

Environmental Impact of Coal based Power Plant of Rampal on the Sundarbans and Surrounding areas

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Background and Justification

Coal based Power Plant produce electricity by burning coal in a boiler to heat water to produce steam. The steam, at tremendous pressure, flows into a turbine, which spins a generator to produce electricity. The steam is cooled, condensed back into water, and returned to the boiler to start the process over. A typical 500-megawatt coal power plant creates more than 125,000 tons of ash and 193,000 tons of sludge from the smokestack scrubber each year. Generally, more than 75% of this waste is disposed of in unlined, unmonitored onsite landfills and surface impoundments. Toxic substances in the waste - including arsenic, mercury, chromium, and cadmium - can contaminate drinking water supplies and damage vital human organs and the nervous system. One study found that one out of every 100 children who drink groundwater contaminated with arsenic from coal power plant wastes were at risk of developing cancer. Ecosystems too have been damaged sometimes severely or permanently -- by the disposal of coal plant waste. Much of the heat produced from burning coal is wasted. A typical coal power plant uses only 33-35% of the coal's heat to produce electricity. The majority of the heat is released into the atmosphere or 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 lake, river, or ocean. This is enough water to support a city of approximately 250,000 people. This water is hotter (by up to 20-25° F) than the water that receives it. This "thermal pollution" can decrease fertility and increase heart rates in fish. Typically, power plants also add chlorine or other toxic chemicals to their cooling water to decrease algal growth. These chemicals are also discharged back into the environment.

Burning coal is a leading cause of smog, acid rain, global warming, and air toxics. In an average year, a typical coal plant generates: (1) 3,700,000 tons of carbon dioxide (CO₂), the primary human cause of global warming--as much carbon dioxide as cutting down 161 million trees; (2) 10,000 tons of sulfur dioxide (SO₂), which causes acid rain that damages forests, lakes, and buildings, and forms small airborne particles that can penetrate deep into lungs; (3) 500 tons of small airborne particles, which can cause chronic bronchitis, aggravated asthma, and premature death, as well as haze obstructing visibility; (4) 10,200 tons of nitrogen oxide (NO_x), as much as would be emitted by half a million late-model cars. NO_x leads to formation of ozone (smog) which inflames the lungs, burning through lung tissue making people more susceptible to respiratory illness; (5) 720 tons of carbon monoxide (CO), which causes headaches and place additional stress on people with heart disease; (6) 220 tons of hydrocarbons, volatile organic compounds (VOC), which form ozone; (7) 170 pounds of mercury, where just 1/70th of a teaspoon deposited on a 25-acre lake can make the fish unsafe to eat; (8) 225 pounds of arsenic, which will cause cancer in one out of 100 people who drink water containing 50 parts per billion and (9) 114 pounds of lead, 4 pounds of cadmium, other toxic heavy metals, and trace amounts of uranium.

Bangladesh government has decided to establish 1320MW coal-fired power plant at the mouth of the Sundarbans under Rampal upazila of Bagerhat beside the Poshur river which project must need a complete environmental clearance. The Bangladesh government signed a joint venture agreement with India's state-run electricity generation company on 29 January 2012 to implement this project. By implementing this coal-fired power plant the Sundarbans will be affected as the sundarbans situated only 9km downstream from the project site.

The Sundarbans- the largest single tract mangrove forest has been declared Ramsar Site and Natural World Heritage which is situated in the South-West area (21°31'-22°38'N and 89°00'-89°55' E) of Bangladesh. It is intersected by a network of tidal canals, creeks and rivers. It is covered an area of 6000 km² of which 3956 km² mangrove forest lands and more than 1800 km² water bodies. 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. More than 500 thousand peoples are directly and indirectly depending on the Sundarbans for their livelihoods as well as socio-economic purposes. Around 200 thousand people go to the Sundarbans regularly to collect the resources for their

livelihoods; less than 200 thousand collect the resources seasonally and around 100 thousand people are doing business of the collected resources and they never go to the Sundarbans directly for resources extraction. Roughly 22% people's livelihoods are involved with the collection of wood resources; 5% are involved with the non-timber forest product; 69% are involved with the aquatic resources and 4% are involved with other purposes.

Government has acquired 1,834 acres of agriculture land in Satmari-Katakhal and Koigordashkathi areas of Lubachhora under Rampal upazila to establish the power plant. Only 86 acres lands are *kash* land and rest of the lands are public lands which are using for rice and fish cultivations by the land owners'. The government has also taken an initiative to dredge 10 kilometers of the Poshur river to allow easy access of Indian ships carrying coal for the plant. Due to an inadequate supply of local coal, the operator suggests to use imported coal – presumably of Indian origin considering the low price of coal and transportation cost. The Bangladesh government has decided to bring in coal through the Mongla sea port. India's National Thermal Power Company and Bangladesh Power Development Board are the two signatories of the project.

Most of the people of three villages who will have to leave their lands are protesting the project coal-fired power plant. They claim the project will jeopardise their dependency on agriculture and other farming due to land acquisition by the government. It will have impact on their lifestyle and education – moreover, the effect on the people of the surrounding areas, land, water, biodiversity, agriculture and river system will also be adverse. This project has drawn much criticism for its location due to the ecological significance of the forest- Sundarbans and at a time when the present government is outspoken and leading the way against climatic threats.

The proposed power plant will burn around 4.75 million tonnes of coal annually when more or less 0.3 million tonnes ashes and around 0.5 million tonnes sludge and liquid waste may be produced. It would also emit a good amount of carbon dioxide (CO₂) – key factor for global warming – some other toxic gases and airborne particles, according to Union of Concerned Scientists, a USA-based group. Prof. Dr. M A Sattar (2011) discuss on the types and levels of pollution of coal-fired power plant.

The ground water and that of the Poshur would also be polluted by the huge amount of waste produced due to burning of the coal. Whereas the existence of strict laws to protect the environment and the wildlife, the government has recently decided to declare a part of Poshur and Andharmanik rivers sanctuaries for dolphins. The liquid waste or sludge contains hazardous arsenic, mercury, cadmium and chromium. These toxic substances can contaminate drinking water supplies and damage vital organs and the nervous system of people living around the place and the natural resources of the Sundarbans.

