International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 11 Issue 9 ǁ September 2023 ǁ PP. 155-162

Assessment Of Groundwater Quality For Drinking Use In Bichiya River Sub Basin Area, Rewa Region, Madhya Pradesh, India

Pushpendra Kumar Tiwari[1]*, RabindraNath Tiwari[1], Vikash Kushwaha[1] and Brahmanand Sharma[2]
[1]*Department of Geology, Govt. Model Science College Rewa-486001, Madhya Pradesh, India*
[2]*Government Adarsh College, Umaria, Madhya Pradesh*
email:geopushpendra@gmail.com;rntiwari33@gmail.com;geolrs.vikash@gmail.com*

ABSTRACT
In the present study, the hydrochemistry and groundwater quality of the Bichiya River Basin were analyzed. Using the Bureau of Indian Standard, the WQI and water quality for the sources of the water were evaluated. It was concluded that the water is safe to drink after examining physicochemical variables such as pH, hardness, alkalinity, iron (Fe), fluoride (F), chloride (Cl), nitrate (NO3), and turbidity using recognized techniques. Since lithology (sandstone and shale aquifer and igneous) changes throughout time, it is noted that groundwater is fresh to slightly salty, hard to very hard, and slightly alkaline. In the anion chemistry, bicarbonate and sulfate predominate, whereas calcium and magnesium predominate in the cation chemistry. Each of these traits is within the permitted range; hence their existence had no effect on the water's quality. Several water samples had nitrate concentrations that are over the permitted limits because to geogenic and human activity. The investigation found that the nearby groundwater is mainly suitable for human consumption. It is found that groundwater is fresh to slightly salty, hard to very hard, and slightly alkaline, reflecting lithological variations. The two main hydrochemical facies are the Ca-Mg-HCO3 and Ca-Mg-SO4 kinds. All the water samples have nitrate concentration within permissible limit. The investigation found that the nearby groundwater is mainly suitable for human consumption.
Keywords: Human Health; Drinking water quality; physiochemical analysis
----
Date of Submission: 11-09.2023 Date of acceptance: 24-09-2023

I. INTRODUCTION

Groundwater is the essence of life, a basic requirement for human existence, and a priceless natural resource. It is the second-most crucial component for life to survive, right after oxygen. 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, has a significant impact on the kind and quantity of dissolved species in natural water **[13, 16, 18]**. 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 **[3]**. One of the major environmental issues confronting many nations today is the deterioration of water quality and lack of access to safe and clean water [**17**]. India, which only has 4% of the world's water resources and 20% of the world's population, relies on groundwater for 60% of its rural population's household needs, making it the sole renewable mineral resource **[13, 15]**. All people have the right to fundamental human rights, such as access to safe drinking water, regardless of their nationality, religion, race, wealth, or creed. Diseases including cholera, diarrhea, dysentery, and polio are spread as a result of poor sanitation and tainted water [**19**]. According to World Water Development, India is placed 120th out of 122 countries in terms of water quality, capability, and commitment to improvement. 20% of the world's population lacks access to safe drinking water, while 40% of the population lacks sufficient water for daily life and hygiene [**2, 20**]. 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 [**9**]. As a result of pollution from multiple point and non-point sources brought on by rising living standards, unplanned urbanization, fertilisers, and pesticides, the water quality in the river's basin region has gradually decreased. Various parts of our country's drinking water quality and hydrochemistry have been evaluated by numerous researchers [**6, 7, 10, 11, 12, 13, 14, 15**] The majority of studies evaluated the impacts of poor water quality on human health risk assessment using 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 [**4**]. The Bichiya 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 region is located between latitudes 81°17'18.762" to 81°44'50.298"E and 24°20'29.363"N to 24°35'20.234"N, respectively. It is located in the India Toposheets numbers 63 H/6, 7, 10 & 11. Underneath the research area are rocks belonging to the Vindhyan Supergroup Rewa District, M.P.. The area experiences a hot summer and extensive dryness, with the exception of the south-west monsoon season. The middle of June to early September marks the start of the south-west monsoon season, which is followed by the post-monsoon months of October and November. The rewa district receives the maximum rainfall during the south-west monsoon season. Rainfall is one of the main sources of groundwater recharge in the area. Additional sources, such as canals, irrigated fields, and surface water bodies, supplement rainfall.

