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Assessment of Physico-Chemical Properties of Coal Mine Water for Sustainable Water Resource Management

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Abstract: *The aim of our study is to gather various facts from coal mine water regarding seasonal changes, water quality, and abiotic variables. Mine water from coal mines is recycled in the Indian state of Chhattisgarh and used as a thermal energy source as well as in the public sector and on agricultural ground. With the onset of Summer, water samples were obtained for this investigation from coal mine in the Korba district of Chhattisgarh. To evaluate the quality of water ,analyses were made of sixteen different physiochemical parameters, such as pH, alkanity, total hardness, fluorides, chlorides, BOD, COD, and DO. The Water Quality Index (WQI), ,. The most useful indicator of the quality of the water is the Water Quality Index (WQI), which is produced by averaging any or all of the features. Therefore, it is safe and there is plenty of source to use mine water as an additional resource for aquatic ecosystems. The preservation and restoration of aquatic ecosystems, as well as the scientific distribution and management of water resources, are essential to the effective use of freshwater. The complete usage and ideal allocation mode of mine water must be taken into consideration based on actual conditions because of the variations in the quantity and quality of coal mine water as well as the notable variations in the surrounding conventional water resource conditions. Additionally, they must include the full utilization of mine water resources into their development plans for the circular economy and local communities.*

Keywords: coal mine water, Monthly variation, Opencast mine .WQI, Physio-chemical parameters

I. INTRODUCTION

In India, opencast as well as underground coalmines supply almost all of coal. Growing human population, industrialization, and human activity collectively contributed to the extreme pollution of water supplies with various hazardous chemicals. Rock weathering and mining operations naturally pollute water. Owing to the numerous water-borne illnesses, it is very important that the quality of water be tested on a regular basis before it is used for irrigation and house hold work. Obtaining Clean water is essential for reducing illness and enhancing quality of life.. In addition to its quality and quantity, water is a vital component of both urban and rural environments and must be available in appropriate quantities when required in relation to time, place, and environmental factors. As cities and industry expanded, water bodies' levels of contamination rose quickly as well. Mining operations have a significant negative impact on the surface topography and remove vegetation, causing excessive erosion. As one of the most profitable industries in Chhattisgarh is coal mining. In district of Korba, Surakachhar, Dipka, Gevra, and Kusmunda produce the majority of the coal. In this study water sample from underground coalmine of Surakachhar district Korba Chhattisgarh were collected during rainy season, and were analysed to focus water quality of water This study compared the physiochemical characteristics of 6 samples of underground coal mine water with international BIS drinking and household uses, which are based on the Water Quality Index (WQI).Based on weighed arithmetic calculations, Harton established the WQI Model in 1965. Other researchers have also developed a variety of WQI Models (Brownetal1972, GEM, UNEP2007; Kavita and Elongovon 2010; Alobaidy et al. 2010; Sankar and Kavo 2020).The WQI is a numerical measure that has a distinct digital rating system and a value ranking ranging from 0 to 100.It is described as the overall

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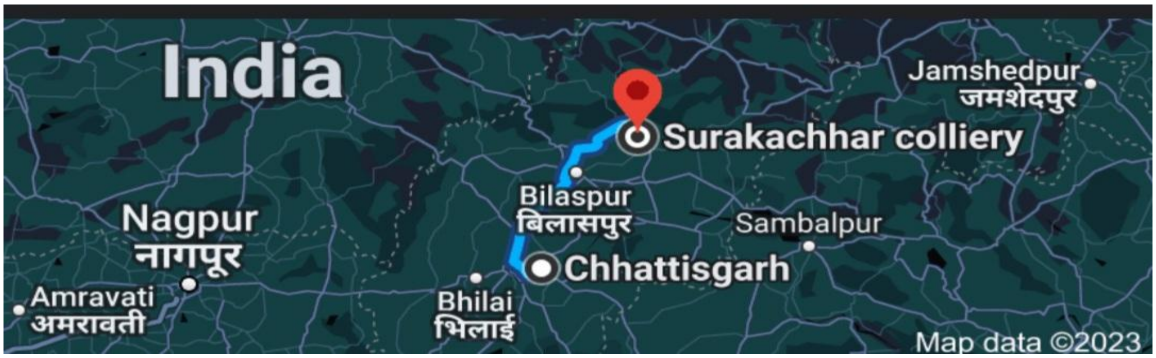
state of the water quality using the terms bad, good, exceptional, etc., depending on different water quality parameters. Additionally, it is crucial for the management of various water samples to compare them.

MATERIALS AND METHODS

:**Study Area:** The present study area located between latitude (22^o.15'N and 22^o.30'N) and Longitudes (82^o.15'E End 82.55'E) further Korba covers an area of about 530 sq. kilometres. The Surakachhar coal mine is a mine complex operated by South Eastern Coalfields limited .



