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Assessment Of Groundwater Quality In Coal Mining Areas Of Chhindwara District: Impacts And Insights

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Abstract: *The quality of water is the major concern survival of living being on earth. The groundwater quality of the mining regions is the most significant issues for the people. In the present study groundwater samples of coal mining areas of the Chhindwara district were collected in the different session and analyzed for water quality characteristics of different parameters such as pH, TDS (Total dissolved Solid), Electrical Conductivity (EC), Chlorides, Sulfate, Nitrate, Iron, Hardness, Magnesium, Sodium. The results obtained after analysis were compared with the different water quality standard such as IS and WHO. The obtained results indicate that the quality of the groundwater was more or less affected by the mining activities.*

Keywords: *Mining activities, Groundwater, Physico-chemical properties, Environmental impacts. quality of the groundwater. The mining activities tends to drain a huge area, and if soluble minerals are found in the coal and accompanying rocks, these minerals may reach the waterbodies, found in a mining areas and severely degrading the quality of water (Energy Report, 1979). Considering the above aspects of groundwater impurity, the present study was carried out to examine the groundwater quality of coal belt provinces of the Chhindwara districts.*

1. INTRODUCTION

Water is the most important natural resource responsible for the survival of the all living being on the entire planet. Groundwater is the one of the most essential natural resources for life agriculture and other practises at many places (Sharma and Vyas 2021). With the increase of the world population and the developmental activities the demand of the groundwater increases significantly (Mishra, et al., 2023). The groundwater contamination has become a major issue of concern all over the world (Ashfaq and Ahmad 2014). There are various human induced contamination in the urban and rural areas such sewage water runoff, dumping of effluent from the industries, mining actions; agricultural runoff due to use of inorganic fertilizers, causes severe changes in the quality of the groundwater quality. Mining is the one of the most significant reason for contaminating the quality of the groundwater. The mining activities tends to drain a huge area, and if soluble minerals are found in the coal and accompanying rocks, these minerals may reach the waterbodies, found in a mining areas and severely degrading the quality of water (Energy Report, 1979). Considering the above aspects of groundwater impurity, the present study was carried out to examine the groundwater quality of coal belt provinces of the Chhindwara districts.

2. STUDY AREA

2.1 *Pench Kanhan Valley Coal Mining Area*

The present study was conducted on the Chhindwara district which is located in the southern part of Madhya Pradesh state. The study was conducted on the Western Coalfield regions of the Chhindwara district which was approximately located between latitude 21°52' N to 22°17' N and longitude 78°45' E to 79°20'E. The Pench Kanhan Valley Coalfield is located 30 kilometres (19 miles) northwest of Chhindwara. While the Pench Valley has five seams in a column of 50-80 m thickness, the Kanhan Valley coal belt runs for around 25 km (16 mi). The total coal reserves (proven, indicated, and inferred) in the Pench Kanhan Coalfield are 2,411.28 million tonnes, according to the Geological Survey of India. Newton, Chikli, Borkuhi, Ramanwara, Eklahera, Bamori, North Chandameta, Chandameta, East Dongar Chikli, Ambara Sukri, Datla, and Shivpuri are important collieries in the Pench valley (Figure - 1).

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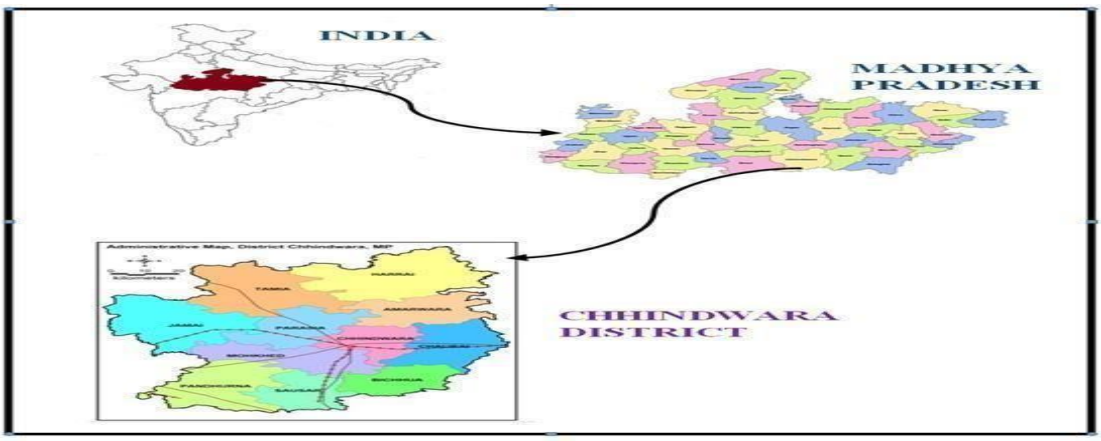

