Journal of Soil Science and Environmental Management Vol. 2(5), pp. 126-131, May 2011
Available online at http://www.academicjournals.org/JSSEM
ISSN 2141-2391 ©2011 Academic Journals

Full Length Research Paper

Evaluation of possible environmental impacts for Barapukuria thermal power plant and coal mine

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Accepted 8 April, 2011

Barapukuria is the only natural coalmine reserve in Bangladesh that is in operation. In this study, an attempt was taken to conduct environmental impact assessment of Barapukuria thermal power and coal mining project through environmental, socio-economical and meteorological study. The analysis showed that, the Mn concentration was found in the satisfactory range. The pH was found slightly alkaline and surface water was bacteria contaminated. SO_4^{2-} concentration was in the range of WHO standard. Calculated SO_x loading was almost same of monitored emission. Corresponding estimated concentration of SO_x was in acceptable range, which may not bring any matter of concern. In the study, an attempt was also made to evaluate the health impacts of SPM (suspended particulate matter) emitted from the combustion of coal in the power plant. The socio economic condition was also considered a dominating factor, for the EIA along with the chemical parameters since increased employment for the project. In general, this study includes comprehensive baseline data for decision makers to evaluate the feasibility of coal power industry at Barapukuria and the coalmine itself.

Key words: Coalmine, power plant, environmental impact assessment (EIA).

INTRODUCTION

From the middle of the 18th to the middle of the 19th century, coal got extracted from nature and was the predominant source of energy in the west, mainly coal introduced the industrial revolution to Europe in that century. Since then, coal was widely used for electricity generation and transportation, reason being the low cost associated with its extraction. About 70% of the coal produced worldwide at present day is used for electricity generation. In order to alleviate the electricity crisis in Bangladesh, Barapukuria Coal and Power project is a blessing indeed. Estimated energy from the project is equivalent to 53 trillion cubic feet (TCF) of natural gas; more than threefold of gas reserves of the country. So, a new dimension is added to the economy of Bangladesh, regarded as coalmine industry. At Barapukuria, itself has the capacity to extract 3,333 tones of coal per day and can be used for electrical power generation. As the civilization has advanced tremendously over the last century, the alternative source of power generation came in effect like nuclear power, which certainly replaced coal in the west. Assessing the coalmine and its versatile impact over the industrial revolution time, the researcher, end of the 20th century revealed that there is huge risk of health, potential air pollution, noticeable change in land-scape, political and social problem, overall sustainability of the environment could get seriously affected by coal mine operation.

Therefore, it is obvious that an assessment of the local environment should go prior and along the project of Barapukuria before any unexpected consequence over-whelms this project. In order to find out possible positive and negative benefits, a thorough analysis considering all the impacts on soil, water, sound levels, and changes in aesthetic environment, were carried out in this study. The major objectives of the study were (i) to assess the socio-economic impacts of these projects, (ii) to assess the impacts on land use pattern and (iii) to identify and quantify the environmental effects.

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METHODOLOGY

The study was based on field observations, sample collections and testing. Coal, soil and drain water samples were collected from the study area for sampling. Coal sample and soil were collected from coalmine in a container. Coalmine water was also collected from the drain. pH is determined directly by 'pH meter'. Arsenic was measured using standard method (APHA, 1985). SO_4^{2-} was measured by sulfa ver 4 method using ultra violet- spectrophotometer. Manganese was measured using standard method (APHA, 1985). NO_3-N was measured by cadmium reduction method by using UV-spectrophotometer. Pollutants emission rates from the power plant are calculated by using the fuel consumption rate and emission factor (Kato and Akimoto, 1992) for the unit consumption.

The Gaussian Plume Model (Peterson, 1978) was used to estimate the pollutant concentration at the selected location in a three-dimensional field downwind of the point source. Change in mortality from exposure to SPM can be estimated from the dose-response relationship (Ostro, 1994). Evaluations of impacts were based on standard EIA procedures and experts opinion. Problem identification and prediction techniques were used for evaluation (Peavey, 1985) of the project. Graded matrix (Leopold et al., 1971) system was used to denote the magnitude and importance of the impacts by numerical values. The flow diagram of the EIA project has been shown in Figure 1.

Baseline data of the projects

Location of the projects

Barapukuria coal mine and power plant site is located in flat paddy land of the north-western corner of Bangladesh at about 45 km east of the district headquarters of Dinajpur, 20 km east from the border of India. The coal field has a proved area of about 5.25 sq km. In addition, the field is suggested to have possible extension for 1 to 1.5 sq km area to the south. The coal mine is located with latitude 25° 31' 45" and 25° 33' 05" N and longitude 88° 57' 48" and 88° 58' 53".

