Review Assessment of Biodiversity Loss and Ecosystem Deterioration Due to Built-Form Considering the Implementation of Rampal Power Plant near Sundarban Forest

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***Abstract*— The Rampal power plant, also known as the Maitree Super Thermal Power Project, is a proposed coal-fired power plant in Rampal near Sundarban, the largest mangrove forest of the world, Khulna division, Bangladesh. Environmentalists objected to the construction many times but the government still could not reach any final decisions about the replacement of the powerplant. As Sundarban is listed in the world heritage site, UNESCO is also perturbate to the matter: already many have been agreed putting Sundarban in endangered list. The aim of this paper is to establish a broad overview how built form responsible for biodiversity loss and ecosystem deterioration. Rampal power plant and Sundarban mangrove forest has been selected for this study. A general analysis and overview have been generated from secondary resources. The study confirms that Sundarban Mangroves is already facing biodiversity loss due to intensified shrimp cultivation, increased dependency on forest and illicit felling, changing land use pattern, oil spillage, and pollution, forest fire, improper management practices, plant diseases, tourism activities, upstream withdrawal of river water, salinity intrusion, climate change, and some natural causes where the implementation of coal based power plant will be acting as major reason for serious ecological and environmental hazard. Therefore, some recommendations have given to minimize the negative impact on the ecosystem. The outcome of the study is expected to make the authorities and people aware of the biodiversity loss and ecosystem deterioration of the Sundarban forest and they have specific responsibilities to protect and maintain this area. It will also raise awareness on the settlement of any built form like Rampal power plants near this sensitive area among authorities, engineers, architects & planners.**

***Keywords*— Sundarban, Rampal power plant, Construction, Biodiversity loss, Ecosystem**

I. INTRODUCTION

Bangladesh, a developing country, has one of the world's largest coal power pipelines, having 29 power stations with a combined capacity of 33.2GW. The Rampal power plant is a proposed coal-fired power plant with a capacity of 1320 megawatts in Bagerhat District, Khulna, Bangladesh, according to 2019 research by an Australian organization that follows fossil fuel investment. The Bangladesh Power Development Board and India's state-owned National Thermal Power Corporation have formed a joint venture. Bangladesh India Friendship Power Company is the name of the joint venture company (BIFPC). It is a controversial project as the site has been selected for the establishment is very close to the largest mangrove forest of the world, Sundarban.

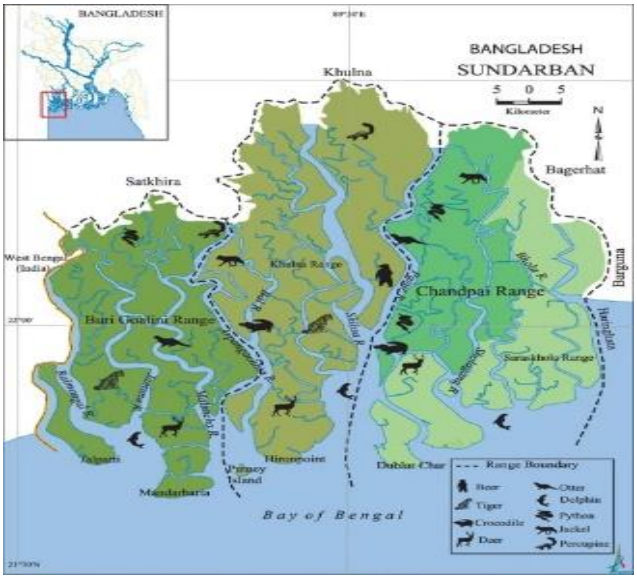

Fig. 1. Biodiversity of Sundarban

The Sundarban mangrove forest covers an area of about 10,000 km2 (3,900 sq mi), of which forests in Bangladesh's Khulna Division extend over 6,017 km2 (2,323 sq mi) and in West Bengal, they extend over 4,260 km2 (1,640 sq mi) across the South 24 Parganas and North 24 Parganas districts. [1] It is home to many rare and globally threatened wildlife species such as the estuarine crocodile (Crocodilus porosus), royal Bengal tiger (Panthera tigris), Water monitor lizard (Varanus salvator), Gangetic dolphin (Platinista gangetica), and olive ridley turtle (Lepidochelys olivacea). This tidal forest is very rich with natural resources especially floral and faunal diversity like 66 species of plants, more than 200 fish species, 42 mammals, 234 birds, 51 reptiles, 8 amphibians, a lot of invertebrates etc. [2] The forest in India is divided into

the Sundarban Tiger Reserve and 24 Parganas (South) Forest Division, and together with the forest in Bangladesh is the only mangrove forest in the world where tigers are found. Biodiversity of Sundarban is shown the Fig.1.[3] The Sundarban delta in India has been a priority region for WWF-India since 1973 due to its unique biodiversity. While it supports a sizeable population of wild tigers and other wildlife, it is also an ecologically fragile and climatically vulnerable region that is home to over 4.5 million people.[4]

The Sundarban is not only rich in biodiversity, but it also provides ecological, economic, and cultural services to the people who live nearby as world's oldest mangrove ecosystems, providing several benefits and services to local populations and the environment. Population pressure, overexploitation, natural disasters, and a lack of viable policy frameworks continue to threaten the forest's natural resources.