Figure 1: Location map of study area

3. materials and methods of analysis

During the study 11 sampling locations were selected for the study. The ground water samples were collected from the hand pumps as well as tube wells. The water samples were during
Premonsoon, and post-monsoon season in the year of 2021 from different sampling sites (Table – 1, Figure – 2). The 13 parameters of the samples were analysed on site such as pH, dissolved oxygen, conductivity whereas other parameters were analysed on the laboratory. The samples were collected in the sterilized plastic sampling bottle by following standard procedures. After sample collection, bottles were sealed on site with proper labelling. The samples were kept cool while being transported to the laboratory of the Indira Priyadarshini College, Chhindwara, where the samples were analysed with the standard procedures of the APHA (1986, 1991). After the analysis the results were compared with standards of the IS, BIS and WHO.

Table 1: Showing the geographical positions of sampling locations

Station Name	Station Code	Type of Water	Latitude	Longitude
Urdhan – 1	Site-1 (S1)	Hand Pump	22.280704	78.948102
Urdhan – 2	Site-2 (S2)	Hand Pump	22.281551	78.955840
Nehariya – 1	Site-3 (S3)	Hand Pump	22.278661	78.964388
Nehariya – 2	Site-4 (S4)	Hand Pump	22.280520	78.977331
Zurra Mathni – 1	Site-5 (S5)	Hand Pump	22.239437	78.932032
Zurra Mathni – 2	Site-6 (S6)	Hand Pump	22.244252	78.943292
Vishnupuri – 1	Site-7 (S7)	Hand Pump	22.201533	78.858497
Vishnupuri – 2	Site-8 (S8)	Hand Pump	22.195165	78.858158
New Sethia – 1	Site-9 (S9)	Hand Pump	22.215822	78.843600
New Sethia – 2	Site-10 (S10)	Hand Pump	22.216018	78.844242
Mahendrapuri	Site-11 (S11)	Hand Pump	22.180273	78.77250

Figure 2: Google earth map showing sample collection sites in study area

3.1 WHO and IS 10500:2012 Drinking Standards

The present study was carried out Pench coal mine area in Chhindwara district. All the water quality parameters compared with WHO and IS 10500:2012 standard. Water quality regulations are critical to making sure the safety of drinking water. The World Health Organization (WHO) and the Bureau of Indian Standards (10500:2012) have established recommendations for acceptable water quality. This study compares the drinking water quality parameters set by the World Health Organization and the Indian Standard 10500:2012 (Table – 2).

Table 2: WHO and IS Standards for drinking water.

S. No.	Parameter	WHO	IS 10500:2012	
			Acceptable Limit	Permissible Limit
1	pH	7 – 8.5	6.5 – 8.5	No relaxation
2	EC	500 – 1000	–	–
3	TDS	600	500	2000
4	Total Alkalinity	200	200	600
5	Chloride	250	250	1000
6	Total Hardness	200	200	600
7	Fluoride	1.5	1.0	1.5
8	Nitrate	50	45	No relaxation
9	Sulphate	No health-based guideline value is proposed	200	400
10	Iron	0.3	0.3	No relaxation
11	Cupper	2.0	0.05	1.5
12	Nickle	0.07	0.02	No relaxation
13	Zink	No health-based guideline value is proposed	5	15

(***Source***: As per CPCB)

4. RESULT AND DISCUSSION

4.1 pH

The pH values are in the water are plays important role in determining the nature of water either it is acidic or alkaline. The nature of water plays important role its suitability for different uses. The values of pH were observed from 6.48 to 8.15, the higher value were observed in post-monsoon season were as the lower value were observed in the pre-monsoon season. Similar observation of the pH values was also observed by Khatik, et al., (2012) in the Chhindwara district.

