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Groundwater Quality Assessment in Rewari District, Haryana, India

Varsha Rani[a], Vineet Verma[b], Neeru Sharma[a], Minakshi[a], Mantesh Kumari Yadav[a,*]

[a]Department of Chemistry, School of Physical Sciences, Starex University, Gurugram,Haryana, 122413, India.
[b]School of Engineering and Technology, Vivekananda Institute of Professional Studies-Technical Campus, AU-Block (Outer Ring Road), Pitampura, Delhi-110034, India.
*Corrresponding author: manteshyadav20@gmail.com

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***Abstract*:The present study investigated the quality of groundwater in the Rewari district of Haryana state, India. We collected and analyzed the groundwater samples using standard methods for various physiochemical parameters such as pH, EC, hardness, TDS, calcium magnesium, chloride, sulfate, and DO. We further compared the observed parameter values with the standard values provided by regulatory agencies. Some of the samples fell within the acceptable limits of the standard values, while some water samples exceeded the permissible limits. This suggests that certain samples exhibit low potability due to a variety of contaminations and pollutants. Therefore, it is necessary to reexamine the potable water conservation and management system of groundwater resources in Rewari, Haryana, using advanced scientific techniques, with the aim of preserving the health of local population.**

***Author Keywords*: Physiochemical parameters, Ground water, pH, TDS, DO, EC**

I. INTRODUCTION

Water is an essential substance for human life, and its quality is a very serious concern. Pollution in the drinking water can lead to serious diseases in society and waterborne illness due to which water quality index is a major concern for developing countries like India. There should be a proper supply of potable and safe drinking water for every human on earth. It is now considered as fundamental right in almost all developed and developing countries, including India. Declines in the quantity and quality of fresh water are a serious concern, especially in developing countries. It is now a worldwide concern due to industrialization, climate change, agricultural runoff, and rapid urbanization [1,2]. Rising water pollution for various human-caused reasons hinders the availability of fresh water [3]. Numerous elements, including air pollution, melting glaciers, rainfall patterns, etc., have an effect on the WQ and contaminate the water supply. However, there has been a noticeable change in temperature and rainfall patterns in recent decades, and this change is anticipated to become more pronounced in the upcoming decades [4,5]. The acceleration of glacier melting has also affected the water ecosystem's balance. The amount of freshwater available to ecosystems and human populations can be significantly impacted by the melting of glaciers, which are an essential source of freshwater for many regions of the world [6]. Global freshwater security is concerned about glacier melting as a result of climate change-induced increases in global temperatures. In addition to these natural water supplies, most people rely on groundwater. Municipalities are essential for the distribution and management of water resources in cities and towns, such as rivers, lakes, reservoirs, and large wells [7-9]. Untreated industrial waste is the prime reason for the global increase in water pollution. The sustainability of ecosystems and human societies is influenced by the quality of freshwater resources. The global process of fast industrialization has made the conservation of water resources and management of the water quality index more complex. Therefore, there is an urgent need to focus on the management and conservation of water resources, particularly the water quality index. Singh *et al.* and Pallanswami*et al.* provide valuable insights for water conservation and management [10,11]. Manzoor *et al.* reported that domestic, industrial, and hospital waste products are the main sources of water contamination for both surface and sub-surface water [12]. In order to guarantee the good quality of portable water, it is very important to supervise and monitor the quality of underground water in a continuous and periodic manner. However, the increased population and the subsequent demand for potable drinking water have led to the overexploitation of underground water in major parts of the world. WQIs (Water Quality Index) are very helpful in making the explained WQ conditions easier to understand. It is recommended for presenting water contamination in surface water basins and groundwater reservoirs in a clear and thorough manner, and it is frequently used to illustrate the quality of surface water bodies [13]. Newly created WQI models are intended to assess the quality of drinking or bathing waters as *E. coli* should be included in the WQIs either in additional to or instead of fecal coliforms [14]. While some WQI applications use an existing WQI exactly as is, others alter it to better fit a specific area or purpose. Often, these modifications entail using alternative WQ metrics or aggregating techniques. It is widely used to depict the characteristics of surface water bodies and is praised for its models that concisely and clearly describe water pollution in surface-level basins and groundwater reservoirs. Singh *et al.* discussed water quality monitoring techniques at the 4th International Conference on Advances in Computing, Communication Control, and Networking [13]. They underlined how important it is to employ state-of-the-art analytical methods for accurate and reliable water quality assessment. Tiyasha *et al.* investigated the variables affecting the choice of water sources using unsupervised machine learning market basket analysis [15]. By providing insight into consumer preferences and behavior regarding water sources, their research enhanced our understanding of water usage patterns. Khullar and Singh proposed a hybrid machine learning approach for river water quality classification [16]. By combining multiple algorithms, they developed a robust classification model that can accurately classify water quality based on a variety of parameters. Nair and Vijaya surveyed river water quality prediction models using machine learning and big data approaches [17]. Their analysis showed how machine learning algorithms can be used to identify pollution sources in rivers and predict water quality metrics. Kogekar *et al.* forecasted the water quality of the Ganga using univariate time-series models [18]. Their study demonstrated the effectiveness of time-series analysis in predicting water quality trends, thereby facilitating proactive management and decision-making. In 2021, German *et al.* looked into the use of big earth data and advanced processing techniques for water quality monitoring [19]. They emphasized the importance of integrating advanced analytics with satellite data to improve the temporal and spatial resolution of water quality monitoring. In 2023, Thylashri*et al.* introduced a convolutional neural network-based technique for monitoring water quality using satellite images [20]. Their research showed how water quality parameters can be assessed and remote sensing data analyzed using deep learning techniques. Khelil *et al.* developed a soft sensing modeling framework based on support vector regression and self-organizing maps for water quality monitoring [21]. Their research aimed to develop accurate prediction models that could estimate water quality parameters using sensor data. Other studies have also examined various aspects of water quality monitoring, including machine learning model comparison [22], bathymetry data analysis [23], data-driven analysis and anomaly detection [24], and Internet -based monitoring systems [25]. Ensuring the sustainability and safety of water resources requires regular water quality monitoring. In order to address several issues pertaining to the assessment of water quality, considerable efforts have been made over time to develop and enhance water analysis techniques.