The possible air pollution will certainly be higher than what is anticipated if it uses Indian coal – considered to be of low quality due to the presence of high sulphur in it. The coal of Barapukuria, however, is recognised as a high quality type has less than 1% sulphur. According to the expert opinion, the quality of Bangladeshi coal is also better than that of Indonesia and Australia.

Due to the Ecologically Critical Area (ECA) rules no power plant should be set up within 12km of the Sundarbans buffer zone. The proposed project is 14km away from the Sundarbans.

Under the circumstances, it has become imperative to institute an investigation on the estimation of coal-fired power plant hazards and their impacts on the floral and faunal communities of the Sundarbans and surroundings of the project area. The present study deals on the possible impact of coal-fired power plant of Rampal on the ecological and biological conditions of the Sudarbans and surroundings area of the power plant.

Materials and Methods

A research team with Environment Specialist has done the proposed research from August 2011 to July 2012 in 10 permanent stations of each study areas (Rampal, Mongla and the Sundarbans). The investigation tools used were site observations, spot and laboratory analyses, Key Informants Interview (KII), Focus Group Discussions (FGD). Besides the primary information from the field investigations, secondary information were also collected and analyzed. With the support of existing environmental condition and proposed interventions, potential environmental impacts were indentified and predicted by using standard tools and methodologies.

Monthly sampling was carried out and air, water, soil and biological samples were studied in the field and laboratory.

The sample of the Pashur river was collected by using a country boat. Water from 10-25 cm depth was collected for physicochemical analyses (Trivedy 1993). A standard Secchi disc was used to measure the transparency of water while for water temperature a digital thermometer was used (Model No. 950). In situ measurements of total suspended solids (TSS), total dissolved solids (TDS), conductivity, salinity, pH, dissolved oxygen (DO), oxidation reduction potential (Eh) and oxidation reduction index (rH_2) were carried out with the help of respective portable field meters. Titrimetric methods were used to determine free CO_2 , CO_3 and HCO_3 alkalinities (Welch 1948). BOD_5 , COD, NO_3N and other chemical parameters were measured following APHA (1989). Calcium and magnesium were estimated following Mishra *et al.* (1992). Phosphate and silicate were measured following Gautam (1990). Shovels and large ladders were used to collect the bottom soil samples according to Trivedy (1993). Bottom soil quality was determined in the laboratory by following Jackson (1973) and Page *et al.* (1982). The populations of aquatic and terrestrial plants in field were measured by following quadrat method (Ambasht 1974).

Results and Discussion

The physico-chemical conditions of air, water and soil of the proposed coal fired area (Rampal), Mongla and Sundrabans were studied and data are presented in tables. The biological components of the study area has also been studied which are presented in the following pages.

Table 1. Monthly Average Temperature of the study areas

Month	Monthly Avg. Temperature (°C)		Daily Temperature (°C)	
	Max.	Min.	Max.	Min.
January	25.2	13.5	28.5	10.5
February	30	17.3	33.9	10.2
March	32.6	22.1	36	17.8
April	34.9	25.2	38.5	19
May	35	25.9	37.3	20.5
June	34.9	27.3	37.6	24.7
July	34.7	27.3	37.5	25.3
August	34.2	27.1	36.7	25.1
September	33.9	26.8	35.4	24.6
October	32.2	25.3	34.5	22.1
November	30.1	21.2	32.8	20.8
December	29.3	16.1	30.1	18.3

Source: Khulna Meteorological Office

Table 2. Monthly Prevailing Wind Speed in Knots and Direction of the study areas during 2001-2011 period

Year	Jan.		Feb.		Mar.		Apr.		May.		Jun.		Jul.		Aug.		Sep.		Oct.		Nov.		Dec.	
	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir
2001	3.4	N	2.9	NW	3.8	NW	4.7	S	5.2	S	4.8	S	4.0	S	3.8	S	3.4	S	3.0	S	2.6	N	2.3	NW
2003	3.3	NW	3.3	NW	3.4	S	4.9	S	4.8	S	3.4	S	3.3	S	3.3	S	4.1	SE	3.6	E	2.1	NW	2.5	NW
2004	2.9	NW	3.0	N	4.0	S	4.6	S	4.1	S	3.9	S	3.6	S	3.5	S	3.0	S	2.4	S	2.1	NW	2.3	NW
2005	2.8	NW	2.8	NW	3.0	S	5.0	S	3.9	S	3.8	S	3.4	S	2.9	S	2.8	S	2.4	S	2.3	N	2.5	N
2006	2.7	N	3.6	N	3.9	S	4.8	S	4.4	S	3.2	S	3.0	S	3.0	S	2.6	S	2.7	N	2.5	N	2.4	N
2007	3.1	N	3.3	NW	3.6	S	4.8	S	4.0	S	4.1	S	3.5	S	3.0	S	2.6	S	3.4	E	2.2	NW	2.9	N
2008	3.6	N	2.9	NW	3.9	S	5.3	S	3.2	S	2.8	S	3.3	S	4.0	SE	3.7	S	2.3	NW	2.2	NW	2.4	N
2009	2.8	N	2.7	S	2.8	S	2.9	S	3.2	S	3.5	S	3.3	S	2.7	S	4.3	SE	3.0	S	2.3	NW	2.4	NNW
2010	2.6	N	2.6	S	2.1	SW	2.8	S	3.7	S	3.9	S	2.9	S	2.9	S	4.4	S	2.8	S	4.0	N	3.2	N
2011	2.8	N	3.4	S	3.2	S	3.5	S	3.0	S	3.1	S	3.3	S	2.9	S	3.4	S	2.4	W	2.5	N	2.3	N

Source: Bangladesh Metrological Department, 2012

Table 3. Climatic Characteristics of the study areas (10 years average)