The Geological Survey of Bangladesh (GSB) discovered the Barapukuria coal field in 1985 in the drill hole GDH-38, that encountered coal seams at depth of 159 m, shallowest occurrence of coal in the country until then. Subsequent drillings in the field found coal at the depth as shallow as 118 m. Wardell Armstrong, Mining Consultant of U.K. was engaged in conducting mining feasibility study of the Barapukuria field. From study, the consultant confirmed that the coalmine at Barapukuria is both technically and economically feasible and concluded in favor of underground mining. On the basis of the aforestated conclusion, the government of Bangladesh decided to establish a coal mine operation and a coal fired thermal power plant at Barapukuria.

Meteorological condition

Meteorological information relevant to the Barapukuria site is available from weather stations at Dinajpur and Rangpur. These stations are about 30 km west and east respectively from the project site. The average annual precipitation in the area is 1,800 to 2,000 mm of which 85% comes from May to September. Heavy rainfall for 24 h or more are recorded which in succession causes 1 to 1.5 m depth flood in the low-lying areas of the vicinity. The relative humidity is above 80% at daytime and 90% at nighttime. The maximum temperature is 38°C in June and the lowest is 4°C in December. The available data on wind directions and speeds indicate that, the wind blows predominantly from East to West (40%), West to East (25%) and from North-East (18%). The wind speed rarely exceeds 8 m/s and mostly the wind is calm.

Ambient noise

The project area is almost noiseless, as there is no activity other than agriculture and small business in the area prior to the intervention of development of coal mine and coal based power plant. Sound level meter Na -20 measured the sound level at the study area. The levels of sound as recorded over time from inside of the mine Barapukuria are given in Table 1. The table confirms that the sound level is rather normal and within the allowable limit.

Soil quality

The soil in the land above the coal mine is under the control of Noadda and Amnura soil association. The soil is predominantly clay-to-clay loam underlain mainly clay soil. The soils in the area were tested and the results are shown in Tables 2 and 3. Table 2 shows the chemical components of the Barapukuria Soil sample and Table 3 shows test result of coal and soil sample of Barupukuria.

Present cropping practice

According to the soil resources guideline of Parbatipur Thana, the cultivable lands of the surveyed area have been classified as high land and medium high land. In the monsoon, water remain 2 to 3 months in the medium high land and depth of water does not exceed more than 90 cm. Double and triple crops are cultured in the investigated area.

Different terrestrial ecosystem

A total of 35 terrestrial flora species were recorded after field investigation within the area. The major habitat patterns of the project are classified under three categories namely 1) terrestrial natural flora, 2) terrestrial planted flora and 3) medicinal flora. If aquatic fauna is affected severely, it could upset the ecological balance. A total of six aquatic fauna species were recorded from the project area. Out of six aquatic faunas one is endangered and one is threatened. A total of eight aquatic floras were recorded from the project area.

Settlement pattern / Socio-economic baseline data

According to the Bangladesh population census report in 1991, on average 565-people/ km^2 living in the investigation area and approximately 0.18 to 0.20 ha land is available per capita. People in the area are used to rural life style based on agricultural activity. They are mostly engaged in farming and are self-employed. In the towns like Phulbari and Parbatipur, there are people in small business and government / non-government services. The Barapukuria coalmine is the largest project at present, nearby to the investigated site.

Activities related with Barapukuria coal–fired power plant

The large extent environmental impact of a power station depends on its location with respect to human settlements, metrological conditions, ambient air quality, water bodies, agricultural and forest-lands etc. The emission of large quantities of sulphur dioxide and oxides of nitrogen from power plants may results in 'Acid Rain' problems. Within the 25 km radius of the project site, both short and long term impacts on especially sensitive targets, such as habitat of endangered species of wildlife or plants, sites/monuments of

Table 1. Sound level near at Parbatipur.

Observation time	Sound level in decibel (db)		
	Lowest	Highest	Allowable limit
Morning (8-30 p.m.)	30	60	60-70 DB
Afternoon (12-45 p.m.)	25	60	- do-
Evening (6-30 p.m.)	20	55	-do-

Table 2. Data on chemical component of the project area.

Item	MgO	CaO	Na_2O	K_2O	B_2O_3		pH	EC	Mg^{2+}	Ca^{2+}	K^+	Na^+	B^{3+}
	%				mg/kg			µS/cm	mg/L				
Barapukuria soil	0.7	0.2	0.2	0.2	427	201	6.5	12.7	0.1	0.2	0.2	1	<0.1

Table 3. Test result of coal and soil sample.

