ICMIEE18-311

Evaluating the Impact of Coal Fired Thermal Power Plant on Water: A Case Study of Barapukuria Dinajpur, Bangladesh

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ABSTRACT

Thermal Power plants have various impacts on land, soil, water, air, and social environment. From the result, it has been identified that pH of the water is relatively low near the plant due to improper water drainage. Moreover, calcium of the water samples is also below than the standard value. On the other hand, Chloride (Cl^-), Total Hardness (TH), Magnesium (Mg) is relatively higher than the Standard Reference value for agriculture. Moreover, maximum degraded water samples are found near the Thermal Power Plant, as the distance increases from the thermal power plant the degradation level of water samples decreases, which is a clear indication of the anthropogenic effects of thermal power plant on the water quality. The collective results of multivariate analysis and Water Quality Index (WQI) imply that most of the areas around the area are dominated by the good to excellent quality water for different purposes. In addition, the results of this research will then be helpful to estimate the major sources of contamination in different areas within the framework of activities intending to improve the quality of water.

Keywords: Thermal Power plant, Water quality, Multivariate analysis, Water quality index.

1. Introduction

Coal is being extensively used as a fuel source for electricity generation. It is one of the main primary energy resources for electricity generation in the world. From the mid of 18th to the mid of the 19th century, coal got extracted from the nature and will be the principal source of energy in the west, mainly coal introduced the industrial revolution to Europe in that century [1]. In Bangladesh, share of commercial energy will be 1.58 M ton (5%) in 2015 and targeted to be 19.18 M ton (27%) in 2021 from coal [2]. The Barapukuria Coal Power Plant is an existing 250 megawatt (MW) coal-fired power station which is owned and operated by the Bangladesh Power Development Board (BPDB) in Dudhipur, Dinajpur province in Bangladesh [3]. Currently the plant has two 125 MW units, recently third unit work is going on and it will generate another 250 MW. The total reserve of coal is about 2083 million tons among which Barapukuria has a reserve of 303 million tons [4]. The power plant was commissioned in 2006 and consumes approximately 450,000 tons of coal a year which is supplied by the Barapukuria coal mine [3-5]. By the year 2016-2017, BPDB has bought 5,334,153.994 tons of coal from the Barapukuria coal mine[3].

Combustion of coal in thermal plant is one of the major sources of environmental pollution due to production of large amounts of ash residues and gaseous and particulate matters, of which ashes disposed to the large ash ponds (disposal site) in the proximity of the plants [6]. During the last few decades the disposal of Coal Combustion Residues produced by Coal fired Thermal Power Plants will be a matter of concern on a worldwide scale [7]. However, Bangladesh is an agricultural country, about 75% people of this country is directly or indirectly related to agriculture. Dinajpur area is also renowned for different agricultural products. However, it is very important to assess the condition of agricultural water sources around the Barapukuria thermal power plant. Therefore, the aim of this study is to determine the possible impact of power plant on water surrounding the Barapukuria Thermal Power Plant by analyzing the chemical component of water samples.

Barapukuria Thermal Power Plant is located in the north-west part of Bangladesh. It is situated at the Parbatipur Upazila of Dinajpur district, at a distance of about 50 km southeast of Dinajpur town. The nearest railway station is Phulbari is 6 km south of Barapukuria. Dinajpur is famous for producing large amount of Paddy and Rice. Figure 1 is showing the study area.

