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ENVIRONMENTAL IMPACTS OF COAL MINING AND THERMAL POWER PLANT ON THE WATER BODIES SURROUNDING CHANDRAPUR, MAHARASHTRA

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ABSTRACT

Chandrapur has been a thriving city for the past 20 years due to rapid industrialisation. The development of coal mining and the setting up of coal-based Thermal power plants are the leading projects of fostered industrialization in this city. This boom in industrial activities resulted in swift population growth, pollution, and deterioration of the environment, which posed serious challenges to mankind and nature. Emissions from coal-based thermal power plants show an impact on the environment and its entities such as air and water. To assess the impact of these emissions on the quality of water in the study area and its suitability for domestic purposes, a total of twelve water samples from different sites, surrounding the thermal power plant Chandrapur were collected and analysed for various physiochemical parameters such as pH, temperature, Total dissolved solids, turbidity, conductivity, chloride, total alkalinity, Hardness, Magnesium, calcium, Iron & sulphate. Standard procedures (APHA/NEERI) were implemented to analyse various parameters, and the findings were compared to the Standard guideline values recommended by BIS (2023). The results indicate that the majority of parameters are beyond permissible limits. The present study intends to evaluate the contamination of water in the surrounding area and villages in the vicinity of a thermal power plant in the Chandrapur district.

Keywords: Coal mines, water pollution, physiochemical, BIS

INTRODUCTION

Advancement in industrialization has marked an increased global energy demand which has been primarily met by fossil fuels. Coal is most ubiquitous among the considerably utilized energy sources for electricity generation and stands as the most prevalent fossil fuel found across the globe. Reportedly, $1/4^{th}$ of the world's total fossil fuel reserves are found in the USA, Russia, China, Australia, South Africa and India. Global coal demand reached a record high in 2022 amid the global energy crisis, rising by 4% year-by-year to 8.42 billion tonnes (Bt) and will reach up to 160 Quadrillion British Thermal Units by 2040. Out of which, India accounts for 2.6%of total coal consumption per year.

Coal mining subjects the groundwater to coal seams, formation of rock, and Human Activities that lead to distinctive water quality which is attributed specifically to the coal sector. A significant amount of suspended solids, poor sensory properties, presence of radioactive components and oxides, some are highly mineralized or even acidic. If they are discharged directly, the generated acidic water might enter into the river or percolate underground, polluting the water supply, and leading to the death of large-scale vegetation. Despite the enormous utility of coal in electricity production, it is reported that most of the coal is of low grade. Consequently, huge amounts of coal combustion byproducts (CCBs) are generated. The formation of CCBs are prominent and intricate process which has a significant impact on the environment and human health. CCBs are comprised of boiler slag, FGD (flue gas desulphurization) materials, fly ash and bottom ash. Almost 80% of total CCBs are constituted by fly ash, which is the prime cause of environmental pollution. A report by the Ministry of Power, mentions that the yearly fly ash generation from Coal/Lignite based power plants is around, 232.56 million tonnes. Exposure to such a huge amount of fly ash is a serious concern for environmental health. Ash-containing emissions from thermal power plants generally find their way by being disposed of in settling tanks with effluent outlets that enter the local waterways. If these tanks are unlined, then a substantial portion of ash leachate percolates beneath the tank up to the water table.

Chandrapur Super Thermal Power Station (CSTPS) coal-based power plant of MAHAGENO and Durgapur coal mine (opencast) which is operated by Western Coalfields Limited is located in Chandrapur District, Maharashtra. The production rate of coal from WCL mine Durgapur in 2020 was 2.05 million tonnes and the power generation capacity of a thermal power plant is 3340MW. The plant receives water supply from Erai Dam. The effluent from the power plant is composed of ash disposal, thermal discharge, cooled water, wastewater effluents, metal cleaning waste, oil, etc.

