Determine Water Quality of Barapukuria Coal Mine Company Ltd and Its Surrounding Area in Dinajpur District

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Abstract: The purpose of this programme is to determine water quality of Barapukuria Coal Mining Company Ltd. and its surrounding area in Dinajpur district. 36 samples of water (Coal water flow stream drain water, surrounding area Water samples from the surface and tube type of tube well) are collected from this study area. Current pH, Conductivity, TDS, DO, temperature Samples physical character are measured and recorded in notebooks. After marking it properly, by adding HNO$_3$ control the collected samples pH 500 ml Polypropylene bottles are stored in ice box samples for chemical laboratories. Besides, the information related to the impact on the area is collected by the Barapukuria Coal Mining Company Ltd. and Barapukuria Coal-based thermal power plant. The amount of Al, Fe, Ti, Cu, Co, Cd, Zn, Ca, Mn, Mg, Na, K, As of the samples collected from the Analytical Chemistry Laboratory of Geological Survey of Bangladesh was determined. Chemical analysis of the samples showed that excessive presence of any element was not exist ECR (Environment Conservation Rule). 1997 of Bangladesh Standard value.

Keywords: Barapukuria, pH, Plant, Chemicals

1. Introduction

1.1. Purpose and Scope of the Work

Barapukuria coal mine & Barapukuria thermal power plant are situated at Parbatipur upazilla in Dinajpur District, Bangladesh. Area of Barapukuria coal mine is 646 acres of agricultural plain land. Barapukuria thermal power is established of 245 acres land. Coal, a natural mineral resource, is a black or brownish-black rock that is formed from plants, which died about 100 to 400 million years ago [1]. It is a heterogeneous mixture of several components such as sulfur, elemental carbon, arsenic, ash and heavy metals etc [2]. Coal has been a major means of fuel used in electricity generation. It has played a huge role in the development drive of several nations. Industrial revolutions had been powered by coal and the energy it supplied. In many countries coal is the primary source of energy [3, 4].

Coal is the second largest stock of energy in Bangladesh. 41.5 percent electricity in the world is produced from coal [7]. In order to alleviate the electricity crisis of 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 coal mine industry. Bangladesh is one of the top coal production countries and supply coal for its internal industrial energy source [13]. Barapukuria coal mine has the capacity to extract 3,500-4,500 tons coal per day. Among them 3,500 tons is used Barapukuria thermal power plant for electric power generation [6].

Assessing the coal mine 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 landscape, political and social problem, overall sustainability of the environment could get seriously affected by coal mine operation [12]. During the mining process huge amounts of water are discharged on the surface, which often contains high loads of TSS, TDS, hardness and heavy metals and consequently contaminates the surface and groundwater [5]. Therefore, it is obvious that an assessment of the local environment should go prior and along the project of Barapukuria before any unexpected consequence overwhelms 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 [15, 16]. The major objectives of the study were (i) to assess the socioeconomic impacts of these projects, (ii) to assess the impacts on land use pattern and (iii) to identify and quantify the environmental effects.

Coal is washed before reaching the thermal power plant. This coal washed water is drained into near paddy field, pond, canal and river. Thus the areas of Barapukuria coal mine are severely contaminated by coal waste water [11]. In spite of the role coal plays, there are strong evidences of coal’s impact on human health and the environment during every stage of its mining, use, and post-combustion disposal [14]. Air pollution generated by coal mining and combustion in power plants [8]. This programme aims is to identify the influence of mine and thermal power plants on the adjoining areas.

1.2. Location of the Study Area

The present study area was carried out to observe environmental effects from Barapukuria coal mining industries and Barapukuria thermal power plant in Dinajpur, Bangladesh. 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 geographical location of the studied area is in between 25.6533°N to 25.6533°N & 88.9155°E to 88.9155°E. Location of the working area was noted in terms of longitude and latitude by using GPS.