Parameters	Month											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Temp. Avg. Max. (°C)	25.1	30.0	32.6	34.9	35.0	34.9	32.8	32.7	32.3	31.9	29.8	26.4
Temp. Avg. Min. (°C)	13.5	17.3	22.1	25.2	25.9	27.3	27.1	26.1	25.6	23.8	18.5	14.5
Temp. Mean (°C)	17.2	20.4	25.2	29.3	29.8	29.8	29.3	29.4	28.9	27.4	23.7	19.2
Relative Humidity Mean (%)	69	65	72	76	79	86	83	81	79	77	72	70
Rainfall Mean (mm)	7	10	148	47	215	103	314	246	320	110	18	9
Sunshine Hour (hr)	6.9	8.0	8.3	8.3	7.2	5.5	4.5	4.8	5.3	7.2	7.9	7.6
Wind Speed Avg. (Nautical miles/hr)	7.6	10.7	9.7	13.0	14.2	12.7	12.5	9.6	11.6	7.9	7.0	6.7

Source: Khulna Meteorological Office, 2012

Table 4. Air Quality

Study Location	SPM (mg/m ³)		NO _x (µg/m ³)		SO _x (µg/m ³)	
	Working Day	Holy Day	Working Day	Holy Day	Working Day	Holy Day
Rampal area	172-292	268	53-85	72	37-52	45
Mongla area	183-312	314	65-109	98	45-61	62
Sundarbans area	145-219	304	42-71	97	29-40	62
EQS- Bangladesh	400		100		100	

Source: Field study 2011-2012

Table 5. physico-chemical conditions of water of the study area.

	Rampal	Mongla	Sundarbans
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Parameter	Range	Mean Value	Range	Mean Value	Range	Mean Value
Air temp. °C	24-37.5	30.6±0.8	24-38.5	30.7±1.1	24-38.5	30.8±1.1
Water temp. °C	22-35	28±0.6	22.5-35.5	28.3±0.4	22.5-35.5	28.5±0.7
Transparency cm	19-37	25±2	18-33	21±3	17-32	20±2
TDS g/l	3-20 g/l	10±1 g/l	8.2-23 g/l	16±5 g/l	10-23 g/l	17±6 g/l
Conductivity ms/cm	4-16.5	9.95±0.42	7.78-14.1	11.44±0.93	9.91-15.6	12.26±0.49
Salinity ppt	2-19	12±3	8-21	14±4	8-22	15±5
pH	7.1-8.7	7.4±0.3	7.3-8.9	7.5±0.7	7.5-8.9	7.7±0.7
DO mg/l	6.1-7.5	6.4±0.2	6.3-8.1	6.5±0.6	6.3-7.9	6.5±0.4
BOD ₅ mg/l	1.3-2.3	1.4±0.5	1.7-2.4	1.6±0.5	1.3-2.4	1.4±0.6
COD mg/l	7.5-8	7.7±0.4	8.6-9.1	8.9±0.4	3.53-4.02	3.8±0.4
CO ₂ mg/l	0-6	2.5±3.5	-	-	-	-
CO ₃ alk. mg/l	6-16	11±7	14-30	22±11	6-9	8±2
HCO ₃ alk. mg/l	100-148	133±22	99-128	110±15	61-77	69±11
Total Hard mg/l	660-1022	710±25	910-1190	955±34	920-1210	990±103
Ca ²⁺ mg/l	476-641	511±33	519-683	566±66	535-716	615±22
Mg ²⁺ mg/l	377-385	378±6	330-412	371±58	413-460	437±33
PO ₄ mg/l	1.53-1.87	1.63±0.19	1.65-1.78	1.71±0.12	1.76-2.55	1.82±0.11
Silicate mg/l	4.96-6.93	5.74±0.26	5.78-6.99	5.95±0.27	6.01-7.12	6.26±0.24
NO ₃ .N mg/l	2.51-3.93	3.18±0.53	2.49-3.73	2.86±0.53	2.33-3.51	2.75±0.47

- = Not detected

Table 6. Physico-Chemical Conditions of Groundwater of the study areas.

Parameter	Value					
	KCC	Batiaghata	Bagerhat	Fakirhat	Mongla	Rampal
Depth (m)	60-110	25-100	60-110	40-105	25-115	25-115
pH	7.6-8.1	7.4-8.2	7.5-7.9	7.3-8.3	7.4-8.1	7.5-8.2
TDS (ppm)	377-1708	596-2632	454-1660	214-986	617-2584	635-2610
EC (µs/cm)	960-3402	1154-3675	908-3270	742-2845	1170-3654	1126-3709
Salinity (ppt)	05-14	04-16	00-13	00-10	05-16	05-16
Arsenic (mg/l)	0.01-0.20	0.01-0.19	0.01-0.21	00-0.18	0.01-0.17	0.01-0.19
Total Iron (mg/l)	0.23-3.15	0.19-3.33	0.16-2.89	0.12-2.75	0.34-3.24	0.18-3.29
HCO ₃ (mg/l)	245-636	268-659	315-651	232-674	244-632	229-645
Ca+ (mg/l)	32-127	26-147	39-122	18-198	37-151	29-154
Mg+ (mg/l)	18-67	25-88	15-63	9-51	22-82	23-79
Na+ (mg/l)	127-586	169-630	135-514	82-455	154-642	164-637
Uranium (ppb)	-	-	4.46-11.58	-	-	-

Source: Field study 2011-2012

Table 7. Chemical Properties of the Soils of the Project Area

Study area	Type of soil associations													
	pH	Salinity ppt	Org.Mat %	N %	P	S	Zn	Br	K	Ca	Mg	Cu	Fe	Mn
					micro-gram/g soil				mv/100g soil			micro-gram/g soil		
Rampal	7.3-8.1	2.3-7.8	1.7-2.7	0.07-0.15	9-60	170-476	1.6-3.3	0.76-2.08	0.59-0.85	8.3-13.2	3.1-6.33	4.7-9.3	21-108	12-46.6
Mongla	7.3-8.1	5-8.5	1.63-2.23	0.07-0.11	4.2-8.2	280-1031	0.4-0.6	0.53-1.55	0.57-1.24	11-21.5	5.05-9.75	2.8-6.2	16-66	4-22
Sundarbans	5.6-8.1	3.0-19	1.37-2.8	0.07-0.15	4.1-7.5	44.5-387.3	0.56-0.99	0.56-2.54	0.27-1.16	3-34.5	5-12.5	3.91-7.67	20.5-72	10.6-35

Source: Field study 2011-20012

Table 8. Herbs, grasses and shrubs of the Project Area.