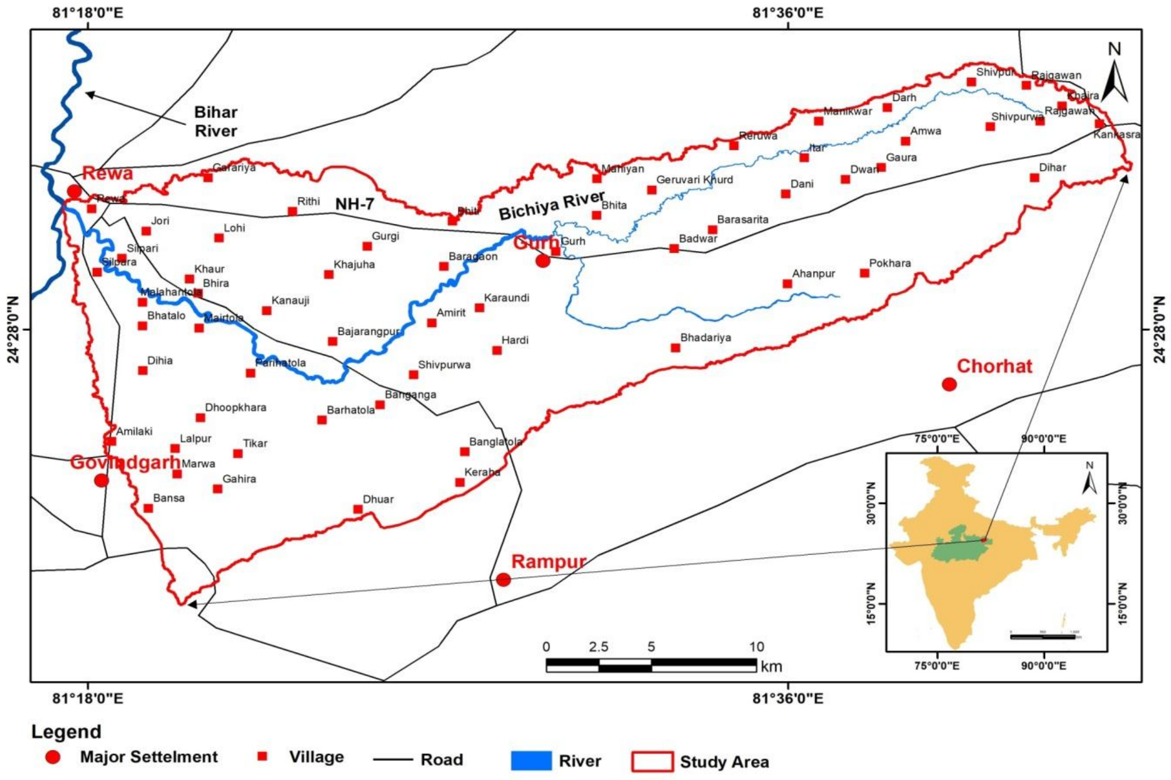

Figure 1. Study area map of Bichiya River basin area

III. METHODOLOGY

Pre- and post-monsoon samples of 2022 were used to collect and compare 50 groundwater samples from different dug wells throughout the research area. Prior to sampling, all sample bottles underwent thorough sanitization, cleaning, and rinsing with double-distilled water. They were regularly used for drinking and had EC, pH, Cations, and Anion determination that adhered to the accepted practices [**1**].

IV. RESULT AND DISCUSSION

The abstract of analytical results is illustrated in table1 and detailed analysis of groundwater pre and post monsoon samples of the study area are presented in Table 2 and Table 3. The pH ranges from 7.5 to 8.6 before the monsoon and from 6.8 to 8.3 afterward, indicating an alkaline to basic nature. All samples from both seasons meet WHO guidelines and fall within the acceptable range. The range of electrical conductivity (EC) before the monsoon is 565 to 1345 s/cm, while the range after the monsoon is 460 to 950 s/cm. The properties of aquifers are what cause the improved electrical conductivity. The greater the EC value, the less appetizing something is for human consumption. It fluctuates according on the concentration of dissolved minerals that are present and grows as the temperature rises. Shale is impervious, and because groundwater and the impervious quality of the shale have had time to react, there is a higher concentration of electrical conductivity. Total dissolved solids (TDS) are quantified in water. It demonstrates how underground minerals and groundwater are related. This type of water should not be consumed over an extended period of time as it raises the risk of kidney stones, acidity, and cardiovascular problems. Reverse osmosis (RO) is indicated for hard water. The water has a fresh to saline character, according to Raghunath's (1987) categorization of TDS. In the pre-post monsoon season, TDS levels range from 376 to 846 mg/l and 287 to 629 mg/l, respectively. TDS levels in groundwater were discovered to be somewhat lower during the post-monsoon season. People's stomachs may upset if they regularly drink water with a high TDS level. The quantity of multivalent metallic cations in the solution is used to calculate hardness. Alkaline earth is present in groundwater, which is the correct explanation. The presence of alkaline earths in the groundwater causes this characteristic. Ca and Mg are the two alkaline earth elements that are most frequently found in natural streams. In the pre-post monsoon season, groundwater samples' total hardness ranged from 286 to 842 mg/l and 162 to 692 mg/l, respectively. The Pre-post monsoon season calcium concentrations range from 50 to 183.2 mg/l and 36.4 to 209.1 mg/l, respectively. Some pre-monsoon groundwater test results exceed the maximum authorized limit, despite the fact that the majority of pre-post-monsoon season samples are within the maximum permitted limit of WHO (2006) and ISI (1991) drinking water standards. A coating of calcium is often deposited there as a result of the fact that water is delivered through pipes and taps. Sandstone and shale aquifers contain k-feldspar and clay minerals, which have increased the sodium and potassium content of the groundwater. The elevated calcium concentration is caused by the local lithology. The Pre-post monsoon season magnesium concentrations range from 32.5 to 153.9 mg/l to 17.2 to 67.9 mg/l, respectively. The range of sodium concentrations during the pre- and post-monsoon seasons is 44 to 102 mg/l and 38 to 85 mg/l, respectively. Water is less suitable for residential usage when its sodium content rises since it poses major health risks like hypertension. The study area's samples are all below the allowed upper limit. Pre- and post-monsoon potassium values range from 1.2 to 2.1 mg/l and 1.0 to 1.9 mg/l, respectively. The potassium concentration in drinking water is less than 10 mg/l. It regulates the fluid equilibrium in the body. Potassium levels must not exceed 12 mg/l. The remaining pre- and post-monsoon season samples, however, are within the WHO (2006) and ISI (1991) water guidelines for drinking water's upper permissible limit.