1.3. Previous Work

Different research and studies have been done by different scientists throughout the world including our country about the impact on the environment of Baropukuria coal mine industry & Barapukuria thermal power plant. Geological Survey of Bangladesh has not done yet any complete relevant study.

2. Methodology

2.1. Sample Collection

Assessment the effect of Barapukuria coal mine and thermal power plant on surrounding environment, the effect of coal water on soil, water, coal waste water and emissions from power plant had been evaluated. The study was based on field observations, sample collections and testing. Soil and drain water samples were collected from the study area for sampling.

![Figure 1. Location of the study area and water sample sampling point.](image-url)
| Sl No | Sample No | Sample source | Village | Post Office | Upazilla & District | Latitude | Longitude | Depth |
|-------|-----------|---------------|---------|-------------|---------------------|----------|-----------|-------|
| 1     | RMW-1     | Baropukuria coal mine ETP outlet water | Chowhati | Baropukuria | 25°32'55" | 88°57'38" | Surface |
| 2     | RMW-2     | Baropukuria Thermal Power Plant Ash dump pond area | Durgapur | Baropukuria | 25°33'04" | 88°56'54" | Surface |
| 3     | RMW-3     | Baropukuria Thermal Power Plant drainage outlet | Durgapur | Baropukuria | 25°33'19" | 88°56'46" | Surface |
| 4     | RMW-4     | Baropukuria coal mine Gondoana layer water outlet | Zigagari | Baropukuria | 25°32'43" | 88°57'33" | Surface |
| 5     | RMW-5     | Baropukuria coal mine Gondoana layer water outlet end point | - | Baropukuria | 25°32'42" | 88°57'23" | Surface |
| 6     | RMW-6     | Tube-well water | Bashpukur | Baropukuria | 25°32'53" | 88°58'43" | 30 m |
| 7     | RMW-7     | Tube-well water | Bashpukur | Baropukuria | 25°32'51" | 88°58'44" | 30 m |
| 8     | RMW-8     | Pond Water | Bashpukur | Baropukuria | 25°32'51" | 88°58'44" | Surface |
| 9     | RMW-9     | Tube-well water | Dhulaoddal | Baropukuria | 25°33'30" | 88°59'09" | 30 m |
| 10    | RMW-10    | Tube-well water | Khalilpur | Khaierpur | 25°34'32" | 88°59'25" | 33 m |
| 11    | RMW-11    | Tube-well water | Pachghoria | Baropukuria | 25°31'38" | 88°58'45" | 30 m |
| 12    | RMW-12    | Tube-well water | Baidgram | Baropukuria | 25°31'36" | 88°58'07" | 30 m |
