment of Industrial Development and Large Infrastructure Activities in Southwest Bangladesh near the Sundarbans World Heritage Site by National Committee for Saving the Sundarbans of 15 April 2023

June 2023

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Prime Minister Sheikh Hasina of Bangladesh has been announced as one of the winners of the United Nations Champions of the Earth award in recognition of her country's initiatives to address climate change.



The UN-sponsored Sustainable Development Solutions Network (SDSN) has awarded Prime Minister Sheikh Hasina with “SDG Progress Award” for Bangladesh’s steady course in responding to the universal call to action to end poverty, protect the planet and ensure peace and prosperity for all.

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Executive Summary

This document presents the State Party's responses to the Third Party's remarks and observations regarding the Assessment of Industrial Development and Large Infrastructural Activities in the vicinity of OUV of the Property. It is the State Party's opinion that the report by the Third Party, in the name of the "National Committee for Saving the Sundarbans" is subjective, perception based, and drawn from misconception and not based on facts. This so-called Committee is not a national committee recognized by the State Party. In response to the recommendations, concerns, and requests given in the Decisions of 41COM 7B.25 and 43COM 7B.3 of the World Heritage Committee, the State Party has already taken steps on the conservation and management of the OUV of the Property.

Bangladesh is a small country, spanning approximately 475 km from east-west and 650 km from north-south, with a land area of 147,570 km^2 with an extremely high population of approximately 170 million. In comparison, the European countries of France, Spain, and Italy have a combined population of approximately 174 million within a land area of 1,451,131 km^2. So, they house a similar population within an area almost ten times the size of Bangladesh. Despite such constraints, Bangladesh has made substantial progress within the last five years, with a GDP growth rate of more than 7%. The country's per capita income has increased to USD 2739 in 2021-2022. Moreover, the country has gone through a significant agricultural boost up with top-ranked countries in rice production (3rd), freshwater fish production (3rd), jute production (2nd), potato production (7th), and tea production (8th) according to Food Outlook, FAO, 2022.

This momentum has also been carried over into meeting the SDG goals. Bangladesh has ranked 101st on the Sustainable Development Report 2023, with an overall score of 66 out of 100, ahead of India, Pakistan, and Afghanistan. Bangladesh is well poised to achieve its target of becoming a developed country by 2041. The country has a twin-tract objective: a) obligation of graduation from LDC to a developed country which includes the diversity of industrialization and enhancing power/energy security, and b) ensuring environmental and ecological sustainability of those interventions so that the environmentally sustained growth is ensured. The State Party is committed to monitoring and ensuring any potential adverse impact on the OUV of the Property.

In direct compliance with the WHC, the State Party also have carried out a comprehensive Strategic Environmental Assessment (SEA) considering the present and potential development that may have a direct and indirect impact on the Southwest region with special attention to OUV of the Property (agreed by UNESCO WHC and the State Party in 41 COM 2017). The Southwest hydrological region was established based on the water flow phenomenon of that area during preparation of the National Water Management Plan in 2001. The SEA was addressed the cumulative impacts of total 89 (eighty-nine) Policy, Plan and Programs/Projects (PPPs) across 9 important sectors and a total of 19 cross-cutting sectors. SEA was prepared following the OECD guidelines and internationally accepted norms and best practices. Additionally, a number of mega existing and proposed projects have been strategically considered during the SEA study.

Most of the statements and the images provided by the Third party are not tenable, ambiguous and in most cases imaginary. The methodology of the third party report is misleading. The list of *new industrial and infrastructural development* of the Mongla region has already been reported to the WH Committee in 2019. The review process of annual reports was ambiguous.

The list of development projects within 50 km provided by third-party is misleading. The list has repeated same projects for number of times. The State Party has already decided to discontinue the proposed 10 coal-based power plants with a capacity of more than 8,000 MW. Out of that the sites of Ashugonj power plant at Payra and Rampal power plant (2nd phase) has been proposed for clean energy, preferably solar power plants. Meanwhile, a 200 MW solar project at Rampal (2nd phase), and a 60 MW hybrid (solar & wind) project at Payra site have been initiated. Prevailing global energy crisis, several developed countries are now considering reopening their coal-based power plants whereas Bangladesh has decided to abandon proposed coal-based power plants.

The observation concerning the PowerPac Economic Zone (PEZ) in the Third-Party Assessment report is solely based on the older version of the PEZ master plan. The revised Master Plan has not considered any heavy/high polluting industries such as power plants, steel mills, leather, and oil tank terminals, in line with the recommendations from the SEA report.

The Southwestern Region of Bangladesh houses a dendritic pattern of river networks, hydro-morphologically interconnected. These vast networks are directly fed through upstream rivers such as the Ganges, through Gorai and Pashur river systems. Given the stark difference between dry and wet season water availability with rising sea levels, these networks have been silted up to a significant extent. As such, the activity of river dredging is not only directed towards increasing river draft for navigability but rather to keeping the rivers themselves alive by ensuring freshwater flow and pushing back salinity intrusion in the vicinity of the property. The river dredging also helps to maintain the environmental flow throughout the year for the mangrove ecosystem.

The State Party recently published the new Environmental Conservation Rule (ECR 2023) to safeguard the environment and reduce environmental pollution in Bangladesh to promote environmental protection, raise environmental standards, and exercise pollution control. The Forest Act has been in effect since 1927 to consolidate the law relating to forests, the transit of forest produce, and the duty leviable on timber and other forest-product. The State Party has already adopted the National Oil and Chemical Spill Contingency Plan (NOSCOP) to address Oil and chemical spelling incidents. The State Party formulated the National Biodiversity Strategy and Action Plan (NBSAP) in 2006, based on the principles of sustainable development, integrated conservation and development, equity across generations, and biodiversity as the foundation of life and livelihoods.

Bangladesh is proud of housing the Sundarbans, the world's largest mangrove forest, and UNESCO World Heritage Center recognition of 3 wildlife sanctuaries as world heritage sites in 1997. The forest spans approximately 6017 sq km within Bangladesh. It is a famous biodiversity hotspot, harboring 270 species of birds, 35 reptiles, and 42 mammals and protecting threatened and endangered species like the estuarine crocodile, Indian python, and Bengal Tiger. According to the Forest Inventory 2019, the carbon stock of the Sundarbans has increased from 106 million tons in 2009 to 139 million tons in 2019, which is 31% of the total carbon stock in the Sundarbans. The Sundarbans experienced almost no forest cover loss from 2001 to 2013. The moratorium on tree logging has been extended up to 2030. Protected Areas have been extended to 53.52% of the total area of the Sundarbans in 2017, which was previously 23%. To protect forest resources and to combat crimes, SMART (Spatial Monitoring & Reporting Tools) and drone-supported patrolling has been implemented since 2015. Six Dolphin Wildlife Sanctuaries have been declared inside and adjacent areas of the Sundarbans for the conservation of the Ganges River Dolphin and Irrawaddy Dolphin. To protect the breeding ground for wildlife and fish and to conserve forest resources, the State Party has imposed periodical banning on collection of all types of forest products and tourism activities for 3 (three) months in each year since 2020. The initiative of ecological monitoring of Sundarbans and preparing a revised Integrated

Resources Management Plan (IRMP) has also been adopted. Additionally, local communities have been involved in managing and conserving Sundarbans, and alternative livelihood support programs have been facilitated for their socio-economic uplift.

The conservation of the Sundarbans is one of the most coveted agenda of the State Party not only because of its value as a wonder of immense beauty but also due to its substantial contribution as a natural resource base and in minimizing the impacts of natural calamities. However, being a densely populated country with a small geographic footprint, development in Bangladesh must go together alongside the preservation of global and national treasures such as the Sundarbans. It is the sincere commitment of the State Party to uphold the OUV of the Property amid the futuristic development plan for the region in the coming decades. The different initiatives taken by the State Party are a direct reflection of said commitment and is a showcase of the lengths we are willing to go to the preservation of nature in our development agenda.

Chapter 1: Observations and Responses

1.1 Introduction

The Third-Party Report titled "Assessment of Industrial Development and Large Infrastructure Activities in Southeast Bangladesh near the Sundarbans World Heritage Site" received from the Third Party in the name of "National Committee for Saving the Sundarbans", dated 15 April 2023 is subjective, perception based and drawn from misconception and not always based on facts.

As the Sundarban World Heritage site (the Property) has not been deteriorated the claims of the Third Party is not tenable. The clause 174 of the Operational Guideline for the Implementation of the World Heritage Convention states that

> "***When the Secretariat receives information that a property inscribed has seriously deteriorated, or that the necessary corrective measures have not been taken within the time proposed****, from a source other than the State Party concerned, it will, as far as possible, verify the source and the contents of the information in consultation with the State Party concerned and request its comments.*".

Here, in the Third Party report no evidence is presented on the deterioration of the Property or on the negative effects of its OUV. On the other hand, a number of improvements have been evidenced within last few years which are recognized by both the WH Committee and two Reactive Monitoring Missions. In addition, all suggested measures of the RMM reports of 2016 and 2019 has been duly complied. **These improvements are detailed out in chapter Two. The Third Party report also does not reflect the observation/findings of RMM reports. Hence, the claims of the Third Party is not supported by substantial evidence and does not reflect the actual situation.**

Bangladesh is in the process of graduating from least developed countries (LDCs) to a developing country country (https://sustainablegraduation-bd.com/, GED, 2020). Its per capita income has been USD 2739 in 2021-2022 Financial Year (BBS 2023a). As an effort of graduation it is aiming to achieve USD 12500 by 2041 (GED, 2020). In the process of reducing poverty and graduation the government is emphasizing on the environmentally sustainable ways of graduation rather, focusing on green growth led economic development. Hence, the green growth process and development efforts in the South-west region has always been focused on the conservation of the OUV of the Property and on the surrounding region.

1.2 Third Party observation/statement 1

Clause/ Reference No. Page 1.

When World Heritage Committee Decision 43 COM 7B.3 requested the "State Party to submit to the World Heritage Center, for review by Advisory Bodies, detailed information including environmental impact assessments for development projects which have the potential to influence the OUV of the property to before they commence…", Bangladesh could have easily provided information available in planning ministry annual development plans, power system master plans and in development approval announcements. It could have also provided the Environmental Impact Assessments for the Rampal, Payra and Patuakhali coal plants and Payra Port. It did not. Instead, it submitted an inadequate Strategic Environmental Assessment (SEA) that addressed "policies, plans and programs"

but did not assess "individual projects" that instigated the World Heritage Committee's request for the SEA in the first place.

1.2.1 Response of the State Party

The statements are factually incorrect. The state party provided all the relevant information as and when solicited by the WHC and the RMM of 2019. In addition, power system master plans and development approval announcements are futuristic and developed as a planning process. These are not to be followed in toto as they are subject to initial environmental examination (IEE) and Environmental Impact Assessments (EIAs), and as such, do not represent the on-ground scenario of infrastructure development. The ongoing and proposed industrial developments outside (far away) the Property including Mongla, Barisal and Payra regions were discussed in length in 43rd meeting of the WHC followed by a RMM mission during 9-17 December 2019. The mission was comprised of the representatives from IUCN and the World Heritage Centre. The mission has expressed satisfaction on the compliance of the decisions of WHC by the State Party (please refer to page 7 of the RMM report 2021). Therefore, bringing back a solved issue is not valid and justified, rather, considered to be intentional and motivated.

The statement "It could have also provided the Environmental Impact Assessments for the Rampal, Payra and Patuakhali coal plants and Payra Port. It did not" is misleading and not tenable. The Government has delivered all the reports (such as EIA reports of large projects including EIA reports of Capital Dredging, TOR of the SEA, Trend of change in water quality of the Possur river) to the WHC whenever asked (Please refer to the RMM report of 2021 and State of the Conservation Report 2021).

The statement 'Instead, it submitted an inadequate Strategic Environmental Assessment (SEA) that addressed "policies, plans and programs" but did not assess "individual projects" that instigated the World Heritage Committee's request for the SEA in the first place' is untrue and ambiguous. The SEA focuses on Policies, Plans and Programmes (PPPs), not on an individual project. EIA is conducted at the project level. The SEA report incorporated, reviewed and addressed the cumulative impacts of total 89 (eighty-nine) PPPs. Accordingly, suggestions, recommendations for environment-friendly development and proposal for reviewing PPPs have been prescribed in the SEA report. In addition, any likely impact on the OUV of the Property has also been assessed by the SEA.

In the SEA report, chapter 1.3, "The SEA Study Area," explains the issues raised by the Third Party and clarifies that the South West (SW) region was designated as the SEA study area and agreed by UNESCO WHC and the state party in 41 COM 2017) because of concerns of likely environmental and socio-economic impacts, particularly on the Sundarbans, arising from existing and planned development activities in this region.

In chapter 3.4.4. of the SEA Report, different large-scale projects were assessed for likely impacts on the OUV of the Property although an internationally standard SEA is not supposed to assess a project. (See Chapter 3.4.4., chapter 4, **Annex-III**)

- The **SEA** also assessed the potential impacts (both Positive & Negative) of the 7th Five Year Plan (2016-2020) and 8th Five Year Plan, 2021-2025, and Power & Energy System Master Plan, 2016 (**Table 6.2 of Final Scoping Report**). **See Annex-I**.
- For the Rampal Coal-fired Power Station, EIA and EMP were also assessed during the SEA (**Chapter-3.5.1; SEA report**). **See Annex-II.**
- The above explanation signifies the SEA study addressed the issues and concerns properly and complied WHC's request adequately.

1.3 Third Party observation/statement 2

Clause/ Reference No. Page 1.

We argue that the permitting of the coal plants and their associated dredging, shipping and waste disposal are such "multiple or very large projects."

1.3.1 Response of the State Party

- The state party argues that the Rampal coal power plant, as mentioned by the third-party, actually titled 'The Maitree Super Thermal Power Project (MSTPP)', and their associated dredging, shipping and waste disposal have been discussed in length in the 41st (Krakow, 2017) and 43rd (Baku, 2019) sessions of the WH Committee. Please refer to the decisions adopted during the 41st session of the World Heritage Committee (Krakow, 2017), wherein, it was decided that the State Party has to ensure about the likely environmental impacts of the Rampal coal-fired power plant on the property arising from air and water pollution. The State Party reiterates that the MSTPP has been strictly scrutinized in different stages of the implementation so that it does not have any impact on the OUV of the Property. It is being developed with all measures to safeguard the Sundarbans from potential hazards as recommended in EIA and RMM report in 2016. A comprehensive checklist had been developed by DoE to monitor the environmental compliance of different components. The Divisional and District offices of DoE in Khulna and Bagerhat continuously monitor the Maitree STPP site to ensure the compliance of the Environmental Management Plan (EMP). Please note that detail information on the state of this art technology of the MSTPP and on its environmental safeguards was provided to the RMM of 2019 and in the Property status reports submitted by the State Party in 2019 and 2021. In addition, the likely increase in shipping and dredging, and additional removal of freshwater was comprehensively assessed as part of the SEA and adequate technological measures have been put in place to Mitigate these likely impacts, in order to protect the OUV of the property.
- The MSTPP has taken all desired measures to control environmental parameters as per Air Pollution Control Rule (APCR), 2022 and Environment conservation Rule (ECR), 1997, ECR 2023 and Noise Pollution Control Rule 2006. Documenting and archiving the monitoring data are being maintained on a quarterly basis. Sampling of biota to the susceptible zone is being done on a quarterly basis. The Life Cycle Assessment (LCA) of bio indicators, Toxicity magnitude, behavioral/attitude in all changes of fauna will be applicable during Operation Phase. The performance of the Ecosystem management plan is satisfactory. Continuation of training and capacity building and awareness, motivational program (Induction training, Rigging and lifting, Electrical safety) are conducted regularly. (detail descriptions are annexed in Annex-II.).
- The state party reaffirms that the other coal power plants and the Payra Port are outside the hydro-logical zone of the Sundarbans Heritage site and hence, will not affect the OUV of the property.
- The statement the energy infrastructure plan for southern Bangladesh clearly has the potential to harm the OUV of the Property is imaginary. The Ministry of Power, Energy & Mineral Resources has undertaken the long-term integrated power & energy plan 'Integrated Energy & Power Master Plan (IEPMP)' with the assistance of JICA. The objective of the Master Plan is to realize the low carbonization and stable supply at an affordable cost. The Institute of Energy Economics, Japan (IEEJ) has been engaged to

develop this IEPMP. The IEPMP is a long-term plan to set targets for primary energy, secondary energy, energy transmission & distribution, clean energy, and energy efficiency. The IEPMP has set a target to go for up to 40% generation from clean energy by the year 2041. To achieve the target, it has considered Renewable Energy, Nuclear Energy, Hydro Power Import, hydrogen (hydrogen-fired thermal, fuel conversion from gas-fired thermal), Ammonia (fuel conversion from coal-fired thermal), Carbon dioxide Capture and storage (CCS) in thermal power plants. Thereby the IEPMP is not going to harm the environment rather, contribute towards climate mitigation and a low carbon regime.

1.4 Third Party observation/statement 3

Clause/ Reference No. Page 1.

The SEA included a map specifically limiting the geographic scope of the SEA to intentionally avoid any review of large industrial projects in the Kalapara, Barguna, Barisal, Patuakhali and Payra regions. To document continued construction of large infrastructure development projects within 50 kilometers of the Sundarbans, the National Committee for Saving the Sundarbans conducted a review of Planning Ministry Annual Development Plans and Satellite photos from 2017 through 2023.

1.4.1 Response of the State Party

- This statement is not tenable. The concern raised by the third party for the energy infrastructure and industrial projects in the Kalapara, Borguna, Borishal, Potuakhali, and Payra regions were clarified in **"Chapter-3, the baseline profile and key environmental and socio-economic issues of mega projects [para 3.4.4 (as stated above); 3.5.1 (Annex-II)] and incorporated their potential impacts and addressed in the** "**Chapter-4, Air and Water Quality Modeling"** of the SEA study report. **Annex-III has substantiated the facts.** Impacts of these megaprojects were properly addressed in the SEA.

1.5 Third Party observation/statement 4

Clause/ Reference No. Methods-page 1

Planning Ministry Annual Development Plans (ADP) and development announcements were reviewed. A list of new industrial and infrastructure developments announced for sitting within 50 kilometers of the Sundarbans were captured and quantified. Google Earth and the Planet Labs archival database with 3-band Planet Scope Scene (3m) satellite images of Southwest Bangladesh were searched from January 2017 to April 2023. Drone photos and videos were taken in March of 2023. The largest industrial development and infrastructure projects that demonstrated active construction within 50 kilometers of the Sundarbans World Heritage site and reserve forest were captured and quantified.

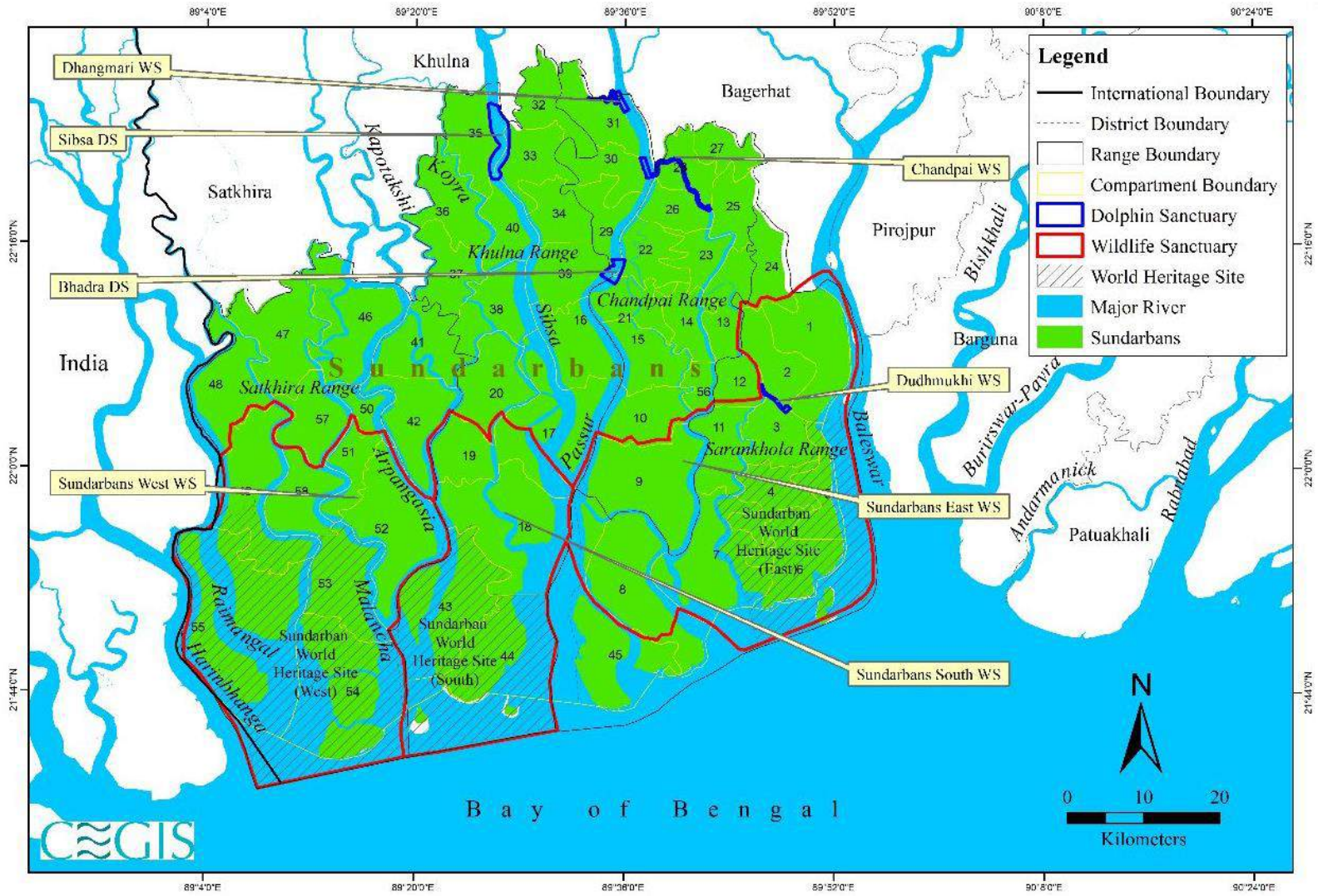
1.5.1 Response of the State Party

- **The methodology of the third party report is misleading**. The list of *new industrial and infrastructural development* of the Mongla region has already been reported to the WH Committee in 2019. The review process of annual reports have been ambiguous because the table 1 has repeated each projects more than once covering different pages of the same Planning Documents without any justification. Power system master plans and development approval announcements are futuristic and developed as a planning

process. These can't be followed in toto and as such do not represent the on-ground scenario of infrastructure development.