4.2 Electrical Conductivity (EC)

The values of the Electrical Conductivity in the present study various from 241.79 to 489.55µS/cm. the higher value of the EC were observed in pre-monsoon whereas lower value in the postmonsoon. The value of the EC was directly depending on the temperature and indirectly measures the salinity of the water. Similar values of the EC were observed by Sonkar, and Jamal (2018) during assessing the groundwater in the Singrauli coalfied region of Madhya Pradesh.

4.3 Total Dissolved Solids (TDS)

The values in the present study was observed from 158 to 328 mg/l. The higher value of the TDS was found in pre-monsoon and lower in post-monsoon. The values of the TDS in the water quality shows the concentration of the solid contents present in the water samples. The values of the similar observation were also reported by Yadav and Jamal (2018) in some coal mining regions of the Sonbhadra district,

Uttar Pradesh and Singrauli district, Madhya Pradesh.

4.4 Total Alkalinity

The values of total Alkalinity were found between 142 to 240 mg/l. the higher value of Alkalinity was found in pre-monsoon and lower during the post-monsoon. Similar values of the total alkalinity were reported by Mahore, M.K (2021) in the groundwater samples of the Pataleshwar region of Chhindwara.

4.5 Chloride (Cl)

The concentration of the chloride was lies between 38 to 114 mg/l. the maximum value of the chloride was observed in pre-monsoon and lower value was in post-monsoon season. The values of the chloride were found in the acceptable limit as per standards. The values of the chlorides were basically depending on the geochemical conditions of the study areas.

4.6 Total Hardness (TH)

The total hardness of the water samples was depending on the presence of Calcium and magnesium ion on the water samples. The reduction in water volume and the increase in water evaporation rate during the summer months are the reasons for a high hardness value (Hussain and Prasadrao, 2014; Anbarasu and Anbuselvan, 2017). During the study the value TH were lies between 92 to 244 mg/l the higher concentration of the TH was found in pre-monsoon season and lower during post-monsoon.

4.7 Fluoride

The concentration of the fluoride in the groundwater were depends on the geological formation and solubility of the fluoride bearing minerals (Khatik, et.al 2012). The amount of the fluoride in the water samples were varies between 0.06 to 0.58 mg/l. the maximum value of the fluoride was found in pre-monsoon season while lower on post-monsoon.

4.8 Nitrate

The major sources of the nitrate in the water concentration was anthropogenic disturbances. The higher level of the nitrate can cause numerous harmful diseases. During the study the concentration of the nitrate were lies between 5 to 11.20 mg/l. The maximum limit of the nitrate was observed during the pre-monsoon season and the minimum during the post-monsoon. Similar values of the nitrate concentration were reported by Pandey, et.al (2020) in the groundwater quality of Allahabad city.

4.9 Sulphate

The concentration of the sulphate in the water samples were lies between 50 to 102 mg/l. higher value of the was recorded during the pre-monsoon season whereas lowest value was recorded during the post-monsoon season. The values of the sulphate in the mining area were depends on the sediments present on this region. Similar observation of the sulphate concentration was observed by Sonkar and Jamal (2018) in Singrauli coalfield region.

4.10 Heavy Metals

The heavy metals incudes Iron (Fe), Nickel (Ni), Cupper (Cu) and Zink (Zn). These heavy metals are seriously threaten to the human health and also to environment. During the study the values of Fe lies between 0 to 0.8 mg/l. Similarly, the values of cupper varied from 0.01 to 0.02, the value of Nickle found from 0.0022 to 0.01 and value of Zink lies between from 0.9 to 4.2. The maximum value of Fe, Cu and Ni were found in the pre-monsoon season while the maximum concentration of Zn were found in the post-monsoon season and minimum value of the Fe, Cu, Ni and Zn were observed in the pre-monsoon season. Similar observation in the concentration of the heavy maters were also recorded by Yadav and Jamal (2018) in coal mining areas of the Sonbhadra district,
Uttar Pradesh and Singrauli district, Madhya Pradesh

Table – 3: Physico-Chemical Parameter of Ground water samples of Pench coal mine area during PreMonsoon 2021