| 13    | RMW-13    | Tube-well water | Eusafpur | Shohidpur Hat | 25°33'39" | 88°56'54" | 28 m |
| 14    | RMW-14    | Tube-well water | East Eusafpur | Shohidpur Hat | 25°35'50" | 88°59'46" | 36 m |
| 15    | RMW-15    | Tube-well water | Hossainpur | Khaierpur | 25°35'13" | 88°58'03" | 30 m |
| 16    | RMW-16    | Tube-well water | Kalikapur | Shohidpur Hat | 25°35'48" | 88°57'44" | 35 m |
| 17    | RMW-17    | Tube-well water | Khamarpara | Durgapur | 25°34'47" | 88°56'47" | 32 m |
| 18    | RMW-18    | Tube-well water | Bhabanipur Bazar | Bhabanipur | 25°34'39" | 88°54'58" | 38 m |
| 19    | RMW-19    | Tube-well water | Chowhali | Habra | 25°34'40" | 88°55'31" | 38 m |
| 20    | RMW-20    | River water | Chowhali | Habra | 25°33'29" | 88°56'22" | Surface |
| 21    | RMW-21    | Thermal plant drainage water | Dhutipukur | Hagirdanga | 25°33'28" | 88°55'58" | Surface |
| 22    | RMW-22    | Thermal plant drainage outlet end point water | Dhutipukur | Hagirdanga | 25°32'17" | 88°55'56" | Surface |
| 23    | RMW-23    | River Water | Ramvadrapur | Rajarampur | 25°31'29" | 88°55'45" | Surface |
| 24    | RMW-24    | River Water | East Jaforepur | Rajarampur | 25°30'42" | 88°56'27" | Surface |
| 25    | RMW-25    | River Water | Ghatpara | Rajarampur | 25°30'00" | 88°57'10" | Surface |
| 26    | RMW-26    | River Water | Phulbari | Phulbari | 25°31'21" | 88°56'50" | 32 m |
| 27    | RMW-27    | Tube-well water | Sultanpur | Rajarampur | 25°32'29" | 88°57'11" | 29 m |
| 28    | RMW-28    | Tube-well water | Ramchandrapur | Barapukuria | 25°32'09" | 88°57'32" | Surface |
| 29    | RMW-29    | Coal mine drainage water | Kalupara | Barapukuria | 25°32'09" | 88°57'32" | Surface |
| 30    | RMW-30    | Tube-well water | Kalupara | Barapukuria | 25°32'09" | 88°57'32" | Surface |
| 31    | RMW-31    | Coal mine drainage water | South Rasulpur | Barapukuria | 25°31'33" | 88°57'40" | Surface |
| 32    | RMW-32    | Tube-well water | South Rasulpur | Barapukuria | 25°31'33" | 88°57'40" | Surface |
| 33    | RMW-30    | Coal mine drainage water | Mubarakpur | Barapukuria | 25°30'29" | 88°57'56" | Surface |
For water samples some physical parameter such as Temperature, pH, Dissolved Oxygen (DO) and Conductivity were also carried out in the field (Table 2). Finally, Collected samples were selected according to priority of location for chemical analysis in the Analytical Chemical laboratory of GSB.