The Pre-monsoon bicarbonate concentrations range from 143.7 to 579.6 mg/l, while post-monsoon bicarbonate concentrations range from 112.8 to 358.4 mg/l. The greater concentration of bicarbonate in the water shows that mineral dissolution is the primary process. It makes up the majority of the anions in groundwater and is created from the carbon dioxide released by the organic breakdown of soil [**16**]. Bicarbonate is a crucial component of the body that aids with digestion. Pre-post monsoon season, the chloride level varies from 37.4 to 128 mg/l and 30.6 to 57.8 mg/l, respectively. The research region's pre-post monsoon groundwater samples were all below the maximum allowable level. Pre-post monsoon season sulphate levels range from 35.6 to 129 mg/l and 16.7 to 138 mg/l, respectively. The research area's groundwater samples from both before and after the monsoon were all below the maximum allowable level. Its higher concentration could have laxative effects on the body. The greater sulphate concentration is due to gypsum minerals that are present in shale formation. Gypsum, a hydrous calcium sulphate (CasSO4.2H2O), dissolves in moving groundwater and can offer a long-lasting type of hardness [**13, 14**]. Nitrate concentrations in the pre-monsoon and post-monsoon seasons range from 9.3 to 44.5 mg/l and 11 to 25 mg/l, respectively. Nitrate concentrations in the research area are less than allowed. According to WHO (2006) and ISI (1991) drinking water standards, the maximum amount of nitrate in groundwater that can be utilized for household purposes is 45 mg/l. The geogenic source of nitrate has received little attention. Anthropogenic activities, such as the use of pesticides like insecticides and nitrate-rich fertilizers, are to blame for the increased nitrate content. Infrastructure for irrigation has been constructed as a result of pressure from farmers to produce more. Fertilizers are used in prodigious quantities by farmers without their adverse effects being considered. Although blue baby illness was not a problem in the area, its potential occurrence in the future cannot be completely ruled out due to the prolonged residence time of nitrate in groundwater. Fluoride concentrations in the pre-monsoon and post-monsoon seasons range from 0.12 to 0.65 mg/l and 0.1 to 0.54 mg/l, respectively. Its concentration is substantially higher in the Shaly Aquifer, demonstrating that geology has significantly influenced groundwater's fluoride content. Furthermore, the usage of fertilisers containing a lot of fluorite is not totally discarded. Its increased content can be neutralized by mixing groundwater and rainwater. For this, artificial recharging structures must be supported.

V. CONCLUSION

Analyses of groundwater samples from the research region reveal that they have a somewhat alkaline nature. Pre-monsoon pH levels are higher due to a decreased supply of atmospheric carbon dioxide. Few samples showed greater electrical conductivity values because the groundwater and impermeable shale formation had time to respond. The characteristics of the aquifer lead the water to be often hard to very hard. Consuming harsh natural materials for an extended period of time may raise the risk of cardiovascular diseases. All of the cations, with the exception of calcium, are within the allowed range. Stone issues, which repeat often in the research, might be caused by a steady increase in calcium consumption. Therefore, it is recommended to chemically treat hard water before consuming it. High fluoride areas are recommended to use the defluorination and ion exchange approach. You must add the required chemicals in order to utilize this kind of water for drinking. With the exception of calcium, all cations are typically within acceptable limits. It is not advised to consume water that has a lot of calcium. An information campaign might be very beneficial for areas with nitrate and fluorite concentrations. Organic fertilizers should be encouraged rather than chemical fertilizers by farmers.

