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Study of Environmental Impacts of the Barapukuria Thermal Power Plant of Bangladesh

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I. Introduction

A thermal power station is a power plant in which the prime mover is steam driven. Water is heated, turns into steam and spins a steam turbine which drives an electrical generator. After it passes through the turbine, the steam is condensed in a condenser and recycled to where it was heated; this is known as a Rankine cycle [1]. Barapukuria power plant is a power station which follows the Rankine cycle. Barapukuria is the only natural coalmine reserve in Bangladesh that is in currently operation. The overall capacity of Barapukuria Thermal Power Plant is 250MW. Total electricity generation is extracted into two units as 2x125MW. In order to alleviate the electricity crisis in Bangladesh, Barapukuria Coal and Power project is a blessing indeed [2].

Besides the blessing indeed property Barapukuria power plant has some adverse effect also. One of the major effects of the power station is the exhaust emission. Due to continuous & long lasting emission of SO_x & NO_x, which are the principal pollutants coal based plants.. It is also worth to note that very high amount of carbon dioxide (CO_2) emission (0.9-0.95kg/kWh) from thermal power plants contribute to global warming leading to climate change [3].

Also Thermal Power Plants have been found to affect Environmental segments of the surrounding region very badly. Environmental deterioration is attributed to emission of large amount of SO_x, NO_x & SPM which disperse over 25kms radius and cause respiratory and related ailments to human beings and animal kingdom. The SPM also includes RSPM (respirable suspended particulate matters) and both types of fine particles normally spread over 25kms from the Thermal Power station.

Alam et al. [4] in their study gives emphasis on the evaluation of possible environmental impacts for Barapukuria thermal power plant and coal mine. In his work an attempt was taken to conduct environmental impact assessment of Barapukuria thermal power. Tamim et al. [5] shows the analysis of fly ash of Barapukuria thermal power plant. Fly ash is one of the common residues produced from combustion of coal. But the study was not enough to recommend the possible measurement to reduce the adverse impact of Barapukuria Power Plant. Now the aim is that, to find out the possible environmental impacts by studying the data from water treatment plant, coal handling unit, ash handling unit and I &C department of Barapukuria thermal power plant and recommending the possible way to minimize the impacts.

II. Methodology

The study was based on field observations, sample collections and data collection. Coal, soil and drain water samples were collected from the study area for sampling. Coal sample and soil data are collected from the authority of Barapukuria thermal power plant.

Overall thesis work was completed by following steps:

Data Collection: The thesis covers both secondary and primary data. Here secondary and primary data sources are used to estimate the emissions and their effects from Barapukuria thermal power plant.

Secondary Data: Secondary data were collected from the authority of Barapukuria thermal power plant, sequentially from the water treatment plant, I&C department, coal & ash handling unit.

Primary Data: Primary data were collected from the analysis of several thesis work based on Barapukuria thermal power plant.

Drain water sample was collected from the Barapukuria thermal power plant and data of drained water collected from the chemistry department to find

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out the level of concentration of different metals or elements.

Exhaust gas emission data was collected from the I&C department of the Barapukuria thermal power plant. Fly ash quantities was calculated from the data given by the authority.

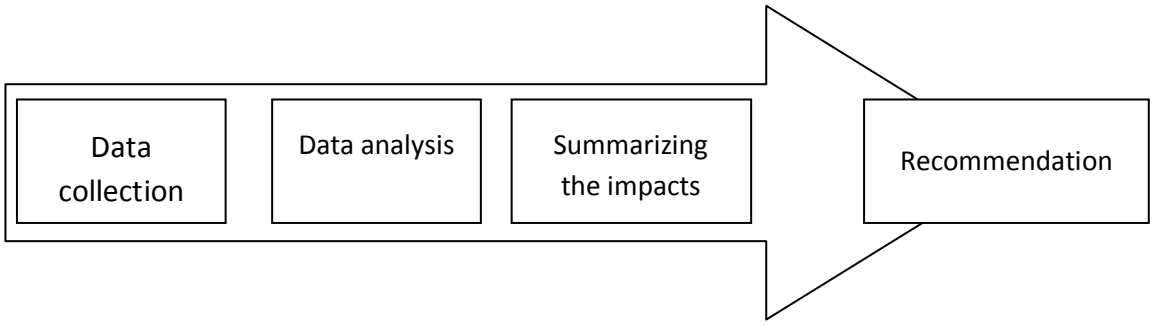

Figure 1 : Methodological Procedures

III. Data Collection and Analysis

As mentioned in the methodology that the data is collected from the different sources.

