Quest Journals
Journal of Research in Environmental and Earth Sciences
Volume 9 ~ Issue 9 (2023) pp: 11-18
ISSN(Online) :2348-2532
www.questjournals.org

Research Paper

Assessment Of Groundwater Quality For Drinking Use In Deonar River Sub Basin Area, Sidhi District, Madhya Pradesh, India

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ABSTRACT
The hydrochemistry and groundwater quality of the Deonar River Basin have investigated in the current study area. The water quality for the water sources were assessed using the Bureau of Indian Standard Physicochemical factors such pH, hardness, alkalinity, iron (Fe), fluoride (F), chloride (Cl), nitrate (NO3 were examined using established tools.This studyreveals that the water is safe to drinking. Groundwater is observed to be hard to very hard, fresh to slightly saline, and slightly alkaline, reflecting changes in lithology (sandstone and shale aquifer and igneous) while bicarbonate and sulphate are dominant in the anion chemistry, calcium and magnesium are dominant in the cation chemistry. Since each of these characteristics is within the allowable limit, their presence had no impact on the water's quality Due to both geogenic and anthropogenic activity, nitrate levels in a few water samples are higher than allowed limit. According to the study, the groundwater is mostly fit for human consumption. The Ca-Mg-HCO3 and Ca-Mg-SO4 types are the two primary hydrochemical facies.Due to both geogenic and anthropogenic activities, nitrate and fluoride levels in a few water samples are higher than allowed.

KEYWORDS: Human Health; Drinking Water Quality; Physiochemical Analysis

*Received 12 Sep, 2023; Revised 24 Sep., 2023; Accepted 26 Sep., 2023 © The author(s) 2023. Published with open access at **www.questjournals.org***

I. INTRODUCTION

The elixir of life, Groundwater is a fundamental human necessity, and priceless natural. One of the most important aspects affecting human health is the quality of drinking water. However, the quality of the drinking water in many nations, particularly those that are developing, are not ideal, and numerous waterborne diseases have been linked to poor drinking water quality. In India, 60% of the country's rural population's household needs are met by groundwater, which is the only renewable mineral resource because it only has 4% of the nation's water resources and around 20% of the worldwide population [12, 14]. Worldwide, having access to clean, fresh water is crucial and advantageous for drinking. It is notable that the population heavily relies on both surface and groundwater for various reasons, especially drinking. Therefore, it is crucial to have a thorough understanding of both the quality of groundwater and surface water. The quality of drinking water is one of the most significant factors that affecting human health. However, many countries, especially those that are developing, do not have adequate drinking water quality. The most important drinking sources in the world are surface water and groundwater All people, regardless of nationality, religion, race, wealth, or creed, are entitled to basic human rights, including access to clean drinking water [2]. Poor sanitation and contaminated drinking water are associated with the spread of illnesses like cholera, diarrhoea, dysentery, and polio [17].According to World Water Development. 40% of the world's population lacks enough water for good living and hygiene, while 20% of the population lacks access to safe drinking water [18]. Groundwater's hydrochemical evolution is a dynamic process that is constantly changing in both space and time. However, mineralogy, the solubility of rock-forming minerals, as well as polluted activities, have a significant impact on the kind and quantity of dissolved species in natural water [13, 15, 16]. The concentration of biological, chemical, and physical contaminants in groundwater, as well as environmental factors and human activity, are major determinants of its suitability for drinking [8]. Numerous researchers have assessed the hydrochemistry and drinking water quality from various regions of our country [5, 6, 9, 10, 11, 12, 13, 14]. The majority of studies used hydrogeochemical evaluation for drinking water and irrigation, seasonal and spatial distribution, development of novel water quality index, geographic information system, and assessment of river water quality to evaluate the effects of poor water quality on human health risk assessment [3]. The Deonar River Basin in Madhya Pradesh, India and its drinking water quality and hydrochemical facies are the main subjects of the current study.

II. STUDY AREA

The study area is located between latitudes 81°37'22.584" and 81°52'58.302" east and north, respectively. It is located in the survey of India Toposheets 63 H/11 and H/15 survey. The whole study region is hilly, with only a little area of plains following the paths of rivers. The Vindhyan Supergroup and the Mahakoshal Group of rocks are main types in the research area. Except for the south-west monsoon season, the climate of Sidhi District, M.P., is characterised by a scorching summer and widespread dryness. The south-west monsoon season lasts from the middle of June to September, and the post-monsoon months of October and November. The south-west monsoon season brings the most rain to the Sidhi district. One of the primary sources of groundwater recharge in the region is rainfall, which is augmented by additional sources like canals, irrigated fields, and surface water bodies.