Rampal is the area adjacent to the Sundarbans. It is one of the country's largest coal-fired thermal power facilities. Government has acquired 1,834 acres of agriculture land in Satmari-Katakhali and Koigordashkathi areas under Rampal upazila to establish the power plant. It is situated only 9 KM downstream from the project site [2]. Experts have been concerned about the power plant's negative impact on the Sundarbans since the beginning. The ecology, however, was known to be deteriorating long before the power plant was commissioned.

Fig.2. Location of Rampal Power Plant and Sundarban from google satellite

This study focused on how the power plant could lead to a loss of biodiversity in the Sundarban and a weakening of mangrove forestry, as well as the effects on ecosystems. It also makes an effort to make possible recommendations for the long-term management and protection of this unique UNESCO World Heritage site for the benefit of both people and nature.

A. *Factors Affecting Sundarban Mangrove Ecosystem Degradation*

The Sundarban mangrove forest is one of the world's most endangered ecosystems. Increased population combined with a lack of other livelihood alternatives poses a severe threat to the Sundarban, as mangrove loss is the primary reason. Mangrove forests in Bangladesh are deteriorating due to over-exploitation, deforestation, land reclamation and pollution. Large areas of mangroves have been cleared for fish and shrimp farming [5]. Major threats to biodiversity have come mainly from the growing human population, and consequently, overexploitation of both timber and fauna, and conversion of the cleared land to agriculture and aquaculture. Today the area around the Sundarban (in both India and Bangladesh) is densely populated. Approximately 2.5 million people live in hundreds of small villages very close to or within parts of the Sundarban, on which very large numbers of people depend for their livelihood at certain times of the year [6]. Some notable causes of deterioration of Sundarban mangrove forest ecosystem are:

1) *Over exploitation and illegal forest cutting.*
2) *Shrimp farming.*
3) *Pollution.*
4) *Management failure.*
5) *Natural Disaster.*
6) *Climate change and rise of sea level*.

1) Over exploitation and illegal forest cutting: Over-exploitation of forests to meet the growing requirement of the people is one of the main problems facing the Sundarban. Encroachment and illicit removal of timber and firewood from the forests and the absence of sustainable management practices are the major forest conservation problems in thearea. The main reason of illicit removal of timber are: wide gap between the demand and supply of wood and almost permanent unemployment in rural areas, which results in compelling dependence on gathering of wood from the forests for subsistence; existence of organized groups of mongers who professionally indulge in illegally cutting and removing of valuable trees. Sundarban have been exploited for timber, fuel wood, bark tannin, animal fodder, native medicines and food (fish, shellfish, honey and wild animals) for centuries, but population pressure has greatly increased the rate of exploitation, leading to serious degradation. Due to illegal cutting, continuous encroachment of forest areas and illegal poaching of wildlife, the mangrove forest is quickly disappearing and as a result biodiversity of the area is reducing in an alarming rate [5].

2) Shrimp farming: The rapidly expanding shrimp farming industry possesses the crucial cause for deteriorating the mangrove forests in Bangladesh. Moreover, recently, mangroves have been used for fish, shrimp and especially giant tiger prawn Penaeus monodon farming. The Chakaria Sundarban has been completely destroyed in recent years because of shrimp farming [5]. Shrimp aquaculture in Cox's Bazar annually uses 620 tons of urea, while introducing 15 tons of waste to the water on a daily basis. Large amounts of natural and synthetic chemicals, including dichlorides, malachite green, debris root, and tea seed cake are used in coastal aquaculture worldwide for the control of pests and diseases. A study found that 14 chemicals and drugs

commonly used in brackish water aquaculture ponds of Bangladesh [5]. Shrimp juvenile gathering has expanded dramatically in recent years, notably for aquaculture in reclaimed areas. It is estimated that up to 60 % of the shrimp post-larvae (PL) collected from nature die during sorting, transportation and stocking. This forces further harvests from the mangroves. Unfortunately, the PL harvest of shrimp and prawns is probably the most lucrative local economic activity available to a large proportion of the Sundarban population. PL harvesting earns approximately five times more gross revenue per capita than rice farming, and probably proportionately even more on a net revenue basis as inputs other than labor are negligible compared to agriculture [6].