Name of test	Coal sample (%)	Soil sample (%)
Total organic carbon	48.8	32

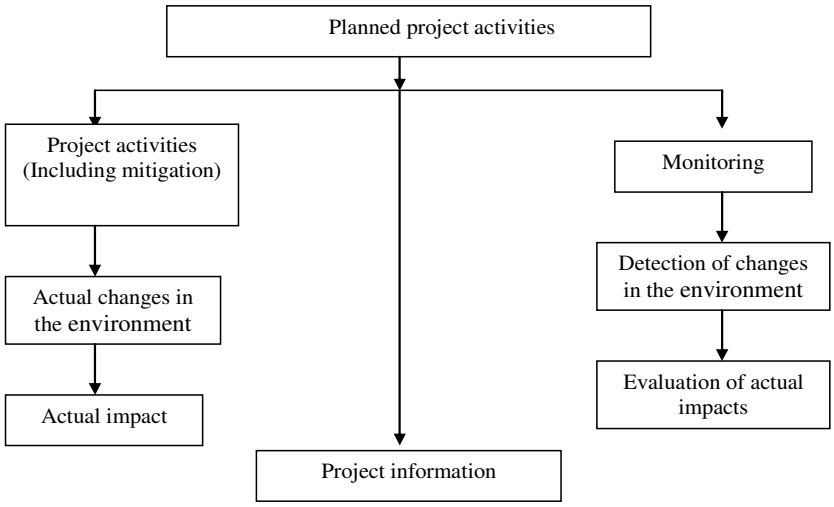

Figure 1. Flow diagram for EIA of the project.

historical and cultural importance, centers with concentrated populations of senior citizens or school going children must be dealt with importance.

RESULTS AND DISCUSSION

The terms no, negative and positive were used in Table 4 to classify the magnitude both from the construction and operational phases of the proposed development in Barapukuria, which supposedly identifies the short and long term impact. It can be observed from the table that, activities which have the potential of creating major (Significant Environmental impact) SEIs of either negative or positive are from coal dust, emission from the power plants, transports and equipment of the coalmine. This sort of development has impact on a large number of environmental objects, namely land acquisition and use, landscape, wildlife, cultural and historical sites, water resources, noise level, air quality, socio-economy. Emission sources from the power plant that have a major impact on the environment are flue gas, waste heat and

Table 4. Ranking of environmental impacts.

Environmental component	Extent of impact	Comments
Land acquisition and use	Negative	The land has already been acquired by coal mine and power plant .The farmers' loss of this land has been compensated financially.
Landscape	Negative	Construction of the coal mine and power plant will be visually intrusive due to the dimensions of the stacks and cooling towers.
Wildlife	No	It is not expected to find any rare species in the investigation area. A reserve forest of the government.
National parks wildlife sanctuaries other protected area	No	There do not exist any national park, wildlife sanctuary or protected areas in the investigation area.
Cultural and historical sites	No	There does not exist a historical site at the power plant area or in its vicinity. A mosque which is located in the investigation area is affected neither during construction phase nor during operation phase.
Water resources	Negative	The suspended solids of the coal water discharge into the field and water quality in the surface water excess in the experimental report. During the construction phase, there will be temporary sediment run off, about 730 m^3/h groundwater will be removed, 9 m^3/h of industrial waste water will be discharged directly into the Tilai River without waste water cleaning and will exceed the Bangladesh standards at least concerning the chloride content of the power plant.
Noise aspects	Negative	During construction the temporary peak noise levels may be as high as 90 db (A) at the projects boundary. During phase of operation the Bangladesh standards will not be exceeded in any case.
Air quality	Negative	The Bangladesh standards will not to be exceeded. However the projects are constructed in a pollution- free rural area with no other industries.
Socio-economic aspects	Positive	Increase of employment. During construction, a more reliable electricity supply.
Employment	Positive	
Infrastructure	Positive	

noise. Table 5 shows the output result of drain water from the coalmine.