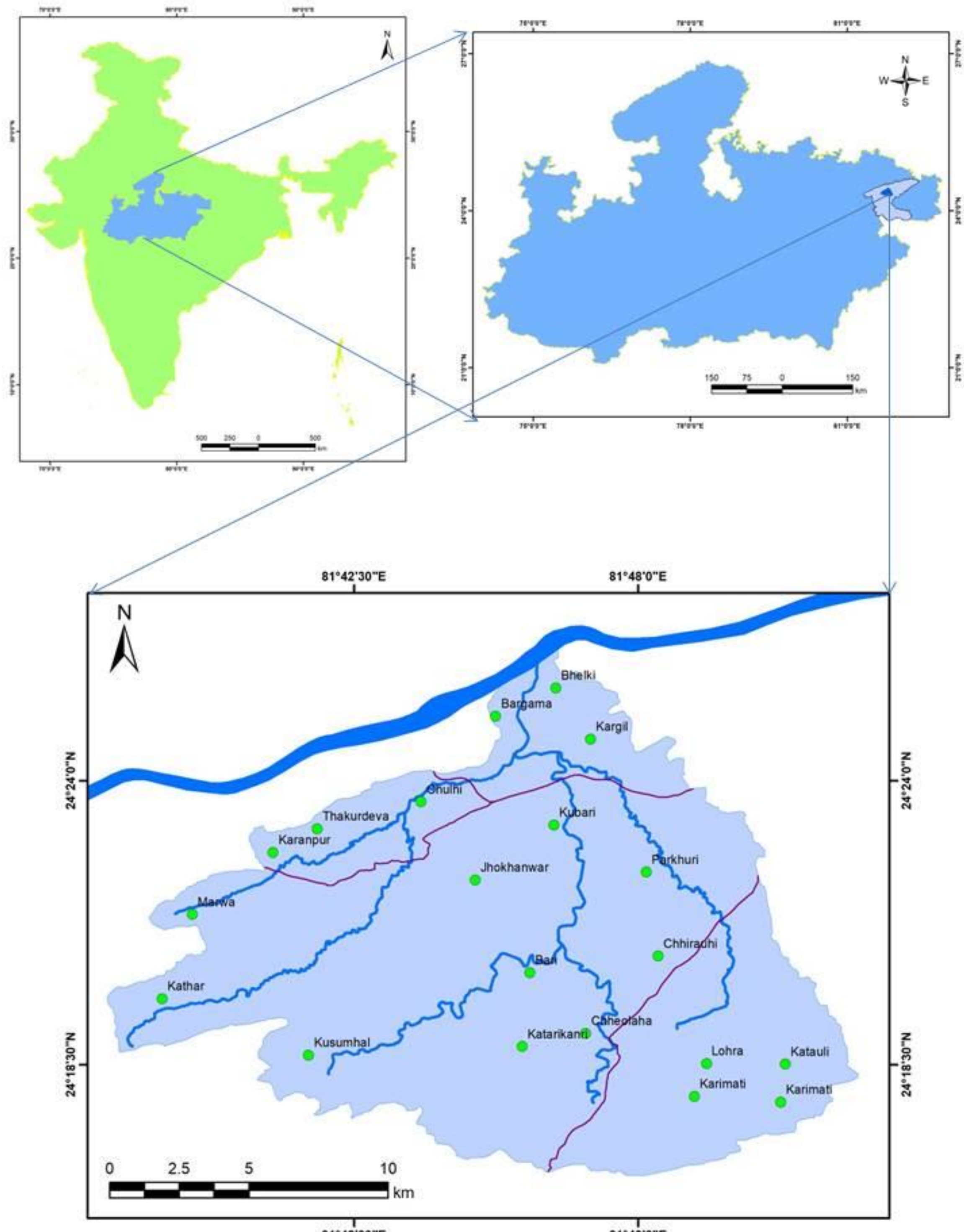

Figure 1:Location map of the Study area

III. METHODOLOGY

The 20 groundwater samples from various dug well of the research area were gathered and analysed in pre and post monsoon samples of 2021 for their suitability for drinking. All sample bottles were fully sanitised, cleaned, and rinsed with double-distilled water prior to sampling. The EC, pH, Cations and Anion were determination following the standard and procedure [1].