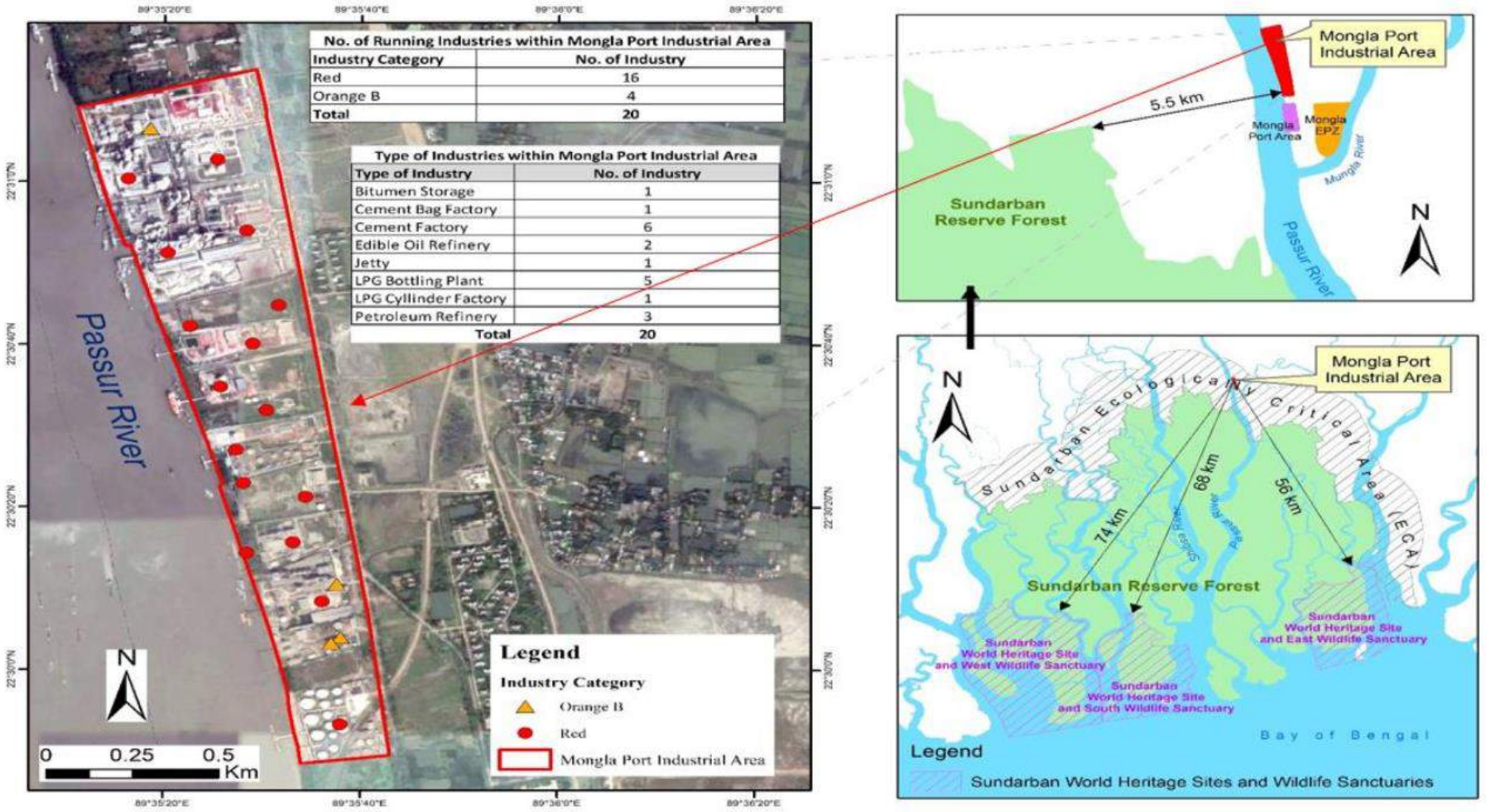
- **The basis for 50 kilometers reference is absent in the methodology.** There are no valid justifications mentioned for using such parameter (i.e., 50km) in the methodology. The state party believes that "within 50 kilometres of the Sundarbans" is not clear and not justified. If the third Party means 50 kilometres from the outer boundary of the Sundarbans nearly one-fourth of the country will come under the vicinity of this reporting which is not justifiable. Although the said projects are outside the boundary and ECA area of the Sundarbans they have been scrutinized rigorously to ensure environmental compliance. The claim of the Third Party in this regard is not evidence-based and not tenable.
- **The Third Party has misled the boundary of the total Sundarbans Reserve Forest (SRF) to the original location of the Property.** The State Party reiterates that the Rampal Coal Plant, as mentioned by the third-party, actually titled 'The Maitree Super Thermal Power Project (MSTPP)', is located about 14.6 Km away from the nearest tip of the Sundarbans Reserve Forests' outer periphery and more than 65 km away from the World Heritage Site of UNESCO. Between the MSTPP and the Property there are a minimum of 50 km of dense forest and 10 km of buffer zone (as designated Ecologically Critical Area-ECA). Please refer to the Maps of page 22 and 23 of the RMM report 2021 where detail information is available[1].

[1] https://whc.unesco.org/en/list/798/documents/



(Source: RMM Report 2021 available at https://whc.unesco.org/en/list/798/documents/)

Map 1: The SRF and ECA and The Property



(Source: RMM Report 2021 available at https://whc.unesco.org/en/list/798/documents/)

Figure 2: Distance of the industries (Development A-E) from the Property

- The Third Party did not provide any quantitative data or qualitative analysis of pollution/degradation of the Property due to those industrial or infrastructural development. Without any scientific basis any prediction is invalid and should be nullified.

1.6 Third Party observation/statement 5

Clause/ Reference No. Page 1 and 2

Results: Twenty new developments totaling 5,172.7 acres were under construction in the Mongla and Kalapara regions between January 2017 and April 2023.

1.6.1 Response of the State Party

- This information is not evident as the methodology did not clarify on how the number twenty and 5172.7 acres have been calculated and generated. Please note that the per capita land area is very low and the country is one of the most densely populated (1176.61 people per sq.km; BBS 2023) in the world. Hence, to fulfil the international commitments made by the State Party (such as SDGs) sectoral policy, plan and programs are addressed accordingly.
- In the Strategic Environmental Assessment (SEA) report assessed the potential environmental and socio-economic impacts, particularly on the OUV of the Property arising from existing and planned development activities in this region. The various large-scale projects (Rampal power plans, Payra power plant, Payra deep sea port, Padma Bridge, Nuclear Power plant, port city, airport, etc.) are addressed through the SEA's pollution modelling (chapter-4, SEA Report). The SEA also assessed the potential impacts (both Positive & Negative) of the 89 PPPs including the Seventh and Eighth Five Year Plan, and Power & Energy System Master Plan, 2016. The air and water quality modeling assessed with large area (300km X 300km) and also the potential water pollution due to the nine sectoral future development in the SW including the adjoining areas, according to high growth development scenario. So, the SEA was not inadequate but properly addressed the WHC's request.

Results (continued)

The Bangladesh Annual Development Plans from FY 2018 - FY 2020 allocated 241,600 lakh taka ($284,278,865 USD) to large scale industrial developments located within 50 kilometers of the Sundarbans.

Table 1: List of funded developments within 50 kilometers of the Sundarbans in the Annual Development Plans1)

- The list of funded developments as mentioned in the Table-1 which are drawn from the Annual Development Plan (ADP) books of different financial years is not adequately evident. ADP indicates the probable allocation of a project of a year out of total duration of that project. Third Party Report indicated (in Table 1) that 12 development projects are included for implementation. However, analysis of ADP says, the following 07 projects were included in the ADP for implementation during 2017 - 2020.

Sl. No	Project Name
01.	Rampal power plant project in the second block of land development, conservation and he boundary wall construction project (BPDB)
02.	Capital dredging in the channels from mongla port to Rampal power plant
03.	Land and infrastructure development for 660*2 MW coal-fired thermal power plant project at Barguna/Patuakhali (NWPGC)
04.	Land acquisition and land development for implementation of Patuakhali 1320 MW coal fired thermal power plant (RPCL)
05.	Ashugonj land acquisition, land development and resettlement for implementation of Patuakhali 1320 (2x660) MW coal fired thermal pow2er plant (APSCL)
06.	Payra Deep Sea port Operations infrastructure/ Facilities Development
07.	Construction of 1st terminal & allied facilities at Payra port authority

- **In the Table 1 of the Third Party Report each project was repeated more than once**. For instance, capital dredging and RPCL land development and land acquisition are shown three times. All these projects are ongoing however, except the dredging of Pashur channel and land development of Rampal Power Plant. All other projects are outside the hydrological zone of the Sundarbans which will not have any impact on the OUV of the property. A comprehensive report on the safeguarding measures for environmental compliance of the power plants are provided in the State of the Conservation Report 2020 [2] and in the RMM report 2021. Information on the power plants of Barishal, Potuakhali and the Payra Port on the basis of EIA and EMP has been detailed out in Annex IV, V, VI.

As a mandatory part of the Bangladesh Environment Conservation Act 1995 and Environment Conservation Rules (ECR) 1997 and 2023, all dredging activities are subject to approval of Environmental Impact Assessment (EIA). In addition, the EIA should also follow the IUCN advice note. As a sea port, maintenance dredging is required to maintain the navigability of the Mongla Port on the Pashur River. Since 1979 Mongla Port has been performing maintenance dredging to keep the port operational. It is assumed that, by now, the maintenance dredging has been adopted by the river ecosystem[3].

The primary objective of dredging is to sustain navigability while safeguarding the delicate ecological balance of the Sundarbans region. Capital dredging was undertaken in the Pashur River from Mongla Port to the Rampal Power Plant, to ensure the smooth flow of navigation. The environmental impact of this dredging activity was carefully assessed, taking into account both the dredging method and the selection of disposal sites for the dredged materials. The disposal sites were strategically chosen to minimize their likely impacts on the environment, specifically by being located far away from the Property area. Throughout the dredging process, strict adherence to prescribed methods was

[2] https://whc.unesco.org/en/list/798/documents/

[3] State of the Conservation Report

maintained, ensuring the protection of the Sundarbans' Outstanding Universal Value while minimizing disruptions to its diverse flora and fauna.

- **The state party believes that "within 50 kilometres of the Sundarbans" is not clear and not justified.** If the third Party means 50 kilometres from the outer boundary of the Sundarbans nearly one-fourth of the country will come under the vicinity of this reporting which is not justifiable. Although the said projects are outside the boundary and ECA area of the Sundarbans they have been scrutinized rigorously to ensure the environmental compliance. The claim of the Third Party in this regard is not evidence-based and not tenable.

Notable that the ongoing and proposed industrial developments outside of the property including Mongla, Barisal and Payra regions were discussed in length at 43rd meeting of the WHC followed by a RMM mission during 9-17 December 2019. The mission was comprised of the representatives from IUCN and World Heritage Centre. The mission has expressed its satisfaction on the compliance of the decisions of WHC by the state party. Therefore, carrying forward the issues before 2021 is not valid and justified.

- Bangladesh has a twin-tract objective – a) obligation of graduation from LDC to a developing country which includes diversity of industrialization and enhancing power/energy security and b) ensuring environmental and ecological sustainability of those interventions so that the environmentally sustained growth is ensured. Hence, to fulfil our other international commitments (such as SDGs) large industries will be installed and will operate in the designated areas (such as in Economic Zones) outside the ECA areas of the Sundarbans and within that said fifty kilometres. In this case, the State Party will definitely ensure that the OUV of the Sundarbans will not have any impact because of those development interventions.

1.7 Third Party observation/statement 6

Clause/ Reference No. Page-3, 9, 10, 11,32

In April 2023, the 7 developments depicted in the satellite image below were in progress or near completion in the Mongla Region.

The Mongla regions developments are located between 0.5 to 11 kilometers from the Sundarbans Reserve Forest boundary. All the developments announced and/or being constructed in the area are located upstream of the Sundarbans World Heritage site. Engineered discharges and rainfall at these developments will wash pollutants downstream into the Sundarbans. Many of the developments, especially the Powerpac Economic Zone and the Rampal coal plant will have numerous pollutant discharges and emissions, including heavy metals, petroleum by products, particulate matter, carbon dioxide, NOx and SOx. (page 03, last para)

1.7.1 Response of the State Party

- Majority of the exhibits and developments, mentioned by the Third Party, was reported to the RMM in 2019 by the State Party and after elaborate discussion the RMM report of 2021 has concluded that "the the OUV of the property remains preserved" (page 54, RMM

report 2021[4]). Among the 07 (Seven) developments depicted in the satellite image in the Mongla region Development A, B & D are industrials activities and Development C is the office building of Bangladesh Nevy & Development E is the food silo and administrative building which are at least 20 years old. Development A, B & D include four LPG Bottling industries. In these industries LP Gas is filled in bottles by automatic process and the likely impacts are strictly monitored so that they do not have any impact on the OUV oft he Property.

1.8 Third Party observation/statement 7

- The statement Many of the developments, especially the Powerpac Economic Zone and the Rampal coal plant will have numerous pollutant discharges and emissions, including heavy metals, petroleum by products, particulate matter, carbon dioxide, NOx and SOx. (page 03, last para) **is provided without any valid data and is imaginary**. The Third Party did not provide any quantitative data or qualitative analysis of pollution/degradation of the Property. Without any scientific basis any prediction is invalid and should be nullified. The State Party has been committed to uphold the environmental sustainability and protection of the Sundarbans and hence, revised the previous master plan of Power Pack economic zone. The allocation of each industry in the PEZ will be subject to EIA to ensure compliance of ECR 2023.

1.9 Third Party observation/statement 8

Clause/ Reference No. Page-4, 9, 10, 11,32

Exibit number 1-20

The exhibit number corresponds to the satellite image of each Project. Two satellite images are provided for each project and additional drone photos are provided for coal-fired power plants. One "before" image taken in 2017 or 2018 and one "after" image taken in 2022. By comparing the before and after images, one can see the how development has progressed over the period of time since the WHC first started asking the Government of Bangladesh to provide information about developments and stop them until an SEA for Southwest Bangladesh was completed. One can also see the size and scale of the developments that the SEA failed to assess and provide additional information on their impacts to the OUV of the Sundarbans World Heritage site.

1.9.1 Response of the State Party

- **The exhibits of 2017 or 2018 and of 2022 are not on the same scale and hence, incomparable and misleading.** Any comparison of exhibits of different years should have pictures of same resolution and same latitudes and longitudes. However, the Third Party report used images of separate scales, different latitudes and longitudes when comparing the images of 2017 or 2018 to images of 2022. For example, if compared between the image of exhibit 2 development A in 2017 and in 2022 it is found that the latitude and longitude of 2017 image and 2022 image are different and the scales are not

[4] https://whc.unesco.org/en/list/798/documents/

the same (Figure 2). The State Party claims that it is intentional and used to confuse and mislead the audience.

Exhibit 2 – Development A, January 2017:



Development A, December 2022:

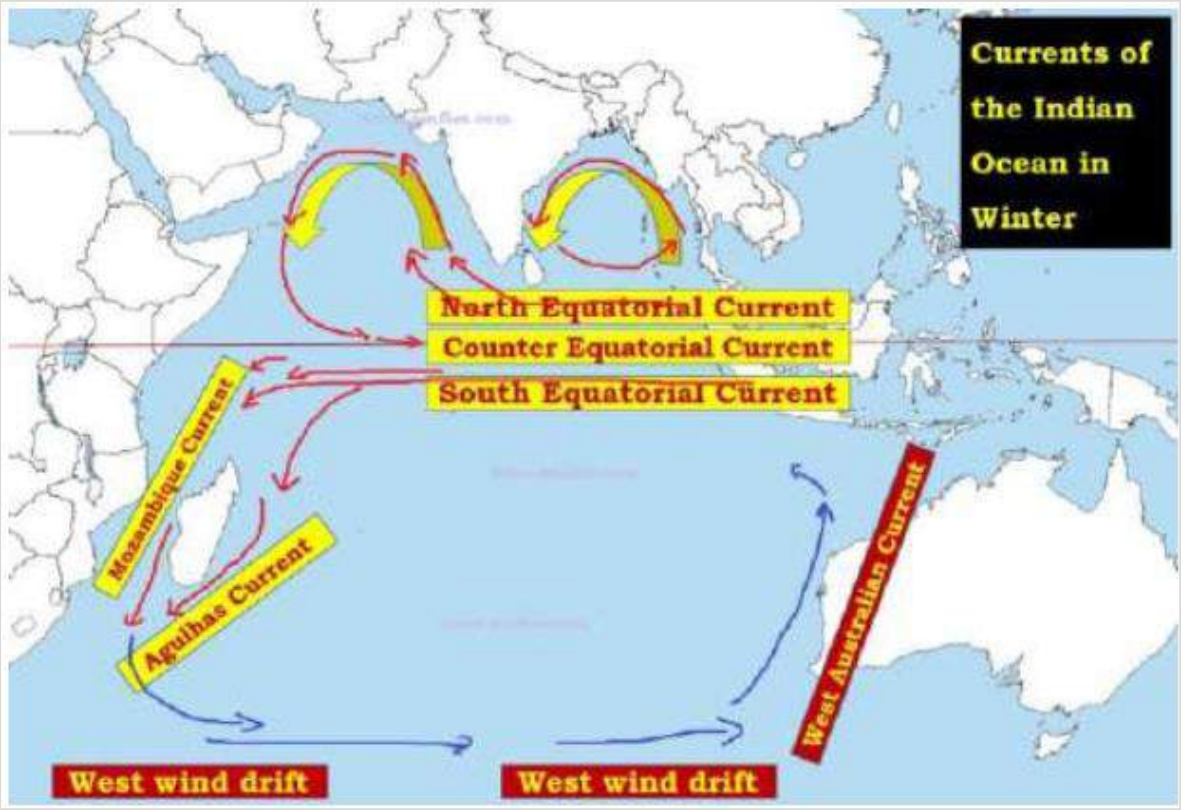


Figure 3: Two images of 2017 and 2022 are not on same scale and same location

1.10 Third Party observation/statement 9

Clause/ Reference No. Page-4

The Kalapara region industrial developments ranged from 20 to 45 kilometers from the Sundarbans. All of them were located near rivers that discharge into the Bay of Bengal. In winter, water circulates in the Bay of Bengal in an anti-clockwise loop, carrying pollutants from the Kalapara region rivers to the Sundarbans:



1.10.1 Response of the State Party

The state party reiterates that stringent environmental measures are being followed to control any discharges to air water and soil following the EIA and EMP of the power plants and the Payra port and therefore, there will not be any discharges to the coastal rivers as well as to the marine water. In addition, the East Indian ocean current that flows down the Bay of Bengal is in the furthest south from the southern tip of the Property. Although the current will flow anti-clockwise, this will not come to close proximity of the Property. In addition, the anti-clockwise current flows down to South direction towards East coast of India instead of upward (North) direction. Hence, it will never reach up to the Property territory or its adjoining areas.

1.11 Third Party observation/statement 10

Clause/ Reference No. Page-10, 11,

Just after the World Heritage Committee Reactive Monitoring Mission arrived in Bangladesh in December 2019 to evaluate compliance with WHC recommendations regarding the Sundarbans World Heritage site, the Government of Bangladesh announced a new industrial development project called the

Powerpac Economic Zone. 2 The 205-acre project is near the Mongla Port. It includes 2 new power plants, a steel mill, an LPG gas bottling plant, a leather plant, a paint plant and an oil tank terminal, all located just 6.5 kilometers from the Sundarbans Reserve Forest Boundary. (page 10, first para).

The power plants are described as the "Keraniganj-II 160 MW Power Plant (Sikdar Group) and the Khulna 110 MW Power Plant (Sikdar Group). However, neither of these newly announced power plants are listed in the Revised Power System Master Plan (PSMP). They appear to be rogue private power plants slated for construction outside the national power development plan. (Page 10, last para).

1.11.1 Response of the State Party

- This observation concerning Powerpac Economic Zone (PEZ) in the Third Party Assessment report is solely based on the older version of the PEZ master plan and hence, is invalid. The revised master plan of the PEZ has no heavy/high polluting industries such as, power plants, steel mill, leather, paint and oil tank terminals etc. The revised PEZ in line with the recommendations of the SEA/SEMP report on the SW region of Bangladesh for conserving the OUV of the Property.
- As per the revised master plan, the zone will now accommodate various types of light engineering and less polluting industries. The focus will be on industries that do not contribute to air and water pollution or any impacts to OUV of the Property. In order to prioritize environmental conservation, particularly in the Sundarbans region, the authority has implemented numerous measures aimed at upholding environmental sustainability.
- Please note that to strengthen pollution monitoring and control industrial pollution the State party has assigned designated zones as economic zones for industries under BEZA[5]. Green belts, Central Effluent Treatment Plants (CETPs), Sewerage Treatment Plants, rainwater harvesting, and other central environmental regulatory management are being developed in each economic zone in a planned way to prevent the likely impacts of environmental pollution.

1.12 Third Party observation/statement 11

Clause/ Reference No. Page 20-21,

Clause/ Reference No. Page 22-23 Exhibit 11- Payra Port development, November 2017

Clause/ Reference No. Page 24 Exhibit 13-The Payra Port bridge and road, February 2017

- Payra port is located 28 km away from the boundary of SRF and the Property and is under a separate hydrological zone, as such, does not have any impact in the OUV of the property. The SEA has assessed the impact on the OUV by using a state of the art air quality and water quality modelling tools. The results have demonstrated that the construction and operation activities of Payra port will not have any likely impact on the OUV of the Property.

[5] Bangladesh Economic Zone Authority has been created by the State Party to control the unplanned development of industries and monitor pollution. Please visit https://www.beza.gov.bd/about-beza/beza-at-a-glance/ and www.beza.gov.bd for more information.

Development of Payra sea Port Infrastructure development was undertaken in the West bank of Andharmanik River in Kalapara, to ensure smooth conduct of port operation. The environmental impacts of this development was carefully assessed, taking into account both the method and the selection of land for the construction of infrastructures/facilities. The development sites were chosen taking the opinions from the Department of Environment and complying all terms and conditions. Moreover, Payra Port is committed and vowed to grow as green sea port. Hence, it would not have any likely impact to the environment and the biodiversity in and around Andharmanik River.

- Bangladesh is on the process of graduating from Least Developed Country (LDC) to a Developing Country. On that note, Payra port will improve the economy and the lifestyle of this underdeveloped South-central region. Since Payra Port is the first green sea port of Bangladesh, the construction process is continuing in full swing complying all the requirements of the **EIA and EMP**.

1.13 Third Party Observation/Statement 12

Exhibit 10: Payra coal plant, January 2017; Payra coal plant Phase 1 (1320 MW) in operation with its air pollution plume moving towards the Sundarbans World Heritage Site March 2023

1.13.1 Response of the State Party

- **The Exhibit 10 is confusing and not according to scale and same latitude and longitude.** DoE has issued Site clearance to this power plant and as mentioned above, the EMP compliance is being strictly monitored by the DoE headquarter and district offices. The issued EIA approvals and Environmental Clearance Certificates is/will be renewed according to the ECR 2023.

All these projects are in a different hydrological region. Rivers are not connected to the Sundarbans-monitoring aerial emissions from the power plant at the project site of Taltoli Power Plant requires ensuring compliance with the national environmental standards. Stringent monitoring ensures that no polluted discharge is occurring to the air, water and soil. The predominant wind direction on the north-south axis at the power plant site nullifies the possible movement of the emissions towards the Sundarbans (Please refer to the SEA ANNEXURE).

1.14 Third Party Observation/Statement 13

Clause/ Reference No. Page 5-6,

Clause/ Reference No. Exhibit 4 and 5

One can also see the size and scale of the developments that the SEA failed to assess and provide additional information on their impacts to the OUV of the Sundarbans World Heritage site.

1.14.1 Response of the State Party

- Since Mongla Port is the second largest sea port of Bangladesh, the boat traffic in Mongla area has also increased correspondingly. Bangladesh is on the process of graduating from Least Developed Country to a Developing Country and hence, committed to fulfil the targets of SDGs. Please note that the Port activities and future PPPs of Mongla Port has been assessed by the SEA and SEMP has recommended a number of suggestions. The State

party has already adopted the 'National Oil and Chemical Spill Contingency Plan' (NOSCOP) and also submitted to the WHCU under the umbrella of NOSCOP, MPA has already prepared a comprehensive **ACTION PLAN** to prevent marine accidents and mitigate impact in case of emergency as per recommendations of RMM Report 2021.