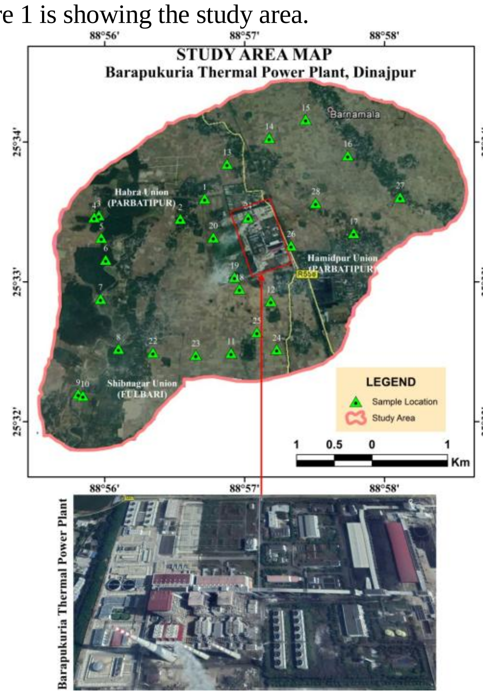

Figure 1: Satellite view of study area. (Around BTPP, Parbatipur upazilla, Dinajpur)

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2. Method of analysis

Methodology includes sample collection, sample preparation, sample analysis and data interpretation.

2.1 Sample Collection and data analysis

All experimental water samples were collected very carefully in each of 500 ml bottles from the study area. At first, all sample collecting plastic bottles were washed out to make it neutralized. Then, water samples were collected in this 500 ml bottles noting Latitude, Longitude and Elevation were recorded during the time of sample collection with the help of GPS reading. Total 28 samples were randomly collected from the study area and thirteen chemical properties of each sample, including pH, Arsenic (As), Chloride (Cl^-), Iron (Fe), Sulfate (SO_4^{2-}), Total Hardness (TH), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Electrical Conductivity (EC), Copper (Cu), Zinc (Zn), Cadmium (Cd) and Lead (Pb) have been determined. Except, EC (determined in µS unit), Cl^- (determined in percentage) all chemical parameters are determined in ppm unit. Chemical analysis was done by using UV Spectrophotometer except pH and Arsenic. Moreover, pH was measured by digital pH meter and Arsenic by EZ arsenic kit.

2.2 Water Quality Index (WQI)

The Water Quality Index (WQI) analysis provides a comprehensive picture of the quality of surface and ground water for most domestic uses. WQI is defined as a rating that reflects the composite influence of different water quality parameters [5-8].

3. Result & Discussion

Result and discussion of this study is divided into two section chemical analysis result and WQI result.

3.1. Chemical Analysis result

It has been prevailed that pH, Chloride, Calcium, Magnesium and Electrical Conductivity of the water samples are deviated from the standard reference value (for agriculture). But the other chemical parameters are within the standard reference value. Moreover, pH and Calcium is bellower than the standard value (96.43% samples for pH and 71.43% for Calcium). Nevertheless, Chloride, Magnesium and Electrical Conductivity of the water samples are higher than the standard value (100% samples for Chloride and Magnesium, and 32.14% samples for Electrical Conductivity). Figure 2 is showing the average value of different chemical parameters and pH which also showing the standard value of different parameter.

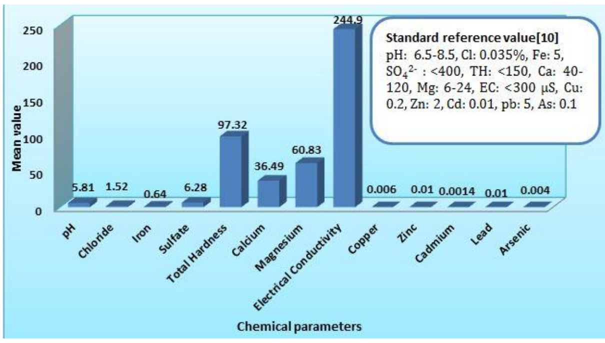

Figure 2 is showing the average value of different chemical parameters and pH.

3.2 Result of Water Quality Index

The Water Quality Index (WQI) is a single value expression that summarizes numerous parameters and provides a measure of water quality. Water quality indices (WQIs) have been calculated for the samples using the concentration of 8 parameters such as pH, EC, Ca, Mg, Cl, SO_4 and TA. From the result of WQI, it has been identified that water is good to excellent quality. Table 1 is showing the result of WQI.