Climate: The study area comes under -tropical type of climate. It is hot and humid because of it proximity to the tropic of Cancer and its dependence on monsoons for rain. In rainy season begins from June to September sometimes extend upto October, in this area ,climate is sub humid with temperature of 27^o C with annual rainfall of 1534 mm.(*Himani Kurre,Lata Sharma 2022)*

OBJECTIVE:

The causes of frequent decline in the ground water level in Chhattisgarh is due increase in population and insufficient rain fall. Villagers use the river's water, but it gets dried up in Summer. they face lot of difficulties during Summer So,underground mine water is preferred as sopplement source Quality of water directly influence life of colonized population so It is very crucial and significant to assess the water before it is used for drinking, domestic work, agricultural or industrial purpose.. Water may contain different types of floating, dissolved, suspended and microbiological as well as bacteriological impurities.so it is duly tested and the choice of parameters for testing of water, exclusively depends upon for what purpose the water will be used in future and range required for its purity and quality

II. METHODOLOGY

Total 6 numbers of water samples were collected from underground mines during July to September 2024 atmorning hours 8.00 AM to 9.00AM The sample bottles were kept air tight and labelled These samples were carried to the laboratory for the analysis of different physicochemical characteristics like pH, total alkalinity, boron, calcium, chloride, colour, fluoride, total hardness, Iron, manganese, nitrate, calcium, turbidity and sulphate The Water quality measured using Water Quality Index WQI under BIS frame work (*Arjun Ram, SK Tiwari, Y.V Singh2021,.)*The weighed Arithmetic Water Quality Index WQI represented as

$$WQI=\sum_{i=1}^{n} WiQi/\sum Wi \ ....(1)$$

Where n= no.of variable of parameter

W_i = Unit weight for i^{th} parameter

Q_i= Quality *rating sub* index of i^{th} water quantity parameter

W_i are inversely proportional to the recommended standard for the correspondingparameters

Wi=K/Sn ……(2)S= Standard value for it^h parameter.

K= Proportional Constant

The value of K= 1/ ∑1/Sn……….(3)

The value of QI = Q 100[(Vo-Vi)/(Sn-Vi)]…(4)

Where Vo = Observed value of i^{th} parameter

Vi= Ideal value of i^{th} parameter in pure water Vi are taken as 0for drinking water except for pH and dissolved Oxygen(DO) *Tripathy etal2005).*

For pH ideal value is7.0 and permissible value is 7.0.Similarly for DO ideal value is 14.6mg/l and permissible value is 5.0mg/l.So the quantity rating for pH and DO are calculated from the equation

respectively shown below.

Q_{pH}=100 Q_{DO} =100

[V_{pH} -7.0]/8.5-7.0 [V_{DO}-14.6/5.0-14.6] …………(5)

Where V_{pH}= Observed value of (DO).

Classification of water quality basad onWQI Chaterjee and

Raziuddin(2002) .

SNO	WQI	RATING CLASS
1	0-25	EXCELLENT
2	26-50	GOOD
3	51-75	POOR
4	76-100	VERY POOR
5	>100	UNSUITABLE

Table 1. Water quality index of mine water July to September

VALUE OF WATERQUALITY INDEX OF SIX UNDERGROUNDMINE WATER SAMPLES									
SAMPLE=S1 TO S6				JULY		AUGUST		SEPTEMBER	
			BIS	s1	s2	s3	s4	s5	s6
S.No	PARAMETER	METHOD							
1	PH	Potentiometer	8.5	7.35	6.54	8.43	8.5	8.45	8.1
2	Turbidity	Nephelometric Turbidity	5	8.16	14	14.5	14.6	20	19
3	Total Hardness	Complexometry EDTATitration	200	198.84	154	151	151	154	153
4	TDS	Gravimetric method	500	406	557	407	402	405	407
5	Chloride	Argentometric titration	250	77.43	75.8	76	77	77.3	77.1
6	Alkanity	Argent metric titration	200	223	224	200	201	125	121
7	Calcium	Argentometric titration	7.5	36	47.98	36	34	35	29

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8	Magnesium	Argentometric titration	30	15.3	19.23	15.3	15.2	13.4	13.4
9	Iron	Spectrometer	0.3	0.3	0.3	0.3	0.31	0.34	0.35
10	Nitrate	Spectrometer	45	0.2	0.3	0.4	0.54	0.34	0.38
11	Sulphate	Spectrometer	200	38	23	32	31	30	35
12	Fluoride	ion selective electrode	1	0.26	0.25	0.23	0.24	0.26	0.25
13	BOD PPM	Incubation method	10	10	19	10	16	21	18
14	CODmg/l	Titration method	100	70	56	70	81	75	76
15	DO mg/l	Titration method	5	12	11	12	10	10	11
16	EC(S/m)	Conductivity Probe	300	231	240	231	232	234	230
WATER QUALITY INDEX				**93.44**	**102.01**	**97.77**	**99.55**	**111**	**104.89**