3) Pollution: Industrial development, agriculture and aquaculture near the river basins, population increase along with attempts to improve or modernize the living standards in coastal areas, has led to the production of huge amounts of garbage, waste water, pollutants and other effluents being discharged to the mangrove wetland. The Sundarban mangrove forest ecosystem also has become vulnerable to pollution such as oil spillage, heavy metals, agrochemicals– especially pesticides and nutrient enrichment which may have changed the mangrove ecosystem's biogeochemistry [6].

Fig. 3. Oil spill in Sundarban waterways [7]

Oil pollution is a severe danger in the Sundarban, with the potential to harm aquatic animals and seabirds in particular. The port of Mongla, on the north edge of the mangroves, and the several big shipping vessels that pass through the Sundarban every day via the north-east shipping route are possible sources of oil pollution

Mongla sea port is situated three Km away from the Sundarban forest. Approximately 400 ships, numerous mechanized river crafts and fishing boats are handled annually at this port. These vessels release waste oil, spillage, balast water and bilge washings. Crude oil and its derivatives are the most dangerous pollutants which enter to the mangrove forest due to oil transportation [5]. Already an incident happened on December 09, 2014 when an oil tanker with 3,57,000 liters of furnace oil capsized in Shela river inside the Sundarban. [7]

4) Management failure: The mangrove forest is disappearing because of the three main management failure reasons: lack of skilled and well-trained officials and failure of institutions to effectively manage coastal mangrove resources and conflicting activities, poor planning and knowledge of coastal land use and implementation of development plan that does not include environmental protection principals. Moreover, the people who live near the mangrove forest and depend on the mangroves for their livelihoods do not have enough knowledge and education regarding the value of mangroves. They do not know how to conserve the mangrove forest thus they lead to the destruction of the forest's resources [5].

5) Natural Disaster: Various natural calamities like cyclone, flood, storms, coastal erosion, naturally shifting hydrology etc. may destroys trees and animals even faster. The damage to Sundarban caused by recent cyclone Sidr has been preliminary assessed at $142.9 million. It has left 26 % of the forest severely damaged [5]. Climate change is set to damage biodiversity of the Sundarban increasing the immersed areas and salinity of water in coastal areas. As a result, a wide range of impacts on socio-economic scale and on the mangrove, ecosystems are anticipated, including the increased damage to crops, fisheries, forests and livestock. Moreover, after such disaster, forest requires enough time to repair itself which sometimes is not provided by the people.[5]

6) Climate change and rise of the sea level: A report by UNESCO-2007, entitled "Case Studies on Climate Change and World Heritage", has stated that an anthropogenic 45 cm rise of sea level (likely to happen by the end of the twenty-first century, according to the Intergovernmental Panel on Climate Change), combined with other forms of anthropogenic stress on the Sundarban, could lead to the destruction of 75 % of the forest. Natural resources of the Sundarban, especially various species of trees, are seriously threatened due to sea level rise. Low areas of the mangrove forest are flooded by tidal waters every year because of sea level rise along with and massive silt deposition. Rising seas are said to have flooded 7,500 ha of mangroves in the Sundarban. Mangrove forests require stable sea levels for long-term survival. They are therefore extremely sensitive to current rising sea levels caused by global warming and climate change. Rising sea levels have submerged two islands in the Sundarban, and a dozen more are under threat of submergence [5].

B. The role of built environment in biodiversity loss:

The ecosystem and biodiversity are vital components of any environment, contributing to environmental resilience and better quality of life. The built environment has been identified as a significant factor to biodiversity loss [8]. The amount of energy and resources required to sustain the built environment has a significant impact on natural ecosystems. It is also important to note that, human activities in the built environment do contribute to loss of biodiversity affecting the ability of the ecosystem to support living organism. In figure 4 The built environment contributes to each of these drivers [8].

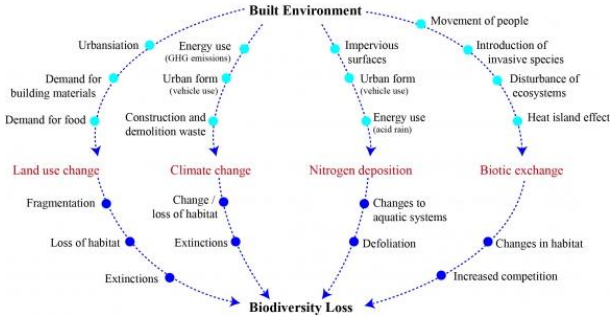

Fig. 4. Built environment drivers of biodiversity loss [8]

Legend: The built environment contributes to biodiversity loss in at least four main ways (text in red). Light blue dots detail the ways the built environment contributes to these main causes of biodiversity loss. The dark blue dots detail how these causes directly contribute to biodiversity loss.