REFERENCES

[1]. APHA (1998). Sandard methods for the examination of water and waste water (20th edn.) American Public Health Association, Washington, D.C. pp. 10-161.
[2]. Barman, P., Ghosh, J. and Deb, S. Study of water quality, socio-economic status and policy intervention in spring ecosystems of Tripura, Northeast India. Discover Water, v.2, 7 (2022). https://doi.org/10.1007/s43832-022-00015-9.
[3]. Chidiac, S., El Najjar, P., Ouaini, N., Rayess Y. El. and Azzi D. El. (2023) A comprehensive review of water quality indices (WQIs): history, models, attempts and perspectives. Rev Environ Sci Biotechnol. V.22, pp.349–395. https://doi.org/10.1007/s11157-023-09650-7
[4]. Duttaa, N., Thakur,B.K., Nurujjaman, M., Debnath, K. and Bal, D. P. (2022) An assessment of the water quality index (WQI) of drinking water in the Eastern Himalayas of South Sikkim, India, Groundwater for Sustainable Development, v.17. https://doi.org/10.1016/j.gsd.2022.100735.
[5]. ISI (1991). Indian standard specifications for drinking water 15: 10,500
[6]. Jain, C.K; Bandopadhyay, and Bhdrpp. A, (2009) Assessment of groundwater quality for drinking purpose, Nainital,Uttarakhan. Environment Monitoring Research, V. 166 pp. 636-676.
[7]. Karanth K.R. (1987) Groundwater Assessment Development and management Tata McGraw Hill Pubnl. Comp. New Delhi;725p.
[8]. Raghunath, H.M. (1987). Groundwater (2nd edn.) Wiley Eastern Let., New Delhi, India.
[9]. Schewab, G.O., Fangmeier, D.D., Elliol, W.J. and Fresvert, R.K (1992) Soil and Water Conservation Engineering (4th edn.). Mc-Graw Hill, New York.
[10]. Tiwari, R.N. (2001). Groundwater quality assessment of Mangawan block, Rewa district, M.P. Int. Jour. Earth Sci. Engg. V.4, pp. 1000-1009.
[11]. Tiwari, R.N. and Singh, A.K. (2010). Groundwater quality and pollution potential of Mohana river basin, Rewa district, M.P. India. Proc. Inter. Conf. Hydr. And watershed JN & T Hyderabad pp. 49-59.
[12]. Tiwari, R.N., Bharti, S.L. and Mishra, U. (2010) Hydrogeochemical studies of groundwater from odda river basin, Rewa District, M.P., Gondwana Geollogical Magazine Sp. V.12, pp. 83-93.
[13]. Tiwari, R.N., Mishra, U.K. and Dubey, P. (2011). Hydrochemistry and groundwater quality of Bichhia river basin, District Rewa M.P. India. Proc. Int. Conf. Groundwater Madurai, pp. 679-692.
[14]. Tiwari, R.N. and Mishra U. (2012). Groundwater quality assessment of Baikunthpur area, Inter. Jour. Eng. V.5 (4), pp.720-726.
[15]. Tiwari, R.N., Mishra, S., Mishra, A. And Mishra, A. (2014). Major and Farace elements of shallow aquifers of Rewa city, M.P. India, Gond. Geol. Magz. V.14.pp.195-202
[16]. Todd, D. K. (20002). Groundwater Hydrology. John wiley and sons, New York, 535 p.
[17]. Ubuoh, E.A., Nwogu, F.U., Ofoegbu, C.C. and Chikezie P. C. (2023) Environmental pollution loads on surface water chemistry and potentially ecological risks of inland aquatic ecosystem in South-Eastern State, Nigeria. Environ Syst Res 12, 22. https://doi.org/10.1186/s40068-023-00302-x.
[18]. Venugopal, T., Giridharan, L., Jayaprakash, M. and Periakali, P. (2009) Environmental Impact Assessment and seasonal variation study of groundwater in the vicinity of River Adyar, Chennai India. Environ. Monit. Assess., v. 149, pp. 81-94.
[19]. WHO (2018) Drinking water. World Health Organization fact sheets, https://www.who.int/en/news-room/fact-sheet s/detail/drinking water.
[20]. World Health Organization/United Nations Children's Fund (WHO/UNICEF). Progress on drinking water, sanitation and hygiene. Geneva/NewYork: Update and SDG baselines; 2017.