### Table 2. Description of physical parameter of collected water samples.

| Sl No | Sample No | Temperature (°C) | TDS (ppm) | DO (mg/l) | Conductivity (µs) | pH |
|-------|-----------|-----------------|-----------|-----------|------------------|----|
| 1     | RMW-1     | 38.6            | 124       | 4.51      | 176              | 7.33 |
| 2     | RMW-2     | 33.1            | 86.9      | 5.32      | 174.6            | 8.25 |
| 3     | RMW-3     | 46              | 41        | 5.2       | 114.5            | 7.95 |
| 4     | RMW-4     | 34.2            | 56.8      | 5.51      | 110              | 7.80 |
| 5     | RMW-5     | 32.4            | 98.3      | 5.07      | 198.7            | 7.74 |
| 6     | RMW-6     | 29.3            | 78.0      | 8.03      | 155.4            | 7.81 |
| 7     | RMW-7     | 27.9            | 46.8      | 8.51      | 93.9             | 7.92 |
| 8     | RMW-8     | 29              | 78.4      | 9.40      | 114.9            | 7.87 |
| 9     | RMW-9     | 27.2            | 41.0      | 8.46      | 82.2             | 7.79 |
| 10    | RMW-10    | 27.6            | 45.5      | 8.56      | 91.8             | 7.79 |
| 11    | RMW-10    | 26.8            | 58.1      | 9.86      | 116.4            | 7.26 |
| 12    | RMW-12    | 28.1            | 63.3      | 9.32      | 126.9            | 7.58 |
| 13    | RMW-13    | 27.1            | 45.5      | 5.77      | 91.9             | 7.18 |
| 14    | RMW-14    | 28.6            | 68.9      | 8.46      | 112.8            | 7.46 |
| 15    | RMW-15    | 28.8            | 60.6      | 5.45      | 66.8             | 7.34 |
| 16    | RMW-16    | 27.6            | 69.6      | 7.76      | 139.1            | 6.97 |
| 17    | RMW-17    | 27.9            | 77.4      | 7.32      | 153.2            | 7.34 |
| 18    | RMW-18    | 27.2            | 56        | 8.78      | 92.1             | 7.44 |
| 19    | RMW-19    | 28.3            | 71.6      | 9.26      | 143.2            | 7.42 |
| 20    | RMW-20    | 29.0            | 68.2      | 8.36      | 136.8            | 7.42 |
| 21    | RMW-21    | 33.6            | 128       | 4.01      | 257              | 7.87 |
| 22    | RMW-22    | 30.3            | 128       | 4.02      | 256              | 7.83 |
| 23    | RMW-23    | 27.3            | 127       | 5.32      | 252              | 7.57 |
| 24    | RMW-24    | 27.2            | 126       | 5.86      | 252              | 7.67 |
| 25    | RMW-25    | 28.8            | 127       | 5.92      | 256              | 7.65 |
| 26    | RMW-26    | 29.4            | 120       | 6.32      | 242              | 7.26 |
| 27    | RMW-27    | 26.9            | 53.2      | 8.57      | 106.3            | 7.23 |
| 28    | RMW-28    | 26.8            | 66.1      | 8.56      | 131.7            | 7.50 |
| 29    | RMW-29    | 31.9            | 68.2      | 6.22      | 196.4            | 8.21 |
| 30    | RMW-30    | 28.88           | 76.3      | 8.78      | 149.7            | 7.51 |
| 31    | RMW-31    | 31.6            | 98.1      | 6.32      | 232              | 8.18 |
| 32    | RMW-32    | 27.5            | 83.1      | 8.32      | 164.3            | 7.66 |
| 33    | RMW-33    | 32.1            | 97.7      | 6.97      | 230              | 8.11 |
| 34    | RMW-34    | 27.2            | 86.7      | 8.98      | 172              | 7.61 |
| 35    | RMW-35    | 27.4            | 56.4      | 8.96      | 87.6             | 7.58 |
| 36    | RMW-36    | 27.4            | 67.5      | 8.98      | 136.0            | 7.46 |

### 2.2. Preservation of Water Sample

Water sample were preserved at $P^4\text{II}$ 1.5 to 2.0 with addition of Nitric acid just after collection in the field. Samples were stored in individual polypropylene bottles at room temperature with proper identification mark.

### 2.3. Chemical Analysis of Water Sample

The heavy metal ion Lead, Copper, Zinc, Cobalt, Nickel, Cadmium were determined with the help ICP-OES using their selective wave length. The concentration measured as ppm level.

### Table 3. Chemical Analysis of water samples.

| Sl. No | Sample No | Cd (ppm) | Co (ppm) | Cu (ppm) | Mn (ppm) | Ni (ppm) | Pb (ppm) | Zn (ppm) |
|--------|-----------|----------|----------|----------|----------|----------|----------|----------|
| 1      | RMW-1     | 0.000599 | 0.00546  | 0.01012  | 0.1395   | 0.0292   | 0.0263   | 0.1672   |
| 2      | RMW-2     | 0.00431  | 0.02133  | 0.2939   | 0.5741   | 0.0966   | 0.1261   | 0.1576   |
| 3      | RMW-3     | 0.001836 | 0.00529  | 0.0132   | 0.1013   | 0.0316   | 0.0204   | 0.0532   |
### Table 4. Chemical Analysis of water samples.