1) Land use and cover change:

The urbanisation and associated satellite settlements, as well as the creation of supporting infrastructure, can lead to ecological fragmentation and degradation. Fragmentation can result in an 'extinction debt' meaning that it can take up to 50 years for the results of the impacts on biodiversity to occur. This means that conventional management strategies of fragmented ecosystems are insufficient to prevent future loss of biodiversity [9]. In addition to converting enormous tracts of land, urbanisation harms habitat and is usually irreversible. Places that experience the most human development are often places of high biological diversity and high ecosystem productivity, such as riparian corridors and coastal land margins [10]. This leads to further significant biodiversity loss [9]

2) Climate change:

The emission of greenhouse gases (GHG) including carbon dioxide, methane, nitrous oxide, tropospheric ozone and chlorofluorocarbons and their effect on the atmosphere is the leading cause of climate change [11]. Up to 40% of all energy and material resources are used to construct and operate buildings and up to 40% of total solid waste results from construction and demolition activities [12]. Construction and demolition waste can contribute to climate change either through the emission of GHGs as materials decompose, or due to the release over time of fluorinated gases with a high potential for global warming from certain construction- and demolition-related wastes [13].

3) Nitrogen deposition and acid rain:

The primary source of nitrogen deposition is industrial nitrogen fixation for fertilizer. The run-off of these nutrients from agricultural and urban areas has caused major ecological changes in river basins, estuaries, and coastal zones. Therefore, many floras, fauna are destroyed from ecosystem. Sulfur dioxide (SO_2) and nitrogen oxides (NOx) released into the air by fossil-fuel power plants, vehicles and oil refineries are the biggest cause of acid rain today, according to the EPA. Acid rain has an impact on the aquatic ecology when it falls and runs into rivers and ponds [8].

4) Biotic exchange:

The nature of urban habitats, as well as human migration between them, tends to enhance the predominance of species that are not native to that area, and hence the presence of invasive species in native ecosystems. In many parts of the world urban parks are made up of approximately half exotic species. The planting of exotic plant species in parks and residential gardens contributes to the release of invasive species into fragmented native ecosystems and often results in their degradation [10]. Urban areas tend to be warmer through the heat island effect and so become climatically unsuitable for some native species. Because of the heat island effect, urban areas tend to be warmer, making some native species climatically inappropriate [8].

C. Built-environment responses to ecosystem degradation:

Although urban areas cannot alone solve all of the identified causes of biodiversity loss, the way people build and inhabit the built environment contributes to the causes of biodiversity loss and may also potentially begin to address these problems [9]. The urban built environment is the main site of human economic, social and cultural life in terms of both magnitude and significance. It is important then that the built environment contributes to mitigating the causes of biodiversity loss but also is able to adapt to its impacts [8].

Fig. 5. Built environment responses to biodiversity loss [8]

Legend: The built environment could contribute to reducing biodiversity loss in at least four main ways (text in red). Light blue dots detail the ways the built environment could contribute to these main strategies to reduce biodiversity loss.

Typical response to addressing the loss of biodiversity in a built environment context (Fig. 5.) are:

- protection or conservation of remnant ecosystems through covenants or nature reserves,
- provision of connections between remnant habitats to reduce fragmentation,
- restoration of degraded ecosystems, and
- management of urban vegetation and/or structure to increase biodiversity.

D. How a coal-based power plant impact on ecosystem

A typical 500-megawatt coal power plant creates more than 125,000 tons of ash and 193,000 tons of sludge each year which contain arsenic, mercury, chromium, and cadmium etc. and more than 75% of this waste is disposed of in unlined, unmonitored onsite landfills and surface impoundments as a result source of drinking water (ground water) is being contaminated and damage vital human organs and the nervous system. According to the studies, ecosystems have been damaged sometimes severely or by the disposal of coal plant waste and heat. A coal power plant uses only 33-35% of the coal's heat to produce electricity and rest of the heat is released into the atmosphere and absorbed by the cooling water. Once the 2.2 billion gallons of water have cycled through the coal-fired power plant, they are released back into the lakes, rivers, or oceans with chlorine or other toxic chemicals which water is hotter (by up to 20-25°F) than the natural water that receives it and this "thermal pollution" can decrease fertility and increase heart rates in fish. Moreover, burning coal is a leading cause of smog, acid rain, global warming, and air toxics [2].