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	7.5 to 8.6	6.8 to 8.3
2	TDS mg/l	500	1000	500	2000	376 to 846	287 to 629
3	TH as $CaCo_3$ mg/l	100	500	300	600	286 to 846	162 to 692
4	Ca mg/l	75	200	75	200	50 to 183.2	36.4 to 209.1
5	Mg mg/l	30	150	30	100	32.5 to 93.7	17.2 to 67.9
6	K mg/l	10	12	-	-	1.2 to 2.1	1.0 to 1.9
7	Na mg/l	20	175	-	200	44 to 102	38 to 85
8	HCO_3 mg/l	-	-	300	600	143 to 579.6	112.8 to 358.4
9	SO_4 mg/l	200	400	150	400	35.6 to 129	16.7 to 138
10	Cl mg/l	200	600	250	1000	37.4 to 128	30.6 to 57.8
11	NO_3 mg/l	-	45	-	45	9.3 to 44.5	11 to 25

12	F mg/l	1	1.5	1	1.5	0.12 to 0.65	0.1 to 0.54

Table 2 Analytical Results of Groundwater Samples of the Study Area (Pre-monsoon- 2022) (Except pH and EC, all values are in ppm)

S.No	Village	latitude	Longitude	pH	EC	TDS	TH	Na	K	Ca	Mg	F	Cl	SO_4	HCO_3	No_3
1	Khaira	24.555020°	81.736112°	8.6	578	391	373	44	1.4	84.4	39.6	0.38	78	45	163.2	13
2	Suji	24.557721°	81.700657°	8.2	582	389	386	46	1.2	77.5	46.8	0.3	67.5	43	176.6	14
3	Kankeshra	24.571955°	81.725186°	7.8	676	423	439	56	1.3	86.5	54.4	0.16	69.6	41	189.8	16
4	Kaimhai	24.536163°	81.704003°	8.4	765	512	406	65	1.5	94.8	41.3	0.36	108	88	183.2	17
5	Moliya	24.579889°	81.688157°	8.2	860	558	457	78	1.6	98.4	51.5	0.44	128	102	151.8	18
6	Tamradesh	24.549729°	81.669393°	8.3	565	376	297	52	1.4	54.2	39.4	0.41	69	50	178.5	15
7	Amiliha	24.536848°	81.655470°	8.5	654	401	363	53	1.3	76.8	41.6	0.39	69	69	143.7	14
8	Dadh	24.557304°	81.631034°	8.5	934	576	406	74	1.6	97.4	39.6	0.5	128	102	227.8	16
9	Farendi	24.558249°	81.612260°	8.1	954	585	423	73	1.5	98.4	43.2	0.32	92.6	102	301.8	19
10	Umariha	24.530367°	81.614010°	8.4	639	434	357	61	1.4	73.7	42.2	0.41	72	72	186.3	16
11	Duari	24.517430°	81.625012°	8.6	612	416	343	59	1.4	83.8	32.5	0.39	82	52.2	173.5	14
12	Itarpahad (HP)	24.489751°	81.631618°	8.3	689	424	286	76	1.4	52.8	37.5	0.4	72	89.7	148.5	16
13	Jaldar (W)	24.518565°	81.592461°	7.9	623	418	346	51.2	1.6	81.8	34.4	0.42	73.9	58.3	198.6	13
14	Dadhwa	24.508588°	81.567669°	8.1	688	415	306	64	1.5	62.8	36.4	0.42	74	58.7	178.1	24
15	Purwa (W)	24.545390°	81.544990°	8.2	690	439	385	55	1.6	85.2	42	0.44	82	52	194.9	19
16	Geruari	24.530203°	81.541175°	8.4	845	556	424	77	2	94.3	45.8	0.42	102	112.3	205.8	16
17	Badwar	24.500588°	81.537267°	8.6	676	412	304	63	1.4	56.8	39.4	0.41	69	68	192.1	15
18	Gurh	24.497161°	81.504721°	8.5	850	569	436	82	1.4	98.8	46.2	0.65	102	99	202.1	35
19	Khajwa	24.532172°	81.506859°	8.5	898	559	496	82	1.9	102.2	58.7	0.45	96	102.4	187.2	19
20	Hardi	24.470778°	81.480690°	8.4	777	482	319	63	1.3	62.8	39.5	0.62	78	84	222.1	39
21	Bhusunwa	24.466248°	81.503046°	8.4	720	476	427	57	1.4	94	46.9	0.3	71	62	234.7	21
22	Amadandi	24.453231°	81.509996°	8.5	742	495	382	60	1.3	87.4	39.9	0.3	84.3	82.4	222.6	14
23	Bela	24.443443°	81.480780°	8.4	730	453	297	57	1.2	50	41.9	0.33	78.2	76.6	257.7	15
24	Amirti	24.461332°	81.445257°	8.3	817	512	440	63	1.3	91.5	51.5	0.49	69.7	71.2	251.1	35
25	Badagaon	24.493517°	81.451074°	7.8	954	595	588	76	1.9	131.6	63.2	0.22	91.4	41.4	336.8	18
26	Gerui	24.516063°	81.452988°	8.5	848	544	372	86	1.3	69.6	48.2	0.37	79	93	278.8	23
27	Mahsaw	24.519040°	81.436888°	8.3	930	607	501	84	1.6	118.8	49.7	0.41	84	96	288.8	25
28	Paipakhra	24.538087°	81.415084°	8.4	878	559	442	58	1.4	95.2	49.8	0.47	99	94.3	278.6	18
29	Bhundha	24.546220°	81.371630°	7.9	1028	663	585	58.4	2	143.5	55.2	0.39	97.5	49.5	462.7	21
30	Rakariya	24.479069°	81.418632°	7.9	764	492	555	74	1.9	134.6	53.2	0.21	63.4	35.6	231.8	9.3
31	Shivpurwa	24.450032°	81.428933°	8.3	955	619	531	68	1.3	128.5	51.2	0.19	102	129	238.8	16
32	Sahijana	24.443344°	81.442843°	7.6	740	481	371	48.5	1.9	89.9	35.6	0.12	37.4	53.5	380.5	19