IV. RESULT AND DISCUSSION

The analytical results of the groundwater pre and post monsoon samples of the study area are presented in Table 1, 2 and Table 3. The pH ranges from 7.1 to 7.9 before the monsoon and from 6.6 to 7.4 afterward, indicating an alkaline to basic nature. All samples from both seasons meet WHO guidelines and fall within the acceptable range for human consumption (6.5 to 9.2). The range of electrical conductivity (EC) before the monsoon is 849 to 2566 s/cm, while the range after the monsoon is 549 to 2266 us/cm. The enhanced electrical conductivity is due to the characteristics of aquifers. The EC increases as the temperature rises and changes depending on the concentration of dissolved mineralspresent in the aquifers. Due to the impervious character of shale and the adequate time for groundwater and shale's impervious nature to react, there is a larger concentration of electrical conductivity. TDS is a measurement of the total dissolved solids (TDS) in water. It illustrates the connection between subterranean minerals and groundwater. Long-term consumption of this type of water should be avoided because doing so increases the risk of kidney stones, acidity, and cardiovascular issues. For hard water, Reverse Osmosis (RO) is advised. The water has a fresh to saline character, As per Raghunath's (1987) categorization of TDS. In the pre-post monsoon season, TDS levels range from 544 to 1645 mg/l and 444 to 1545 mg/l, respectively. The post-monsoon period was found to have slightly lower TDS levels in groundwater. Regular consumption of water with a high TDS level can cause gastrointestinal upset in people. Hardness is calculated using the number of multivalent metallic cations present in the solution. The proper explanation is that groundwater contains alkaline earth. This feature is brought on by the presence of alkaline earths in the groundwater. The most prevalent alkaline earth elements in most natural streams are Ca and Mg. In the pre-post monsoon season, groundwater samples' total hardness ranged from 286 to 1128 mg/l and 216 to 1058 mg/l, respectively. The Pre-post monsoon season calcium concentrations range from 56.8 to 215.6 mg/l and 36.8 to 195.6 mg/l, respectively. While the majority of the pre and post-monsoon season samples are within the maximum permitted limit of WHO (2006) and ISI (1991) drinking water standards, some pre-monsoon groundwater test samples surpass the maximum allowable limit. Since water is provided through pipes and taps, a layer of calcium is typically deposited. Aquifers of sandstone and shale includes k-feldspar and clay minerals that have added sodium and potassium to the groundwater. The lithology of the area accounts for the increased calcium concentration. The Pre-post monsoon season magnesium concentrations range from 18.6 to 153.9 mg/l to 13.6 to 148.9 mg/l, respectively. The range of sodium concentrations during the pre and post-monsoon seasons is 29.5 to 105.4 mg/l and 19.5 to 95.4 mg/l, respectively. The higher the Sodium concentration, the less suited the water is for residential use because it causes serious health hazards like hypertension. The samples from the study area are all below the permitted upper limit. Pre- and post-monsoon potassium values range from 1.8 to 35.3 mg/l and 1.6 to 35.1 mg/l, respectively. Less than 10 mg/l of potassium can be found in drinking water. It controls the body's fluid balance. Potassium concentrations must not go over 12 mg/l. While the remaining pre and post-monsoon season samples are within the maximum permitted limit of WHO (2006) and ISI (1991) water standards of drinking.

The Pre-monsoon bicarbonate concentrations range from 76.2 to 547.7 mg/l, while post-monsoon bicarbonate concentrations range from 105.6 to 467.7 mg/l. The higher bicarbonate concentration in the water suggests that mineral dissolution is the main mechanism. It is formed from the carbon dioxide emitted by the soil's organic breakdown and makes up the majority of the anions in groundwater [15]. An essential element of the body that facilitates digestion is bicarbonate. Pre-post monsoon season, the chloride level varies from 32.8 to 212.6 mg/l and 17.8 to 197.6 mg/l, respectively. The pre-post monsoon groundwater samples were all below the maximum allowable level. Pre-post monsoon season sulphate levels range from 25.6 to 356.6 mg/l and 21.6 to 326.6 mg/l, respectively.All pre- and post-monsoon groundwater samples in the study area were below the maximum permitted level. The body may experience laxative effects from its greater concentration. Gypsum minerals found in shale formation are to main culprit for the higher sulphate concentration. Gypsum, which is a hydrous sulphate of calcium ($CasSO4.2H2O$), dissolves in circulating groundwater and can provide a persistent kind of hardness [14]. Nitrate concentrations in the pre-monsoon and post-monsoon seasons range from 2.9 to 41.5 mg/l and 2.1 to 35.6 mg/l, respectively. In the study area nitrate concentration is below the permitted limit. The nitrate level in groundwater that can be used for domestic purposes is 45 mg/l. drinking water criteria from WHO (2006) and ISI (1991). Nitrate's geogenic source has been largely disregarded. The greater nitrate concentration is caused by anthropogenic activities including the usage of chemicals like insecticides and nitrate-rich fertilisers. Due to pressure from farmers to produce more, irrigation infrastructure have been developed. Farmers use enormous amounts of fertilisers without being aware of their negative impacts. Although the issue of blue baby sickness was not observed in the region, its potential occurrence in the future cannot be fully ruled out because longer nitrate in groundwater residence duration.Fluoride concentrations in the pre-monsoon and post-monsoon seasons range from 0.4 to 1.7 mg/l and 0.15 to 1.45 mg/l, respectively. Its concentration is noticeably higher in the Shaly aquifer, indicating that geology has contributed significantly to the fluoride content of groundwater. In addition, the use of fertilisers may increase fluorite is not entirely disregarded. By combining groundwater with rainwater, its higher concentration can be neutralised. Artificial recharge structures must to be encouraged in the area.