Local Name	Scientific Name	Status	
		Outside the project area	Project area
Herbs and grasses			
Assamlata/Baraty	<i>Eupatorium odoratum</i>	Vc	C
Bish-katali	<i>Polygonum Hydropiper</i>	C	R
Badaeya	<i>Andropogon aciculatus</i>	C	F
Banna danga shak	<i>Amaranthus viridis</i>	F	F
Bilai achra	<i>Mucuna pruriens</i>	F	F
Dubba ghas	<i>Cynodon dactylon</i>	Vc	C
Fenkachu/Mankachu	<i>Alocasia indica</i>	F	R
Fanimonasha	<i>Euphorbia nerifolia</i>	R	R
Gimashak	<i>Alternanthera pernociodes</i>	C	R
Kukurmuta	<i>Blumea lacera</i>	C	F
Khuirakata/Kata danga	<i>Amaranthus spinosus</i>	F	F
Kachu	<i>Colocasia esculenta</i>	Vc	C
Kashjar	<i>Saccharum spontaneum</i>	F	R
Lajjabati	<i>Mimosa pudica</i>	R	R
Marich (Banna)	<i>Croton bonplandianum</i>	C	F
Shealmotra	<i>Vernonia patula</i>	F	F
Telakucha	<i>Coccinea cordifolia</i>	C	F
Shrubs			
Varanda/Venna	<i>Ricinus communis</i>	F	R
Bhat	<i>Clerodendrum viscosum</i>	C	F
Bet	<i>Calamus sp.</i>	F	E
Dhaincha/Dhanchi	<i>Sesbania canabina</i>	F	R
Gagra	<i>Xanthium strumarium</i>	C	F
Chitki	<i>Phyllanthus reticulatus</i>	C	F
Titabegun	<i>Solanum torrum</i>	F	F

Status: Vc-very common, C-common, F-fairly common, R-rare, E-endangered, T-threatened, Et-extinct (**Source:** Field study 2011-2012)

Table 9. Natural woody plants and fruit trees of the Project Area.

Local Name	Scientific Name	Status	
		Outside the project area	Project area
Natural woody plants			
Bannay	<i>Crataeva religiosa</i>	R	Et
Bandar lathi	<i>Cassia fistula</i>	R	R
Debdaru	<i>Polyalthia longifolia</i>	R	R
Jobb dumur	<i>Ficus glomerata</i>	F	R
Kharajura	<i>Litsea monopetala</i>	F	R
Kadam	<i>Anthocephalus chinensis</i>	F	R
Gab	<i>Diospyros peregrine</i>	F	Et
Gudu/Pitadonga/Medda	<i>Trewia nudiflora</i>	F	F
Khoksha/dumur	<i>Ficus sp.</i>	C	F
Kharchuna/Teet gila	<i>Derris indica</i>	R	R
Chattim/Chaitan	<i>Alastonia scholaris</i>	R	R
Shaora	<i>Strebulus asper</i>	F	R
Titijam	<i>Eugenia sp.</i>	F	Et
Iika	<i>Alangium salvifolium</i>	F	Et
Pitraj	<i>Amoora rohituca</i>	C	F
Jarul	<i>Lagestroemia speciosa</i>	F	R
Hijal	<i>Barringtonia acutangula</i>	E	Et
Harhari/Shola	<i>Trema orientalis</i>	F	F
Nim	<i>Azadirachta indica</i>	F	R
Shimul	<i>Salmalia malabarica</i>	F	R
Fruit trees			
Aam	<i>Magnifera indica</i>	Vc	C
Amloki	<i>Phyllanthus embelica</i>	R	R
Amrah	<i>Spondias pinnata</i>	F	F
Ata	<i>Anona squamosa</i>	F	F
Ata (nuna)	<i>Anona reticulata</i>	F	F
Bel	<i>Aegle marmelos</i>	F	F
Boroi/Kul	<i>Zizyphus jujube</i>	C	F
Chalta	<i>Dillenia indica</i>	R	R
Dalim	<i>Puncia granatum</i>	F	F
Deophal	<i>Artocarpus lacucha</i>	R	E
Jam	<i>Eugenia jambolana</i>	C	F
Jambura	<i>Citrus grandis</i>	F	R
Jamrul	<i>Eugenia javanica</i>	F	F
Kala	<i>Musa spp.</i>	C	F
Kamranga	<i>Averrhoa carambola</i>	F	F

Local Name	Scientific Name	Status	
		Outside the project area	Project area
Karamcha	<i>Carissa carandas</i>	R	R
Kadbel	<i>Feronia elephantum</i>	C	C
Kanthal	<i>Artocarpus heterophyllus</i>	C	F
Khejur	<i>Phoneix sylvestris</i>	C	F
Lebu	<i>Citrus spp.</i>	C	C
Narikel	<i>Cocos nucifera</i>	C	C
Pepe	<i>Carica papaya</i>	C	F
Peyara	<i>Psidium guajava</i>	C	C
Sajna	<i>Moringa olifera</i>	C	F
Supari	<i>Areca catechu</i>	C	C
Safeda	<i>Achras sapota</i>	C	C
Tal	<i>Borassus flabellifer</i>	C	F
Tetul	<i>Tamarindus indica</i>	F	R

Status: Vc-very common, C-common, F-fairly common, R-rare, E-endangered, T-threatened, Et-extinct (**Source:** Field study 2011-2012)

Table 10. Wild medicinal plants and non-fruit trees of the project area.