E. Modern technologies for minimizing impact on ecosystem

Different types of technologies can be used in a coal based powerplant. Pulverized coal combustion (PC) is the most widely used technology in coal-fired power plants globally. The technology's developments in the past decades have primarily involved increasing plant thermal efficiencies by raising the steam pressure and temperature. Based on the differences in temperature and pressure, the technology is categorized into three tiers: subcritical, supercritical (SC) and ultra-supercritical (USC) is showing table 1 [15].

TABLE I: APPROXIMATE PRESSURE AND TEMPERATURE RANGES

Level	Main stream pressure, Mpa	Main stream temperature, ˚C	Reheat steam temperature, ˚C
Subcritical	<22.1	Up to 565	Up to 565
Supercritical	22.1-25	540-580	540-580
Ultra-supercritical	>25	>580	>580

SC and USC technologies achieve high efficiency and consequently use less coal and result in reduced CO_2 emissions. According to the IEA Clean Coal Centre, CO_2 emissions may be reduced by 23% per unit of electricity generated by replacing existing subcritical plants with SC/USC technology (Nalbandian 2008). Specifically, a 1% increase in efficiency reduces emissions by 2.4 million tons (Mt) CO_2, 2000 tons (t) NOx, 2000 t SO_2 and 500 t particulate matter over the life of the facility (Balling & Rosenbauer 2007). USC is routinely used for new pulverized coal power plants in Japan today. The efficiency gain also reduces fuel costs by 2.4%. More advanced USC technology promises efficiencies of up to 55% for PC power plants. Its economic benefits are comparable to integrated gasification combined cycle (IGCC) and natural gas combined cycle (NGCC) technologies is showing table 2 [15]

TABLE 2: ESTIMATED COST

	Average efficiency	CO_2 emissions, g/kWh	Power generation cost, US¢/kW
Subcritical	36	766-789	4.0-4.5
Supercritical	45	722	3.5-3.7
Ultra-supercritical	>45	<722	4.2-4.7
IGCC	42-44	710-750	3.9-5.0
NGCC	50	344-430	3.4-6.8

Although SC/USC is a mature technology, the majority of existing coal-fired power plants worldwide are still using subcritical technology. The barriers to the diffusion of SC/USC technologies are not technical but largely economic and regulatory [15]. Supercritical technology needs to be made more readily available. One way to enable its use is to ensure that local markets are fully functional, so that the price of the units for local suppliers reflects international prices. Another is to promote technology transfers to local venders. The capital costs of the supercritical boiler and turbine will be 2–5 percent higher than the those of subcritical technology because the pressure parts of the supercritical unit are thicker. But since it improves efficiency and reduces plant size, the total capital costs of the unit will be only slightly higher than for subcritical units [15].

II. METHODOLOGY

A general overview of ecosystem deterioration and biodiversity loss is presented. It involves the collection of data from secondary sources. The articles and publications were discovered through an online search using several search engines. Secondary data collected from journals and other recorded researches related to the study were extensively reviewed. The location of coal-based power plants in Sundarban areas was also investigated using government legislation, institutional guidelines, and professional power plant planning standards.

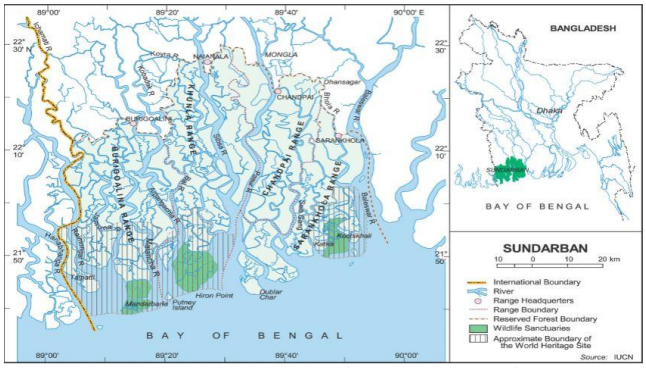

Fig. 6. Map showing the distribution of mangrove forest of Sundarban in Bangladesh

The study area is The Sundarbans mangrove forest, one of the world's largest (140,000 acres), is located on the Bay of Bengal's Ganges, Brahmaputra, and Meghna river deltas. Sundarban forest, located in the southwest of Bangladesh, is one of the largest continuous blocks of mangrove forests in the World, lieing between 21º30´ N and 22º30´ N and 89º00´ E and 89º55´ E. Total geographic area is approximately 6017 km2 which represents 23% of total forest area of Bangladesh [16]. A complex network of tidal rivers, mudflats, and small islands of salt-tolerant mangrove forests intersect the site, which serves as an excellent illustration of continuous natural processes. The area is recognized for its diverse biodiversity, which includes 260 different bird species, the Bengal tiger, and other endangered animals like the estuarine crocodile and the Indian python.