Survey to the inhabitants: A survey was directed to the surrounding area within about 5km from the power plant. A conversation was made among 210 people of different profession nearby the plant area to investigate the impact on their health. They informed about their health condition (suffered by the Barapukuria power plant). The survey was based on several questions about asthma, allergy, skin diseases, and other respiratory problems on their health impact. Result of the survey given in table (1).

Table 1 : Health impact on inhabitants (degree of responsive analysis)

Variable	Asthma	Allergy	Skin diseases	Other respiratory problem	Total	Percentages %
Agree	5	7	6	12	30	14
Undecided	35	33	24	28	120	58
Disagree	20	10	30	30	80	38
Total	60	50	60	50	210	100

The above Table 1 reveals that 14% of the inhabitants suffer from allergy, asthma, skin diseases and other respiratory problems and the 58% of the inhabitants were undecided and rest of the 38% were disagreed about the effect of exhaust emission from the Barapukuria thermal power plant.

Conversation was also made with the local doctors about the patient condition around the power plant area. They informed that the skin diseases and the respiratory problems have been increased since when the Barapukuria power plant started operation in 2006.

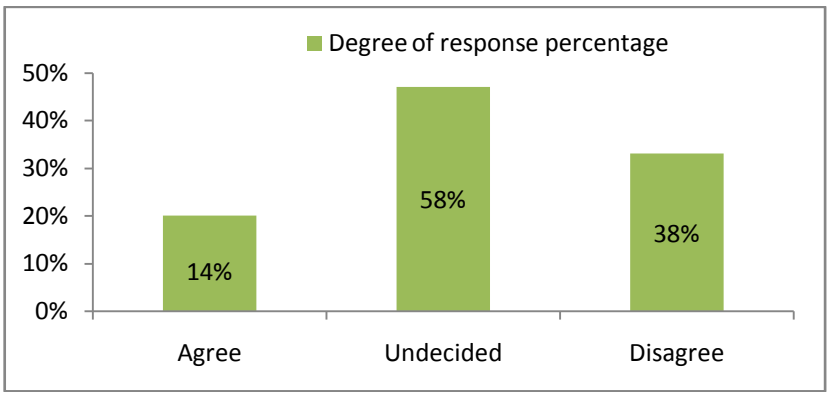

Figure 2 : Percentage of degree of response on health impact

Table 2 : Impact on production and atmosphere

Variable	Less production	Ash in the air	Ash deposited on the leaf	Total	Percentage %
Agree	40	20	30	90	47.36
Undecided	15	15	20	50	26.33
Disagree	15	15	20	50	26.31
Total	70	50	70	190	100

The above Table 2.2 reveals that 47.36% of the inhabitants were agreed that it causes less production, ash in the air, ash deposited in the leaf, and the26.33% were undecided and the 26.31% were disagreed.