In thermal power plants, water slurries are used for the conveyance of ash from the power station to ash ponds for disposal. Two consequences are associated with the ash transfer. Water seeps down into the ground along with ash leachate due to which groundwater gets contaminated by the constituent components of ash. Hence groundwater becomes unsuitable for domestic use, release of ash ponds into the local water bodies, which leads to an increase in turbidity of water. Another significant environmental impact of thermal power plants is cooling water and its requirement is more than it is considered. Therefore, they are generally set up in proximity to natural water sources like rivers where the generated warm water is discharged into lakes and streams causing thermal pollution. Water, after being used as a coolant is released to natural waterbodies, resulting in temperature differences which directly impact aquatic organisms by i) decreasing oxygen levels and ii) affecting ecosystem composition. As warm water contains less oxygen the rate of decomposition of organic matter also decreases and hence affects the environment.

Thermal power plants generate a broad array of waste pollutants, in turn affecting all the major domains of the environment i.e., soil, water, and Air. From this perspective, the reuse and recycling of treated effluent in the industrial sector with high water consumption is a feasible alternative to conserve valuable resources. Considering the impact of various pollution-causing chemical constituents present in water and its impact on human health and their biological systems, assessment of water before its use for drinking and other domestic uses becomes very important.

The main objective of this study is to assess the environmental impact on water bodies in the vicinity of the coal mining area and coal-based thermal power plant of Chandrapur district, Maharashtra.

EXPERIMENTAL SECTION:

To assess the quality of water, a total of twelve water samples were collected from the areas in the vicinity of thermal power plant Chandrapur. After an initial survey of the area, sampling sites were chosen that encompassed the thermal power station in all possible directions. Samples were sealed and brought to the environment laboratory, for analysing various physiochemical parameters as mentioned in the standard manual of water and wastewater analysis (CPCB/BIS).

Sterilized polythene bottles were used for the collection of samples. For sterilization, these bottles were leached with 2M reagent grade nitric acid for 48 hrs at room temperature and rinsed with double distilled water.

After the collection of samples, field parameters viz. pH, and temperature were analysed immediately after collection. The prime aim of the study was to evaluate the physio-chemical parameters of groundwater as per the standard procedure mentioned in CPCB. All the collected samples were assessed for Temperature, pH, Conductivity, Total solids (TS), Total dissolved and Total suspended solids (TDS &TSS), Dissolved Oxygen (DO), Hardness, chlorine, Alkalinity, Sulphate, and fluoride. The broad spectrum of variations in the measured parameters was reported, thus making it quite adaptable to comment on the quality of water from a pollution aspect.

RESULT AND DISCUSSION

The location of the sample site and data of analysed physicochemical parameters of the sample are summarised in Tables No. 1 and 2

pH: pH (Negative $\log_{10}$ of H^+ ion activity) is a fundamental water-quality parameter. pH is measured by using a pH meter. The pH of water is an important parameter as it controls most of the major geochemical reactions or solubility estimates within groundwater. As per IS- 105000 (2012), the permissible limit of pH is 6.5 to 8.5. The pH values of the bore well and dug well were in the range of 8.8 to 9.5 and 6.8 to 8.0 respectively **Table no.1** which is an indication of the slightly alkaline nature of the water at the sample site. This is due to the higher concentration of bicarbonates in the study area.

Electrical Conductivity: It is the measure of the capacity of any substance or solution to conduct electricity through the water. The higher value of EC of water or any solution indicates the presence of a higher amount of ionized inorganic substances present in it. As per CPCB, the range of EC should not be more than 2250 µmho/cm. The Range of EC of the Bore well and Dug well in the study area are 509.23µmho/cm – 686.15µmho/cm and 547.69 µmho/cm –707.69 µmho/cm respectively **Table no.1**.

Turbidity: Turbidity refers to the cloudiness occurred in water, caused by suspended particles such as clay, slit, chemical precipitates like Mn, Fe and other organic particles including plant debris and organisms. Turbidity of water is inversely related to the clarity of water. Turbidity is measured in the Nephelometric Turbidity Unit (NTU). As per IS 10500- 2012 the range of Turbidity must be 1 NTU to 5 NTU. In our study, the range of turbidity of Borewell and dug well is 0.68 NTU to 0.82 NTU **Table no. 1**. The value of turbidity was found to be the permissible limit.

