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IMPACT OF OPEN CAST COAL MINING ON WATER ENVIRONMENT- A CASE STUDY AT SOUTH BOLANDA COLLIERY, TALCHER, ORISSA

Dr. BANDITA DEO

Plant Physiology and Biochemistry Division, Regional Plant Resource Centre, Nayapalli, Bhubaneswar-751015, Odisha, India.

Corresponding author: bdeo2008@gmail.com

Dr. BANDITA DEO

ABSTRACT

Mining operations contribute to water pollution through the discharge of mine waste into streams or water bodies and by leaching toxic substances from dumps to the water bodies. The mining activities affect agriculture and flora and fauna of the surrounding area. To study the impact of coal mining operation South Bolanda coal mine is taken for the example. In this study an attempt has been made to cover various sources of water pollution in South Bolanda open cast coal mine and the measurement of pH and elemental status to assess the water quality degradation collected from in and around the mining area.

Key words: coal mine, waste, environment, toxic, water, heavy metals.

Introduction

Since mining activities are observed almost in every country all over the world to exploit natural, mineral and coal resources, environmental degradation caused due to mining is a global problem [8]. The dumping and digging process not only destroy the natural landscape but disturb the total ecosystem of the area. The adjoining river systems, land and air receive contaminants/pollutants during these mining operations. The intensive efforts for increasing annual coal production can cause serious deterioration and degradation in the quality of soil, water and air environment in particular [4, 5, 6, 7]. The mining activities affect the hydrology of the area in many ways. Mining operations contribute towards water pollution through the discharge of mine water into streams or water bodies and by adding toxic substances into water bodies. Chemical speciation of elements is important to bioavailability. Many studies examined the distribution of elements in coal ash basin waters [9]. The water contains elements leached from the coal ash may be insufficient concentrations to be toxic to biota. A large influence of coal mine activities on the chemical composition of the surface water and sediments was studied by Campaner *et al.*, 2014 [3]. Acid mine drainage from the oxidation of sufides, mainly pyrite and also characterised by low pH and high concentration of SO_4^{2-}, Fe, metalloids and many metals [11]. It is not possible to assess the total impact of mining activities at a single place; here we are trying to study only the impact of coal mining on the water quality in these mining areas.

Materials and Methods

Study site

Field investigations were undertaken at South bolanda coal mine operated by South Eastern coal Fields Limited. It is situated in the South eastern part of the Talcher Coalfields. The project became operational in the year 1959. The area is predominantly undulating. The surface elevation varies from 103 meters in the south-east to154 meters in the north-west above the mean sea level sloping towards south. A gravel ridge forms the northern boundary of the flock. Rock exposures are limited to a few sandstone and pebble beds

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often stand out of stand out as small flat-topped -ridges and knolls. The coal bearing Karhabaris are represented by medium to coarse grained pale brownish yellow loose textured sand stone with thin shale bands and coal seams. The geological structure of South Bolanda Block is a part of a shallow basin. The thinning of the seam towards outcrop and its ultimate pinching out is a characteristic feature of the area.

The climate of the mining area is subtropical with seasonal rainfall during the South-West monsoon season from June to October. Occasional heavy showers are also received due to the receding North-East monsoon in the month of November and December. In summer the temperature varies from 34°-42°C and in winter it is between 22°-30°C.

Water sampling and analysis

Water samples from different locations of in and around mining area were collected. The pH of the water samples collected from the mining areas was determined by Elico Digital pH Meter (Model - Li - 10) and was analysed for determination of Zn, Fe, Cu, Al, Cr, Ni, Ca, Mg, K by ICP-8410 plasma scan by using respective wave length Zn-213.856, Fe-238.204,Cu-324.754, Al-396.152,Cr-205.552, Ni-352.454, Ca-317.933, Mg-285.213 and K-766.490nm.

Result and Discussion -

Various metal pollutants and trace elements from the dumping sites of the overburden and coal piles pollute soil and water. In this mining area the various sources of water are ground water and surface water. Here remarkable changes in water quality can be marked. The water carries many types of wastes from the mine into the adjoining rivers and reservoirs. In total 12 water samples were collected from the mining areas and from the paddy field near the mine site. The water was moderately to highly alkaline. The pH of water collected from paddy field was also alkaline in nature. The heavy metal (Zn, Cu, Fe, Al, Cr and Ni) contents showed significant variation (Table1). Butler *et al* (2008) [1] observed seasonal trends in dissolved and particulate Cu, Fe, Mn and zn in a mining impacted stream. The iron content was more in drinking water and water collected from the paddy field. One of the samples collected from a water pool had high amount of iron. Sridharan (1987) [11] reported high content of iron in the water sample of Bina open cast coal mine. Aluminium content was not so high like iron in the collected samples. Chromium content was less in all the samples including the drinking water. Nickel level was slightly higher than that of chromium. Zinc and copper were present but in very negligible quantities. Dhar and Ratan (1980) [8] also reported very little Cu and Zn in water samples of Western Kentuky coal fields. Byerly *et al.,* (1978) [2] studied that coal surface and mine water were highly acidic, low in pH, increased levels of turbidity and silt and had high concentrations of heavy metals. The calcium, potassium and magnesium content varied significantly in the water samples. Calcium content was less in reservoirs in the mine area but one sample contained very high amount of calcium. The calcium content in water from one paddy field and drinking water collected from study site were nearly same. Magnesium content was not so high like calcium. The highest amount of magnesium was observed in mine water and in the samples from rice field and drinking water taps. Little potassium was present in the samples of mining area except in one sample. In drinking water, potassium content was high but low concentrations in water sample from rice field were noted.