1.15 Third Party observation/statement 14

Clause/ Reference No. Page-32

In Conclusion, the SEA failed to fully evaluate the impacts of all these developments on OUV of the Sundarbans World Heritage site. (page 32).

1.15.1 Response of the State Party

- **This statement is very generalized.** The SEA has been rigorous and has considered all the issues mentioned in the Third Party report. Detailed information has been attached herewith as ANNEX I, II, and III. The SEA study has conducted for conserving the outstanding universal value (OUV) of the Sundarbans, situated in the south west (SW) hydrological zone of Bangladesh. The study does not limit its scope to a specific geographic area rather it deals with Policies, Plans and programmes (PPPs). Eighty-nine (89) PPPs related to socio-economic and environmental development of Bangladesh were reviewed and their cumulative impacts, issues and concerns were addressed. Accordingly, all level of stakeholder consultations suggestions, recommendations for sustainable development and proposal for reviewing PPPs and potential mega projects have been considered and assessed in the SEA report.
- This SEA and SEMP (Strategic Environmental Management Plan) have been prepared for the period of twenty years till 2041, when Bangladesh has targeted to become a high-income country. List of development projects mentioned by the third-party report (Table-1) are either under 7th five year plan or 8th five year plan. As SEA deals with PPPs so, both the five years plans, and their cumulative impacts have been addressed by the SEA study. Both industrial and infrastructural developments were addressed in the SEA report **chapter 3 and 4**. Large-scale industrial development, including projects, are listed in **para 3.4.4, 3.5.1 (Annex-II), and 3.5.2 (See Annex-IV).** A list of the major projects was also considered in the two development scenarios, 2031 and 2041, for air and water pollution assessment. The project assessments were spotted in **Table 4.5, 4.6, 4.8, 4.9, 4.10, 4.12, and 4.23 (See Annex-III)** of the SEA study report. The mentioned projects are within and/or more than 50 km of the Sundarbans World Heritage Site. The SEA report considers the potential impacts on the OUV of the Sundarbans that could cause by the sectoral development plans/mega projects, irrespective of distance and the air quality modeling considered large area, (300km*300km =90,000 Sq.km) which was beyond SW region and also included transboundary impacts.

The linkage diagram in Chapter-9 of the SEA report also assessed the cumulative impact of the industrial and infrastructural development objectives **(See Annex-V)**. Accordingly, the Strategic Environmental Management Plan (SEMP) prescribes indicator monitoring against sectoral development plans/programs/mega projects to understand and mitigate the environmental and social impacts. So, the geographical scope limitation and the concluding remarks by the third party is inaccurate and misleading.


WORLD HERITAGE SITE বিশ্ব ঐতিহ্য ফলক PATRIMOINE MONDIAL
THE
SUNDARBANS
WORLD HERITAGE SITE
উদ্বোধন করেন
শেখ হাসিনা
মাননীয় প্রধানমন্ত্রী
গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
তাং-২২শে মাঘ, ১৪০৫ বাংলা
INAUGURATED BY
SHEIKH HASINA
HONOURABLE PRIME MINISTER
THE PEOPLE'S REPUBLIC OF BANGLADESH
DATE :04 FEBRUARY,1999.
■ THE SUNDARBANS IS THE LARGEST MANGROVE FORESTS IN THE WORLD COMPRISING AN AREA OF 6017 SQ.KM. OF WHICH 1400.SQ.KM. HAVE BEEN INSCRIBED AS WORLD HERITAGE SITE.
■ THE AREA IS INTERSECTED BY A COMPLEX NET WORK OF TIDAL WATER WAYS, MUD FLATS AND SMALL ISLANDS OF SALT-TOLERANT MANGROVE FORESTS.
■ IT HAS A UNIQUE ECOSYSTEM HAVING A WIDE VARIETY OF FLORA AND FAUNA.
■ THE ROYAL BENGAL TIGER, THE ESTUARINE CROCODILE, SPOTTED DEER AND OTHER INNUMERABLE VARIETIES OF WILD LIFE ARE PRESENT IN SUNDARBANS.
■ ABOUT 330 SPP. OF PLANTS, 400 SPP. OF FISHES, OVER 270 SPP. OF BIRDS, 35 SPP. OF REPTILES AND 42 SPP. OF MAMMALS ARE RECORDED.
UNESCO

Chapter 2: Updated Initiatives to Conserve the Sundarbans

2.1 Updated Initiatives to conserve the OUV of Sundarbans

The updated information on the substantial efforts to enhance the protection of the Outstanding Universal Value (OUV) of the Sundarbans through the implementation of various conservation measures are mentioned below:

a) Moratorium on logging for conservation of floral species

Previously commercial logging was permitted in the Sundarbans. For the protection and conservation of the Sundarbans, the government imposed a moratorium on logging in the natural forest, including the Sundarbans, from 1989 until 2022. The moratorium has been extended up to 2030. Moreover, the Government has imposed a ban on trade, transportation and use of two major timber species namely Sundri (*Heritiera fomes*) and Passur (*Xylocarpus mekongensis*) to completely stop the illegal trade of these species from the Sundarbans. It depicts that the Government does not treat the Sundarbans as a source of revenue earning like earlier days but wants to conserve it.

b) Expansion of Protected Areas



Three wildlife sanctuaries with an area of about 1,39,699.49 hectares were declared in 1996 for biodiversity conservation and maintain undisturbed breeding ground for wildlife. They are Sundarbans East Wildlife Sanctuary, Sundarbans West Wildlife Sanctuary and Sundarbans South Wildlife Sanctuary, which are also the World Heritage Site (WHS). All types of extraction of forest produces including fish, crabs and other non-wood forest produces are prohibited in the Protected Areas. The area of these 3(three) Protected Areas has been increased to 3,17,950.08 ha in 2017. Moreover, new 5(five) Wildlife Sanctuaries covering an area of 4093 ha. have been declared to conserve the Dolphin in the Sundarbans. Now, the total area of Protected Areas covers about 53.52% area of the Sundarbans. Collection/extraction or harvesting of all kinds of resources is strictly prohibited from the Protected Areas.

c) Spatial Monitoring and Reporting Tools (SMART) Patrolling in the Sundarbans:

SMART (Spatial Monitoring & Reporting Tools) based monitoring system is being implemented in the Sundarbans since 2015. This monitoring system becomes very much helpful to monitor and protect the resources (floral, faunal and aquatic) for the Sundarbans especially to protect wildlife and prohibit illegal fishing. Due to SMART patrolling, wildlife poaching, smuggling and illegal fishing reduced appreciably.

To support the implementation of the SMART patrolling approach in the SRF- BFD and Wildlife Conservation Society (**WCS**) of Bangladesh with support from GIZ and inputs from Wild-Team (a local NGO) have jointly developed: 1) a SMART Operating Procedures (**SMART-OPs**) for Law Enforcement and Wildlife Monitoring in the Sundarbans, and 2) a Handbook for SMART Patrols in the Sundarbans Reserved Forest. The WCS of Bangladesh also helped BFD for developing a configurable data model for data collection via Cyber Tracker-equipped handheld devices.

During January, 2018 to March 2023, a total of 459 patrols were conducted in 4,22,009 km channels in 3,654 days of patrol effort. During the patrolling, 68,913 sightings of wildlife species were recorded. In this time period total 2,399 offenders were arrested. During the patrolling total 1,106 boats or transports and 1,840 fishing and crab harvesting gears, 343 cutting tools, 38 poison fishing were seized.

d) Drone based monitoring in the Sundarbans

For better and updated monitoring, drone-based monitoring system has been adopted in the Sundarbans since March, 2021. Several training sessions on drone operation and data collection have been provided to the staff of the Bangladesh Forest Department. The drone-based monitoring system is very useful to cover very remote and inaccessible areas within a short time.



e) Initiatives for Dolphin Conservation

Waterways of the Sundarbans mangrove forest supports the Vulnerable Ganges River dolphin (*Platanista gangetica*) (IUCN Red List, 2015) and Near Threatened Irrawaddy dolphin (*Orcaella brevirostris*) (IUCN Red List, 2015), the last two remaining species of freshwater dolphins in Asia.

For effective conservation and management, based on scientific study and survey 3(three) dolphin sanctuaries (Dhangmari, Chandpai and Dudhmkhi) covering an area of 1070.0 hectares have been established in 2012 at eastern portion of the Sundarbans for conservation of Ganges River dolphin and Irrawaddy dolphins.

In 2020,3 (three) dolphin sanctuaries in and around the Sundarbans a. Shibsha Wildlife (Dolphin) Sanctuary, b. Bhodra Wildlife (Dolphin) Sanctuary and c. Pankhali Wildlife (Dolphin)Sanctuary covering an area of 3,427.00 hectares have been declared by Government. 7 Dolphin Conservation Team (DCT) is working in the field along with Bangladesh Forest Department (BFD) staffs and Co-Management Committee to aware local people for Dolphin conservation, rescue the stuck dolphins and monitor the Dolphin.

Activities for Dolphin conservation: Various activities have been implemented for conservation of Dolphin in the Sundarbans. Some of the major activities are mentioned below-

Introduce an effective management system in the existing PA established for dolphin conservation in the Sundarbans:

For reducing the excessive pressure on the aquatic resources, livelihood support has provided (worth of BDT 40,000 for each) to1,000 (one thousand) households. They have been imparted training based on their choice, experience and willingness. After imparting training by the experts, they are given supports.

Seven Dolphin Conservation Team (DCT) have been formed under the project involving 70 community people living around the Sundarbans. Each DCT has 10 (ten) members for providing information on illegal activity (if there is any) in the dolphin sanctuary.





Maps of Sundarbans WHS: Showing Dolphin Sanctuaries in and adjacent Sundarbans

f) Initiatives to mitigate Human-Wildlife Conflict through compensation

To resolve the issue of Human-Wildlife Conflict, the Government enacted Wildlife Victims Compensation Rules in 2021. Under the rules if any person is injured or killed by tiger or crocodile in the Sundarbans, he/her family or he/she will get compensation from Government. In case of death casualty by wildlife, the family of the victim will get 3,00,000 BDT and in case of severe injury, the victim will get 1,00,000 BDT.

Previously the Compensation rates were 1,00,000 BDT (for case of death) and 50,000 BDT (for severe injury). This compensation package for Wildlife Victims is helping to reduce the human-wildlife conflict in the Sundarbans Impact Zone.

g) Initiatives forwarding the informer for proving information about the wildlife poachers/smugglers

For wildlife conservation, Bangladesh Government enacted Rules declaring Reward package for the informers regarding the Wildlife crimes in October, 2020. Under the rules, if anyone provides any crime information related with poaching, hunting, trapping, smuggling or other related crime, the informer will be rewarded. For Tiger related crime information, the informer will be rewarded for 50,000 BDT; for crocodile related crime information, the informer will be rewarded for 30,000 BDT; deer related crime information, the informer will be rewarded for 20,000 BDT; and other wildlife related crime information, the informer will be rewarded for 15,000 -10,000 BDT. Through this reward system, now Forest Department is getting more wildlife crime related information which help to arrest the poachers/ smugglers as well as to prevent the occurrences of wildlife crimes.

h) Initiatives for Tiger Conservation

Bangladesh Tiger Action Plan (2018-2027)

Second generation Tiger Action Plan (2018-27) has been approved by the Ministry of Environment Forest and Climate Change (MoEF&CC). The Bangladesh Tiger Action Plan (BTAP) is a policy level document that offers a structured approach to achieve long-term conservation of tigers in Bangladesh. The first generation BTAP was for the period 2009 -2017. It provides a vision, goals and objectives to guide an integrated and focused tiger conservation programme.

The implementation of this BTAP will ensure that the nation attempts to sustain the current tiger occupancy in over 6,017 sq. km. and increase the density in the Sundarbans from the current 2.17 to 4.50 tigers per 100 sq.km. within the next ten years. Systematic monitoring and evaluation of progress against the BTAP goals will be done to enable the adaptation of conservation activities.

National Tiger Recovery Programme (NTRP)

As a party to the Global Tiger Recovery Program (GTRP), Bangladesh had produced its first version of the National Tiger Recovery Program (NTRP) in 2010 and the revised version has been prepared for the period of July 2017 to June 2022, which is currently under updating for the period 2023 to 2034.

In compliance with the NTRP the following steps are taken from Bangladesh Government:

- To reduce the human-tiger conflict, 49 Village Tiger Response Team (VTRT) with 332 community people and a 3-member Forest Tiger Response Team (FTRT) has been formed and working at the Sundarbans Impact Zone (SIZ).





- The GoB has become the member of CITES, GTI, GTF, CBD, CMS, Ramsar Convention, and SAWEN for the conservation of biodiversity in the country including the SRF.

- A Protocol and Memorandum of Understanding has been signed between the government of India and Bangladesh on 6th September 2011 to conserve tiger and the Sundarbans.

- Through Camera Trapping method the number of Royal Bengal Tigers in Sundarbans was found 106 in the year 2015, where as in 2018 it was found 114. Recently another camara trapping survey is on-going to know the updates on tiger population under a project with a aim to publish report on 2023-24.

i) Wildlife Rescue and Breeding Centre

A Wildlife rescue and breeding center has been established in 2000 at Karamjal mainly for deer, crocodile and turtle. After collecting eggs from the nest manually the eggs are kept in an incubator in March-April. The hatchlings are collected and kept several pans which are later released in nature. So far 216 nos. of crocodiles have been released in Sundarbans. *Batagur baska* is also kept in Karmajal Wildlife Breeding Center for the conservation of this reptile MoU has been signed among Forest Department, Vienna Zoo, Turtle Survival Alliance and Parkrity O Jibon Foundation. Now there are 435 no. of individuals in the breeding center. This year, 10 Batagur have been released in nature tagged with satellite transmitter.

j) Fish Conservation Measures

At present fish is the main harvestable resource in the Sundarbans. The following measures have been taken for the management and conservation of the fishery resources:

- Fishing is prohibited all the year round in eight existing wildlife sanctuaries (including 5 dolphin sanctuaries), 18 recognized canals in the buffer zone and the canals less than 25 feet wide within 3 km area of BFD permanent camp office/Petrol office located throughout the Sundarbans. These identified areas have been found suitable as a breeding ground for fishes and aquatic animals. Fishing is prohibited during Breeding Season throughout the Sundarbans during the months of June, July and August.
- To limit the resource users not more than 12000 Boat License Certificates (BLC) are issued annually.
- Pangas (*Pangasius pangasius*) and Sea bass (*Lates calcarifer*) catching is banned on each alternating year and Ilish (*Hilsha hilsha*) fishing is banned in September and October. Catching of Ilish (*Hilsha hilsha*) and Pangas (*Pangasius pangasius*) below 23 cm is prohibited.

k) Crab Conservation Measures

Crab harvesting is allowed only outside of Protected Areas. Crab harvesting is banned in January and February as well as it is also banned in June, July and August months. After getting permission and paying govt. revenue, the crab harvesters are allowed to harvest crab outside the Protected Areas (PAs) only.



l) Periodical banning of all types of Forest products and tourism

June, July and August are considered as the breeding season for most of the wildlife of the Sundarbans. For better conservation of the Outstanding Universal Values (OUV) of the Sundarbans, and to maintain an undisturbed breeding ground for wildlife, the Government has prohibited collection of all sorts of forest produces including fishes, crabs, honey etc. for the period of three months (from June to August) yearly. Eco-tourism in the Sundarbans is also prohibited for this period in the Sundarbans. This Government order was enacted from August, 2020.

m) Reduce the pressure of Eco-tourism in Core Areas of the Sundarbans and development of Eco-tourism facilities in the Sundarbans

A project is under implementation to develop eco-tourism facilities in 4(four) new spots of buffer zone of the Sundarbans. As a result, pressure of the tourists from the core area or world heritage site will be reduced as well as eco-tourism activities will be enhanced in the buffer zone area and lessened in the core zone area.

n) Restriction on yearly festival Rashmela in the Sundarbans

Every year in the month of November, a fair named "Rashmela" took place inside the Sundarbans at Dublar char island (Alorkol) for 3(three) days. Considering the disturbances on biodiversity of the Sundarbnas, Government imposed some restrictions in November, 2021 to perform the rituals.

o) Involvement of Local Community for Conservation and Monitoring through Co- Management approach

Co-management activities was initiated in the Sundarbans in 2009-10 to ensure equitable participation and distribution of rights and benefits received from the natural resources. For 3 (three) Protected Areas in the Sundarbans, (viz, Sundarbans East Wildlife Sanctuary, Sundarbans West Wildlife Sanctuary, Sundarbans South Wildlife Sanctuary), 4 (four) Co-Management General Committee (CMGC) as well as 4 (four) Co-Management Executive Committees (CMEC) were formed. Also 211 Village Conservation Forums (VCF), 4 (four) People's Forums (PF), 22 Community Patrolling Groups (CPG), 49 Village Tiger Response Teams (VTRT) and 7 Dolphin Conservation Team (DCT) are working. The Co- management activity is regulated by the Protected Area Co- management Rules, 2017.

p) Provisions of Alternative Income Generation (AIG) opportunities of the forest dependent local community

The resource users of the Sundarbans are identified and provided with alternative income generation (AIG) opportunities to reduce pressure on the Sundarbans. Different Government Organizations and NGOs had been involved in providing AIG supports through projects in the community people living around the Sundarbans. Improved cooking stoves, solar system, pond sand filter, rain rater harvesting units have been set up in the periphery of Sundarbans. Training on AIG activities, kinds and grant have also been provided to the forest dependent people to reduce the pressure on the resources of Sundarbans. So far, 75,840 individuals got training on alternative livelihoods (like training on fish, duck and chicken rearing, handicrafts, vegetable cultivation, crabs & shrimps processing, sustainable resources use, honey cultivation, crab farming, goat rearing, small business tea stall, cloth business, tailoring etc.).

q) Ecological Monitoring of the Sundarbans

Government has been decided to conduct ecological monitoring of the Sundarbans. Accordingly, an ecological monitoring framework was developed under a project. Several activities are currently under implementation to collect data on terrestrial and aquatic mammals, birds, amphibians and reptiles, butterfly and bees, fish, crab, water, soil, plants, lichens etc. and analysis to know the status following the framework is planned under a government funded.

r) Preparation of NOSCOP

In order to address Oil and chemical spelling incident, The Government has already declared the National Oil and Chemical Spill Contingency Plan (NOSCOP) which was published in February, 2020. Under the NOSCOP, Bangladesh Forest Department has taken steps to prepare an effective Localized Contingency Plan under a project and it will be finalized sortly.

s) Introduction of engine free country boat for eco-tourism in the Sudarbans

Sundarbans is a unique mangrove ecosystem and rich with huge biodiversity, it attracts tourists by it's natural scenic beauty. **Every year, thousands of tourists visit Sundarbans and the number of tourists is increasing day by day.** Tourists visits Sundarbans by engine-based launches and trawlers. In order to reduce sound and water pollution, in some portion of Sundarbans where water turbulences and wave action is less, engine free country boat for eco-tourism were adopted rather than mechanized engine boat. Subsequently it may be replicated in the other parts of the Sundarbans to promote nature friendly tourism in the Sundarbans.

t) Pond Excavation and re-excavation to supply fresh water for wildlife and forest resource collectors

Recent cyclones named Bulbul, Yash, Amphan along with heavy tidal surges struck Sundarbans and submersed and destroyed most of the ponds which were the only source of fresh water for wildlife as well as for forest resource collectors and FD officials inside the Sundarbans. A project to excavate and re-excavate the ponds for supplying the fresh drinking water in order to sustainable forest management of the Sundarbans is implemented in the Sundarbans.

u) Carbon Stock in Sundarbans

According to the results of Forest Inventory 2019, the carbon stock of the Sundarbans has increased from 106 million tons in 2009 to 139 million tons in 2019 which is 31% of the total carbon stock in the Sundarbans. Next cycle of forest inventory is planned for a duration of 2 years to know the recent status.

2.2 General Response of Department of Environment

- Department of Environment have issued ToR, Site Clearance, Environmental Impact Assessment Approval(s) and Environmental Clearance Certificates to development projects in accordance with the Bangladesh Environment Conservation Act 1995 and Environment Conservation Rules 2023. After issuing the approvals, clearance and certificates, the compliance of Environmental Management Plan (EMP) is strictly monitored and regulated. Approval, certificate or clearance are not issued or renewed until required action plan and mitigation measures are completed or in place and documents submitted.



The third-party report is subjective and literature based. So far, the WHC had appreciated the overall activities and responses of Bangladesh as a state party since its 43rd meeting held in Baku in 2019. Moreover, as per the decision taken on that 43rd meeting, the Reactive Monitoring Mission (RMM) of the WHC and IUCN visited the WHS in December 2020. So far there was no adverse comment on the activities around the WHS of the Sundarbans. The SEA has been completed by Bangladesh Forest Department and the final draft has been submitted to MoEFCC for validation and finalization. Yet there are room for modification and amendments. Department of Environment remain careful to conserve the environment, ecology and biodiversity of the Sundarbans and other ecologically critical areas of Bangladesh in accordance with the existing rules and regulations as well as ensuring the ongoing development process of Bangladesh.

2.2.1 Initiatives of the State Party for increased freshwater flow to the Heritage site

The Government of Bangladesh approved Bangladesh Delta Plan-2100 to steer the opportunities and vulnerabilities created by the interface of water, climate change, natural disasters, environment, ecological balance, agriculture, land use and inland water management for national development. As a part of the strategy for preservation of the Sundarban, the BDP2100 puts emphasis on restoring the Gorai River to allow freshwater inflow that will wash away the adverse effects of saline intrusion in the Sundarbans and also the regular dredging and maintenance of other rivers and khal in South -West Regions as well as in Sundarbans.

The government has been implementing an integrated freshwater inflow management plan which includes regular capital and maintenance dredging/re-excavation of rivers, canals and water bodies to;

- Improve the flow of freshwater flow by reducing siltation/deposition.
- Maintenance flow.
- Improve water quality.
- Decrease salinity.
- Improve connectivity
- Increase retention capacity.
- Improve water volume for better marine life, flora and fauna,
- Improve ecosystem etc.

Maintenance of the flow of the Gorai River, a main distributary of the Ganges, is imperative for freshwater supply to the south-west regions of Bangladesh which include the Sundarbans. The government of Bangladesh has been undertaking continuous initiatives for the restoration of the Gorai River. The restoration increased freshwater flow to the Sundarbans area and reduced salinity significantly. After the successful implementation of Gorai River Restoration Project (GRRP)-Phase I and II and "Gorai River dredging and bank protection" project implementing by BWDB from 2018 where 44 km river dredging has been proposed. The completion date of the project is June 2024. After completion of the project, every year 18.500 km (Ch. -0.500km to Ch. +18.000km) should be dreged as maintenance dredging for the removal of river siltation every year to get benefits from Gorai river.

Moreover, the government of Bangladesh has also undertaken the following initiatives for the regular dredging and maintenance of Ghasiakhali and other channels in the Sundarban.