TS, TDS and TSS: The total concentration of organic and inorganic salts dissolved in water is referred to as Total Dissolved Solids. As per BIS- 10500 (2012), the permissible range of TDS in water is 500 mg/l -2000 mg/l. The range of Total Suspended Solids, Total Dissolved Solids, and Total Solids of Borewell of the study area is 28 mg/l to 61 mg/l, 331 mg/l to 446 mg/l and 355 mg/l to 494 mg/l respectively and that of dug well study area is 36 mg/l to 63 mg/l, 356 mg/l to 460 mg/l and 400 mg/l to 510 mg/l respectively **Table no. 1**. Results show that the value of TDS is below permissible limits.

Dissolved Oxygen (DO): DO is ascribed to the level of free, non-compound oxygen available in water or any other liquid. It is the most important parameter for assigning the quality of water because it influences all living organisms within the water body. Too high or too low values, both affect the quality of aquatic life. The value of Dissolved oxygen for Bore-well and Dug-well samples was found to be in the range of 1.8 mg/l to 3.1 mg/l and 3.4 mg/l to 4.5 mg/l respectively **Table no.1.**

Alkalinity: Alkalinity is the function of carbonates and bicarbonates, where their salts get hydrolyzed in the solution and give hydroxyl ions. Total components present in water that tend to elevate the pH value beyond the alkaline side of neutrality are referred to as Alkalinity. It is the buffer capacity of all water bodies. It is measured as the capacity of the water body to neutralize Acids and bases to maintain a stable pH. As per IS-10500 (2012), the range of alkalinity should be 200 mg/l to 600 mg/l. In the present study, the value of alkalinity for Bore well and dug well samples are found to be 46 mg/l to 122 mg/l and 58 mg/l to 122 mg/l respectively, **Table no. 2** which are found to be within permissible limits.

Hardness: Water hardness is the conventional measure of the ability of water to react with soap. Hard water often results in discernible precipitate deposited in containers, notably "bathtub rings" comprising of insoluble metals, soaps or salts. Hardness in groundwater is not a result of a single substance, but a range of dissolved polyvalent metallic ions (bicarbonates, carbonates, sulphates) predominantly calcium and magnesium cations followed by others (Aluminium, barium, iron, manganese, strontium & Zn^{+} ions) are responsible for such Hardness. As per IS-10500 (2012), the range of total hardness for groundwater is 200 mg/l to 600 mg/l.

The Total Hardness, Ca^{+} Hardness, and Mg^{+} Hardness of the borewell were observed in the range of 82 mg/l to 182 mg/l, and and the values for the dug well varied from, 120 mg/l to 166 mg/l, **Table no. 2** respectively. The hardness of the water sample collected from the study area was found to be the permissible limits of IS-10500.

Chloride: Chloride ions (Cl^{-}) are widely distributed in almost all types of natural water bodies in the form of Calcium, Magnesium and Sodium salts. The major sources of Cl- ion in waters are Battery recycling, domestic sewage, effluent discharge from soap, salt, alkali fur and leather industries. High levels of chloride ions in water affect in many ways such as reducing the self-purification process of water leading to a decrease in the biodiversity of aquatic flora and fauna, corroding stainless steel instruments in industries, consumption by humans may lead to hypertension, arteriosclerosis cerebral infraction, responsible for hindrance in COD determination etc. As mentioned in IS- 10500 (2012) the concentration of Chloride in groundwater must be in the range of 250 mg/l to 1000 mg/l. In this study, the range for Bore well and Dug well water samples were within permissible limits i.e., 42 mg/l to 98 mg/l and 62 mg/l to 98 mg/l respectively **Table no. 2**.

Sulphate: Sulphate occurs naturally in Groundwater. Gypsum is the prime source of high sulphate concentration in many aquifers. Mineral dissolution, mining activities, and excessive use of fertilisers are among other sources of sulphate in groundwater. It is found that diarrhoea, catharsis, dehydration in humans, and osmotic stress for aquatic organisms, are associated with High levels of sulphate in water. As per IS-10500(2012), the permissible range for sulphate is 200 mg/l to 400 mg/l. The range of sulphate concentration for Bore well and dug well water samples was 2.3 mg/l to 3.9 mg/l and 1.0 mg/l to 2.6 mg/l respectively **Table no. 2**.