The Mn concentration was found in the range of 0.19 to 0.26 mg/L, the pH was found slightly alkaline (7.2 to 7.4). The concentration of bacteria was found from 7.5×10^4 to $10x10^4$ C.F.U/100 ml. From Table 5 it is also found that S042- concentration is 2.4 mg/l in gut side boundary drain water and 3.1 mg/l in out side boundary water, which is within the WHO range. Calculated SO_x loading was 0.85 ton/h, which is almost same of monitored emission (0.735 ton/h). Corresponding estimated concentration of SO_x was 0.318×10^{-3} ppm, which does not cause any matter of concern. The identified environmental parameters were analyzed by Leopold matrix. Table 6 represents Leopold matrix of EIA. It was found that surface water source, ground water source, water quality, air quality, noise level, health condition, ecology; land scope will be affected negatively by the project. But the project will create employment opportunities, increase public utility, attract tourist, and accelerate economy and fisheries activities. Most of the negative impacts are due to land acquisition, influx clearance, land clearance, site preparation, transport activities, handling raw materials, mining and milling, refining, conversion, fuel preparation, fabrication, power generation, transport, reprocessing, waste storage.

Conclusion

The Leopold matrix depicted a result of totaling +950 positive scores, certainly favors to environment. It is clear from the analysis that the Mn concentration was found in the range of 0.19 to 0.26 mg/L. The pH was found slightly

Table 5. Test results of drain water samples.

Water parameters	Sample collected from	
	Gut side boundary drain water	Outside boundary drain water
Mn	0.19 mg/L	0.26 mg/L
pH	7.2	7.4
Total count (number of all colony forming bacteria)	$7.5x10^4$ C.F.U/100 ml	$10x10^4$C.F.U/100 ml
Total coliform	28	28
Fecal coliform	9	9
As	-	-
SO_4^{2-}	2.4 mg/L	3.1 mg/L
NO_3^-N	0.4 mg/L	1.6 mg/L
Fe^{3+}	0.45 mg/L	0.61 mg/L

Table 6. Leopold matrix of coal fired plant and power plant.

Environmental parameters	Importance Vol.	Impacting action																									
		Construction phase										Operation phase															
		Land aeq.	Influx clearance	Land Clearance	Site Preparation	Civil Construction	Trans. Cons.	Civil Facilities	Socio-economic Recla.	Soil-conser. Measures	Biological measures	Transp. Raw Metarial	Handling Raw Meterial	Mining and Milling	Refining	Conversion	Enrichroent	Fuel Prep.	Fuel Febri.	Power generation	Spent Fuel Traps	Reprocessing	Waste Storage	Up gradation of civil	(+vc) or (-vc)	Impact scale
Surface water Res.	25	-1	-1			-1		-9			+1													-2	-6	-150
G.W. Res.	50							-1			+1													-1	-1	-50
Water Quality	25		-1					+1		+1			-1	-1	-1		-1			-1		-1		+1	-4	-100
Air Quality	25			-1		-1	-1					-1	-1	-2	-1	-1	-1	-1	-1	-1	-1	-1	-1		-16	-400
Noise Level	25	-1					-1					-1	-1	-1	-1	-1			-1	-1	-1				-10	-250
Health	25							+1	+1				-1	-2	-1	-1	-1	-1	-1		-1	-1			-8	-200
Employment	100	+2		+1	+1	+2	+1					+2		+2	+2										+17	1700
Land Use	100	-1	-1	-1	-1					+1	+1												-1		-3	-300
Geological Res.	50			-1		-1				+1	+1												-1		-1	-50
Pedd. Res.	50						-1			+1															-1	-50
Ecology	25	-1	-1	-1	-1	-1				+2	+1														-1	-50
Public Utility	25		-1					+1	+1				+1							+1				+1	+6	+150

Table 6. Contd.

Land scape	50	+1	-1	-1		+1		+1						+1	-1	-50
Tourism	25					+1		+1	+1					+1	+4	+100
Socio Economic st.	50		-1					+1	+2					+1	+3	+150
Business	50	+1	+1			+9	+9	+1				+1		+1	+10	+500
Total																+950

alkaline (7.2 to 7.4). Bacteria contaminated surface water. The concentration of bacteria was found from 7.5×10^4 to $10x10^4$ C.F.U/100 ml. SO_4^{2-} concentration was in the range of 2.4 to 3.1 mg/L, it is within the WHO range.

Calculated SO_x loading was 0.85 ton/h which is almost the same of monitored emission (0.735 ton/h). The suspended solids of the coal water discharge into the field and water quality in the surface water excess in the experimental report. Corresponding estimated concen-tration of SO_x was 0.318×10^{-3} ppm, which does not cause any matter of concern. In the study, an attempt was also made to evaluate the health impacts of SPM (suspended particulate matter) emitted from the combustion of coal in the power plant. It was found from the cumulative analysis of the study that the impact was positive.

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