| Sl. No | Sample no | Al (ppm)  | Ca (ppm)  | Fe (ppm)  | Mg (ppm) | Na (ppm)  | K (ppm) |
|--------|------------|-----------|-----------|-----------|----------|-----------|---------|
| 1      | RMW-1      | 0.42455   | 26.2127   | 1.3924    | 9.6399   | 19.2680   | 14.0639 |
| 2      | RMW-2      | 46.2870   | 26.6653   | 3.9565    | 7.5385   | 17.5438   | 10.1691 |
| 3      | RMW-3      | 1.6361    | 1.4346    | 0.1157    | 0.2831   | 0.9372    | 2.3932  |
| 4      | RMW-4      | 2.3254    | 2.1630    | 0.1598    | 0.4073   | 1.3650    | 7.2613  |
| 5      | RMW-5      | 2.7760    | 2.4387    | 0.1879    | 0.4701   | 0.9854    | 7.8560  |
| 6      | RMW-6      | 2.5630    | 2.29698   | 0.1708    | 0.4543   | 1.2624    | 2.2904  |
| 7      | RMW-7      | 2.18927   | 1.97678   | 0.1402    | 0.3850   | 1.2184    | 2.2409  |
| 8      | RMW-8      | 2.1686    | 1.99539   | 0.1283    | 0.3651   | 1.2409    | 16.1534 |
| 9      | RMW-9      | 1.5100    | 1.4447    | 0.0862    | 0.2466   | 0.8440    | 1.6350  |
| 10     | RMW-10     | 1.550     | 1.3915    | 0.0878    | 0.2578   | 0.8627    | 4.1021  |
| 11     | RMW-11     | 1.4308    | 1.3252    | 0.0763    | 0.2323   | 0.8275    | 1.2555  |
| 12     | RMW-12     | 0.9910    | 0.8766    | 0.0541    | 0.1567   | 0.5225    | 5.64516 |
| 13     | RMW-13     | 1.0088    | 0.8957    | 0.0551    | 0.1608   | 0.5797    | 6.42626 |
| 14     | RMW-14     | 1.0451    | 0.9488    | 0.0545    | 0.1625   | 0.5453    | 0.7494  |
| 15     | RMW-15     | 0.7564    | 0.72076   | 0.0426    | 0.1194   | 0.4510    | 2.4867  |
| 16     | RMW-16     | 0.7229    | 0.67687   | 0.0378    | 0.1157   | 0.4178    | 0.75323 |
| 17     | RMW-17     | 0.6778    | 0.62886   | 0.0353    | 0.10713  | 0.3501    | 0.8931  |
| 18     | RMW-18     | 0.5557    | 0.4986    | 0.0279    | 0.0824   | 0.2549    | 0.3494  |
| 19     | RMW-19     | 0.4707    | 0.59816   | 0.0235    | 0.0684   | 0.22347   | 1.9290  |
| 20     | RMW-20     | 0.4508    | 0.68371   | 0.0211    | 0.0642   | 0.21417   | 4.5324  |
| 21     | RMW-21     | 0.5374    | 0.5122    | 0.0260    | 0.863    | 0.2565    | 5.970   |
| 22     | RMW-22     | 0.4206    | 0.6246    | 0.0198    | 0.0620   | 0.1942    | 5.2380  |
| 23     | RMW-23     | 0.5789    | 0.56376   | 0.0303    | 0.11066  | 0.25132   | 6.705   |
| 24     | RMW-24     | 2.2229    | 25.7398   | 0.6011    | 8.6409   | 20.9964   | 5.9465  |
| 25     | RMW-25     | 0.8700    | 25.9851   | 0.7396    | 8.7592   | 21.8164   | 6.3779  |
| 26     | RMW-26     | 0.4288    | 24.0763   | 0.2754    | 8.1267   | 23.3166   | 7.3639  |
| 27     | RMW-27     | 0.0518    | 7.2724    | 2.2154    | 7.3761   | 14.1131   | 0.8698  |
| 28     | RMW-28     | 0.0266    | 8.4242    | 2.2913    | 3.8452   | 17.3691   | 1.3034  |
| 29     | RMW-29     | 0.51669   | 25.2039   | 1.2053    | 9.429    | 19.0092   | 7.451   |
| 30     | RMW-30     | 0.06167   | 11.7777   | 0.1463    | 4.6642   | 15.2152   | 3.0522  |
3. 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 hours 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 night time. 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.