33	Gaddi	24.411704°	81.462126°	8.5	739	468	307	61	1.4	57.4	39.9	0.31	102	76	207.7	22
34	Supiya	24.426861°	81.400295°	7.7	719	450	421	62	1.4	101.9	40.6	0.21	64.4	41	231.3	19
35	Teekar	24.420726°	81.377434°	7.5	824	519	469	64	1.8	117.9	42.6	0.22	65.4	48	315.4	18
36	Gahira	24.393193°	81.344277°	8.2	745	483	449	66	1.7	117.9	37.6	0.23	61.4	52	248.4	17.8
37	Dhowkhari	24.420442°	81.335214°	8.1	720	466	437	62	1.4	115.3	36.4	0.2	66.4	46	232.4	18.3
38	Chua	24.445961°	81.362731°	8.2	904	571	404	70	1.2	84.9	46.7	0.39	76	101	298.5	38
39	Neega	24.455056°	81.332965°	8.5	898	569	517	64	1.5	131.5	45.9	0.36	72	65	321.6	25
40	Bhatlo	24.469219°	81.323018°	8.3	1040	650	622	73	1.4	168.3	49.2	0.43	79	90	311.2	29
41	Khirma	24.448767°	81.322329°	8.4	865	549	482	77	1.6	98.5	57.5	0.39	88	93	213.5	23
42	Dihiya (HP)	24.447569°	81.304946°	8.1	890	576	630	52	1.6	153.6	59.9	0.43	84	37	317.2	25
43	Kanauja	24.469687°	81.370658°	7.6	819	528	470	92.4	2.1	123.2	39.4	0.12	65.3	62.4	224.6	24.2
44	Dhurehti (W)	24.477003°	81.367159°	8.3	839	536	539	65.2	1.6	139.2	46.5	0.14	78.2	59.9	233.8	22.5
45	Khajuha kala	24.489214°	81.388951°	8.2	928	589	515	82.3	2.1	132.8	44.6	0.13	110.8	68.3	243.6	23.9
46	Gorgi	24.495605°	81.412550°	7.8	880	562	600	72	1.7	152.8	53.2	0.21	71.4	44	266.8	29.9
47	Hiraul	24.498256°	81.373493°	8	850	552	556	64.6	1.7	134.8	53.5	0.15	86.5	55.5	215.8	44.5
48	Umari	24.513652°	81.383989°	7.6	1345	846	842	102	2	183.2	93.7	0.59	78	58	579.6	33.3
49	Lohi	24.524962°	81.351059°	8.3	1154	729	762	73	1.6	166.5	84.4	0.19	72.4	74	463.6	22
50	Silpari	24.497676°	81.314980°	8.2	1070	670	672	65	1.4	140.6	78.1	0.22	64.6	64	448.7	28.6

Table 3: Analytical Results of Groundwater Samples of the Study Area (Post-monsoon- 2022) (Except pH and EC, all values are in ppm)