Fig. 7. The satellite map of google shows the power plant project site in Mongla upazila, Bagerhat district, Khulna division

The power plant is located in the Bagerhat district's Rampal Upazila. To construct the Rampal power station, the government purchased 1,834 acres of agricultural and fish (shrimp) producing land from Rajnagar's Sapmari Katakhali and Kaigar Daskati Mauza. A photograph of Mahmud Hossain Opu showing (Fig.8) the present scenario of the project. The power station is approximately 13 kilometres from the Sundarbans and approximately 70 kilometres from the Sundarbans World Heritage Site.

Fig. 8. Present scenario of the Rampal power plant project

III. Discussion And findings

A literature assessment reveals that a coal-fired power plant, such as Rampal, will be injurious to a fragile forest like the Sundarban. The power plant's hazardous substances will have an impact on Sundarban's ecosystem which will lead to foremost biodiversity loss.

Comparing Google images of the area from 2012 to 2019, a physical land transformation can be seen, followed by land accumulation for the powerplant(Fig. 9).In the image, blue-lined area refers to the Rampal power plant, which had just been accumulated in 2012 and filled with sand later(2019 image).Spatial analysis on google images also shows that an additional 1666 acres of shrimp ghers have been sand-filled (red lines in 2019 image after 2012.About 3500 acres of land including land acquired for the power plant have been sand-filled for industrial establishment until 2019 [16].

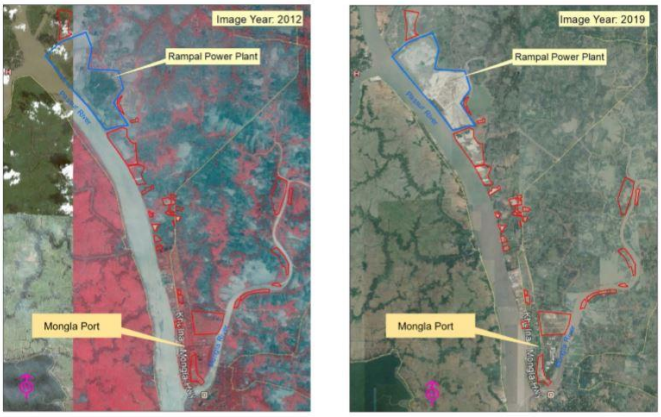

Fig. 9. Spatial extent of land transformations in the study area for industrial setups

A. *Distance from Sundarban*

EIA report by Bangladesh DoE states that a radius of 10 kilometres from the Sundarbans is considered the Environmentally Critical Area (ECA) and the proposed spot for the plant is 14 kilometres away from the forest, making the plant not risky as it is 4 kilometres away from the Sundarbans' ECA. But our findings through Geographical Information System (GIS) software exhibit that this distance is between 9 and 13 kilometres.

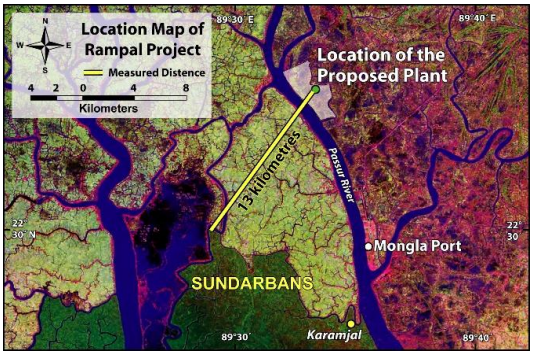

Fig. 10. Distance of the proposed plant from Sundarba

According to India's 'Wild Life Protection Act 1972', it is prohibited to build a power generation plant with wildlife reservations, national parks and forestry within its 15 kilometres radius. This means that the power plant that the Indian NTPC has proposed to build near the Sundarbans, a Bangladeshi forestry, could be never built in India according to their law if it were an Indian forestry. In addition, no international standard would approve establishment of a coal-based power plant so close to a reserved forestry as the Rampal plant is proposed [17].