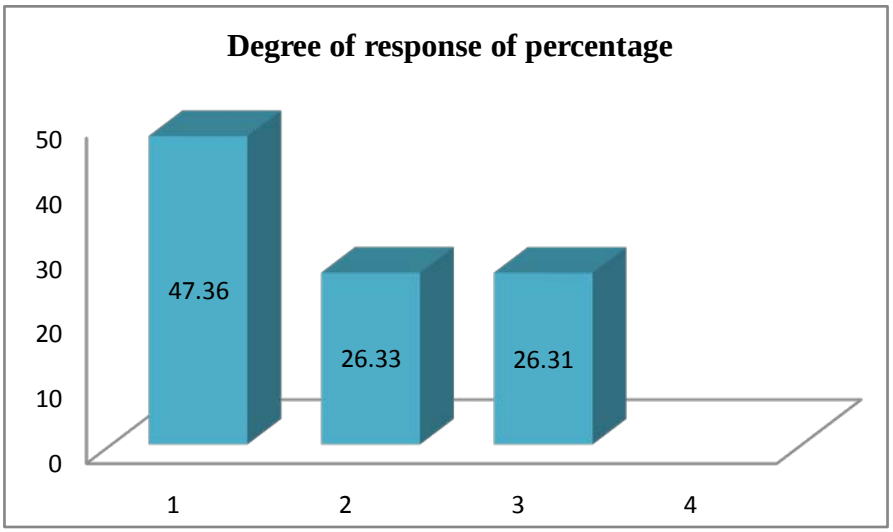

Figure 3 : Percentage of degree of response of production and atmosphere

IV. Analysis of Waste Water (drained)

The test result of drained water sample showed that pH is slightly basic.

Table 3 : Drained water analysis

Water parameters	Gut side boundary drain water	Outside drain water
Mn	0.19 mg/L	0.26mg/L
pH	7.2	7.4
Total count	$7.5x10^4$ C.F.U/100mL	$10x10^4$ C.F.U/100mL
Total coliform	28	28
Fecal coliform	9	9
As	0	0
SO_4^{2-}	2.4mg/L	3.1mg/L
NO_3-N	0.4mg/L	1.6mg/L
Fe^{3+}	0.45mg/L	0.61mg/L

It is clear from the analysis that the Mn concentration was found in the range 0.19 to 0.26 mg/L. The ph was found slightly acidic (7.2 to 7.4). Bacteria is within WHO ranges. The concentration of bacteria was found from 7.5. It is also found that $S0_4^{2-}$ concentration is 2.4 mg/l in gut side boundary drain water and 3.1 mg/l in outside boundary water, which is within the WHO range .NO_3 is slightly varied from the standard range and the concentration of Fe3 was found within the WHO range.

V. Coal Analysis

Coal, the most important fossil fuel remained essential in achieving a diverse, balance and secure energy mix. Barapukuria Coal field has been operating officially since 2004, with a coal reserve of 390 Million Tones. The yearly production is 1 million tones, out of which 65% is supplied to the Barapukuria Coal fired Thermal Power Plant, the only operating thermal power plant of Bangladesh, with a capacity of 250MW [6].

a) Coal consumption (at rated load)

- Each unit per day: 1200 M.ton
- Total for 2 units per day: 2400 M.ton
- Coal consumption/kWh: 0.4 kg

- Annual ash generation: 0.08 million M.ton
- Cooling water consumption/h: 800-1200 M.ton

b) Fly ash analysis

The ash analysis of Fly ash obtained from Barapukuria Power Plant.

Oxides	Percentage
SiO_2	54.4
Al_2O_3	35.6
Fe_2O_3	2.9
TiO_2	3.2
Mn_3O_4	0.11
CaO	0.56
K_2O	0.66
Na_2O	0.06
MgO	0.18

c) Fly ash Disposal

Fly ash disposal is carried out by two techniques, namely dry disposal scheme and Wet disposal scheme. In dry disposal, the produced fly ash is transported from site by various methods (truck, conveyor belt etc.) and disposed into a dry embankment. In wet disposal, the fly ash is mixed with water to form a slurry, which is transported by pipes to be disposed off in a confinement called the 'ash pond'[7].