S.No	Village	latitude	Longitude	P^H	EC	TDS	TH	Na	K	Ca	Mg	F	Cl	SO_4	HCO_3	No_3
1	Khaira	24.555020°	81.736112°	8.1	520	334	314	38	1.3	72.8	32.1	0.32	69	38	139.4	12.4
2	Suji	24.557721°	81.700657°	7.8	532	336	301	41	1.1	65.4	33.42	0.16	60.41	34	165.2	13
3	Kankeshra	24.571955°	81.725186°	6.9	580	359	341	49	1.2	71.4	39.52	0.15	59.47	36	169.8	13
4	Kaimhai	24.536163°	81.704003°	7.9	647	412	351	52	1.2	83.8	34.4	0.29	89	79	112.8	14
5	Moliya	24.579889°	81.688157°	8.3	715	458	358	69	1.3	66.8	46.7	0.42	102	88	127.9	14
6	Tamradesh	24.549729°	81.669393°	8.2	460	287	162	45	1.2	36.4	17.2	0.3	57	41	150.6	11
7	Amiliha	24.536848°	81.655470°	8	528	343	303	44	1.1	65.5	33.9	0.37	61.4	62	115.2	12.9
8	Dadh	24.557304°	81.631034°	8.3	795	506	367	59	1.3	86.8	36.7	0.32	102	98	198.9	16
9	Farendi	24.558249°	81.612260°	7.3	870	529	379	66	1.2	93.8	35.2	0.21	75.3	98	278.5	18
10	Umariha	24.530367°	81.614010°	8.1	559	357	279	53	1.2	58.3	32.5	0.35	59	62	150.4	12.6
11	Duari	24.517430°	81.625012°	8.2	540	352	323	48	1.1	78.4	30.9	0.3	69	38.4	142.2	13
12	Itarpahad	24.489751°	81.631618°	7.9	540	355	230	60	1.3	44.8	28.8	0.32	64	78.9	117.5	14
13	Jaldar	24.518565°	81.592461°	7.2	560	332	289	48.4	1.4	67.84	29.2	0.1	67.5	16.7	172.8	12
14	Dadhwa	24.508588°	81.567669°	7.4	570	348	268	54	1.2	54.5	32.2	0.3	66	48	145.3	17
15	Purwa (W)	24.545390°	81.544990°	7.9	650	400	329	56	1.3	71.2	36.8	0.3	51	65.34	197.2	17
16	Geruari	24.530203°	81.541175°	8.2	659	420	273	59	1.8	44.8	39.2	0.38	82	82.12	176.8	19

17	Badwar	24.500588°	81.537267°	8.1	530	345	272	53	1.2	52.8	34.2	0.32	58	59	143.6	12.5
18	Gurh (HP)	24.497161°	81.504721°	8.3	765	476	352	69	1.2	69.2	43.7	0.54	99	86	178.2	15.3
19	Khajwa	24.532172°	81.506859°	8.1	801	517	476	75	1.5	103.8	52.8	0.32	88	88.5	175.5	16
20	Hardi	24.470778°	81.480690°	7.8	688	429	357	58	1.2	76.5	40.4	0.48	62	72	206.5	14
21	Bhusunwa	24.466248°	81.503046°	7.9	590	383	277	52	1.3	59.4	31.4	0.28	63.7	54	199.3	19
22	Amadandi	24.453231°	81.509996°	8	665	390	260	53	1.2	49.4	33.4	0.29	70.3	75	180.5	15
23	Bela	24.443443°	81.480780°	8.1	570	374	220	49	1.3	43.1	27.4	0.32	65.1	69	201.1	15
24	Amirti	24.461332°	81.445257°	7.9	665	445	402	57	1.1	89.5	43.4	0.42	63	74	188.5	18
25	Badagaon	24.493517°	81.451074°	7.2	950	621	541	67	1.6	119.84	58.96	0.18	77.48	138	274.5	19
26	Gerui	24.516063°	81.452988°	8.1	798	515	331	77	1.1	62.2	42.8	0.34	121	94	198.5	14
27	Mahsaw	24.519040°	81.436888°	8.1	880	548	426	73	1.2	99.2	43.3	0.38	128	78	204.1	21
28	Paipakhra	24.538087°	81.415084°	8.2	785	492	405	55	1.3	92.8	42.3	0.41	86	88.5	213.3	15
29	Bhundha	24.546220°	81.371630°	7.4	940	629	692	41	1.8	209.1	41.2	0.34	81	52.6	353.2	22
30	Rakariya	24.479069°	81.418632°	7.5	850	526	492	64	1.6	119.8	46.9	0.18	66.5	71	270.5	18
31	Shivpurwa	24.450032°	81.428933°	7.8	803	512	432	59	1.1	99.3	44.9	0.16	89	102	199.3	14
32	Sahijana	24.443344°	81.442843°	7.1	599	383	299	41.9	1.7	73.5	28.2	0.11	30.6	49.2	276.3	17
33	Gaddi	24.411704°	81.462126°	8.1	586	376	253	51	1.3	46.4	33.4	0.29	85	64	161.1	14
34	Supiya	24.426861°	81.400295°	7.2	624	400	370	56	1.3	92.8	33.69	0.18	58.42	47	187.5	17
35	Teekar	24.420726°	81.377434°	6.8	655	420	380	58	1.3	99.84	31.69	0.19	57.42	41	235.5	13
36	Gahira	24.393193°	81.344277°	7.8	645	413	385	59	1.4	98.8	33.7	0.19	57.42	58	175.5	17
37	Dhowkhari	24.420442°	81.335214°	7.5	769	493	499	67	1.2	99.8	60.9	0.18	69.4	49	259.2	16
38	Chua	24.445961°	81.362731°	7.9	830	532	399	73	1	80.4	48.3	0.34	87	88	279.9	14
39	Neega	24.455056°	81.332965°	8.1	854	547	529	78	1.2	115.9	58.3	0.33	85	79	215.4	22
40	Bhatlo	24.469219°	81.323018°	7.8	861	552	517	64	1.2	141.6	39.8	0.38	68	82	272.4	19
41	Khirma	24.448767°	81.322329°	8.1	774	496	371	63	1.4	76.8	43.6	0.33	75	83	267.5	19
42	Dihiya (HP)	24.447569°	81.304946°	7.2	738	473	483	58	1.5	131.2	37.9	0.38	71	28	260.4	15
43	Kanauja	24.469687°	81.370658°	7.1	713	457	380	78.2	1.9	102.8	29.9	0.1	37.5	48.2	278.5	19
44	Dhurehti	24.477003°	81.367159°	7.6	758	486	478	58.3	1.3	123.8	41.2	0.12	67.4	51.8	252.3	16
45	Khajuha kala	24.489214°	81.388951°	7.5	834	534	398	75.8	1.8	109.8	30.2	0.1	97.5	56.2	287.9	19
46	Gorgi	24.495605°	81.412550°	7.2	855	548	569	85	1.4	116.4	67.9	0.17	85.8	58	224.5	21
47	Hiraul	24.498256°	81.373493°	7.2	763	489	459	59.3	1.4	119.8	38.9	0.1	77.4	48.8	245.4	21
48	Umari	24.513652°	81.383989°	6.9	935	599	601	82	1.6	143.9	58.94	0.1	52.48	56	358.4	25
49	Lohi	24.524962°	81.351059°	7.7	930	576	601	59	1.3	143.8	58.9	0.11	57. 8	58	355.2	20
50	Silpari	24.497676°	81.314980°	7.8	820	511	512	49	1.1	122.8	49.9	0.18	48.9	56	315.3	23