Local Name	Scientific Name	Status	
		Outside the project area	Project area
Wild medicinal plants			
Akanda	<i>Calotropis procera</i> Br.	R	Et
Anantamul	<i>Hemidesmus indicus</i> L.	R	Et
Apang/Shisakanda	<i>Achyranthes aspera</i> L.	C	R
Bandhonia/Chinigura.	<i>Scoparia dulcis</i> L.	C	F
Basak	<i>Adhatoda vasica</i> Nees.	R	R
Chui Jhal	<i>Piper chaba</i> Hunter	F	R
Dhutura	<i>Datura metal</i> Linn.	F	R
Durba ghas	<i>Cynodon dactylon</i> Pers	C	C
Ghritakumari	<i>Aloe indica</i> Willd.	R	R
Hatisur	<i>Heliotropium indicum</i> L.	C	F
Kalokasunda.	<i>Cassia occidentalis</i> L.	C	R
Kalokeshi	<i>Eclipla alba</i> (Hassk).	F	R
Kalomegh	<i>Andrographis paniculata</i>	R	Et
Kumarilata.	<i>Smilax zeylancia</i> L.	F	R
Lajjabati (white)	<i>Mimosa pudica</i> Linn.	R	Et
Mehedi.	<i>Lawsonia inermis</i> L.	F	R
Nayantara.	<i>Catharanthus roseus</i> .	F	F
Nisinda	<i>Vitex negundu</i> L.	F	R
Olotkombol	<i>Abroma augusta</i> L.	F	R
Pathor kuchi	<i>Kalanchoe pinnata</i> (Lam.)	C	F
Pipul	<i>Piper longum</i> Linn.	R	Et
Pudina	<i>Mentha arvensis</i> L.	F	R
Sharpagandha.	<i>Rauwolfia serpentina</i>	R	Et
Shoti	<i>Curcuma zedoaria</i> Rosc.	R	Et
Shotomuli	<i>Asparagus racemosus</i> L.	R	Et
Telakucha	<i>Coccina cordifolia</i> (L)	C	R
Thankuni	<i>Centella asiatica</i> (L) Urban.	C	R
Tulshi	<i>Ocimum basilicum</i> Linn.	C	F
Non-fruit trees			
Arjun	<i>Terminalia arjun</i>	R	F
Asawatha	<i>Ficus religiosa</i>	R	R
Bansh	<i>Bambusa spp.</i>	C	R
Bot	<i>Ficus bengalensis</i>	R	R
Jilapi	<i>Acacia sp.</i>	F	R
Krishnachura	<i>Delonix regia</i>	R	F
Mandar	<i>Erythrina variegata</i>	F	R
Mehedi	<i>Lawsonia mermis</i>	F	F
Zigha	<i>Lannea coromandelica</i>	C	R

Status: Vc-very common, C-common, F-fairly common, R-rare, E-endangered, T-threatened, Et-extinct (**Source:** Field study 2011-2012)

Table 11. Social forest plants and aquatic plants of the Project Area.

Local Name	Scientific Name	Status	
		Outside the project area	Project area
Social forest plants			
Akashmoni	<i>Acacia moniliformis</i>	F	F
Rendi Koro	<i>Samanea saman</i>	C	C
Shil Koro	<i>Albizia sp.</i>	F	R
Mahogany	<i>Swietenia mahogany</i>	C	C
Piya	<i>Melia sempervirens</i>	F	R

Local Name	Scientific Name	Status	
		Outside the project area	Project area
Eucalyptus	<i>Eucalyptus citriodora</i>	F	F
Shegun	<i>Tectona grandis</i>	R	R
Shishu	<i>Dalbergia shishu</i>	C	C
Babla	<i>Acacia Arabica</i>	C	F
Ipil Ipil	<i>Leucaena latisiliqua</i>	C	F
Aquatic plants			
Azola	<i>Azolla sp.</i>	R	R
Buripana	<i>Spirodela polyrhiza</i>	C	C
Chaicha	<i>Scirpus articulatus</i>	C	C
Dhol Kalmi	<i>Ipomoea fistulosa</i>	F	F
Helencha	<i>Alternanthera philoxeroides</i>	C	F
Jhanji	<i>Utricularia sp.</i>	R	R
Kachuri Pana	<i>Eichhornia crassipes</i>	C	F
Kalmi	<i>Ipomoea aquatic</i>	F	R
Keshordam	<i>Ludwigia adscendens</i>	C	F
Khudipana	<i>Lemna minor</i>	C	C
Malanchi	<i>Enhydra fluctuans</i>	F	R
Shapla	<i>Nymphaea stellata</i>	F	R
Shusni Shak	<i>Marsilea quadrifolia</i>	C	F
Topapana	<i>Pistia stratiotes</i>	F	R

Status: Vc-very common, C-common, F-fairly common, R-rare, E-endangered, T-threatened, Et-extinct (**Source:** Field study 2011-2012)

Table 12. Shrimp, crab, molluscs and fishes of the Project Area.

Bangla Name	Scientific Name	Habitat	Status	
			Outside the project area	Project area
Shrimp, crab and mollusks				
Golda- Chingri	<i>Macrobrachium rosenbergii</i>	RB	C	R
Bagda- Chingri	<i>Penaeus monodon</i>	RB	C	R
Harina-Chingri		RB	C	R
Guara-chingri	<i>Palaemon spp.</i>	RBP	C	F
Boro- kakara	<i>Scylla serrata</i>	RBP	F	R
Choto-kakra	<i>Gelasimus annulipes</i>	RBP	C	F
Boro- Shamuk	<i>Pila globosa</i>	BP	F	R
Guli- Shamuk	<i>Vivipara bengalensis</i>	BP	C	F
Choto- Shamuk	<i>Lymnea spp.</i>	BP	C	F
Choto- Shamuk	<i>Bithynia tentaculata</i>	RBP	C	F
Lamba- hamuk	<i>Melania tuberculata</i>	RB	F	R
Zinuk	<i>Lamellideus marginalis</i>	RBP	F	R
Fishes				
Kakila	<i>Xenentodon cancila</i>	RBP	C	R
Shol	<i>Channa striatus</i>	RB	C	R
Taki	<i>Channa punctatus</i>	RB	C	F
Gazar	<i>Channa marulius</i>	RB	R	Et
Darkina	<i>Esomus danricus</i>	RB	C	F
Chela	<i>Onygaster phulo</i>	RB	F	Et
Mola	<i>Amlypharyngodom mola</i>	RB	F	R
Rui	<i>Labeo rohita</i>	RBP	C	C
Catla	<i>Catla catla</i>	RBP	C	C
Mrigal	<i>Cirrhinus mrigala</i>	RBP	C	C
Tatkini	<i>Cirrhinus reba</i>	RB	F	Et
Silver Carp	<i>Hypophthalmichthes molitrix</i>	RBP	C	C
Grass carp	<i>Ctenopharyngodon idellus</i>	RBP	F	F
Carpio	<i>Cyprinus carpio</i>	RBP	E	Et
Tit punti	<i>Puntis ticto</i>	RBP	F	R
Punti	<i>Puntiu stigma</i>	RB	C	F
Thai Punti	<i>Puntius goniontus</i>	RBP	F	F
Gutum	<i>Lepidocephalus guntea</i>	RB	F	R
Shingi	<i>Heteropneustes fossilis</i>	RB	C	F
Magur	<i>Clarias batrachus</i>	RB	R	Et
Boal	<i>Wallago attu</i>	RB	C	Et
Bangla Name	Scientific Name	Habitat	Status	
			Outside the project area	Project area
Kanipabda	<i>Ompok bimaculatus</i>	RB	R	Et
Pangas	<i>Pangasius pangasius</i>	RBP	C	C
Rita	<i>Rita rita</i>	RB	F	Et
Ayre	<i>Mistus aor</i>	RB	C	Et
Tengra	<i>Mystu vittatus</i>	RB	C	F
Chitol	<i>Natopterus chitola</i>	RB	R	Et
Foli	<i>Notopterus notopterus</i>	RB	F	Et