Site → / Parameter ↓	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
pH	6.48	7.23	7.45	7.12	7.05	6.98	7.56	7.88	7.19	6.78	7.42
EC	328.36	459.7	364.18	411.94	450.75	438.81	394.03	391.04	429.85	465.67	489.55

TDS	220	308	244	276	302	294	264	262	288	312	328
Total Alkalinity	180	210	220	198	160	164	210	240	190	174	198
Chloride	72	88	78	80	92	64	82	68	76	102	114
Total Hardness	154	230	204	200	232	206	206	210	210	244	234
Fluoride	0.09	0.37	0.1	0.55	0.23	0.11	0.18	0.08	0.12	0.33	0.58
Nitrate	6.8	8.2	6.2	7.8	11.2	10.4	8.2	7.8	8.2	7.2	8.2
Sulphate	76	98	78	88	98	92	88	90	92	102	98
Iron	0.09	0.01	0.08	0	0.01	0.8	0.2	0.1	0.2	0.11	0.22
Cupper	BDL	0.017	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.02	0.01
Nickle	0.0022	0.009	0.006	0.007	BDL	0.006	0.0043	0.0078	BDL	0.01	0.009
Zink	0.9	1.4	2.3	0.9	1.1	3.3	2.1	1.8	1.1	1.3	1.9

Table – 4: Physico-Chemical Parameter of Ground water samples of Pench coal mine area during Post-Monsoon 2021

Site → / Parameter ↓	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
pH	7.85	8.1	7.9	7.7	7.9	8	8.15	7.9	8	8.1	8.05
EC	301.49	283.58	271.64	280.59	319.4	310.44	241.79	268.65	242.82	254.77	342.37
TDS	202	190	182	188	214	208	162	180	158	164	218
Total Alkalinity	162	170	172	160	142	148	160	162	152	150	162
Chloride	60	64	56	48	38	44	58	64	54	42	78
Total Hardness	118	102	102	112	130	126	128	110	120	92	106
Fluoride	0.06	0.14	0.08	0.32	0.2	0.13	0.2	0.12		0.28	0.42
Nitrate	5	7.2	6.4	9.2	8	8.4	7	6.8	7.8	7	9.4
Sulphate	62	68	58	64	74	72	62	58	52	58	60
Iron	0.08	0.09	0.04	0.02	0.04	0.08	0.1	0.1	0.09	0.2	0.14
Cupper	0.01	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01	BDL
Nickle	0.009	0.0078	0.007	0.0089	0.0078	0.0098	0.0072	0.0086	BDL	0.0092	0.0048
Zink	1.4	2.1	2.3	2.4	3.2	4.2	3.9	2	1.8	1.9	2.2

Table – 5: Summary of statistics of groundwater parameter of Pench coal mine area during 2021

Statistics → / Parameter ↓	Min.	Max.	Mean	Median	S.D.
pH	6.48	8.15	7.58	7.775	0.4852
EC	242	490	351.88	335.37	80.6280
TDS	158	328	234.73	219	54.8402
Total Alkalinity	142	240	176.55	167	26.0635
Cloride	38	114	69.18	66	19.4462
Total Hardness	92	244	162.55	142	53.8045
Fluoride	0.06	0.58	0.22	0.18	0.1536
Nitrate	5	11.2	7.84	7.8	1.3838
Sulphate	52	102	76.73	75	16.2427

Iron	0	0.8	0.13	0.09	0.1635
Cupper	0.01	0.02	0.01	0.01	0.0048
Nickle	0	0.01	0.01	0.0078	0.0020
Zink	0.9	4.2	2.07	1.95	0.9057

CONCLUSION

In the present study, the ground water samples taken from 11 samples sites from six villages present in and around Pench Kanhan coalfield, Chhindwara District area were analyzed. According to the study, mining operations have a major influence on the quality of the groundwater in the Chhindwara area of Madhya Pradesh. Pre-monsoon typically exhibits greater pollutant concentrations, according to analysis of a number of physicochemical parameters, including pH, TDS, EC, chloride, hardness, nitrate, and heavy metals. The results highlight the need for regular monitoring because of the possible dangers associated with mining-induced contamination, even if the majority of values are below the acceptable ranges established by ISI and WHO guidelines.

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