Copyright Form

International Journal of Research in Engineering and Science (IJRES)

1. I hereby transfer the Copyright of the paper title: **ASSESSMENT OF GROUNDWATER QUALITY FOR DRINKING USE IN BICHIYA RIVER SUB BASIN AREA, REWA REGION, MADHYA PRADESH, INDIA**

By (Authors): Pushpendra Kumar Tiwari[1]*, RabindraNath Tiwari[1], Vikash Kumar Kushwaha[1] and Brahmanand Sharma[2]

[1]Department of Geology, Govt. Model Science College Rewa-486001, Madhya Pradesh, India,

[2]Government Adarsh College, Umaria, Madhya Pradesh

email:geopushpendra@gmail.com*;rntiwari33@gmail.com;geolrs.vikash@gmail.com

Full Postal address of Principal Author (With Phone no. and mail id):

RabindraNath Tiwari , Department of Geology, Govt. Model Science College Rewa-486001, Madhya Pradesh, email: rntiwari33@gmail.com, phone no. 9425361881.

2. I understand that the Editor-in-Chief IJRES may transfer the Copyright to a publisher at his discretion.

3. The author(s) reserve(s) all proprietary rights such as patent rights and the right to use all or part of the article in future works of their own such as lectures, press releases, and reviews of textbooks. In the case of republication of the whole, part, or parts thereof, in periodicals or reprint publications by a third party, written permission must be obtained from the Editor-in-Chief IJRES.

4. I hereby declare that the material being presented by me in this paper is our original work, and does not contain or include material taken from other copyrighted sources. Wherever such material has been included, it has been clearly indented or/and identified by quotation marks and due and proper acknowledgements given by citing the source at appropriate places.

5. The paper, the final version of which I enclose, is not substantially the same as any that I/we have already published elsewhere.

6. I/we have not sent the paper or any paper substantially the same as the enclosed one, for publication anywhere else.

7. Furthermore, the author may only post his/her version provided acknowledgement is given to the original source of publication and a link is inserted to the published article on IJRES website

8. The submitted/enclosed camera-ready paper is thoroughly proof read by me and in conformity with the instructions for authors communicated to me.

Author's signature(s) :

Name(s) in Block Letters : PUSHPENDRA KUMAR TIWARI RABINDRANATH TIWARI, VIKASH KUSHWAHA AND BRAHMANAND SHARMA

Date and Place : 20.09.2023; Rewa, Madhya Pradesh