01. Re-excavation of 83 Rivers/Khals and Increase Navigation of Mongla-Ghasiakhali Channel in Bagerhat District. (2016-2021)

- **Dredging /Re-excavation of Rivers /Khals (83 Nos. Rivers/Khals) - 309.68 km**

02. Rehabilitation of Polder no. 36/1 in Bagerhat District. (2015-2021)

- **Dredging/Excavation of River (Bhairab River, Chitra River, Mora-Chitra River, Old Madhumoti River, Haque Channel) - 59.60 km**
- **Re-excavation of Internal Drainage Khals (55 Nos.) -172.79 km**

03. Rehabilitaion of Bhutiar Beel and Barnal-Salimpur-Kolabashukhali Flood Control and Drainage Project in Khulna District (Phase-II). (2013-2021)

- Dredging /Re-excavation of rivers - 78.40 km
- Re-excavation of Internal Drainage Khals -117.25 km

04. Drainage Improvement and Sustainable Water Management of Bhairab River Basin. (2016-2022)

- Dredging/Re-excavation of rivers (Bhairab, Upper Bhairab) – 117.00 km
- Re-excavation of khals- 26.50 km

05. Drainage Improvement of Upper Bhadra River, Harihar River, Buri-Bhadra River and Adjacent khals in Monirampur & Keshabpur Upazilla, District- Jashore (2018-2021).

- Re-excavation of Rivers (Upper-Bhadra, Harihar, Buri-Bhadra) – 42.95 km
- Re-excavation of Khals- 20.00 km

06. Re-excavation of Small Rivers, Khals and Water Bodies in 64 districts (phase-1). (2018-2020)

- Re-excavation of Small Rivers/Khals (42 khals)-287.70 km

07. Rehabilitation of Madhumoti-Nabaganga Sub-Project and Re-Excavation/Dredging of Nabaganga River to revival and Conservation of Environmental Balance in Lohagora Upazila of Narail District. (2019-2023)

- Dredging/Re-excavation of Rivers (Nabaganga, Madhumoti) – 43.00 km
- Re-excavation of Khals- 72.20 km

08. Removal of drainage congestion from Kobadak river basin (Phase-1). (2012-2017)

- Re-excavaion of Kobadak river– 82.50 km
- Re-excavation of Khals- 18.30 km

09. Removal of drainage congestion from Kobadak river basin (Phase-2). (2020-2024)

- Re-excavaion of Kobadak river– 79.00 km
- Re-excavaion of Upper Bhairab river– 62.00 km
- Re-excavaion of Shalikha Branch River– 30.00 km
- Re-excavation of Khals- 22.50 km

10. Protection of Morelganj Upazila Sadar and adjacent area from the erosion of Pangusi river and re-excavation of Bishkhali river. (2022-2024)

- Dredging of Bishkhali river– 27.73 km
- Re-excavation of Khals- 18.30 km

- The Delta Plan-2100 (BDP 2100), a hundred-year strategic plan, would help reach the nation in the resilient state through adaptive policymaking and policy implementation concerning climate change impacts and environmental degradation mitigations. The plan gives clear strategic pathways for the protection and expansion of the Sundarbans in the coming decades. The government of Bangladesh has already undertaken initiatives includes: such as restoration of Gorai River (capital and regular maintenance dredging), Bhairob River, Kobadak River, Pangusi River, Bishkhali River, Madhumoti Rivers, Nabaganga Rivers and maintenance of perennial tidal flow through regular dredging in channels whereas required has to be done in the Sundarban etc.



Chapter 3: Conclusion

The Third-Party Report titled "Assessment of Industrial Development and Large Infrastructure Activities in Southeast Bangladesh near the Sundarbans World Heritage Site" can't be able to provide any scientific analysis and evidence on the deterioration of the Property or on the negative future impacts on the OUV of the Property. On the other hand, a number of improvements have been evidenced within last few years which are recognized by both the WHC and the two Reactive Monitoring Missions (2016 and 2019). In conclusion, The State Party likes to reiterate that

- The Third party failed to understand the meaning and objectives of the SEA and the difference between SEA and EIA. Therefore, their claims of the SEA to be inadequate is to be nullified. This State-of-the-art process of SEA not only assessed a total of 89 relevant PPPs but also broaden up its analysis towards individual large-scale projects relating the OUV of the Property. The SEMP has provided directions for various large projects and the future developments to protect the OUV of the Property.
- Most of the statements and the images provided by the Third party are not tenable, ambiguous and in most cases imaginary. The methodology of the third party report is misleading. The list of *new industrial and infrastructural development* of the Mongla region has already been reported to the WH Committee in 2019. The review process of annual reports was ambiguous.
- Most of the claims of the Third Party was discussed in length in the 41st (Krakow, 2017) and 43rd (Baku, 2019) sessions of the WH Committee followed by a RMM mission during 9-17 December 2019. The mission has expressed the satisfaction on the compliance on the decisions of WHC by the state party. Therefore, carrying forward the issues before 2021 is not valid and justified.
- The State Party has delivered all the reports (such as EIA reports of large projects including EIA reports of Capital Dredging, TOR of the SEA, Trend of change in water quality of the Possur river) to the WHC whenever asked (Please refer to the RMM report of 2021 and State of the Conservation Report 2020). **The mission has expressed satisfaction on the compliance of the decisions of WHC by the State Party (please refer to page 7 of the RMM report 2021).**
- The methodology of the third party report is misleading and ambiguous. The basis for 50 kilometers reference is absent in the methodology. There are no valid justifications mentioned for using such parameter (i.e., 50km) in the methodology.
- The Third Party has misled the boundary of the total Sundarbans Reserve Forest (SRF) to the original location of the Property. If the third Party means 50 kilometers from the outer boundary of the Sundarbans nearly one-forth of the country will come under the vicinity of this reporting which is not justifiable.
- The Third Party did not provide any quantitative data or qualitative analysis of pollution/degradation of the Property. Without any scientific basis any prediction is invalid and should be nullified.
- This observation concerning Powerpac Economic Zone (PEZ) in the Third Party Assessment report is **solely based on the older version of the PEZ master plan** and

hence, is invalid. The Plan was revised and current master plan of the PEZ does not have any power plants or steel mill, leather, paint and oil tank terminals etc.

- **The exhibits 1-20 of 2017 or 2018 and of 2022 are not on the same scale and hence, these are incomparable and misleading.** Any comparison of exhibits of different years should have pictures of same resolution and same latitudes and longitudes. However, the Third Party report used images of separate scales, different latitudes and longitudes when comparing the images of 2017 or 2018 to images of 2022.
- The IEPMP has set a target to go for up to 40% generation from clean energy by the year 2041. In order to achieve the target, it has considered Renewable Energy, Nuclear Energy, Hydro Power Import, hydrogen (hydrogen-fired thermal, fuel conversion from gas-fired thermal), Ammonia (fuel conversion from coal-fired thermal), Carbon dioxide Capture and storage (CCS) in thermal power plants. Thereby the IEPMP is not going to harm the environment rather, contribute towards climate mitigation and low carbon regime.
- The SEA and SEMP (Strategic Environmental Management Plan) reports have been prepared for the period of twenty years till 2041, when Bangladesh has targeted to become a high income country. List of development projects mentioned by the third party reports are either under 7th five year plan or 8th five year plan. As SEA deals with PPPs so, both the five years plans, and their cumulative impacts have been addressed by the SEA study considering industrial and infrastructural developments.
- The country has a twin-tract objective: a) obligation of graduation from LDC to a developed country which includes the diversity of industrialization and enhancing power/energy security, and b) ensuring environmental and ecological sustainability of those interventions so that the environmentally sustained growth is ensured. The State Party is committed to monitoring and ensuring any potential adverse impact on the OUV of the Property.

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Annexures



Annex I: Policies, Plans, and Programs (PPPs)

Table 6.2: List of Screened PPPs

Negative impacts: High, Med, Low

Positive impacts: High, Med, Low

Note: The last two columns on impacts indicate likely or potential impacts

Sector	Code	Name of PPP	Impacts	
			Negative	Positive
Nine Key Sectors Identified by Forest Department				
Forestry	001	Forestry Policy 1994		
	002	National Forestry Policy 2016 (draft)		
	003	Bangladesh Forestry Master Plan, 2017-2036		
Fisheries	004	Chingri (Shrimp) Mohal Management Policy, 1992		
	005	National Fisheries Policy, 1998		
	006	The National Fisheries Strategy, 2006		
	007	National Shrimp Policy, 2014	•	
	008	Public Water Body (Jalmahal) Management Policy (PWBMP), 2009		
	009	Bhabadah Area Fish Gher Establishment Policy, 2019		
Water Resources	010	National Water Policy, 1999		
	011	National Water Management Plan, 2001		
	012	National Strategy for Water Supply and Sanitation, 2014		
Power and Energy	013	Power & Energy System Master Plan , 2016	•	
	014	Draft National Energy policy, 2006	•	
	015	Renewable Energy Policy of Bangladesh, 2008		
	016	Energy Efficiency and Conservation Master Plan up to 2030, (2015)		
	017	Gas Sector Master Plan 2018		
	018	Policy Guideline for Small Power Plant (SPP) in Private Sector, 2008		
	019	Power and Energy Sector Strategy Paper (SSP), 2018		
	020	National Action Plan for Clean Cooking, 2020-2030		
Tourism	021	National Tourism Policy, 2010		
Urbanization	022	National Urban Sector Policy, 2011 (draft)		
Industry	023	National Industrial Policy, 2016		
	024	National Policy for the Management of Radioactive Waste and Spent Nuclear Fuel, 2019	•	

Sector	Code	Name of PPP	Impacts	
			Negative	Positive
	025	National Textile Policy, 2017		
	026	Leather and Leather Products Development Policy, 2019		
	027	National Strategy for Sustainable Brick Production in Bangladesh 2017		
Transportation and Communication	028	Integrated Multi-Modal Transport Policy, 2013		
	029	National Land Transport Policy, 2004		
	030	Road Master Plan 2009		
	031	Railway Master Plan, 2016-2045		
Shipping	032	National Shipping Policy, 2000	•	
Other sectors				
Environment, Biodiversity and Climate	033	National Environment Policy, 2018		
	034	National Biodiversity Strategy and Action Plan for Bangladesh (NBSAP,B), 2016-2021		
	035	Country Investment Plan (CIP) for Environment Forestry and Climate Change, 2016-2021		
	036	National Adaptation Plan of Action (NAPA) – for Climate Change, 2005, updated 2009		
	037	Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009		
	038	Bangladesh Climate Change and Gender Action Plan (CCGAP), 2013		
	039	Bangladesh Wildlife Master Plan, 2015-35		
	040	Bangladesh National Action Programme for Combating Desertification Land Degradation and Drought (DLDD) 2015 – 2024		
	041	National Road Map for Combating Land Degradation for 2024-2041 (Draft)		
Sundarbans	042	Integrated Resource Management Plan of Sundarbans, 2011		
	043	Bangladesh Tiger Action Plan 2018-2027		
Agriculture	044	National Agriculture Policy, 2018		
	045	National Organic Agriculture Policy, 2016		
	046	Agricultural Extension Policy, 2015 (draft)		
	047	National Dairy Development Policy, 2016		
	048	National Livestock Extension Policy, 2013 (Final Draft)		
	049	National Livestock Development Policy, 2007		
	050	National Integrated Livestock Manure Management Policy, 2015 (draft)		

Sector	Code	Name of PPP	Impacts	
			Negative	Positive
	051	National Poultry Development Policy, 2008		
	052	National Integrated Pest Management Policy, 2002		
	053	Integrated Minor Irrigation Policy, 2017		
	054	Master Plan for Agricultural Development in the Southern Region of Bangladesh 2012		
	055	National Seed Policy, 1993 [EXCLUDED]		
	056	Bangladesh Second Country Investment Plan Nutrition-sensitive food system, 2016-2020		
Cultural affairs	057	National Cultural Policy, 2006		
Disasters	058	National Plan for Disaster Management, 2016-2020		
Economy	059	Export Policy of Bangladesh, 2018-2021		
	060	Medium Term Macro Economic Policy Plan, 2019		
Education	061	National Education Policy, 2010		
Food	062	National Food Policy, 2006		
	063	Food/Cash for Work (F/CFW) Program, 1974		
Health & Family Welfare	064	National Health Policy, 2011		
	065	Occupational Health and Safety Policy, 2013		
Labour, Employment and Livelihoods	066	National Labour Policy, 2012		
	067	My Home and My Farm (Amar Bari Amar Farm) Program, 2009		
Land	068	National Land Use Policy, 2001		
Local Government, Rural Development and Cooperatives	069	National Rural Development Policy, 2001		
Planning	070	Khulna Metropolitan Development Plan (Mongla) 2012-2031		
	071	Khulna Development Authority (KDA) Master Plan 2001-2020;		
	072	Khulna Development Authority (KDA) Detailed Area Plan 2001-2020		
Population	073	Bangladesh Population Policy, 2012		
Posts, telecommunications & Information	074	National ICT Policy, 2009		
Science & Technology	075	National Science and Technology Policy, 2011		
Waste Management	076	The National Sanitation Strategy, 2005		
	077	National 3R Strategy for Waste Management, 2010		
	078	National Women Development Policy, 2011		
	079	National Children Policy, 2011		

Sector	Code	Name of PPP	Impacts	
			Negative	Positive
Women and Children Affairs and Vulnerable Groups	080	National Action Plan on Women, Peace and Security, 2019-2022		
	081	Vulnerable Group Development (VGD) Programme, 2011		
	082	Vulnerable Group Feeding (VGF) programme, 1974		
National and Cross-sector PPPs				
	083	Bangladesh Delta Plan. 2100		
	084	Seventh Five Year Plan FY 2016 – FY 2020: Accelerating Growth, Empowering Citizens		
	085	National Sustainable Development Strategy (2010-21), 2013		
	086	First Perspective Plan of Bangladesh: 2010-2021		
	087	Coastal Zone Policy, 2005; and Coastal Development Strategy, 2006		
	088	Second Perspective Plan of Bangladesh: 2021-2041		
	089	Eighth Five Year Plan, FY2021-FY2025		

Annex II: Rampal Coal-fired Power Station

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).

Annex III: Air and Water Quality Modelling

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.

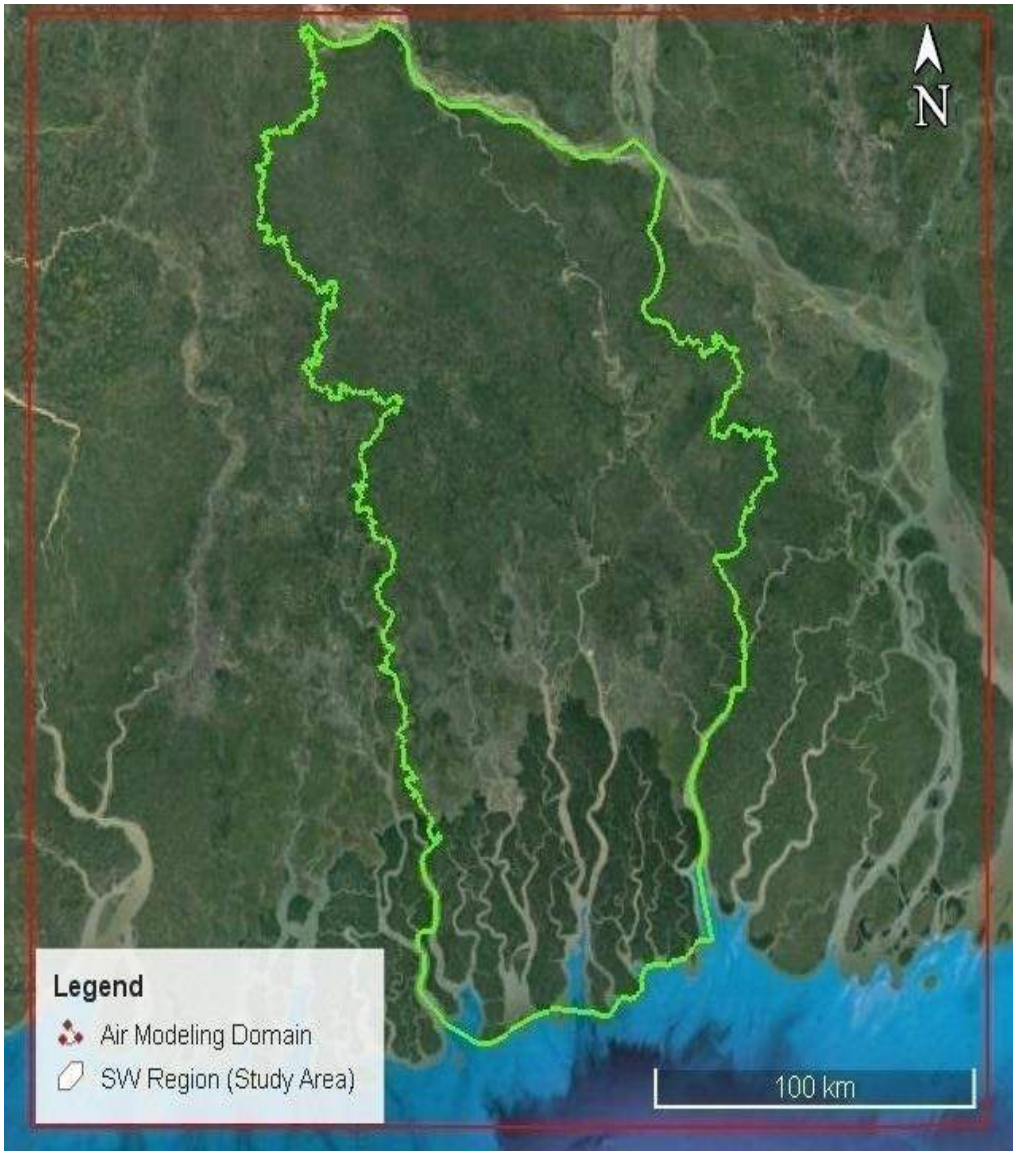


Figure 4.1: The Air Quality Modelling Area

Modelling of air quality was undertaken for 300 x 300 km (90,000 km2) 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 SO2, NOx, PM2.5 and PM10 emissions on ambient air quality. There are many other dispersion models available, but CALPUFF was selected for to the following reasons:

1. It is designed for long-range analysis, more than 50 kilometers from the source of pollution;
2. It can accurately model both simple and complex terrain;
3. It can model both urban and rural areas;
4. It can take into account multiple point, line, area, and volume sources of emissions;
5. 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 PM10 and PM2.5) 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 $\mu g/m^3$.

- 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[6] (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)[7];
- Volume sources (buildings).

Emissions were estimated using the US EPA AP-42 Emission Factors Compilation[8] 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).

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[6] 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/

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

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

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.

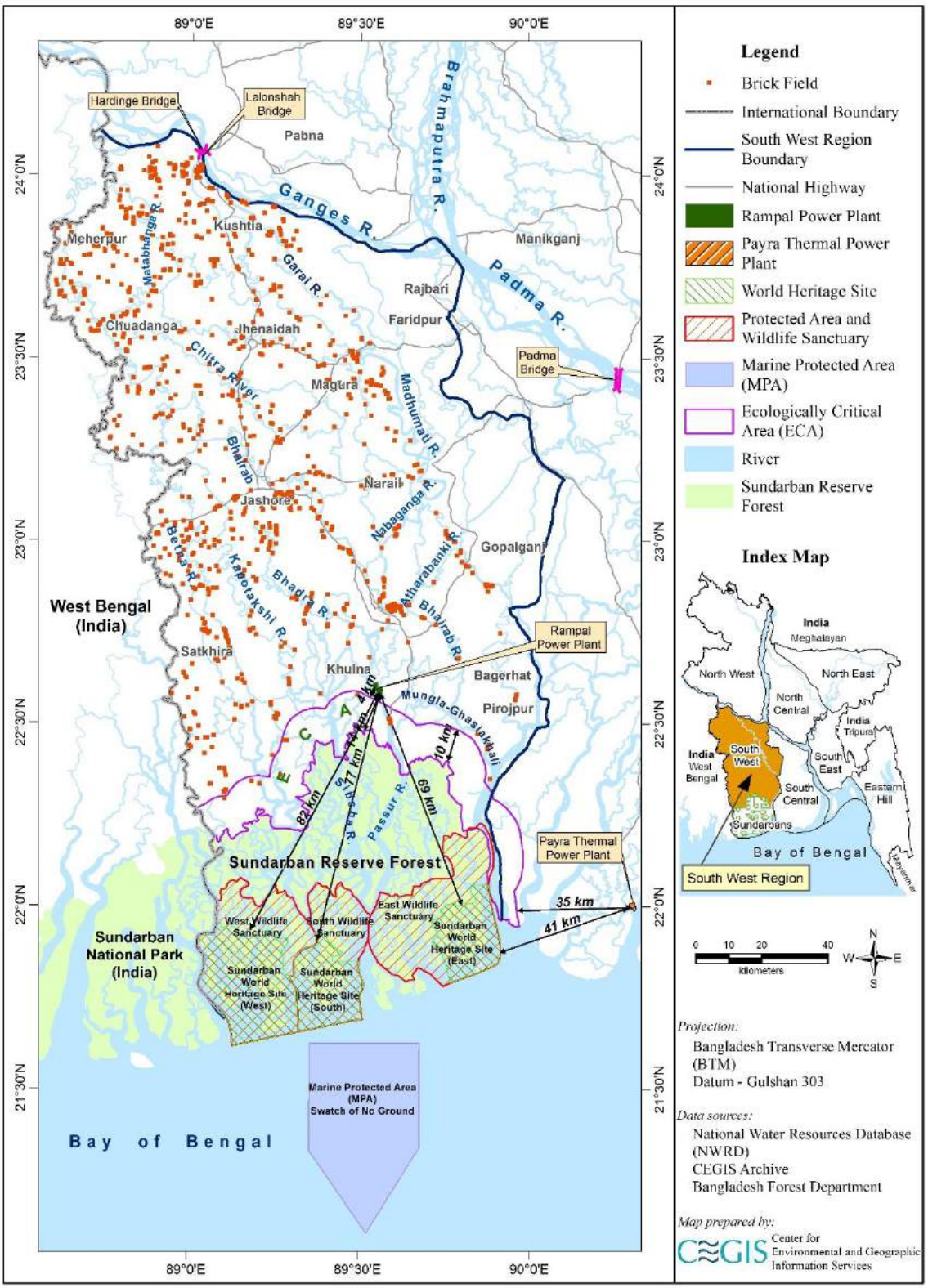


Figure 4.2: Active Brick Kilns in SW Region of Bangladesh

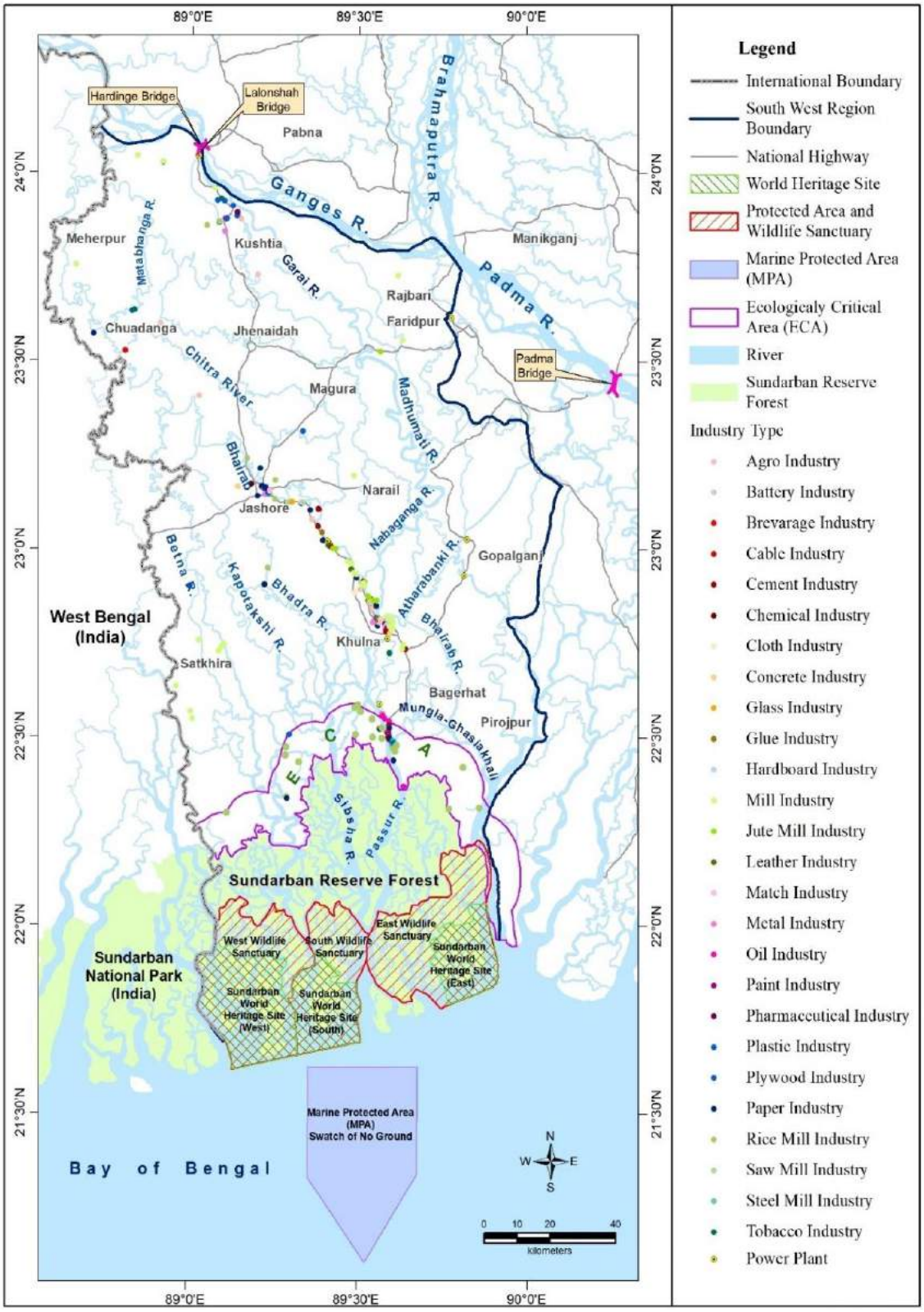


Figure 4.3: Location of Major Air Polluting Industries in SW Region of Bangladesh