Table 2.Value of water quality index of six underground mine water samples

III. RESULT AND DISCUSION

During the summer, groundwater and river water are insufficient to meet water demands, making clean water essential for a healthy living. So water of rainy season must be stored and utilized .From July to September 2024, six underground mine water samples were tested for physicochemical characteristics such as pH, color, turbidity, hardness, chloride, alkalinity, and dissolved particles, and compared to BIS drinking water quality standards.The Water Quality Index is also computed.This study is based on selected parameters and BIS considered as standard for reference.

pH –It is one of important indicator for assignment of water.in present study it ranges from 6.54 to8.45 ideal for consumption(.fig1)

Turbidity: Water turbidity consists from suspense inorganic substances, dispersion organic substances, micro microorganisms etc. Turbidity is important because it affects both the acceptability of water to consumers, and the selection and efficiency of treatment processes, particularly the efficiency of disinfection with Chlorine since it exerts a Chlorine demand and protects microorganisms and may also stimulate the growth of bacteria. The turbidity of water samples varied from 18.6 to 19 NTU (Average: 3.7 NTU). So in the present study it is higher value I not fit for domestic use.(fig .2)

Alkanity: The highest alkalinity level was measured in July and the lowest in September The alkalinity of the water reached its peak due to an increase in bicarbonates. Three of the six water samples had alkalinity readings that were within the acceptable range.(Fig3).

Calcium: The presence of Calcium in samples is directly proportional to the hardness of water. The calcium concentrations in the samples ranged from 29 to 47.38 mg/L.Calcium levels peaked in February and fell to their lowest point in April. Except for the month, the calcium concentration of all water samples was within the acceptable range.(Fig4)

Chloride: : Chloride is often associated with sodium since sodium chloride is a common constituent if some water sources, the levels above 140 mg/L are considered to be toxic for plants (Flood, 1996). The chloride contents indicate domestic as well as industrial pollution (*Chatterjee, et al., 2002*). The values of chlorides in different months were found to be various ranges from 75.8 mg/L to 77.43 mg/L. One of the most crucial factors in determining the quality of water is chloride.According to Munawar (1970), higher chloride concentrations indicate more organic contamination. The chloride concentration of all of the water samples was generally within the required range.

.Fluoride: The fluoride concentration of water samples ranged from 0.23 mg/l to 0.26 mg/l.The lowest value of fluoride was found in the month of March, while the highest was recorded in the months of February and March. Overall, the fluoride concentration of all water samples was below acceptable limits. Total hardness Total hardness is a characteristic of water that causes leather development with soap and increases the boiling point of water.

Sulphate-:In the present study it ranges from 23mg\L to 38mg/L.All samples have Sulphate value within permeable range which is deal for domestic purpose,.

Hardness :Hardness :of water mainly depends upon the amount of magnesium and calcium salts dissolved (Trivedi and Goel,1986). The value of total hardness of water samples in the present study fluctuated from 150mg/L 198.84mg/L. 90% of the water samples were showing under the desirable limit.

Iron: Iron is the important metal for life of vegetable and animal organisms. It is undesirable for household and for industry. Iron concentration in all the samples was fluctuating from 0.3mg\L to0.34 Generally, the concentration of iron of all the samples was within the desirable limit

Magnesum: It is often associated with calcium in all kinds of water, but its concentration remains generally lower than the calcium. In the present investigation, the results of Magnesium of water samples in all the months were vary from 13.4mg\Lto 19.3mg\L

Nitrate: Nitrate is present final products of biological oxidation form organic pollution. Nitrate concentration depends on the activity of nitrifying bacteria which in turn get influenced by presence of dissolved oxygen. This signifies that in the most time water where polluted. The values of nitrates in the study area in different months were varied from0.2 mg/L to 0.54mg/L. The lowest and highest value was measured in February and April respectively (High concentrations of nitrates increase the growth of vegetation in water systems and elevate oxygen demand (Mc Junkin, 1982). Generally, the nitrate content of all the water samples was within limit..

TDS:Dissolved solids value of water samples in all the months were found to be exceed the desirable to maximum Dissolved Solids In natural waters, dissolved solids consists mainly of inorganic salts such as carbonates, bicarbonates, chlorides, sulphates, phosphates and nitrates of calcium, magnesium, sodium, potassium, iron etc. and small amount of organic matter and dissolved gases. The values of dissolved solids of the water samples ranged10mg\L to12 mg\L

BOD:ranges from56mg\L to 81mg\L is enumerating the mount of oxidizable pollutant found in underground water and BOD for healthy drinking water1PPM to 2PPM.In present study it ranges10PPM to 19PPM from,not fit for consumption.