Fluoride: Excess fluoride in water used for drinking purposes may lead to dental fluorosis. The concentration of fluoride in samples collected from the bore well and dug well was in the range of 0.2 mg/l to 0.6 mg/l and 0.2 mg/l to 0.5 mg/l respectively **Table no. 2**. According to IS-105000(2012), the concentration of fluoride should be in the range of 1.0 mg/l to 1.5 mg/l. The concentration of fluoride present in groundwater from the study area is within permissible limits.

Sr.no.	Location name		pH	Temp (^oC)	Turbidity (NTU)	TSS (mg/l)	TDS (mg/l)	TS (mg/l)	EC (µS/cm)	DO (mg/l)
1.	Krishna nagar	Dug well	6.9	26	0.76	63	392	455	603.07	4.2
		Bore well	8.7	25	0.78	55	331	386	509.23	2.5
2	Babupeth	Dug well	7.3	28	0.72	36	387	423	595.38	3.8
		Bore well	8.9	24	0.68	46	431	477	663.07	3.1
3.	Tukum	Dug well	6.8	23	0.82	50	460	510	707.69	4.0
		Bore well	8.7	24	0.74	61	433	494	666.15	2.9
4.	Durgapur	Dug well	7.4	26	0.78	44	356	400	547.69	4.5
		Bore well	8.2	26	0.84	33	446	479	686.15	3.1
5.	Urjanagar	Dug well	8.0	25	0.78	40	435	475	669.23	4.2
		Bore well	9.2	24	0.62	28	327	355	503.07	2.3
6.	Bhatadi	Dug well	7.6	23	0.72	38	371	409	570.76	3.4

		Bore well	8.7	25	0.78	53	438	491	673.84	1.8
	IS 10500-2012 Standard		6.5-8.5	-	1-5 NTU	-	500-2000	-	-	-

Table 1: Physical & Demand parameters of all 12 samples

Sr. no.	Location name		Total Alkanlinity	Total Hardness	Calcium Hardness	Magnesium Hardness	Chlorides	Sulphates	fluoride
1.	Krishna nagar	Dug well	66	120	68	52	42	1.0	0.2
		Bore well	58	82	36	46	62	2.3	0.4
2.	Babupeth	Dug well	46	94	52	42	72	0.6	0.4
		Bore well	98	156	68	86	92	3.1	0.3
3.	Tukum	Dug well	122	166	82	84	98	2.2	0.4
		Bore well	102	170	92	78	94	3.5	0.2
4.	Durgapur	Dug well	78	162	84	78	62	2.3	0.2
		Bore well	122	186	98	88	96	3.7	0.3
5.	Urjanaga r	Dug well	116	174	88	86	98	2.6	0.5
		Bore well	68	146	72	74	54	3.9	0.4
6.	Bhatadi	Dug well	74	162	88	74	62	1.3	0.5
		Bore well	98	180	96	84	98	2.8	0.6
	IS 10500-2012 Standard		1000 PPM	300-600 PPM	-	-	250-1000 PPM	150- 400 PPM	1-1.5 PPM

Table 2: Inorganic Parameters of all 12 samples.

CONCLUSION

In this paper, the physicochemical characteristics of groundwater of Chandrapur district Vidharbha region have been evaluated. As per the evaluated data, the groundwater quality of Chandrapur City is not too polluted. The majority of parameters were either above or slightly below the permissible limits. Parameters such as pH was above permissible limits. Therefore, the groundwater quality of Chandrapur district is not potable for drinking purposes. However, it is safe to utilise only after simple treatments such as RO installation, boiling of water, alum treatment, etc can be used for cooking and drinking purposes. To maintain the quality of groundwater, continuous screening or analysis of physiochemical parameters needs to be done.

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