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[9]	Sources
		PM2.5	PM10	SO2	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

9 HSD = High Speed Diesel, CNG = Compressed Natural Gas, HFO = Heavy Fuel Oil

Present Running Power Plant	No	Emissions Rate (g/s)				UTM Coordinates		Fuel Type[9]	Sources
		PM2.5	PM10	SO2	NOx	East.	North.		
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

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

Roads and Locomotives		Baseline (gm/s/m)			
	Width (m)	PM2.5	PM10	SO2	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	PM10	SO2	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.	PM2.5	PM10	SO2	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
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
		PM2.5	PM10	SO2	NOx			
NWPGCL 225 MW Combined Cycle Gas Power Plant	1	1.31	1.31	0.73	19.6	60	LNG[10]	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
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

10 LNG = Liquefied Natural Gas

Future Power Plant	No	Emissions Rate (g/s)				Stack Height (m)	Fuel Type	Emission Inventories
		PM2.5	PM10	SO2	NOx			
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	Width (m)	Baseline (gm/s/m)			
		PM2.5	PM10	SO2	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)
	PM2.5	PM10	SO2	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.	PM2.5	PM10	SO2	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 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
		PM2.5	PM10	SO2	NOx			
NWPGCL 225 MW Combined Cycle Gas Power Plant	1	1.31	1.31	0.73	19.6	60	LNG[11]	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

[11] LNG = Liquefied Natural Gas

Future Power Plant	No	Emissions Rate (g/s)				Stack Height (m)	Fuel Type	Emission Inventories
		PM2.5	PM10	SO2	NOx			
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

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

Roads and Locomotives	Road Width (m)	Baseline (gm/s/m)			
		PM2.5	PM10	SO2	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)
	PM2.5	PM10	SO2	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

Name	Emission Rate (g/s-m2)				Release Height (m)
	PM2.5	PM10	SO2	NOx	
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.	PM2.5	PM10	SO2	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

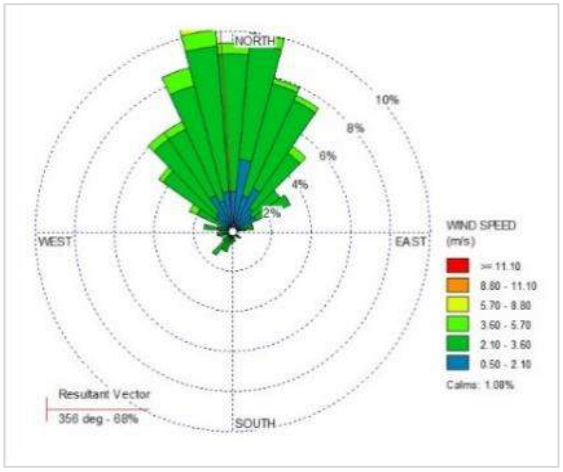
A numerical system combining the MM5 meteorological model12 and the air quality model CALMET (a diagnostic three-dimensional meteorological model which is a part of the CALPUFF package13) was applied to the SW region. Pre-processed hourly Weather Research and Forecasting (WRF) meteorological data (resolution 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., Canada14.

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.

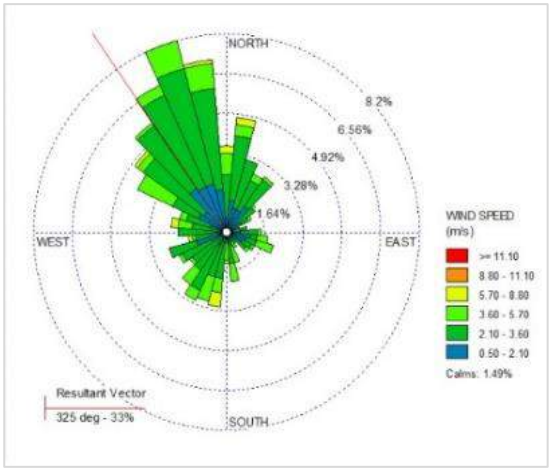
[12] See https://www2.mmm.ucar.edu/mm5/

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

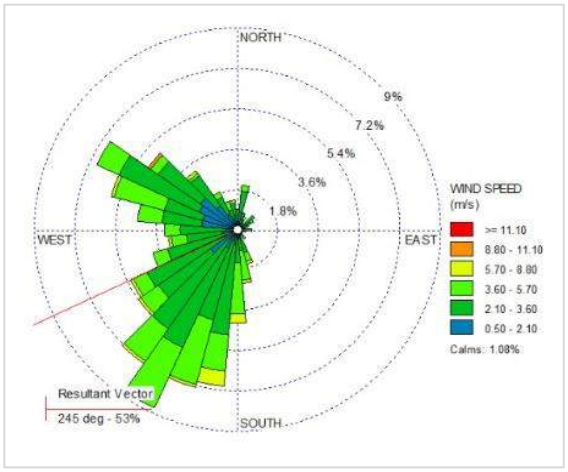
[14] See: https://www.weblakes.com/?AspxAutoDetectCookieSupport=1



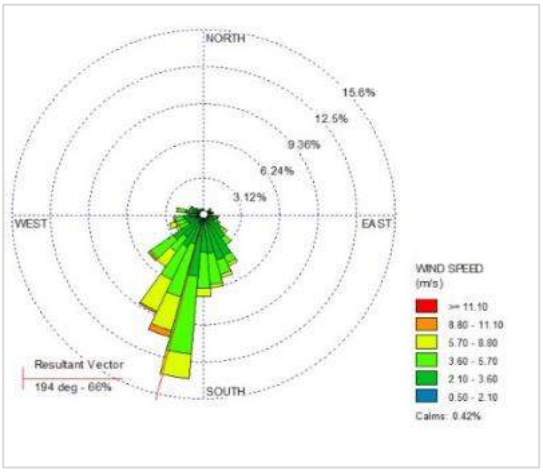
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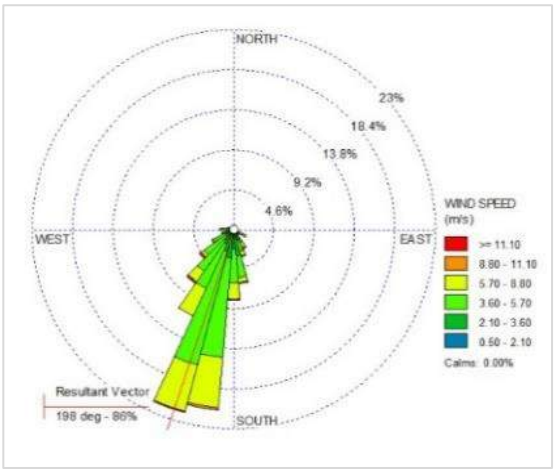
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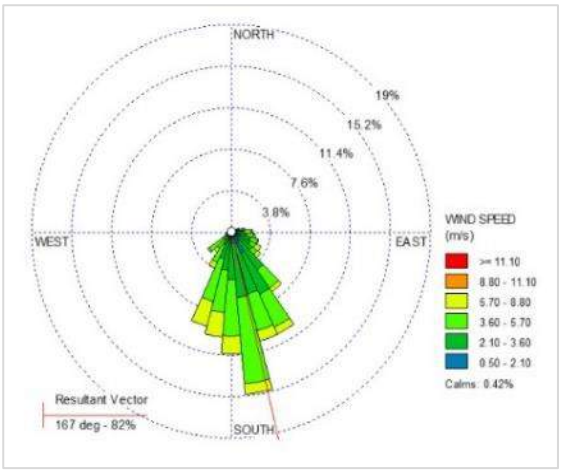
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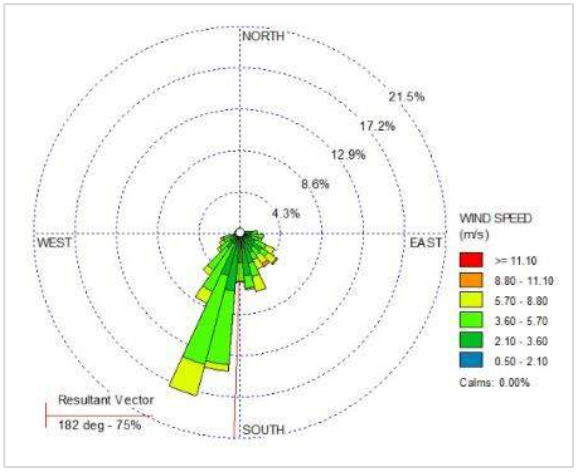
April 2019



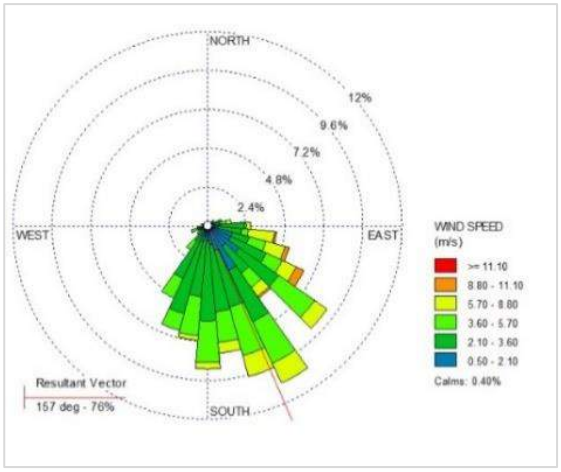
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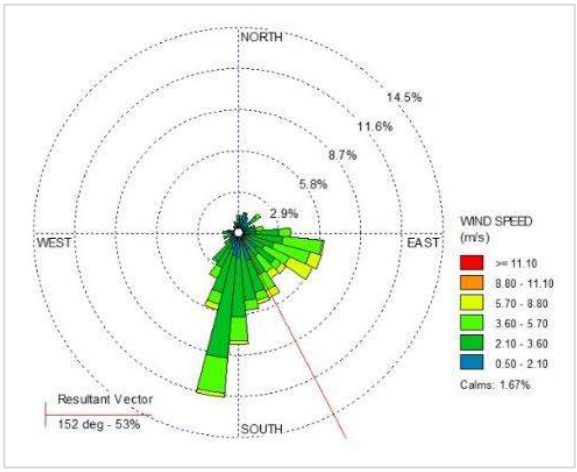
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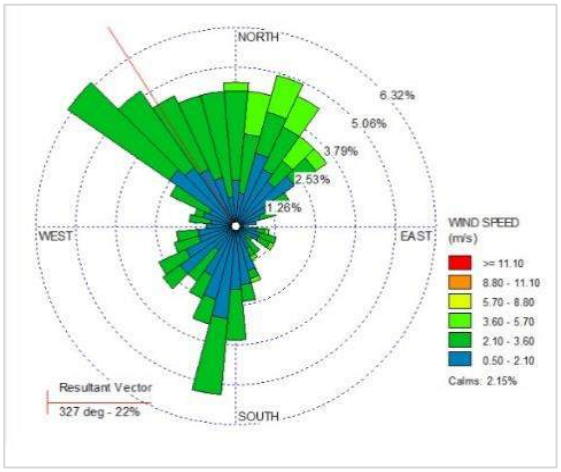
July 2019



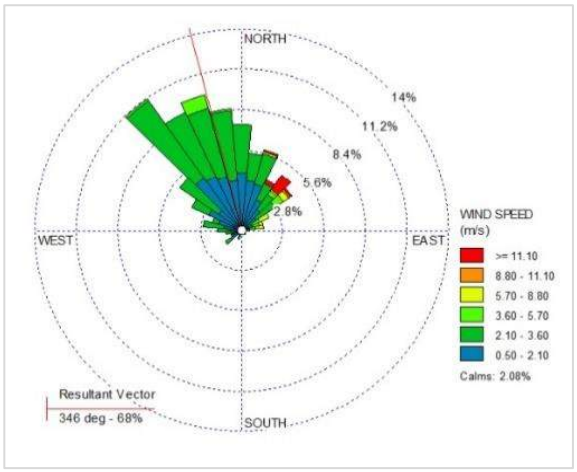
August 2019



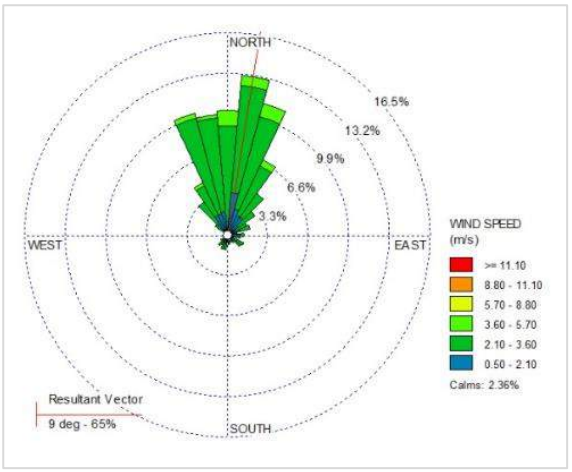
September 2019



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).

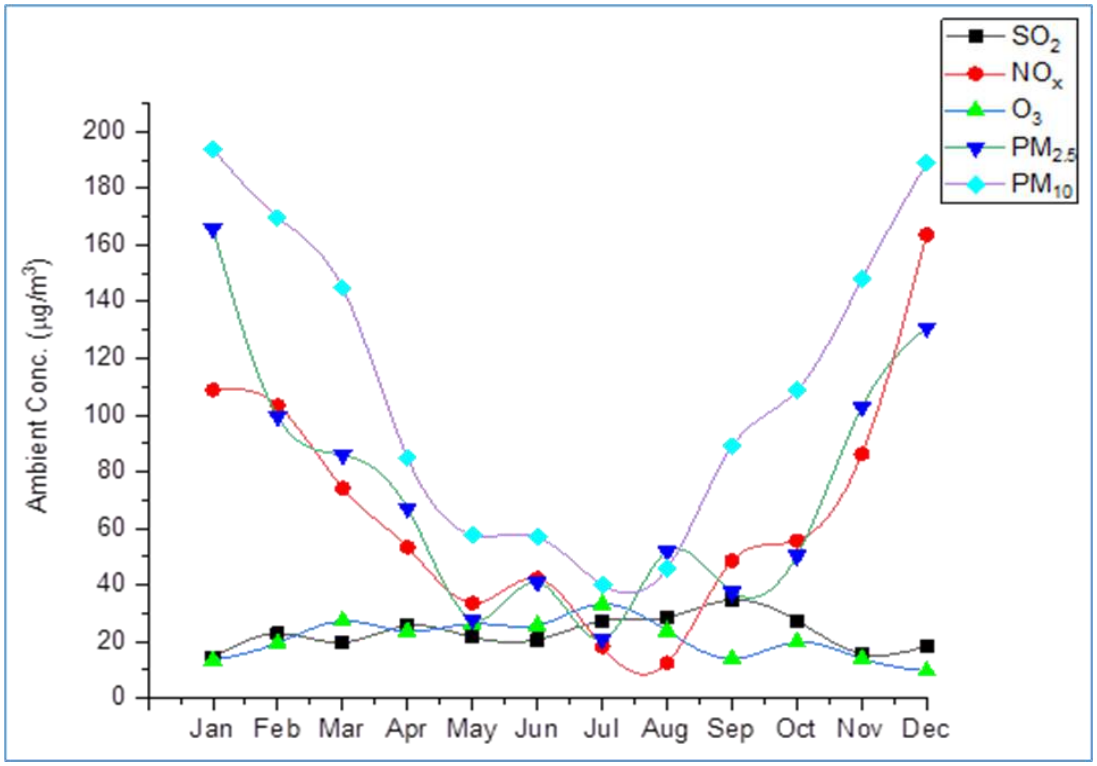


Figure 4.5: Monthly Ambient Air Quality at CAMs-9 (Khulna City)

Air quality was found to be compliant with national air quality standards for SO2 and NO2, but extremely poor as regards particulate matter (PM10 and especially PM2.5.). Annual average ground level concentration of PM2.5 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 PM2.5 (more than 40 µg/m3) was also recorded in the Khulna area in all seasons. Similarly, the concentration of PM10 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 SPM15 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).

15SPM = Suspended Particulate Patter

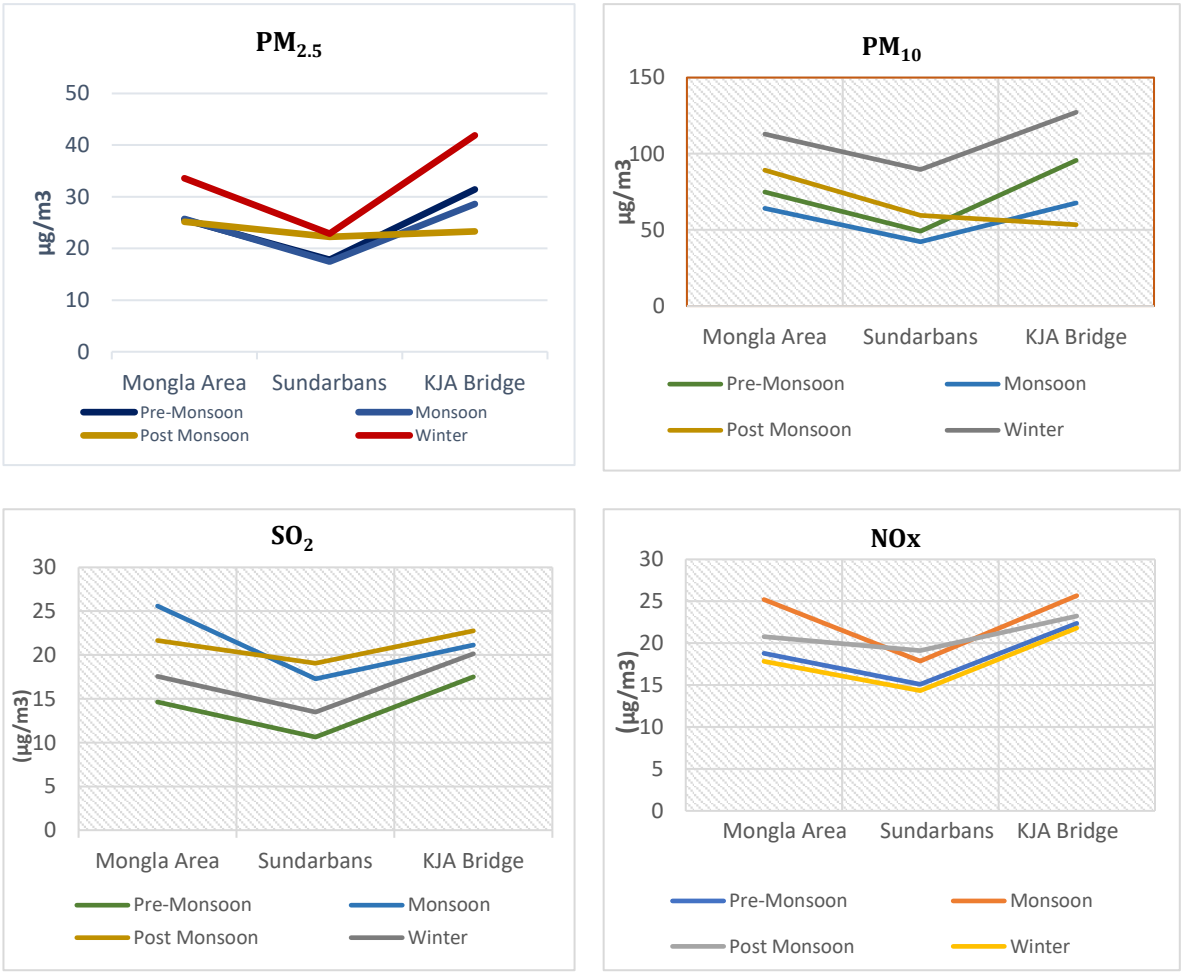


Figure 4.6: Seasonal Variation of Air Quality at Mongla, Sundarbans and KJA Bridge

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 PM10 and PM2.5 respectively as mentioned in the Eighth Five Year Plan.

The concentration of SO2 also varies depending on the fluctuation of emission sources, location and quantity, and weather conditions. Ambient SO2 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 PM2.5 was found to be higher (124 µg/m3) in the Khulna area than in other areas during 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 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 SO2 was higher (25 µg/m3) 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/m3) 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 SO2 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.