Chapila	<i>Gudusia chapra</i>	RB	C	Et
Baim	<i>Mastacembelus armatus</i>	RB	C	Et
Gochi baim	<i>Mastacembelus pancalus</i>	RB	C	F
Tara Baim	<i>Macrognathus aculeatus</i>	RB	R	Et
Khalisha	<i>Colisa fasciatus</i>	RB	C	F
Chata/Boichn	<i>Colisa lalius</i>	RB	F	R
Koi	<i>Anabas testudineus</i>	RB	F	R
Telapia	<i>Oreochromis niloticus</i>	RBP	C	C
Baila	<i>Glossogobiu giuris</i>	RB	C	R
Baro Chanda	<i>Chanda nama</i>	RB	R	R
Chto Chanda	<i>Chanda ranga</i>	RB	F	R
Khorshula	<i>Phinomuqil corsula</i>	RB	F	Et
Vetki		RB	C	F
Faishsa		RB	C	F
Datina		RB	C	F
Roop Chanda		R	F	Et
Taposhi		R	F	Et
Khorkuno		RBP	C	F
Hilsha	<i>Hilsha ilisha</i>	R	F	Et

Habitat: R=River, B=Beel/ Gher and P=Pond; **Status:** Vc =Very Common, C = Common, F =Fairly Common, R =Rare and T =Threatened, Et = Extinct (**Source:** Field study 2011-2012)

Table 13. Amphibians and reptiles of the project area.

Bangla Name	English Name	Scientific Name	Status	
			Outside of the project area	Project area
Amphibians				
Kotkoti/Baiya bang	Skipper frog	<i>Rana cyanophlyticus</i>	F	R
Sonalibang	Bull frog	<i>Rana tigrin</i>	F	R
Kunobang	Toad	<i>Bufo melanostictus</i>	F	F
Reptiles				
Tiktiki	Wall lizard	<i>Hemidactylus flaviviridis</i>	C	C
Anjali/Nenja	Shink	<i>Mubuya carinata</i>	C	F
KaloGui shap	Monitor lizard/Grey lizard	<i>Varanus bengalensis</i>	C	F
Sonali/Haldey Gui	Yellow lajnd monitor	<i>Varanus flaviscens</i>	F	R
Bara-kasim	Soft shell turtle	<i>Trionyx gangeticus</i>	R	Et
Kaitta Karia/Kori kaitta	Roofed turtle	<i>Kachugo teeta</i>	F	R
Saundi kasim	Spotted flap shell tortoise	<i>Lissemys punctata</i>	F	Et
Paina/Matia shap	Common water snake	<i>Enhyadris enhydris</i>	C	F
Dora Shap	Checkered kedbeck	<i>Xenochro phispiscator</i>	C	F
Daras Shap	Rat snake	<i>Ptyas mucosus</i>	F	R
Gokhra Shap	Cobra	<i>Naja naja</i>	F	R

Status: Vc =Very Common, C = Common, F =Fairly Common, R =Rare and T =Threatened, Et = Extinct (**Source:** Field study 2011-2012)

Table 14. Birds of the project area.

Bangla Name	English Name	Scientific Name	Status	
			Outside of the project	Project area
Terrestrial bird				
Bhuban Cheel	Black kite	<i>Milvus migrans</i>	F	F
Tila Baz	Kestre eagle	<i>Falco tinnunculus</i>	R	Et
Mala Ghughu	Ring dove	<i>Streptoplia decaocto</i>	F	R
Tila Ghughu	Spotted dove	<i>Streptoplia chinensis</i>	F	R
Jalali Cobutor	Blue R. pigeon	<i>Columba libia</i>	C	C
Teya	Parakeet	<i>Psittacula krameri</i>	F	R
Kokil	Koel	<i>Eudynamys scolopacea</i>	F	F
Kanakoka	Lesser coucal	<i>Centropus bengalensis</i>	F	Et
Lokhi pecha	Bran owl	<i>Tyto alba</i>	F	R
Bhutum pecha	Spotted owlet	<i>Athena brama</i>	F	R
Katthokra	Golden-backed wood pecker	<i>Dinopium javanense</i>	F	R
Bangla Name	English Name	Scientific Name	Status	
			Outside of the project	Project area
Ababil	House swift	<i>Apus affinis</i>	C	C
Shipahi-bulbul	Red-whiskerbulbul	<i>Pycnonotus cafer</i>	C	C
Doyal	Magpic robin	<i>Copsychus saularis</i>	C	C
Tuntune	Tailor bird	<i>Orthotomus sutorius</i>	F	F
Fingae	Black drongo	<i>Dicrurus macrocercus</i>	C	C
Pati kak	House crow	<i>Corvus splendens</i>	C	C
Dar kak	Jungle corw	<i>Corvus macrorhynchos</i>	C	C
Baht salik	Common myna	<i>Acridodheres tristis</i>	C	C
Jhuti-salik	Pied myna	<i>Sturnus contra</i>	C	C
Chorui	House sparrow	<i>Passer domestica</i>	C	C