Table 1 Calculated Water Quality Index and their classification of the samples

Sample No	Water Type	Sample No	Water type
W1	Excellent	W15	Excellent
W2	Good	W16	Excellent
W3	Excellent	W17	Excellent
W4	Excellent	W18	Good
W5	Excellent	W19	Good
W6	Excellent	W20	Good
W7	Excellent	W21	Excellent
W8	Excellent	W22	Excellent
W9	Excellent	W23	Good
W10	Excellent	W24	Good
W11	Excellent	W25	Good
W12	Good	W26	Excellent
W13	Excellent	W27	Excellent
W14	Excellent	W28	Good

4. Conclusion

Water is valuable natural resources and now it is facing depleting due to ever-increasing consumption in the industrial and domestic sector. From the present study, we try to identify and analyze the level of depletion of Tillai River and other surface water due to fly ash pollution from BTPP. From the analysis of water samples, it has revealed that several important chemical parameters that are necessary for agriculture deviate from the Standard Reference value. It is also clear that water samples are degraded because of improper disposal of Plant water as water samples near the ash pond have been found in the degraded condition. Fly ash released during Plant activities are mixing with the water and consequently degrading the water quality. Chemical analysis shows that pH of the water was found relatively low near the plant due to the improper disposal of Plant water. Based on the Total Hardness (TH) values the water samples were found slightly hard. Percentage of cl and concentration of Mg, EC was also high from the standard reference value. All other parameters except these were almost in the permissible level based on water quality standards. Therefore, thermal power plant must be the major reason for the degradation of the water quality of the surrounding area. Proper management of fly ash from ash ponds should be the primary and immediate responsibility to the BTPP authority. The main innovative things of this research work are that Water Quality Index (WQI) which ultimately helps us to understand the water quality in surrounding area. Moreover, it will be helpful in monitoring activities and for further water quality management to prevent the pollution.

REFERENCES

[1] Howladar MF and Hasan K (2014) A study on the development of subsidence due to the extraction of slice with its associated factors around Barapukuria underground coal mining industrial area, Dinajpur, Bangladesh. Environ Earth Sci 72(9):3699–3713. doi:10.1007/s12665-014-3419-y.

[2] Power cell (2015) Annual Report, Power Division, Ministry of Power and Mineral Resources, Government of the People's Republic of Bangladesh. www.powercell.gov.bd.

[3] Bangladesh Power Development Board (BPDB), "Annual Report 2011-12", Bangladesh Power Development Board, page 44, 48.

[4] Barapukuria Coal Mining Company Limited (BCMCL), Petro-Bangla website, accessed May 2018

[5] Food and Agriculture Organization of the United Nations (FAO), http://www.fao.org/home/en/. Barapukuria Coal Power Plant (BCPP), Global Energy Observatory website, accessed May 2018.

[6] Querol X, Alastuey A, Lopez SA, Mantilla E, Plana F (1996), Mineral composition of atmospheric particulates around a large coal-fired power station. Atmospheric Environment, 30, 3557–3572

[7] Spadoni M, Voltaggio M, Sacchi E, Sanam R, Pujari PR, Padmakar C, Labhasetwar SR (2014), Water impact of the disposal and re-use of fly ash on water quality: The case of the Koradi and Khaperkheda thermal power plants (Maharashtra, India). Science of the Total Environment 479–480 (2014) 159–170, http://dx.doi.org/10.1016/j.scitotenv.2014.01.111.

[8] Howladar MF, Numanbakth MAA, Faruque MO (2017) An application of Water Quality Index (WQI) and multivariate statistics to evaluate the water quality around Maddhapara Granite Mining Industrial Area, Dinajpur, Bangladesh. Environ Syst Res 6:13. https://doi.org/10.1186/s40068-017-0090-9.

[9] Sahu P, Sikdar PK (2008) Hydrochemical framework of the aquifer in and around East Kolkata wetlands, West Bengal, India. Environ Geol55:823–835

[10] Food and Agriculture Organization of the United Nations (FAO), http://www.fao.org/home/en/.