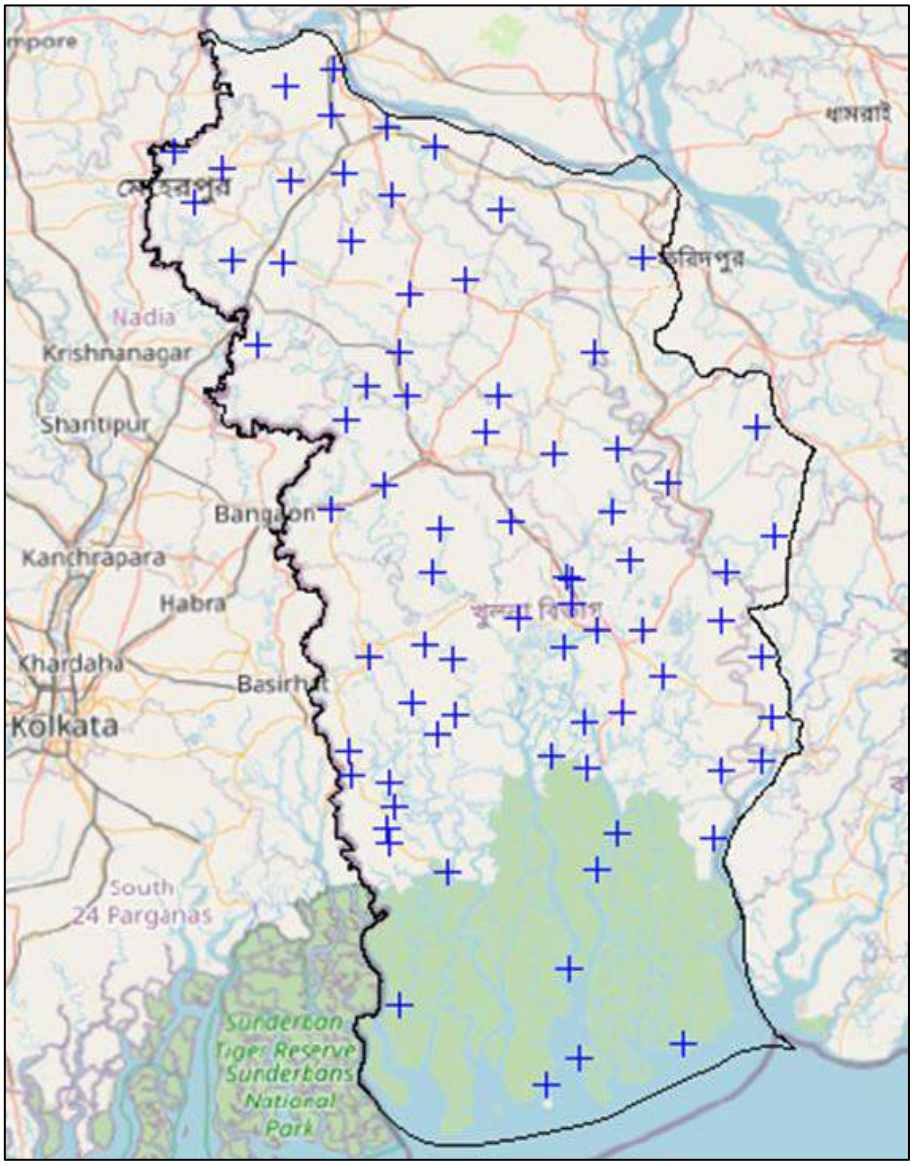


Figure 4.7: Location of Key Receptor Points

4.1.9 Dispersion Modelling for Particulate Matter

The spatial distribution of PM2.5 and PM10 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 PM2.5 and PM10 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 km2 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 PM2.5 exceed 30 µg/m3 in any year; at 66 points, a concentration of 25 µg/m3 is not exceeded in any year; and at 42 points, a concentration is less than 20 µg/m3 in any year. The lowest modelled concentrations of PM2.5 are 17.1 µg/m3 in 2019, 18.3 µg/m3 in 2031 and 18.38µg/m3 in 2041.

In the case of PM10, modelled concentrations at the remaining 75 key receptor points are lower than 73.2 µg/m3; and at 19 points, the concentration is 60 µg/m3 or above. At 50 points the average annual concentration usually does not exceed 60 µg/m3 in any year. The lowest modelled concentration of PM10 is 53.2 µg/m3 in 2019, 53.6 µg/m3 in 2031 and 54.0 µg/m3 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.

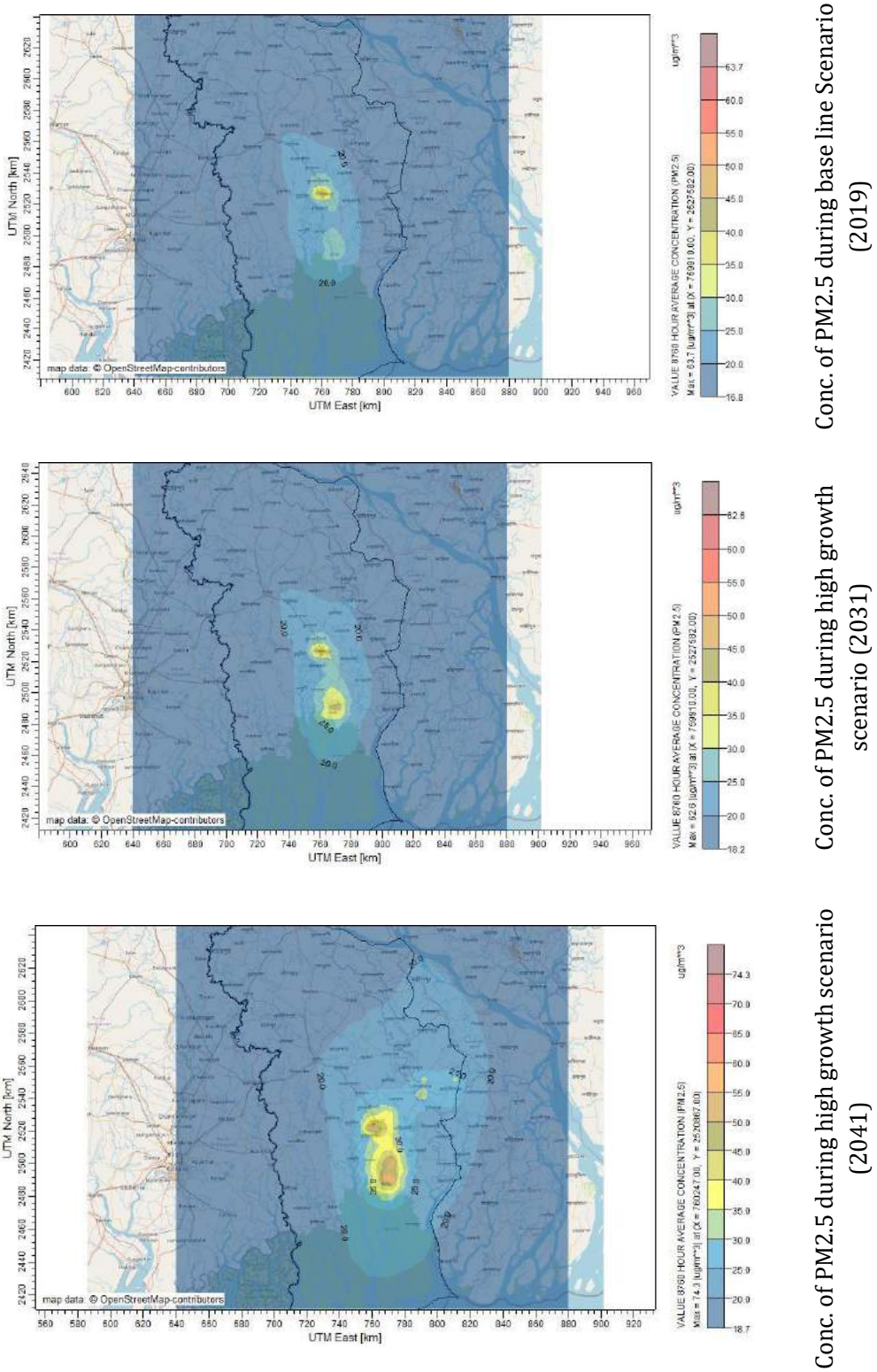


Figure 4.8: Spatial Distribution of PM2.5 Concentrations for Baseline and Projected for 2031 and 2041 (Annual Average Ground Level Concentrations)

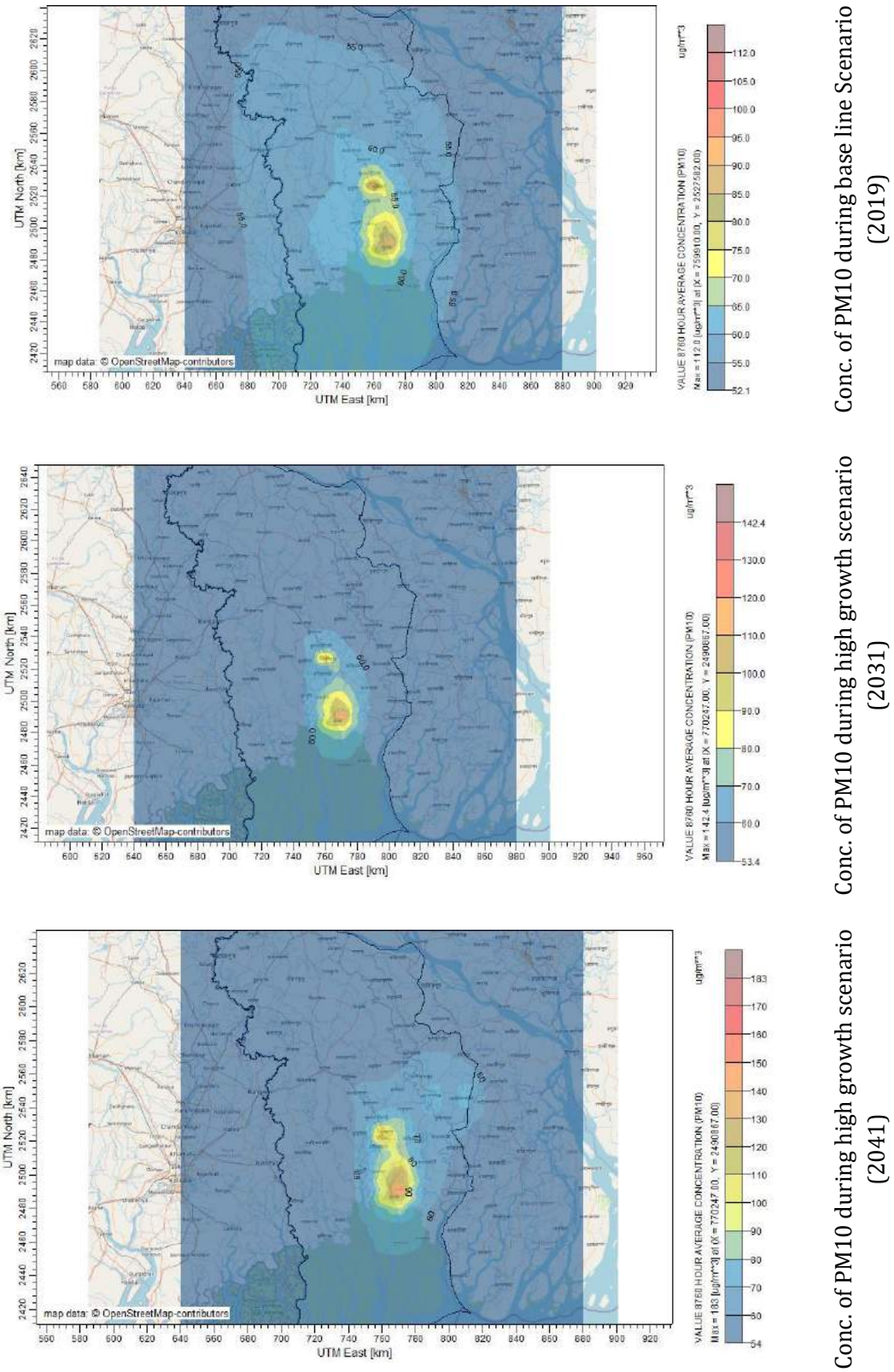


Figure 4.9: Spatial Distribution of PM10 Concentration for Baseline and Projected for 2031 and 2041 (Annual Average Ground Level Concentrations)

Table 4.13: Key Receptor Points with the Highest Concentrations of PM2.5 and PM10

Receptors	Annual GLC for PM2.5 (µg/m3)				Annual GLC or PM10 (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 PM2.5 across the majority of the SW region is, and will remain, below 25 µg/m3, while the high particulate pollution is, and will stay, concentrated in relatively small areas (Khulna and Mongla). Air quality (PM10 and PM2.5) 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 PM10 is currently exceeded, and most probably will be exceeded at all key receptor points by 2031 and 2041. In the case of PM2.5, 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 PM10 and PM2.5 at the key receptor points within the Sundarbans are presented in Table 4.14.

Table 4.14: Concentrations of PM10 and PM2.5 at Key Receptor Points within the Sundarbans

Important points in Sundarbans	PM2.5 (µg/m3)				PM10 (µg/m3)			
	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 PM10 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 PM2.5 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 PM10 and PM2.5 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 PM2.5 and PM10 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 SO2 and NOx/NO2 for the baseline (current situation 2019) and high growth scenario by 2031 and 2041 (it is assumed that 100% of the NOx emissions are converted into NO2).

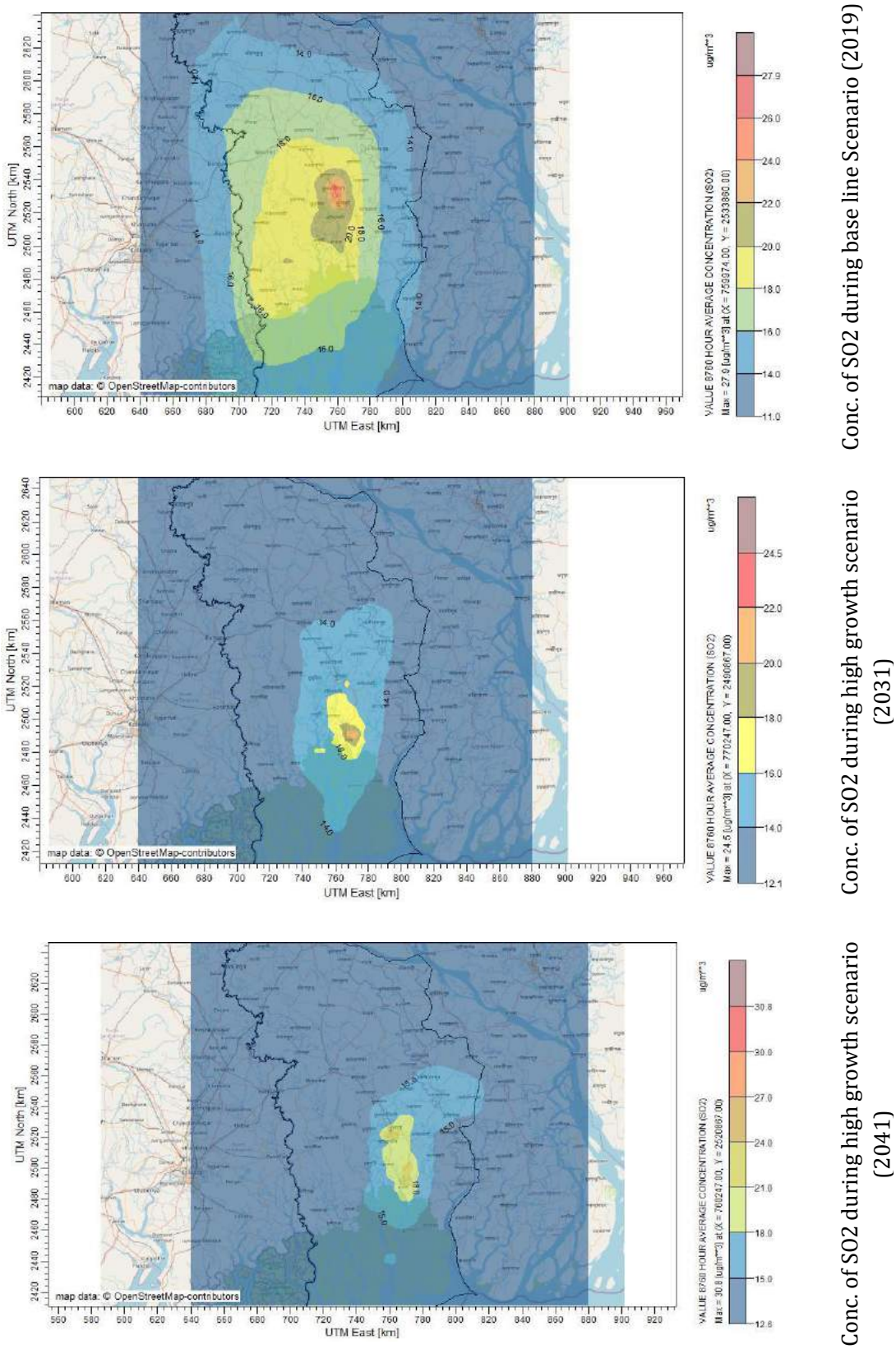


Figure 4.10: Spatial Distribution of SO2 Concentrations for Baseline Year (2020) and Projected for 2031 and 2041 (Annual Average Ground Level Concentrations)

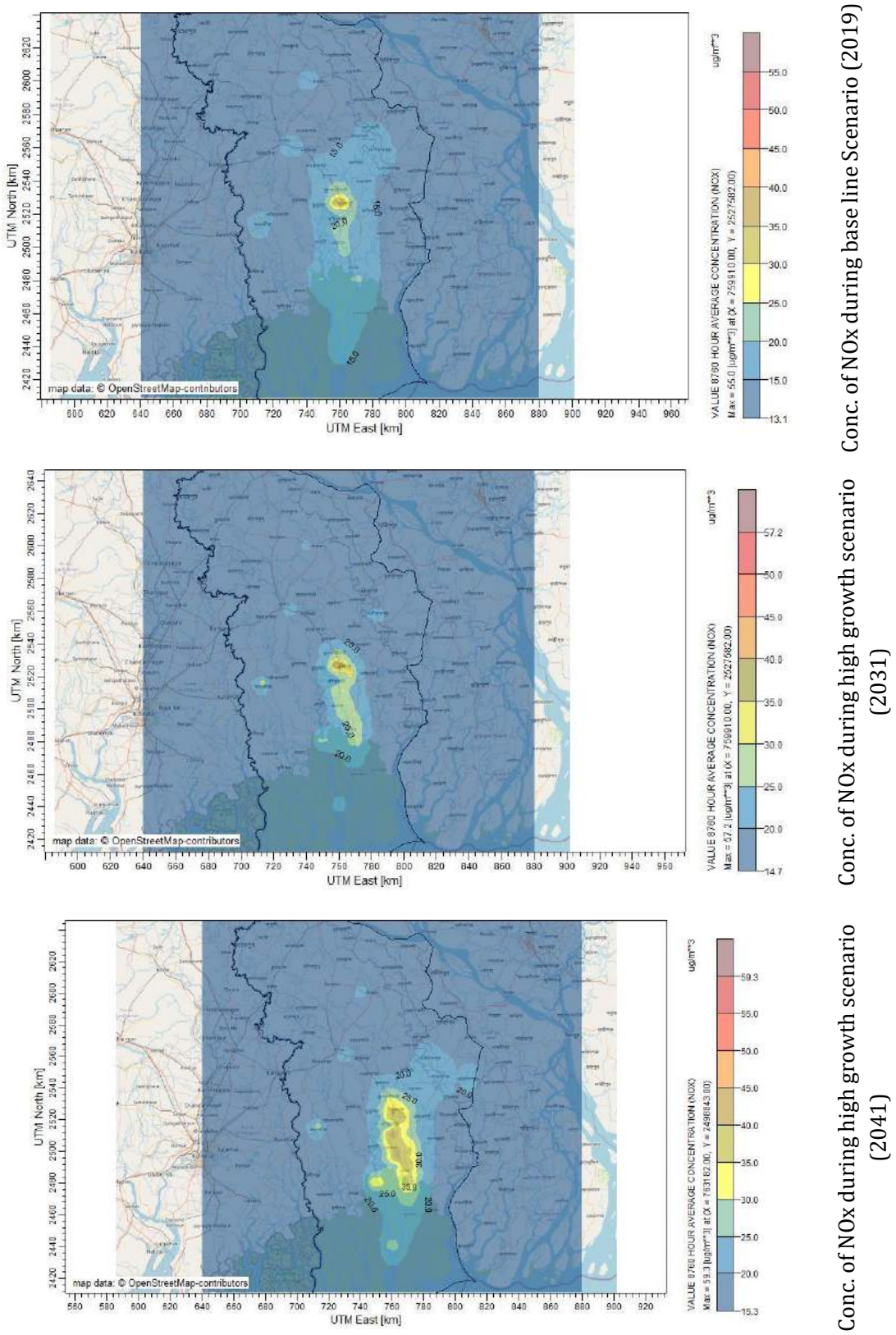


Figure 4.11: Spatial Distribution of NOx /NO2 Concentrations. for Baseline Year (2020) and Projected for 2031 and 2041 (Annual Average Ground Level Concentrations)

SW region

The eight key receptor points with the highest annual average ground level concentrations of SO2 are listed in Table 4.15.

Table 4.15: Key Receptor Points with the Highest Concentrations of SO2 in the SW Region

Receptors	Coordinates		SO2 (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 SO2 exceeds 20 µg/m3 in any year; and only in 3 points is it greater than 20 µg/m3 in 2041. The lowest modelled concentrations of SO2 were µg/m3 12.1 in 2019, 12.3 µg/m3 in 2031 and 12.6 µg/m3 in 2041. Overall, the maximum yearly concentration of SO2 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 SO2 concentrations;
- (see Figure 4.10), the modelling shows that the concentration of SO2 across the majority of the SW region is, and will remain, below 20 µg/m3 while the slightly increased pollution is, and will be concentrated, around the Mongla-Khulna roads. However, the values of SO2 at all receptor points are well below the national standard (ECR 2005) of 80 µg/m3.
- The key receptor points with the highest concentrations of NO2 are presented in Table 4.16 (it is assumed that 100% of the NOx emissions are converted into NO2).

Table 4.16: Key Receptor Points with the Highest Concentrations of NO2 in the SW Region

Receptors	**Coordinates**		**NO2 (µg/m3)**			
	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 NO2 is less than 25 µg/m3 in any year; at 55 of them, the concentration is less than 20 µg/m3 in any year. The annual average ground level concentration of NO2 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 NO2 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 NO2 concentrations occupying an area of 2,000 km2 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 NO2 concentrations (see Figure 4.11), it can again be concluded that the concentration of NO2 across the majority of the SW Region is, and will remain, below the Bangladesh standard of 100 µg/m3 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 SO2 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 NO2 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 SO2 and NO2 at the key receptor points within the Sundarbans are presented in Table 4.17.

Table 4.17: Current and Projected Annual Average Concentrations of SO2 and NO2 at the Key Receptor Points within the Sundarbans

Key receptors poinst in the Sundarbans	SO2 (µg/m3)				NO2 (µg/m3)			
	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 SO2 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 NO2 at all key receptor points located within the Sundarbans show an increasing trend from 2019 to 2041; but are well below the Bangladesh standard16.

4.1.11 Conclusions and Recommendations

SW region

The most polluted sites as regards PM and NO2 (predicted by 2031 and 2041) are in the Mongla–Rampal-Khulna and Khanjan-Ali areas. The higher PM and NO2 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 PM2.5, presents a very high risk for human health, and may also have an impact on fauna and flora.
- Pollution by NO2 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 SO2 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 (PM10, PM2.5) 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).

16 For international standards, see Annex 9.

As regards gaseous pollutants, the concentration of SO2 will reduce considerably by 2041 in the Sundarbans Reserve Forest and is considered negligible. But NO2 shows an increasing trend particularly close to source points up to 2041.

The impact of NO2 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).

4.2 Water Quality Modelling

4.2.1 Introduction

The modelling addressed levels of nitrate (NO3-) and phosphate (PO4-) 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 (NO3-) and phosphate (PO43-). 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 eutrophication17 and result in algal blooms18.