V. CONCLUSION

The groundwater samples of the research area have been assessed. The study reveal a mildly alkaline character of groundwater. Pre-monsoon pH levels are higher because there is less atmospheric carbon dioxide supply. Few samples have greater electrical conductivity values because the groundwater and impermeable shale formation had time enough to react. Due to the aquifer's characteristics, the water is often hard in nature. Consuming really hard water over an extended period of time may raise the occurrence of cardiovascular diseases. All the cations aside from calcium are within the allowable range. Stone issues, which frequently arise in the study, may be caused by a constant increase in calcium intake. Therefore, it is advised that hard water be chemically treated before consumption. In areas with high fluoride levels, the deflouridation and ion exchange approach is recommended. An awareness campaign may be highly beneficial for areas with greater nitrate and fluorite concentrations. The usage of organic fertilisers rather than chemical fertilisers should be encouraged to the farmers.

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Table 1: Concentration Range of Suitability of Groundwater for Domestic Use

Sr. No.	Water Qulaity Parameters	WHO (2006)		ISI (1991)		Concentration in study area	
		Max. Desirable	Max. per Missible	Max. Desirable	Max. per Missible	Pre-Monsoon	Post-Monsoon
1	Ph	7.0 to 8.5	6.5 to 9.2	6.5 to 8.5	No relaxation	7.1 to 7.9	6.6 to 7.4
2	TDS mg/l	500	1000	500	2000	544 to 1645	444 to 1545
3	TH as $CaCo_3$ mg/l	100	500	300	600	286 to 1128	216 to 1058
4	Ca mg/l	75	200	75	200	56.8 to215.6	36.8 to 195.6
5	Mg mg/l	30	150	30	100	18.6 to 153.9	13.6 to 148.9
6	K mg/l	10	12	-	-	1.8 to 35.3	1.6 to 35.1
7	Na mg/l	20	175	-	200	29.5 to 105.4	19.5 to 95.4
8	HCO_3 mg/l	-	-	300	600	76.2 to 547.7	105.6 to 467.7
9	SO_4 mg/l	200	400	150	400	25.6 to 356.6	21.6 to 326.6
10	Cl mg/l	200	600	250	1000	32.8 to 212.6	17.8 197.6
11	NO_3 mg/l	-	45	-	45	2.9 to 41.5	2.1 to 35.6
12	F mg/l	1	1.5	1	1.5	0.4 to 1.7	0.15 to 1.45

Table 2: Analytical Results of Groundwater Samples of the Study Area (Pre-monsoon- 2021) (Except pH and EC, all values are in ppm)