B. Pollution of Ash

Rampal plant will produce 750 thousand tons of fly ash and 200 thousand tons of bottom ash. According to the EIA report, 15% of the ash will be generated as a result of burning coal. To preserve this ash, a pond will be dug. The ash pond in the cyclone and flood prone area will pollute soil and ground water by mixing up with rain water and spreading beyond the plant area [2]. Moreover, these wastes, comprising of fly ash, bottom ash and liquid ash, are extremely hazardous. They contain hazardous and radioactive metals like arsenic, lead, mercury, nickel, vanadium, beryllium, barium, cadmium, chromium, selenium and radium. The EIA report again becomes evasive by stating that the fly ash will be filtered before discharging through the chimney, and "some ash" "may" release to the atmosphere. The report disregards the amount of this "some ash". How much is this "some"? Even if we take it a per cent a year, 7,500 tonnes of fly ash will be released in and around the Sundarbans by the Rampal plant, which would not only fatally affect the forest, but also cause a range of lung diseases including pneumonia to the people living nearby [17].

C. Pollution caused by coal transport through the Sundarbans

Another major threat of Rampal for the surrounding environment of the Sundarbans is the transportation of the vast amount of coal to the plant area from outside. It is mentioned that 4.72 million tonnes of imported coal will be transported to the Sundarbans' Akram Point using large ships. From there, lighterage will ship the coal to the plant. According to this plan, large ships will sail to the Akram Point, which is 30 kilometres deep into the Sundarbans, 59 times a year. The rest of the way to the plant, spanning 67 kilometres, will be sailed by a number of lighterage's 236 times a year**.** In this way, even according to the so far found evasive EIA report, the transportation of coal will affect the environment from three aspects. First, discharge of coal, dirt, fuel and other chemicals from the frequently sailing large and small ships will heavily contaminate the adjacent sea, rivers and the coast. Second, at Akram Point, where the transfer from the large ships to the small lighterage's will take place, discharge of coal wastes to the river water will cause contamination. Third, extensively frequent maritime transportation throughout the Pashur river will damage its banks, adding to the sound and light pollutions caused by the ships those would hamper the ecosystem and the wildlife [17].

D. The impact of water withdrawal and discharge

Rampal plant will withdraw 9,150 cubic meters of water per hour from the Pashur River which is less than 1% of the total water flow. After use in the plant, purified water will be discharged at the rate of 5,150 cubic meters of water per hour into the river. Without assessing the impact on the flow of the river due to withdrawal and discharge of the water, the EIA report only commented "hydrological features may not be changed". We can say that the purification, water temperature, water discharge motion and dissolution of various elements in the water will negatively affect the Pashur and over the Sundarbans and the Bay of Bengal [2]. The EIA states that the plant, for rotation of turbines and to use as a coolant, would require extracting 9,150 cubic metre of water per hour from the Passur River adjacent to the Sundarbans and would release back 5,150 cubic metres of water, implying that the ultimate extraction of water from the river would be 4,000 cubic metre per hour. This loss of water would impact the salinity, flow, tidal patterns, habitats and ecosystem of the river. The report states that the 4,000 cubic metres per hour of water is an insignificant figure because it is only a percent of the river's water flow during the dry season. The evasion in this case is this data of '1 per cent' is taken from the reading of 2005. Over the period of last sixteen years, the water flow of the Pashur River has significantly gone down, notably due to newly constructed dams between the river and her source in India during that period. At the same time, demand of water has gone up by both household and industrial means in these sixteen years. The DoE is found to completely disregard these analyses in its EIA report which could stringently clarify that the Rampal plant is not an environmentally approvable project [17].

E. Emission of the chemicals

According to the EIA report, 4.72 million tonnes of coal will be burnt to produce the estimated 1,320 megawatt of electricity at the proposed Rampal power plant. According to Avogadro's law, a tonne of burnt coal will produce 2.86 tonnes of carbon dioxide. Therefore, at a load factor of 80 per cent, the plant will produce 18 million tonnes of carbon dioxide. Though the EIA report itself mentions that 7.9 million tonnes from it will be added to fly ash. Taking the report into account, it becomes obvious that at least 7.9 million tonnes of carbon dioxide will be produced from the plant, which is too highly risky and environmentally threatening. In addition to carbon dioxide, the plant will release 142 tonnes of sulphur dioxide and 85 tonnes of nitrogen dioxide every day, amounting at 51,830 tonnes and 31,025 tonnes respectively in a year. As a result, the natural density of sulphur dioxide and nitrogen dioxide in the Sundarbans will rise at many folds, which will trigger the eventual destruction of the forest.

According to the Environment Preservation Act 1997, it is illegal to artificially raise the amount of sulphur dioxide and nitrogen dioxide above 30 microgram per cubic metre of air in and around an environmentally sensitive area.