4.2.3 Methodology

The study was based on a hydrological model developed by CEGIS using SOBEK suite19. 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).

17 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.

18 Some algal bloom can release toxins that contaminate drinking water.

19 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/).

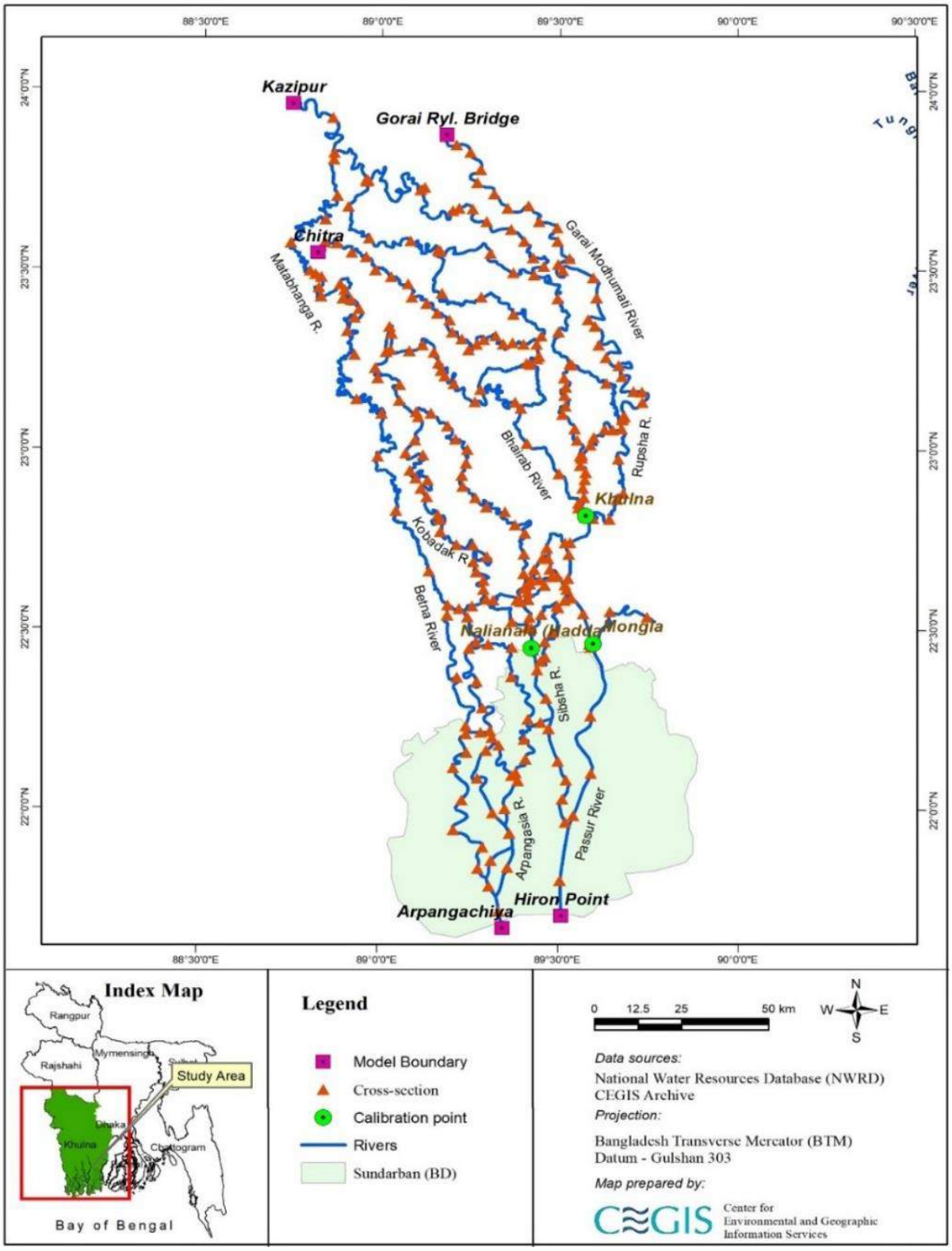


Figure 4.12: Computational Domain of the Hydrodynamic Model

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 region20.

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 model21 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.

20 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/).

21 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.).

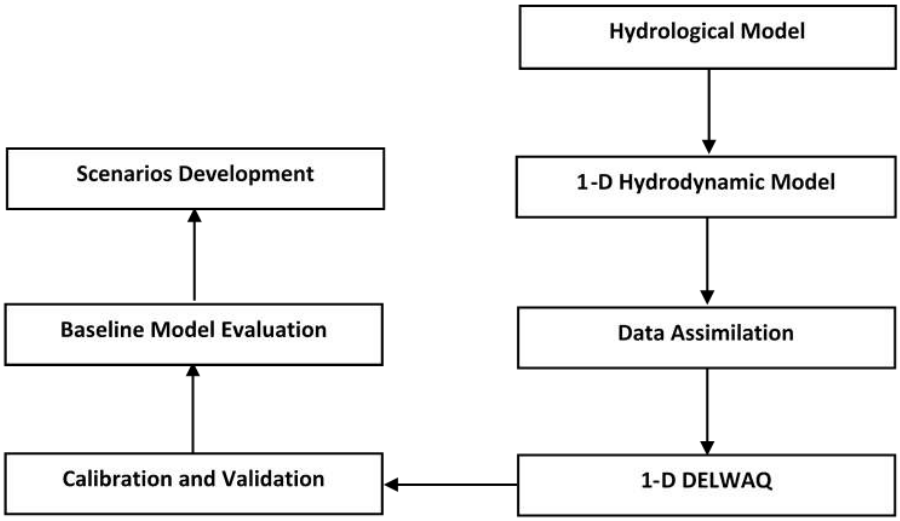


Figure 4.13: Approach of the Water Quality Modelling

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

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)[22] and the export processing zone (EPZ) (at Mongla)[23]. 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 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.

22 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.

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

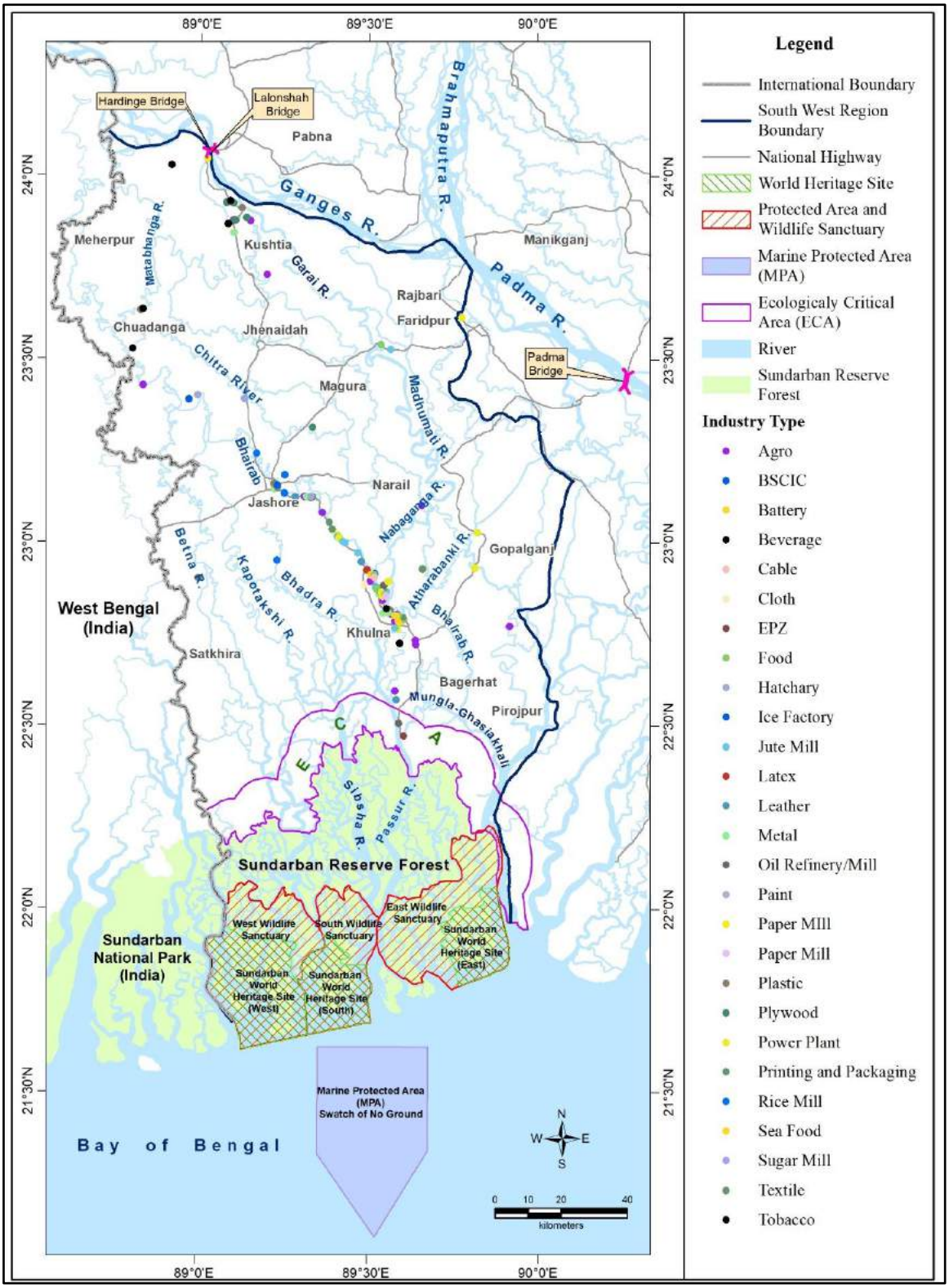


Figure 4.14: Distribution of Industrial/Mills, Medium and Small-scale Processing Zones, Factories and the Small-scale Units Discharging Liquid Wastes Directly to the River Systems in SW Region

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

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.

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.

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).

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

Month	Flow (m3/s)	Nitrate (mg/L)	Phosphate (mg/L)
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

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

SL	Industry Type	Baseline (2020)	Projected Industry (2031)	Projected Industry (2041)
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[24] is expected to be achieved. Thus, the concentration levels of nitrate and phosphate are projected to be one-third of the baseline (2020) 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.

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).*

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

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.

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.

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[25] 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

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

Month	Discharge (m3/s)		
	Gorai-Madhumati	Hisna-Mathabanga	Chandana-Barasia
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.

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 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

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 flow26.

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 seasons27 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

26 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.

27 Wet season = June to early October, dry season = later October – May.

validation period at Mongla station where consistent hourly-observed data was available. For the other two 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)28, 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.

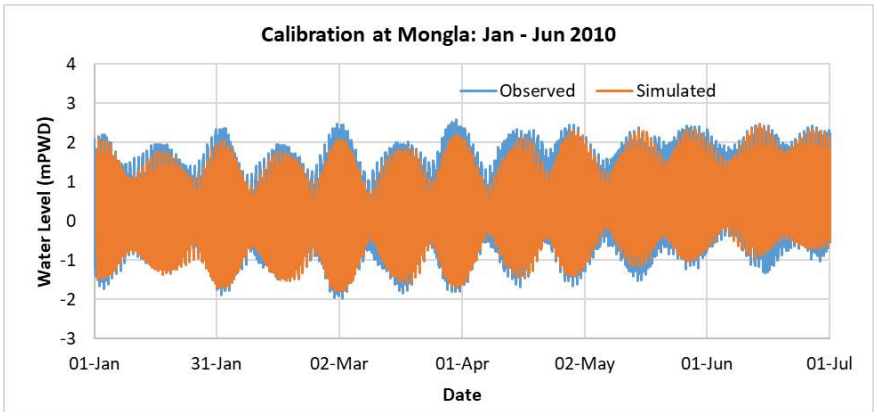


Figure 4.15: Observed and Simulated Water Levels for Calibration Period at Mongla Station on the Passur River (Jan – Jun 2010)

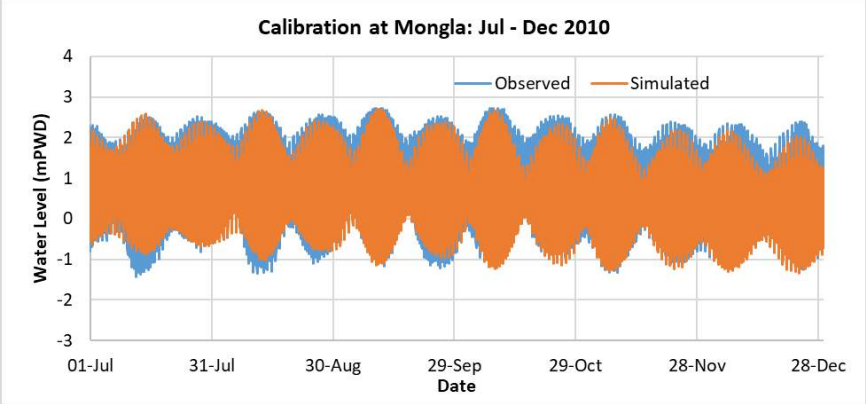


Figure 4.16: Observed and Simulated Water Levels for Calibration Period at Mongla Station on the Passur River (Jul – Dec 2010)

28 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).

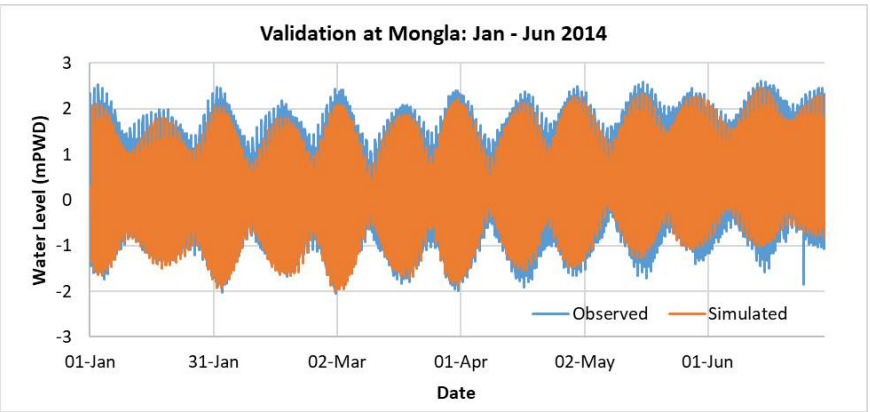


Figure 4.17: Observed and Simulated Water Levels for Validation Period at Mongla Station on the Passur River (Jan – Jun 2014)

Water quality model development

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

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).

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.

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).

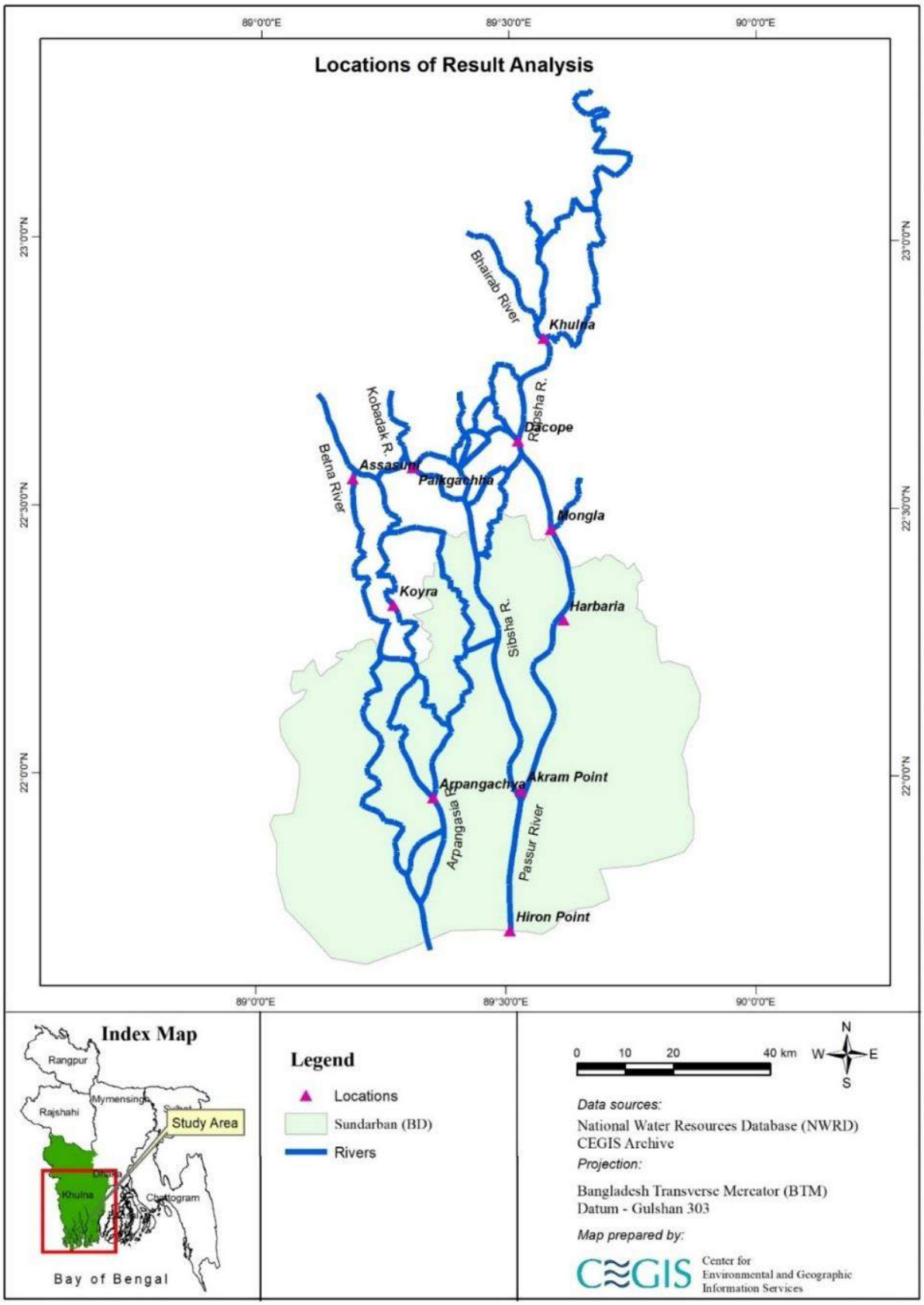


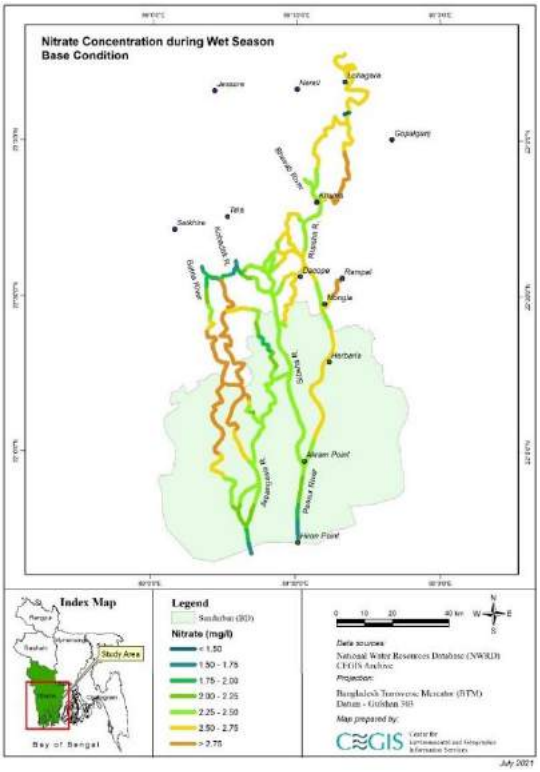
Figure 4.18: Simulation Site Locations

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

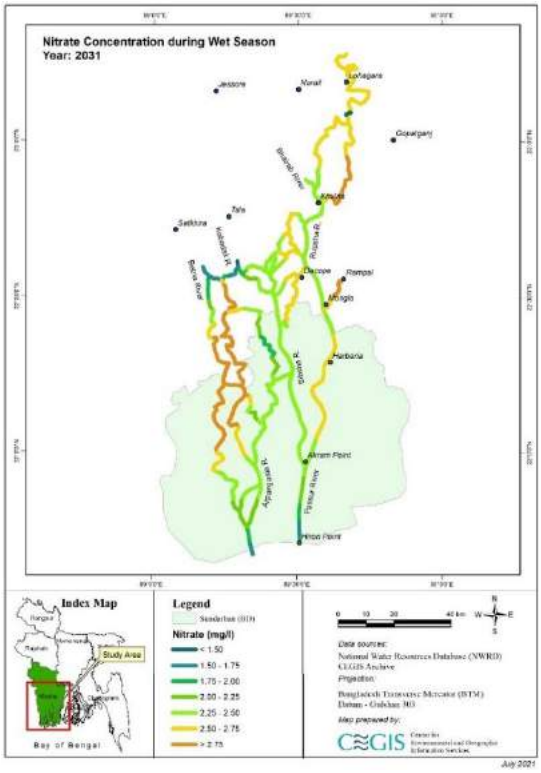
Location	Nitrate during dry season (mg/l)			Nitrate during wet season (mg/l)			Inland Surface Water Quality Standard (ECR'1997 and Draft ECR'2017)
	Base	Y_2031	Y_2041	Base	Y_2031	Y_2041	
Khulna	3.97	2.48	2.48	2.44	2.54	2.48	5.0 mg/L
Dacope	3.84	2.76	2.76	2.50	2.50	2.42	
Mongla	3.78	2.85	2.84	2.49	2.50	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)

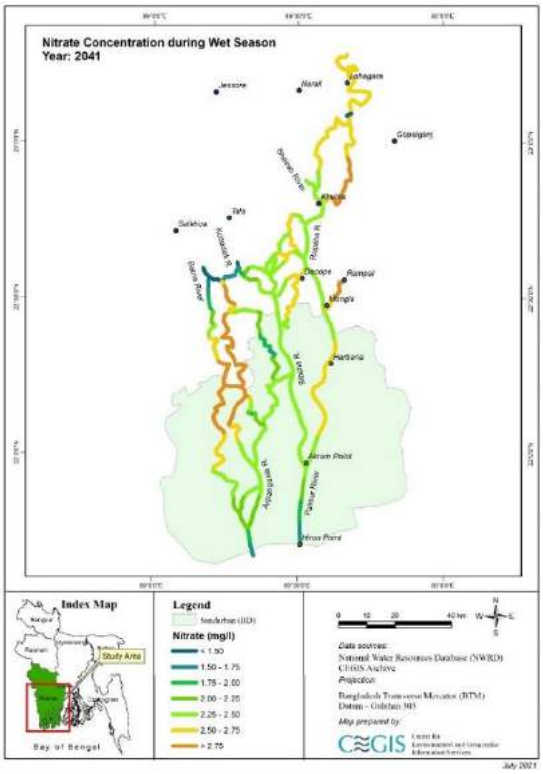
Location	Phosphate during dry season (mg/l)			Phosphate during wet season (mg/l)			Inland Surface Water Quality Standard (ECR'1997 and Draft ECR'2017)
	Base	Y_2031	Y_2041	Base	Y_2031	Y_2041	
Khulna	0.26	0.18	0.19	0.58	0.36	0.36	0.5 mg/L
Dacope	0.23	0.18	0.19	0.59	0.38	0.39	
Mongla	0.22	0.18	0.19	0.58	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 2: 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[29], oil pollution, hydrocarbon pollution, dissolved organic carbon, AOX30, 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.