Babui	Baya	<i>Ploceus philippinus</i>	C	F
Kutum	Black headed oriole	<i>Orilus chinensis</i>	F	R
Shakun	White backed vulture	<i>Gyps bengalensis</i>	E	Et
Wetlands bird				
Pancowri	Little cormorant	<i>Phalacrocorax niger</i>	F	Et
Kani bok	Pond heron	<i>Ardeola grayii</i>	C	F
Sada bok	Little egret	<i>Egretta garzetta</i>	C	F
Bali hash	Lesser Whistling duck	<i>Dendrocygna javanica</i>	F	Et
Chota machranga	Common kingfisher	<i>Alcedo atthis</i>	F	R
Machranga	White throated kingfisher	<i>Halcyon smyrnensis</i>	C	R
Dahuk	Water hen	<i>Gallinix cinerea</i>	F	Et
Kora	Water cock	<i>Amouronis phoeniculus</i>	F	Et
Shamuk banga	Openbill stork	<i>Anastomus oscitans</i>	T	Et
Pancowri	Little cormorant	<i>Phalacrocorax niger</i>	F	Et

Status: Vc =Very Common, C = Common, F =Fairly Common, R =Rare and T =Threatened, Et = Extinct (**Source:** Field study 2011-2012)

Table 15. List of mammals the project area.

Bangla Name	English Name	Scientific Name	Status	
			Outside of the project area	Project area
Borobadur	Flying fox	<i>Pteropus giganteus</i>	F	R
Shial	Jackal	<i>Canis aureus indicus</i>	R	Et
Khak shial	Fox	<i>Vulpen bengalensis</i>	T	Et
Beji	Mongoose	<i>Herpestes edwardsi</i>	T	R
Banbiral/Bongaora	Jungle cat	<i>Felis chaus</i>	T	Et
Khorgosh	Black-naped hare	<i>Lepus nigricollis</i>	Et	Et
Katbirali	Irrawaddy squirrel	<i>Callosciurus pygeregthrus</i>	R	Et
Udd	Otter	<i>Lutra lutra</i>	T	Et
Gasu indur	L.bandicoot rat	<i>Bandicota bengalensis</i>	C	F
Indur	G.bandicoot rat	<i>Bandicota indica</i>	Vc	C
Chika/Sucho	House shrew	<i>Suncus murinus</i>	C	C

Status: Vc =Very Common, C = Common, F =Fairly Common, R =Rare and T =Threatened, Et = Extinct (**Source:** Field study 2011-2012)

On the basis of present conditions of the study areas like physico-chemical conditions of air, water and soil; meteorological data and, floral and faunal status it can be concluded that inside and outside of the project area such as Rampal, Mongla and the adjacent Sundarbans are free from different types of pollution except salinity intrusion. Floral and faunal statuses are indicating that some plants and animals are already in extinct conditions and some are in rare conditions due to natural climatic hazards. Due to pollution of the coal fired power plant rest of the floral and faunal diversity will be destroyed by changing air, water and soil quality of the study areas. Sattar (2011) describe on the emission level of different toxic gases and heavy metals of coal fired power plant. Human health hazards and possible impact on the Sundarbans due to coal-fired power plant have been also discuss by Sattar (2011). The wind flow is indicating that the total study area i.e. Rampal, Mongla and the Sundarbans will be affected by the toxic gases and ashes of the coal based power plant in different seasons. Especially the Sundarbans will be affected during pick tourism period in the month of December to February. It is a matter to be concerned when the Sundarbans reserve forest is already facing threats from natural calamity, deforestation, rise in salinity and extinction of many species mainly due to human carelessness, ignorance and lack of implementation of laws, poaching and illegal wildlife trade.

Environmental impact assessment (EIA)

Most of the development projects produce impacts on or changes in the state of natural environment. Of which some are positive and some are negative. Similarly, some positive and negative impacts have been identified for the Coal based Power Plant Project. Although the DOE Guidelines for Industries (1995) have sorted out many problems related to industrial and development projects. Asian Development Bank Guidelines (1993) has included Industrial Project for Initial Environmental Evaluation (IEE) study. This guideline helped to ascertain the potential impacts arisen from Coal Power Plant. FPCO EIA Guidelines (1992) have been followed during impact assessment. However, DOE EIA Guidelines has also been considered in describing the existing environmental condition of this report in conjunction with FPCO EIA Guidelines. Screening and Scoping were used to determine the environmental issues and impacts for Coal fired Power Plant Project and identified as IECs. These issues and impacts have been evaluated in terms of distribution, quantity, quality, seasonality, socio-economic and ecological importance. The sources of information for the scoping process are,

- Field visit and environmental survey

- Collected data from KDA, Khulna University, DPHE, Public Health, BWDB, Meteorological Department, Bangladesh Atomic Energy Center, Upazilas, UPs, NGOs etc.
- Meeting with chairmen, members and local people
- Meeting with govt. officials, teachers, social workers

Selection of important environmental components (IECs): Through the screening and scoping process, the IECs relevant to environmental study of the proposed coal fired power plant project have been identified and presented in vertical column of table 16. The IECs are climate, topography, land use, flood, river erosion, drainage congestion, surface water pollution, groundwater table depletion, groundwater pollution, loss of wetlands, air pollution, noise pollution, loss of habitat and biodiversity, loss of capture fisheries and agriculture, human population, literacy, status of women, water supply, sanitation, electricity and telephone facilities, health services, human diseases, solid waste, urbanization, industrialization, employment, business opportunity, housing, transportation, markets and bazaars, traffic congestion, fire hazard, tourism, etc.

Impact assessment matrix: The impact assessment matrix is presented in table 16 identifies the potential impacts of coal based power plant of Rampal. The assessment matrix was done in consultation with multi-disciplinary team members. When an impact could not be quantified, qualitative judgment was used based on professional experience. The scoring was done within a 21 point score scale ranging from -1 to -10 for negative impacts and +1 to +10 for positive impacts while “0” was used for no impact (neutral impact). This impact assessment matrix is a useful tool, which will be helpful for the decision Makers to make a better judgment of project.