Sr. No.	Village Details	Ph	EC (cm)	TDS	TH	Na	K	Ca	Mg	F	Cl	SO4	NO3	HCO3
1	Bargama	7.1	1570	1007	647	94.6	3.5	122.2	83.4	0.7	211.5	67.9	41.5	381.3
2	Bari	7.2	1587	1017	655	95.7	3.8	123.5	84.5	0.8	212.6	69.8	41.4	385
3	Bhelki	7.5	1146	735	688	46.7	3.5	184.5	55.2	0.5	56.7	116.5	21.6	249.3
4	Chheolaha	7.9	1456	933	583	61.5	5.2	114.7	71.9	1.3	134.8	325.7	32.4	185.6
5	Chhirauhi	7.7	1775	1138	865	64.8	27.8	215.6	79.5	1.7	143.4	347.2	4.8	252.9
6	Chulhi	7.5	974	624	286	76.1	1.8	56.9	35.1	0.75	32.9	194	16.4	210.4
7	Jhokhanwar	7.4	1271	815	522	34.7	4.4	143.5	39.9	0.5	64.4	153.6	36.7	336.8
8	Karanpur	7.1	1141	714	410	58.2	6.1	63.2	61.5	0.8	174.7	83.3	12.6	253.5
9	Kargil	7.6	976	626	290	76.2	1.9	56.8	36.1	0.8	32.8	193	16.6	211.3
10	Karimati	7.1	1053	675	388	29.6	30.5	124.7	18.6	0.4	75.8	53.5	26.5	315.2
11	Karimati	7.6	977	627	584	78.1	1.9	73.4	97.6	0.6	96.5	165.6	36.6	76.2
12	Katarikanri	7.3	1050	673	517	45.8	4.8	128.6	47.8	0.7	57.7	25.6	37.6	324.3
13	Katauli	7.4	1271	815	522	34.7	4.4	143.5	39.9	0.5	64.4	153.6	36.7	336.8
14	Kathar	7.5	1069	685	317	42.7	23.6	91.3	21.6	0.5	71.8	142.8	5.7	285.4
15	Kubari	7.6	849	544	301	46.4	2.3	74.7	27.8	1.3	39.2	94.9	2.9	254.7
16	Kusumhal	7.8	2566	1645	1128	105.4	35.2	198.7	153.88	1.3	210.1	356.6	35.8	547.7
17	Lohra	7.8	2529	1621	1127	105.2	35.3	198.6	153.9	1.2	209.1	353.4	35.7	528.5
18	Marwa	7.7	1775	1138	865	64.8	27.8	215.6	79.5	1.7	143.4	347.2	4.8	252.9
19	Parkhuri	7.1	1063	682	466	37.9	6.1	123.6	38.4	0.6	71.9	126.3	29.9	249.7
20	Thakurdeva	7.4	887	569	384	29.5	26.5	121.4	19.7	0.4	74.6	51.6	29.7	215.2

Table 3: Analytical Results of Groundwater Samples of the Study Area (Post-monsoon- 2021) (Except pH and EC, all values are in ppm)

Sr. No.	Village Details	Ph	EC (cm)	TDS	TH	Na	K	Ca	Mg	F	Cl	SO4	NO3	HCO3
1	Bargama	6.6	1270	907	577	84.6	3.3	102.2	78.4	0.45	196.5	37.9	35.6	301.3
2	Bari	6.7	1287	917	585	85.7	3.6	103.5	79.5	0.55	197.6	39.8	32.3	305
3	Bhelki	7	846	635	618	36.7	3.3	164.5	50.2	0.25	41.7	86.5	16.5	169.3
4	Chheolaha	7.4	1156	833	513	51.5	5	94.7	66.9	1.05	119.8	295.7	25.6	105.6
5	Chhirauhi	7.2	1475	1038	795	54.8	27.6	195.6	74.5	1.45	128.4	317.2	3.6	172.9
6	Chulhi	7	674	524	216	66.1	1.6	36.9	30.1	0.5	17.9	164	12.5	130.4
7	Jhokhanwar	6.9	971	715	452	24.7	4.2	123.5	34.9	0.25	49.4	123.6	30.6	256.8
8	Karanpur	6.6	841	614	340	48.2	5.9	43.2	56.5	0.55	159.7	53.3	25.6	173.5
9	Kargil	7.1	676	526	220	66.2	1.7	36.8	31.1	0.55	17.8	163	12.4	131.3
10	Karimati	6.6	753	575	318	19.6	30.3	104.7	13.6	0.15	60.8	23.5	22.6	235.2
11	Karimati	7.1	677	527	514	68.1	1.7	53.4	92.6	0.35	81.5	135.6	32.5	-3.8
12	Katarikanri	6.8	750	573	447	35.8	4.6	108.6	42.8	0.45	42.7	-4.4	34.9	244.3
13	Katauli	6.9	971	715	452	24.7	4.2	123.5	34.9	0.25	49.4	123.6	32.1	256.8
14	Kathar	7	769	585	247	32.7	23.4	71.3	16.6	0.25	56.8	112.8	4.7	205.4
15	Kubari	7.1	549	444	231	36.4	2.1	54.7	22.8	1.05	24.2	64.9	2.1	174.7
16	Kusumhal	7.3	2266	1545	1058	95.4	35	178.7	148.88	1.05	195.1	326.6	26.7	467.7
17	Lohra	7.3	2229	1521	1057	95.2	35.1	178.6	148.9	0.95	194.1	323.4	32.1	448.5
18	Marwa	7.2	1475	1038	795	54.8	27.6	195.6	74.5	1.45	128.4	317.2	3.6	172.9
19	Parkhuri	6.6	763	582	396	27.9	5.9	103.6	33.4	0.35	56.9	96.3	22.4	169.7
20	Thakurdeva	6.9	587	469	314	19.5	26.3	101.4	14.7	0.15	59.6	21.6	21.2	135.2