Figure 4 : Ash pond of Barapukuria Thermal Power Plant

d) Exaust Gas Emission

Table 4 : Exhaust gas emission from stack of the power plant (analytic data of I&C department)

Date	Particulates	Units	Time: 12.00	Time: 24.00
12-8-2012	NO_x	mg/Nm^3	182.22	182.26
	SO_2	mg/Nm^3	327.20	327.20
	CO_2	mg/Nm^3	10.48	10.49
	O_2	%	6.37	6.37
	Dust	mg/Nm^3	125.20	125.20
14-8-2012	NO_x	mg/Nm^3	172.42	171.26
	SO_2	mg/Nm^3	357.20	348.29
	CO_2	mg/Nm^3	9.44	10.49
	O_2	%	6.67	6.37
	Dust	mg/Nm^3	122.29	121.22
16-8-2012	NO_x	mg/Nm^3	179.33	180.26
	SO_2	mg/Nm^3	318.23	315.20
	CO_2	mg/Nm^3	11.45	11.33
	O_2	%	6.97	6.87
	Dust	mg/Nm^3	128.20	129.50
18-8-2012	NO_x	mg/Nm^3	168.32	169.26
	SO_2	mg/Nm^3	344.76	344.46

	CO_2	mg/Nm^3	9.58	9.79
	O_2	%	6.65	6.78
	Dust	mg/Nm^3	129.35	129.54

All the reading are taken away from the emission point of power plant, this show that emission is somehow more than allowable limit. When the power plant which are in construction phase when they start their operation then this limit is easily exceeded. So we should take care of all such factors as well as take necessary preventive action to control this emission level .

VI. Summerisation of Impacts on Environment

Figure 5 : Emission from the stack of Barapukuria thermal power plant

Air Quality Around the coal based plants the ambient concentrations of Sulphur Dioxide, Oxides of Nitrogen and SPM are high. Epidemiological Studies have shown that of the area surrounding coal based thermal plants, population living within a 2 -5 km radius of the plant suffers from respiratory disorders. Two other gases, carbon dioxide and ozone are emitted. The high amount of carbon dioxide emission from thermal power plants contribute to global warming leading to climate change is significant Ground level ozone, which is formed due to photolytic reactions of NO_x and its impacts are under study Mercury vapour is also emitted with these gases and its toxicity has far reaching consequences on all life forms.

Impact on water: The water requirement for Barapukuria thermal power plant is 60ton/hr for each unit. Among these water 30 ton/hr is drained and rest of water is recycling. Ash pond decant contains harmful heavy metals like B, As, Hg which have a tendency to leach out over a period of time. Due to this the ground water gets polluted and becomes unsuitable for domestic use. $9m^3/h$ of industrial waste water is discharged directly into the Tilai River without waste water cleaning.

Figure 6 : Drain water disposal at Tilairiver from Barapukuria thermal power plant

Effect of fly ash on soil environment: Large amount of land is used to dispose fly-ash from the coal based plants. Due to this there is change in natural soil properties. It becomes more alkaline due to the alkaline nature of fly ash. Soft bodied soil workers like earthworms will die out.

VII. Recommendation

a) The drained water which is directly disposed to the Tilai river without cleaning waste water should be cleaned before disposing.

b) There is not any process of reusing the ash, directly thrown in the nearest ash pond. Fly ash can be used in different construction purposes. From the study of this thesis shows that the analyzed fly ash are of useful component for recovery of alumina, opencast mine filling, road reclamation, cement and concrete production, waste water treatment and various agricultural applications.

c) Flue Gas De-sulphurization (FGD) process can be applied to remove sulphar from the flue gas

d) More source of water can be thought not only by using the ground water

VIII. Conclusion

The analysis showed that the emission of SO_x, NO_x and particulates matter is in allowable range but this may cause adverse effect to the environment of the surrounding region.

- Total emissions from the Barapukuria thermal power plant is 1.1ton/hr.
- The high amount of CO_2 emission from thermal power plants before 2009 was 756,020 tons, that make the Barapukuria thermal power plant a red marked power plant in this zone
- Problem associated with ground water is the main challenge of Barapukuria Thermal Power Plant.
- There found poor productivity of cultivating crops due to the lack of water source.
- Upper surface of land become more alkaline due to components of fly ash.
- A significant amount of inhabitants (14%) suffered by the impacts of Barapukuria thermal power plant.
- 47.3 % of inhabitants ensured about less production of their crops, ash in the air, and leaf damage due to fly ash or flue gas.

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