Table 16. Environmental Impact Assessment Matrix for Coal based Power Plant Project

IECs	Present Amount/Frequency	Project Impact	Impact Type	Impact Rating
A. Physical Environment				
Climate: Temp	Mean temperature varies from 29.8°C to 17.2°C.	Will be increased	IR	-6
Rainfall	Annual mean 1,507 mm	May slightly decrease and acid rain may be created	IR	-1
Topography	Highly disturbed in and around the project areas	May be highly disturbed in all areas	IR	-7
Land Use	Agricultural land use dominated with rural set up	Changed into coal based industrial and unplanned urban land use	IR	-5
Flooding/water logging Hazard	Low in some parts of Rampal	Flood hazard will be increased due to earthen filling for new construction	RM	-4
River Erosion	Common in Mongla and Rampal	Increase river erosion for movement of coal loaded cargoes	RM	-4
Drainage Congestion	Low	May be increased drainage congestion due to earthen filling in low lands	RM	-4
Surface Water Pollution	Low	Will be increased due to leaching of coal, discharge of cooling and waste water and dumping of waste	IR	-8
Groundwater Table	Fall in dry period (Feb.-May)	Water table may further decline due to use of huge amount surface and ground water	RM	-5
Groundwater Pollution	Polluted by Salinity, Fe and slight As in some places	Arsenic, mercury, uranium, thorium and other heavy metals content will be increased by absorbing coal leached chemicals	IR	-6
Water Bodies	Khals, beels, rivers, many	Water bodies will be reduced	IR	-6

IECs	Present Amount/Frequency	Project Impact	Impact Type	Impact Rating
	ghers and ponds exist	by land-filling and for increasing land price due to unplanned urban situation		
Air Pollution	Very poor	Air pollution will be increased by increasing oxides, hydrides and nitrides gases of carbon, sulfur and nitrogen	IR	-4
Noise Pollution	Low	Moderate	RM	-3
B. Biological Environment				
Habitat	About 87% habitat for flora and fauna in rural area	Reduced habitat of flora and fauna of the rural area and the Sundarbans	IR	-7
Flora	Among the existing species some are decreasing due to salinity	May endanger and extinct of some natural floral species in Rampal, Mongla and the Sundarbans	IR	-7
Wildlife	56 species (5 endangered) of the project area	More wildlife will be endangered and extinct	IR	-9
Social Forestry	Common road side, embankments, highland and some homesteads	May be decreased due to increasing pollution	RM	-3
Capture Fisheries	Meet the 20-25% of fish demand	Reduced production for increasing pollution in the natural water bodies	IR	-7
Culture Fisheries	Meet the 80-85% of fish demand	Reduced production for loss of ghers and ponds for land-filling	RM	-4
Agriculture	Covered by 60% land area	Reduced area	RM	-8
C. Social Environment				
Human Settlement	30-40% area covered by settlement	Decrease human settlement due to land acquisition	RM	-4
Population of land less	Poor no.	Population of land less will be increased	RM	-4
Status of husband less Women	Poor no.	No. of husband less women will be increased	RM	-4
Electricity Facility	Absent in some villages	Electricity facility will be available in all villages	S	+8
Health hazards	All most nil in the project areas except salinity	Health hazards will be increased by increasing air and water pollution	RM	-7
Human Diseases	Prevalence of diarrhea, skin diseases, worm infection and anemia	Lung and pharyngeal diseases, air and water borne diseases will be increased	RM	-7
Parasitic Diseases	Dengue, malaria and other parasitic diseases are uncommon.	May increase the parasitic diseases	RM	-2
D. Economic Environment				
Urbanization	Rural area	Semi urbanization will be developed by establishing	SM	+3
Industrialization	No industries	Increase industrialization and pollution will be increased	SM	+3
Employment:				
Government sector	Average 10 %	May slightly increase	S	+2
Industrial sector	Average 3 %	May moderately increase	S	+3
Business	Average 30 % people involved in business	Business opportunity will increase	S	+6
Transportation	Poor local transportation,	Improve with automotive	SM	+4

IECs	Present Amount/Frequency	Project Impact	Impact Type	Impact Rating
	rickshaw-van based	vehicles; sound and air pollution will be increased		
Market and Bazars	Mainly Rampal Bazar; Mongla Port Market and Foylahat	Increased numbers of small markets/ bazars without sanitation condition	SM	+4
Tourism	Medium	Tourism will be decreased inside the Sundarbans due to the loss of ecosystem and biodiversity of the Sundarbans	IR	-8
Traffic Congestion	Low	Moderate	RM	-4

S - Sustainable, SM - Sustainable with Mitigation, RM - Reversible with Mitigation, IR - Irreversible

EIA of physical, biological, social and economic environment indicate that most of the impacts of coal-fired power plant are negative and irreversible (-81) which can't be mitigated in any way. It is indicating that climate, topography, land use pattern, air and water (surface and ground both) quality, wetlands, floral and faunal diversity, capture fisheries and tourism will be affected permanently due to proposed coal fired power plant. Increasing of water logging conditions, river erosion, noise pollution and health hazards; decreasing of ground water table; loss of culture fisheries, social forestry and health hazards, and major destruction of agriculture will be happened due to coal fire power plant. These problems may be reversible after long mitigation process except agriculture. But all reversible mitigations are negative (total no. is -67). Mitigation of agricultural loss will be very difficult and many people will become land less. Urbanization, development of markets/ bazaars, transportation and industrialization will be developed which may be sustainable but mitigation must be ensured. The total no. of sustainable mitigation is only + 14 which indicate that the study area is not suitable for industrialization and urbanization (table 16). By establishing the coal fire power plant only electrification in the rural area, and very few job and localized business facilities will be increased. The benefits/facilities of proposed coal fire power plant of Rampal is very poor (S+19) than that of negative irreversible impact (-81).

So economically, socially, physically and environmentally the selected area is not suitable to establish any type of coal based power plant. On the basis of IECs and EIA, coal based power plant will be act as "to add insult to injure" in the project area as well as on the Sundarbans, Rampal and Mongla areas.