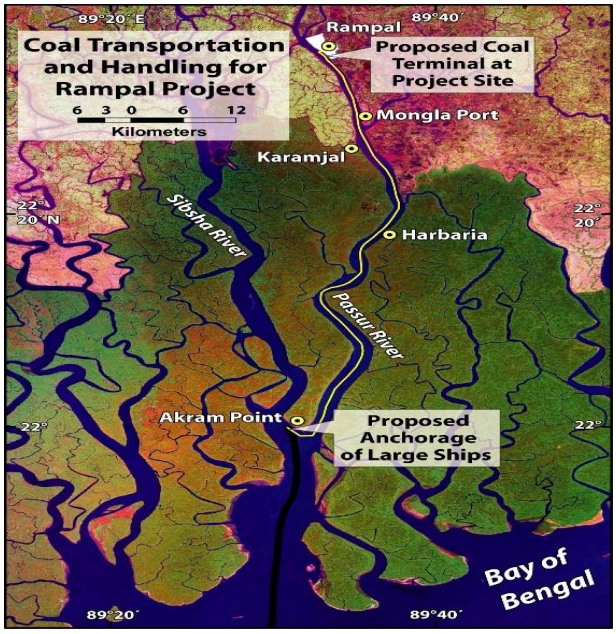

Fig. 11. Coal transportation and handling for Rampal project

According to the EIA report by Bangladesh Department of Environment, this amount in and around the area of the power plant upon completion would be 54 micrograms, which is nearly two-fold of what law approves. This means, if the Sundarbans is categorized as an 'environmentally sensitive area' which it rightfully is, the authority cannot validate the approval of the Rampal power plant. This precisely why the DoE categorized the Sundarbans as 'residential area and village', where according to the law the maximum approvable level is 80 micrograms. This has been precisely an act of fraudulence by the DoE just to deceive the judiciary for justifying its approval of the power plant [17].

IV. RECOMMENDATION

In order to address the decline in ecosystem health and loss of biodiversity on a large scale and in scope, numerous solutions are required to accommodate the wide range of political, economic, cultural, climatic, and ecological situations in which humans live. The ability of adaptive reuse to enable the built environment to address climate change and biodiversity loss might be researched further. A transition from a built environment that degrades ecosystem capacity to one that regenerates ability for ecosystems to thrive will not be a gradual process, but will necessitate a fundamental rethinking of built environment design. Where the developed countries are avoiding coal-based power plant and looking for renewable energy here Bangladesh is establishing Rampal power plant only 13km away from largest Mangrove Forest.

Although Environmentalists oppose the power plant's existing site, not the power plant itself. As a result, the option is to relocate the facility to a place that does not conflict with long-term development. Sourcing and implementation of alternative power supply source can be practice for stopping Rampal power plant. The tidal waves power plant can be addressed of the Bay of Bengal to general power. The Sandweep Channel has 5.5 nautical mile per hour tidal waves, according to the International Marine Electronic Chart. If we use the waves appropriately, the Sandweep Channel alone can provide approximately 300 megawatts of power. Chittagong and Cox's Bazar are two such places where such projects can be effective.

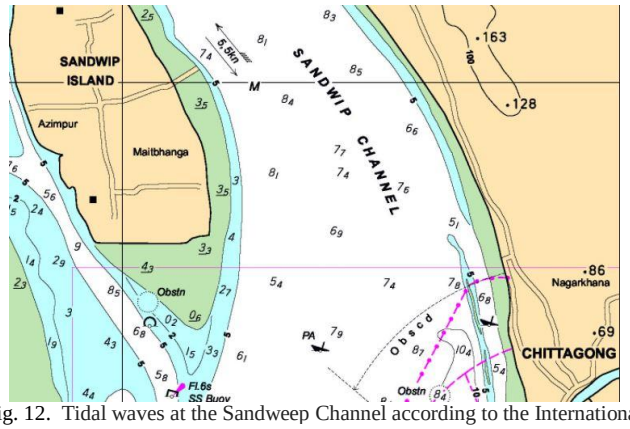

Fig. 12. Tidal waves at the Sandweep Channel according to the International Marine Electronic Chart [17]

V. CONCLUSION

Sundarban is vital to the general people of Bangladesh's southern shoreline. However, it is deteriorating day by day. Coastal disaster, natural calamities, global warming, human activities are major reason for deteriorating this world's largest Mangroves Forest and its surrounding area. Where The Rampal project would act another new and foremost issue for deteriorating the Sundarbans and eventually result in enormous social and environmental calamities in Bangladesh therefore Reduced biodiversity, species loss, genetic erosion, extinction, increased flooding, and a fall in water quality are all possible repercussions of the Sundarbans' fall. The shield of Sundarban and its surrounding area depends on the development and successful implementation of a sustainable management plan to protect and conserve its important resources. Moreover, we need to understand the inherent relationship between nature and architecture, they are not adversely of each other until we make them to be. They can be together in a sustainable way and make the world a better place to live in.

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