Electrical Conductivity: The value of EC ranges from 230 S/m to 241 S/m . All the samples have EC value within the Approximately six physiochemical parameters were used to assess the water quality of coal mine water.Parameters include pH, alkalinity, total hardness, chlorides, fluorides, BOD, COD, DO, nitrate, sulphate, TDS, and electrical conductivity, among others.

IV. CONCLUSION

All of the water samples were examined, and it was discovered that the water quality is poor , with the exception of turbidity, calcium, fluoride, and total hardness being slightly higher than the acceptable value. As a result, it is safe for human health. As a result, there is abundant opportunity to use mine water for drinking and household reasons to meet local demands after some treatment. To regulate water pollution, the industry, State Pollution regulate Board, and government must take proper efforts to prevent water pollution. The mentioned preventive steps can be very useful. During the rainy season groundwater and river water are sufficient to meet water demands, and clean water is vital for a healthy life.The current study shows the Water Quality Index of a sample collected from a coal mine in Surakachhar is unsuitable for drinking.but there are several opportunities to use mine water for domestic and drinking purposes following treatment.

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CONFLICT OF INTEREST:

The authors declare that there is no conflict of interests regarding the publication of this paper

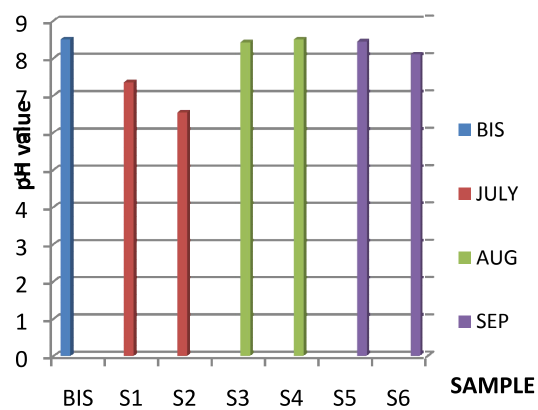

fig1 .graph representing pHvalue of samples from monthJuly to September 2023

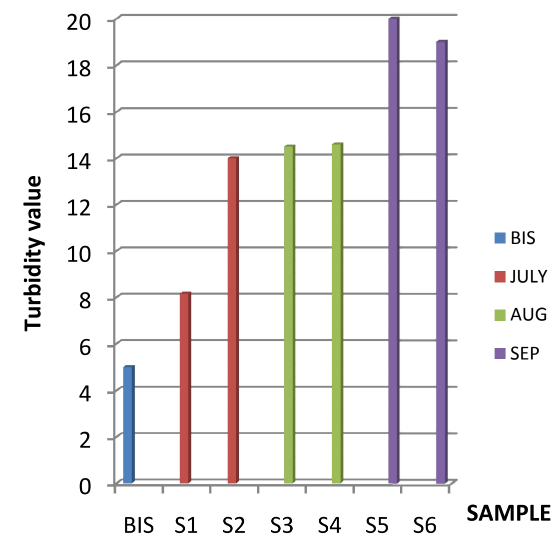

fig 2.graph representing turbidity value of samples from month July to September 2023

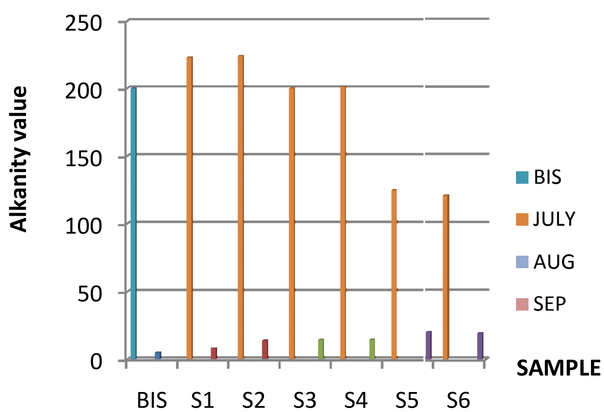

fig 3.graph representing Al kaanityvalue of samples from monthJuly to September 2023

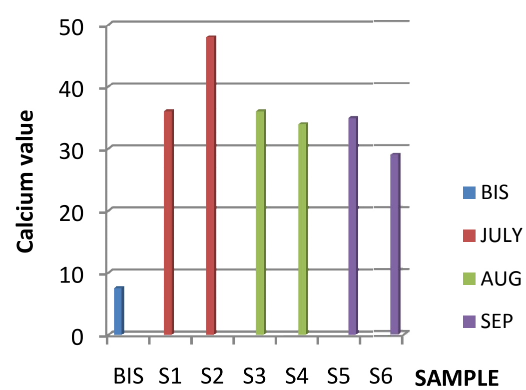

fig 4.graph representing pHvalue of samples from monthJuly to September 2023

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