Dhar and Ratan (1980) [8] reported the chemical composition of coal fly ash with silicates of Ca, Mg, Fe, Ti, oxides of iron and silicon, carbohydrates of Ca and Mg and some phosphates. When the coal comes in contact with water, pyrites, carbonates minerals, gypsom and phosphate release their components easily in water. Sulphur may be found in the form of organic sulphur compounds, mostly of calcium and iron. Jones (1974) [10] studied the physical and chemical nature of the water collected from nallas, reservoir and ground water found dissolved heavy metals in precipitated condition. Total dissolved solids, chlorides, bicarbonates,

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calcium, magnesium, arsenic, iron and chromium content were high in all the water samples of Bina open cast coal mine [12]. Miller (1979) found that the abandoned mines caused the worst water quality problems with reduced pH, metal like aluminium, manganese, iron and sulphur.

Table- pH and status of different elements in water samples collected from various locations in and around South Bolanda Coal Mine, Talcher.

Sl. No.	Locations	pH	Levels of elements (ppm) (m + S.E)								
			Zn	Cu	Fe	Al	Cr	Ni	Ca	Mg	K
1	Quarry No. 1a	7.36	0.009 ±0.001	0.0013 ±0.0002	0.8105 ±0.092	0.0685 ±0.011	0.0135 ±0.002	0.0233 ±0.004	150.94 ± 2.02	9.66 ±0.52	0.8099 ± 0.03
2	Quarry No. 1b	8.47	0.0210 ± 0.002	0.0023 ±0.0008	5.23 ±0.124	0.2237 ±0.085	0.0673 ±0.003	0.0423 ±0.002	299.94 ± 5.23	17.44 ± 0.13	1.51 ±0.04
3	Quarry No. 1c	7.68	0.0088 ±0.001	0.0011 ±0.0006	1.15 ±0.012	0.0540 ±0.008	0.0216 ±0.001	0.0380 ±10.60	273.04 ± 0.24	16.63 ± 0.03	1.34 ±0.009
4	Quarry No. 2a	8.15	0.0142 ±0.006	0.0016 ±0.0004	0.7238 ±0.074	0.0905 ±0.008	0.0264 ±0.006	0.0294 ±0.008	343.04 ±6.42	20.20 ±0.13	1.83 ±0.08
5	Quarry No. 2b	6.55	0.0069 ±0.001	0.0001 ±0.0	0.1794 ±0.051	0.0207 ±0.002	0.0175 ±0.005	0.0207 ±0.002	188.79 ±12.21	15.84 ±0.43	1.04 ±0.01
6	Quarry No. 2c	6.66	0.0065 ±0.001	0.0002 ±0.0001	0.2675 ±0.046	0.0527 ±0.008	0.0168 ±0.002	0.0527 ±0.002	233.04 ±5.71	14.41 ±0.26	0.9654 ±0.06
7	Mine reservoir (a)	7.06	0.0005 ± 0.0001	0.0002 ±0.0	0.2413 ±0.069	0.0181 ±0.004	0.0114 ±0.009	0.0181 ±0.006	214.82 ±8.32	10.60 ±0.22	0.6469 ±0.05
8	Mine reservoir (b)	7.46	0.0065 ±0.0001	0.0016 ±0.0002	0.7777 ±0.029	0.0544 ±0.006	0.0174 ±0.006	0.0432 ±0.007	186.81 ±10.14	11.66 ±0.24	0.7877 ±0.04
9	Paddy field	7.85	0.0166 ±0.004	0.0010 ±0.0005	0.4659 ±0.075	0.0309 ±0.007	0.0239 ±0.003	0.0484 ±0.008	298.56 ±14.06	20.03 ±0.11	1.15 ±0.08
10	Mine site	7.86	0.0166 ±0.004	0.0010 ±0.0005	0.4659 ±0.075	0.0309 ±0.007	0.0239 ±0.003	0.0484 ±0.008	298.56 ±14.06	20.03 ±0.11	1.15 ±0.08
11	Mine site pipe	8.79	0.0235 ±0.006	0.0431 ±0.008	0.4453 ±0.081	0.0236 ±0.004	0.0162 ±0.008	0.0510 ±0.003	316.79 ±8.37	13.52 ±0.19	1.02 ±0.03
12	Drinking water	8.27	0.0360 ±0.002	0.0004 ±0.0001	0.5431 ±0.037	0.0538 ±0.008	0.0187 ±0.004	0.0328 ±0.006	183.14 ±4.72	14.37 ±0.61	1.06 ±0.04

Conclusion

From the data it is evident that most of the chemical parameters are within the tolerable range. This paper gives some idea about the impact of mining on quality of water. To know the proper measurement of various pollutants, further detailed analysis of other trace elements is required to give a clear idea of impact caused by this coal mine. Further research in this field will be needed to know the other problems caused by this coal mine.

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