29Chemical Oxygen Demand

30Adsorbable Organic Halides

Annex IV: Padma Bridge

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.

Annex V: Linkage Diagram, Industrialization

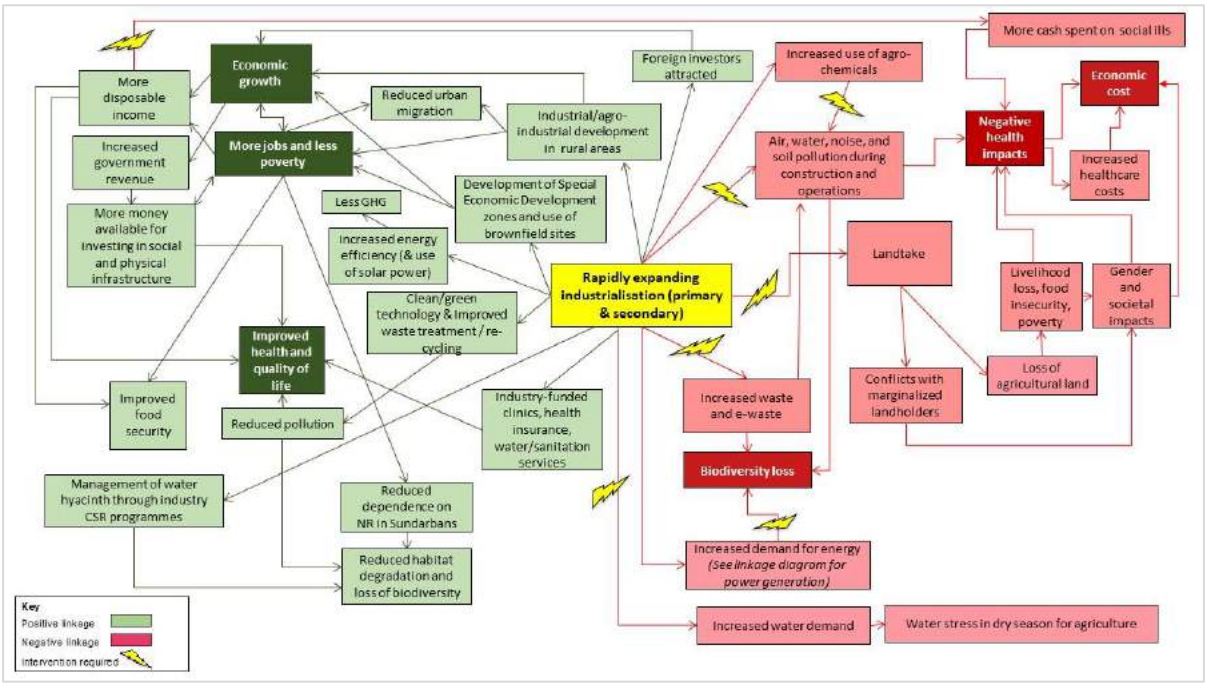


Figure 9.1: Industry: Rapidly Expanding Industrialization

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.

Annex VI: Environmental safeguards of Rampal Power Plant

Environmental safeguards of Rampal Power Plant

- Rampal plant is located about 14 Km away from the nearest tip of the Sundarbans outer periphery and more than 65 km away from the World Heritage Site of UNESCO. Rampal power project has taken all desired measures to control environmental parameters as per Air Pollution Control Rule (APCR), 2022 and Environment conservation Rule (ECR), 1997 &2023 and Noise Pollution Control Rule 2006.
- Salient points of Environment clearance by DOE for project have been implemented in line with Environment Approval conditions:
  - 100% utilization of fly ash and bottom ash
  - Dry Bottom ash collection.
  - 275 Meter Height Chimney for wider dispersal of any remaining gases,
  - ETP for removing suspended oil and other impurities
  - High Efficiency Electro Static Precipitator (ESP)- Efficiency > 99%,
  - Integrated wet Flue Gas Desulfurization (FGD) eliminated 96% SO2 – (Capacity to remove upto 3.5 MT SO2 per hour). Wet FGD will also reduce mercury emission if any traces are available in coal.
  - Low NOx Burner for reduction of NOx emission
  - Online air and water quality monitoring system
- High steam temperature and pressure to increase plant efficiency in turn less coal consumption per unit of electricity and less Green House Gas emission. Imported coal of High GCV, Low Sulphur and Low Ash content is being used.
- Also tree plantation is in progress to develop Green belt. As on todate 116,000 saplings already planted.
- To safeguard environment, Rampal Plant has implemented online air, water quality monitoring system. The current operating parameters may be summarized below:

Stack/ Flue Gas Emission Parameter		
Parameter Name	**Current Operating Data (mg/Nm3)**	**DoE Limits (APCR'2022)**
SOx	<25	200
NOx	< 75	200
SPM	<10	50
CO	<10	

Discharge/Drain Water Parameter			
Parameter Name	**Current Operating Data**	**Measurement Unit**	**DoE Limits (ECR'2023)**
pH	8.7		6 - 9
DO	7.2	Milligram/l	4.5 - 8 (as per ECR'1997)
TOC	4	Milligram/l	
Conductivity	38400	microS/cm	
TRC	Nil	Milligram/l	1.2
O&G	<1	Milligram/l	20
BOD	<50	Milligram/l	100
COD	<100	Milligram/l	250
TSS	<25	Milligram/l	100
Temp	<35 ^{0}C	^{0}C	Temperature differential of 5^{0}C

Data of air quality at plant gate - AAQMS1			
Other 3 AAQMS likely to become functional in June/ July'23			
Parameter Name	**Current Operating Data**	**Measurement Unit**	**DoE Limits of Ambient Air Quality Standards (APCR,2022)**
NOx	6.07	microgram/m3	40
SO2	58.92		80
CO	2.12		5
O3	31.77		100
PM10	33.23		50 (Yearly average data)
Hg	0.41		

Pollution at Jetty Area		
Parameter Name	**Last measured Data in Apr'23 (microgram/m3)**	**DoE Limits of Ambient Air Quality Standards (APCR,2022)**
SO2	17	80
NOx	42.86	40
SPM	197.4	
PM10	81	150 (1hour average data)
PM2.5	69	65
CO	0.3	5
O3	19.6	100

Online monitoring at present
All above mentioned parameters except air quality at jetty

- Moreover, BIFPCL is strictly following the EIA clauses mentioned during approval for coal transportation
- The Coal Handling Plant is designed as closed system including conveyors with Dust Suppression and Dust Extraction system.
- Coal is stored in a fully covered storage yard and water sprinkler system provided with automated moisture sensor to Control self-combustion
- Coal shipment and transshipment is being carried out in closed vessel and barges.
- Coal shipment vessels are following all the guide lines of Mongla Port Authority (MPA) protocols to ensure no hindrance to other vessels.
- The vessels used for coal shipment are maintaining IMO (International Maritime Organization) criteria to enable identification of substances harmful to the marine environment.
- Further, an Environment Monitoring Plan (EMP) is in place for monitoring of environmental Parameters during Construction and Operation phase. Regular monitoring is being done in the following areas:
  - Physical Environment (Air, water, noise)
  - Water Resources
  - Transportation
  - Land and agriculture
  - Fisheries
  - Ecosystem
  - Socio-economic Environment
- A reputed third party M/s CEGIS (Centre for Environmental and Geographic Information Services), Dhaka, Bangladesh has been monitoring environmental parameters as per EIA approval since Feb 2014 and quarterly reports are being submitted to Department of Environment, Bangladesh on regular basis.
- In view of the above, state party confirms that the Rampal Coal Plant is not affecting the Outstanding Universal Value (OUV) of the Sundarbans Reserve Forest.

Third Party observation/statement

Clause/ Reference No. Page Page- 5 & 12

Increase in Boat Traffic in Mongla Exhibit 5A – Mongla and Pashur River boat traffic showed approximately 52 vessels - Jan 2018;

Mongla and Pashur River boat traffic showed approximately 135 vessels - December 2022

Bangladesh Responses

Mongla Port Authority

Dredging in Pashur River: Capital dredging was undertaken in the Pashur River from Mongla Port to the Rampal Power Plant, to ensure the smooth flow of navigation. The environmental impact of this dredging activity was carefully assessed, taking into account both the dredging method and the selection of disposal sites for the dredged materials. The disposal sites were strategically chosen to minimize their impact on the environment, specifically by being located far away from the Sundarban

area. Throughout the dredging process, strict adherence to prescribed methods was maintained, ensuring the protection of the Sundarban's Outstanding Universal Value while minimizing disruptions to its diverse flora and fauna. The primary objective of this endeavor was to sustain navigability while safeguarding the delicate ecological balance of the Sundarban region.

Increased number of boat traffic. Bangladesh is on the process of graduating from Least Developed Country to Developing Country. Since Mongla Port is the second largest sea port of Bangladesh, the boat traffic in Mongla area has also increased correspondingly. However, with this rise in boat traffic comes an elevated risk of marine accidents in the Pashur River, which could potentially have catastrophic environmental consequences. MPA has already prepared a comprehensive **ACTION PLAN** to prevent marine accidents and mitigate impact in case of emergency.

At present, MPA operates one Oil Spill Recovery Vessel in her fleet. MPA has recently undertaken a project namely 'Modern Waste and Spilled oil Management Project' which is expected to be completed by June 2024. The project includes a Waste Processing Plant, two Oil Spill Response Vessel, one Waste Collection Vessel, tug boats, barges etc. Once completed, all types of wastes including accidental oily discharges from all industries and ships in Mongla area will be collected and processed in the plant. Moreover, the capability of MPA in responding to accidental spillage of oil in the area will also increase manifold.

Mongla Port being an eco-friendly port remains committed to the conservation of the biodiversity of Sundarban and maintain the OUV of the World Heritage site.

Clause/ Reference No. Payra Port, Payra Port Bridge; Exhibit number 11 and 13, page-5

Response of the State Party

- Payra Sea Port Infrastructure/Facilities Development: Development of Payra sea Port Infrastructure development was undertaken in the West bank of Andharmanik River in Kalapara, to ensure smooth conduct of port operation. The environmental impact of this development was carefully assessed, taking into account both the method and the selection of land for the construction of infrastructures/facilities. The development sites were chosen taking the opinions from Environmental Ministry and complying in full to their terms and conditions. Moreover, Payra Port is committed and vowed to grow as green sea port. The construction materials were carrying from distant places and sometime outside Bangladesh. Hence, it would not have any adverse effect to the environment and the flora and fauna in and around Andharmanik River.
- Construction of First Terminal. Bangladesh is on the process of graduating from Least Developed Country to Developing Country. On that note, Payra port will improve the economy and the lifestyle of this underdeveloped Southwestern region. Since Payra Port is the first green sea port of Bangladesh, the construction process is continuing in full swing complying all the requirements of the Environmental Ministry. It may be mentioned that the first GoB terminal is growing on the west side of Rabnabad channel. Payra sea port is following all parameters of SEA and are closely monitored to have a negative catastrophic impact on environment as well as Sundarbas, the world heritage site.
- Payra Port being a Green Field Project of the Govt of Bangladesh and all the projects of Payra are marked as ORANGE category. Therefore, port remains committed to the conservation of the biodiversity of Sundarban and maintain the OUV of the World Heritage site.
- Ministry of Shipping is committed to the conservation of the biodiversity of Sundarban and maintain the OUV of the World Heritage sit

Annex VII: Environmental safeguards of Payra 1320 MW Thermal Power plant

Environmental safeguards of Payra 1320 MW Thermal Power plant

Payra 1320 MW Thermal Power plant is 42.75 km away from Sundarbans outer territory.

1. Online monitoring system:

- At Payra Thermal Power Plant, CEMS (continuous emission monitoring system) is adopted to monitor the stack emission concentrations continuously which may have potential threats to climate change and global warming. Emission level of SO2, NOx, PM, and CO are continuously monitored. CEMS has been set up on the chimney which continuously works for monitoring the mentioned air quality parameters.
- An interface of CEMS is provided to Department of Environment (DoE) for their continuous observations remotely. In addition, the DoE inspect the ambient air quality on quarterly basis.
- Quality of blow down water discharge from cooling tower is also monitored by DoE through online monitoring system.

1.A. Air pollution control:

Modern Technologies:

- Low NOx Burner

  - Nitrogen oxides form when oxygen and nitrogen from the air interact during a high-temperature combustion event.
  - Low NOx burners are designed to control air and fuel mixing at each burner, which creates more branched and larger flames. By reducing the peak flame temperature, significantly less NOx is formed in the process. By means of this process, NOx concentration at outlet of the chimney is kept under 350 mg/Nm3 maintaining international standard. BCPCL is using an effective and proven Low NOx burner technology for reduction of NOx emission and control emission of NOx within the limit of 510 mg/Nm^3 as per WB/IFC guidelines.

- ESP

  - Electrostatic precipitator (ESP) is being used in payra 1320 MW thermal power to collect the ash, dust content from the flue gas. In this process, flue gas is transferred through two type parallel sequential plate which are named as emitter and collector. Those plate are placed in very high potential field which collect the ash particles by means of electro static force. Hence, ash is separated from the exhaust. Efficiency of ESP is approximately 99%. World Bank standard for Particulate Matter is 50 mg/Nm+ and design standard is <50 mg/Nm3.

- FGD

  - Flue Gas Desulfurization (FGD) is mainly deployed to remove SO_2 which eventually turns into sulfuric acid which results in acid rain having very detrimental impact on environment.

- Wet limestone-gypsum flue gas desulfurization technology is being adopted in this project. The SO2 removal efficiency of FGD is not less than 93%.The SOx concentration at outlet of the chimney is under 200 mg/Nm^3 maintaining international standard.

➢ Chimney height

- The flue gas after passing through electrostatic precipitator, it goes to open environment through the chimney. A 220m height chimney is incorporated at Payra Thermal Power plant. As the opening of the chimney is well above the ground so the hot emission doesn't affect the air we breathe. Rest of the emissions after passing through the pollution controllers are dispersed at 220m height. As a result, effect on ground level is minimal.

➢ Covered coal storage:

- Coal is the primary fuel as consumable of Payra 1320 MW Thermal power plant, we have to store coal in connection with the uninterrupted operation of the plant. We have coal domes which are covered. As a result hardly any coal particle/ dust to be dispersed in the environment to pollute the air.

➢ Afforestation:

- Large scale afforestation in and around the project which will improve overall environment/ ambience and also act as a carbon sink. Payra 1320MW Thermal Power Plant has a plan for the plantation of two hundred thousand saplings of different species. Till date around 116,000 saplings have been planted. These saplings consist of, Fruit/ Medicinal Trees, flowers and Coconut trees, Urichiya (Jhaw) etc. BCPCL is not only planting but also taking enough management care to ensure their growth.

Air pollution control in Bulk material (Coal, ash, limestone) handling:

- Bag filters: This filters act as dust collector in all the transfer towers. Additionally, they are also present in fly ash silo. The efficiency is around 99.6%
- Water spray system: Water spray is used throughout the conveyor galleries and jetty to mitigate coal dust dispersion. The water then goes to coal waste water system for treatment.
- Fly Ash removal system: ESP is being used to collect the fly ash from flue gases. This fly ash is then stored at fly ash silo by using the pneumatic piping system. As ESP efficiency is more than 99.9%, there is no issue of environmental pollution from fly ash. Then the ash is sold out to third party by bulker trucks.
- Bottom ash removal system: The bottom ash is collected from the bottom ash bin of the boiler. The bottom ash is then carrying through the bulker trucks for selling. Bag filters and water spray system is adopted to suppress the dust.
- Covered coal conveyor system: All coal conveyor belts are fully covered. Therefore, no coal dust come outside during movement through coal conveyors.
- Covered limestone shed: The limestone stored in the limestone shed which is fully covered.as a result no particle come out to the environment.

2. Water pollution control

- Comprehensive and rigorous measures are taken throughout different water related bodies of the power plant to halt water pollution suitably. Water quality is continuously monitored in different parts of the plant by means of CEMS.

➢ Blow down water

- Induced draft cooling tower is used in this plant so that water can be efficiently reused for cooling action. This technology removes the waste of water significantly. A part of this water is continuously drained. By design, the temperature difference between input and output water is kept within three degree Celsius in accordance to the International standard. The output water quality monitoring system is established and through CEMS the blow down water properties are monitored continuously.

➢ Waste water treatment system

- BCPCL adopted advanced water treatment technologies to treat different liquid effluents from its power plant. Properly treat regular and irregular waste water, Industrial Waste Water System is embraced. Coal waste water treatment system is being taken care of the waste water which get in contact with coal. Sewages from different office buildings inside the power plant are being treated in Sewage waste water treatment center. Accidental oil spillage from fuel oil tanks, transformer or EH oil from turbine comes to Oily Waste Water Treatment System by dint of oil waste water line and properly filtered for reuse. Waste water generated in handling the gypsum slurry here are properly treated in a sophisticated manner within FGD. HCL, NaOCl, organic sulphur and flocculants are used in buffer tank, neutralization tank, reaction tank and flocculation tank to treat this water. The treated water is reused while the sludge is carried to ash pond.

3. Measures for preventing and controlling noise:

Steam/water pipes and flue gas/coal powder pipes are reasonably designed and arranged, and supporting and hanging frames are reasonably chosen, so as to avoid vibration and noise.

Such equipment of relatively loud noise as blower and pump are arranged in closed buildings so as to insulate sound by buildings. Noise at the border of the plant is reduced by means of reasonable planning, arrangement and based on such conditions as distance, terrain and surface features. Use silencers to control air power noise from boiler steam venting and emergency door steam venting, so as to ensure noise is <100dB(A).

4. Coal and ash transportation:

Coal is being imported from Indonesia. At the coal loading port the vessel is completely covered its all hatches after vessel loaded. So, when coal transportation occurs from Indonesia to BCPCL jetty no coal come out to the outside in the environment. As a result, there is no chance to pollute the air, sea water and finally environment. After reaching the vessel at BCPCL jetty the coal unloading start with opening the covered hatches by using grab ship unloader. The unloading coal then discharged to the hopper to carry out through covered conveyor belt C1 to C4 to the coal dome. So, when coal transported from vessel to coal dome there is no scope to spread out any coal particle to the environment. Therefore, no air pollution occurs due to this transportation of coal.

Also an individual ECC for Coal Transportation, River Dredging & handling of Coal Transportation Jetty has been given by DoE as on 04 November, 2021.

Annex VIII: Initiatives to safeguard the environment and biodiversity

Initiatives to safeguard the environment and biodiversity

(***Clause/ Reference No. Page 15, Page 16, of Third Party Observation/Statement-****Exhibit 8 – Barisal coal plant, March 2018; Barisal coal plant -December 2020; Barisal Coal Plant looking north March 2023*)

Barisal 307 MW Coal fired Power Plant Project (Taltoli)

Barisal 307 MW Coal Fired Plant is about 22 km away from the boundary line of Sundarbans.

The Environmental Management Plan (EMP) as per Environmental Impact Assessments (EIAs) is as follows:

2.c.1. Land Development

a) Quality of the dredge soil was ensured by the EPC contractor before starting the dredging and landfilling activities.

b) Regular spraying water on possible dust generation source and sites.

c) Dredged spoil was disposed of in such a manner so that it does not any additional environmental issues and refill the dredged channel.

2.c.2. Construction Waste Management Plan

The measures for controlling construction waste included limiting site clearance activities, planned stocking and gathering of construction materials and equipment's, fencing around the construction yard, maintaining existing right of way to carry construction materials, adopting proper sanitation system for employees, banning of waste burning, and quality housekeeping. A waste dumping place was provided with efficient waste collection and disposal techniques. No waste was dumped to the surrounding water bodies. Burning of solid waste in the construction site was strictly prohibited.

2.c.3. Air Pollution Management

a) Particulate Material Control: Twin-chamber five-electric-field Electrostatic Precipitator (ESP) with dust collection efficiency of not lower than 99.72% adopted; meanwhile, desulfurization system with dust collection efficiency of 50% was considered, in order to assure smoke dust concentration at chimney outlet lower than 50 mg/Nm^3.

b) Sulfur Control: Flue Gas Desulfurization (FGD) system has been installed for this project. Limestone- gypsum wet type desulfurization was adopted with desulfurization efficiency of not lower than 93%. The sulfur dioxide concentration at chimney outlet is lower than 200 mg/Nm3, which can satisfy the requirement of World Bank IFC EHS standard.

c) NO_x Control: The boiler adopts low NO_x burner and staged air distribution combustions to assure NO_x emission concentration at boiler outlet lower than 510 mg/Nm3, which satisfies the requirement of limit value required by standards.

d) Continuous Emission Monitoring System (CEMS): Continuous online monitoring system installed to monitor Particulate matter, SO2, NOx and other pollutants.

2.c.4. Waste Water Management

a) The wastewater of this project is treated in the centralized treatment plant and the treated water is reused. Domestic sewage treatment system is mainly used to collect domestic sewage water of the whole power plant. Domestic sewage water mainly includes staff shower drains and flush water drains, toilet drains, canteen drains etc. The domestic sewage in plant area is discharged into domestic sewage treatment plant through underground pipeline. The treated water is reused for landscaping of the whole power plant.

b) Production waste water mainly includes acid and alkaline wastewater from boiler make-up water treatment system, wastewater from condensate polishing system, drains from air pre-heater flushing, etc. The wastewater is collected, pressurized and discharged to industrial wastewater central treatment plant. The treated wastewater is discharged to recycling water system for dry ash humidification, coal handling system flushing, etc.

c) Effluent quality is being monitored at different stage of discharge and intake. Before discharging the treated effluent to the Buriswar-Payra River the effluent standard are complied with ECR, 1997 defined standard for effluent.

2.c.5. Noise Management

a) For noise control at sound source, energy saving & low noise products was selected in design; during equipment tendering, requirements on noise level of equipment was specified; associated acoustic enclosure and silencer was provided for the equipment.

b) Silencer was installed at boiler exhaust vent and fan inlet, Acoustic enclosure installed for turbine-generator set, Turbine-generator set adopted rigid coupling and Low noise exciter selected.

2.c.6. Thermal Pollution Management

The power plant utilizes a once-through cooling system for the condenser. For the cooling purposes, water is withdrawn from Buriswar-Payra River and heated water is discharged into river thereby raising the water temperature must be below 3°C at the discharge point.

Besides the above three power plants, other power plants as mentioned in the report namely, RPCL power plant at Payra, Ashugonj power plant at Payra and Rampal power plant are concerned with only land development. Coal based power plants are supposed to be installed at these sites. However, these proposed coal based power plants are included among the 10 proposed coal based power plants that the government has already abandoned. Alternative energy, preferably solar power plants will be installed in these sites.

Annex IX: Power Plants

Environmental measures (Clause/ Reference No. Page 17-19, *Exhibit 9-Patuakhali coal plant, Feb 2018; Patuakhali coal plant, November 2022; Patuakhali Coal Plant looking northeast March 2023; Patuakhali Coal Plant looking northwest March 2023; Patuakhali coal plant site in the background, the haul road to jetty and Payra coal ash ponds (middle left) March 2023 Patuakhali coal plant site in the background, the haul road to jetty and Payra coal ash ponds (middle left)March 2023; Patuakhali haul road and jetty under construction in the foreground with the Payra coal plant in background and its air pollution plume moving towards the Sundarbans World Heritage site March 2023)*

Clause/ Reference No. Page 30-31 Exhibit 20 – Ashuganj Power Plant February 2018

Clause/ Reference No. Ashuganj Power Plant site clearing and groundwork in progress March 2023