4. Results and Discussions

The International Accountability Project reports that mining operations at Barapukuria have destroyed roughly 300 acres of land, impacting about 2,500 people in seven villages, as land subsidence of over one meter in depth has destroyed crops and lands and damaged homes. People in 15 villages have also reportedly lost their access to water, as huge quantities of water pumped out for the Barapukuria mine caused a rapid drop in water levels. [9] The environmental impact of Barapukuria Coal Mining Company Ltd. and Barapukuria Thermal Power Plant Ltd. is generally observed in two ways. Physical effects are the physical changes in the vegetation, soil, water and structure around the area. The chemical effect is a change in the amount of chemical elements present in the soil and water in the area. Physical effects show in a short time. Chemical effects are usually seen after a long time.

The colour of the water samples of coal leached drainage water appeared blackish and the agricultural land water samples appeared slightly blackish. Therefore, the water was unsuitable not only for aquaculture but also for domestic, industrial or agricultural purposes. However, the groundwater and surface water were colorless. The temperature recorded in water samples beside the mine drainage was 40°C whereas the temperature of agricultural land water, surface and groundwater was 32, 25 and 22°C, respectively (Table 2).

The pH values measured in Barapukuria coal mine industry showed that all of the samples have pH values of greater than 7, which is slightly alkaline whereas the standard value of pH was 6 to 9 (ECR 1997) [10]. The pH value of mine drained water was recorded 7.55 whereas the pH values of agricultural land water, groundwater and surface water were 7.4, 7.45 and 7.52, respectively (Table 1), which reflects its suitability for aquatic life and for all types of water uses.

The EC and TDS at different sampling points were ranged from 204-370µS/cm and 104-198 mg/l, respectively. The highest TDS (198 mg/l) and EC (370 µS/cm) were founding surface water and in mine drained water, respectively (Table 2). Water that contains less than 500 ppm of dissolved solid is generally satisfactory for the domestic use and other industrial purposes and water containing more than 1000 ppm of dissolved solids usually contains minerals that give it a distinctive taste or make it unsuitable for human 68 defined the standard value of TDS for the inland surface water as 2100 mg/l. As the total concentration of dissolved solids in water is a general indication of its suitability for any particular purpose, the result of the study concluded that the water at the downstream of the river is considered as suitable for fish culture and other purposes.

The mining authority release remaining waste water into the mining drain. The local people used this water in agriculture. Last December 2017 Barapukuria Thermal Power Station has already started using unused water from Barapukuria Coal Mine in this thermal power plant. The Barapukuria thermal power plant discharges unused water into the nearby Tilai river through a drain. The temperature of the water is about 46°C. The high temperature of abandoned water is affecting the biodiversity.

![Figure 2. The end of the drain of the abandoned water flow of the Barapukuria coal mine.](image2)

![Figure 3. Drainage water used by thermal power plants.](image3)
Most of area of Bouddhanathpur (Jigagari) and Gopalpur (Maupukur) near Barapukuria Coal Mining Company Ltd. have been subside, creating a reservoir about 5-6 m deep.

Figure 4. Subside reservoirs created as a result of coal extraction.

Figure 5. Reservoir created in the new area of Subside as a result of coal extraction.

5. Conclusion

The study showed the overall scenario regarding the concentration of different water quality parameters resulted from the Barapukuria coal mine activity and their suitability for aquatic life as well as for irrigation. The results of the study concluded that the water in the coal mine industrial area were found quietly contaminated, which can deteriorate the aquatic life and agriculture. The study showed that all the water quality parameters of mining area i.e. temperature, pH, EC, TDS, DO were in standard levels. The average concentration of Cu, Fe and Zn content in the water samples was below the standard level. The study identified that the pH and DO were appropriate for the environment. Although the concentration of heavy metals in the water samples was in permissible limits, the study has depicted that high levels of these heavy metals from the coal mine can pose a serious threat on the environment within a short period of time.

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