Area of study

The area of study in the present research work was the Rewari district of Haryana State, India (27.95o to 28.28o N and 76.29o to 76.85o E, Figure 1).

Figure 1. Map Showing Sample Collection Sites in Rewari District

The national capital region connects with the Rewari district in Haryana, nestled among various industrial zones. We determined the sample collection locations through a detailed survey and suggestions from local experts from both the department of public health and the Municipal Corporation. We collected the samples from six open wells (OW) and eight borewells (BW) during rainy and summer seasons, from June 2023 to September 2024 (Table 1).

TABLE 1
Location of Open Wells (OW) and Borewells (BW) for Sample Collection

Zone	Sample No.	Type of Well	Location
	S1	OW	KHORI
	S2	BW	BHARAWAS
	S3	BW	KHOL
Zone-1	S4	OW	NAHAR
	S5	OW	DHALIWAS
	S6	BW	RAMPURA
	S7	OW	BAWAL
	S8	OW	GARHO BOLNI
	S9	BW	UTTAM NAGAR
	S10	OW	MEERPUR
Zone 2	S11	OW	SECTOR 4
	S12	BW	DHARUHERA
	S13	OW	DOHEKI
	S14	BW	PALHAWAS
	S15	BW	NANDRAMPUR BAS

II. Materials and Methods

All these samples were collected in one liter PVC bottles, and tagged with sample Id. Samples were then transported immediately for the further investigations. Standard methods were used for the chemical analysis of each parameter to determine the water quality. In present study, all the physiochemical parameter were examined by prescribed BIS 10500/2012 and APHA 1992 standards as mentioned in Table 2 [26].

TABLE 2
Analytical Methods adopted for Determining various Physiochemical Parameters

S. No.	Parameter	Analytical Method
1.	Water Sampling	Grab Sampling: CPCB India
2.	pH	Digital pH Meter (Systronics)-371
3.	Electrical Conductivity (E.C.)	Digital Conductivity Meter-Systronics 304
4.	Total Alkalinity	Titrimetric method using HCl or H2SO4
5.	Total Hardness	EDTA Complexometric Method
6.	Calcium	EDTA Complexometric Method
7.	Magnesium	EDTA Complexometric Method
8.	Total Dissolved Solids	Gravimetric Method
9.	Dissolved Oxygen (DO)	Titrametric Method
10.	Sodium	Flame Photometric Method
11.	Potassium	Systronics-S-128 Flame Photometric Systronics-S-128
12.	Chloride Content	Mohr's Method using standard AgNO3 solution
13.	Heavy Metals	AAS-ECI-AAS4 139A

III. Results and Discussion

A range of physico-chemical analysis was conducted to assess the quality and potability of the collected samples. Standard methods were employed to ascertain physico-chemical parameters, such as temperature, electrical conductivity, total dissolved solids, dissolved oxygen, total hardness, total alkalinity, calcium, magnesium, sodium, potassium, and chloride [26-28]. The values obtained for the various physico-chemical parameters after the analytical determination were collected in Table 3-4. The values were contrasted with the standard values provided by the International Standards Organization (10500-1994) and the World Health Organization in 2003 (WHO, 1971), Table 5

In addition to the sediment effect, low water levels in aquifers may be the cause of the higher TDS value. During the summer, the highest total dissolved solids (TDS) value ever measured was 1040 mg/L. Dissolved oxygen also fluctuated in ground water samples. The maximum dissolved oxygen was observed during rainy season (7.2mg/L, Table 4), which might be due to percolation of rain water which is rich in DO content. The minimum dissolved oxygen was observed during summer season (3.8 mg/L, Table 3). Rising temperature cause slow solubility of oxygen resulting in the decrease of DO content during summer season [29]. EC is an excellent indicator of TDS, which is a measure of salinity that affects the taste of potable water (WHO 1984). In the present study EC was maximum in rainy season (4441 µmhos/cm, Table 4). The variation in EC is also based on sedimentary structure and composition of rocks [29]. Seasonal variation of TDS in ground waters, observed in the study area, shows that it increased during summer season ranging from 447 to 1040 mg/L (Table 3) and is comparatively lower in rainy season ranging from 149 to 924mg/L (Table 4). Water containing high TDS concentration may cause laxative or constipation effects [30]. The total hardness of the ground water samples varied from 325 to 563 mg/L in summer season and 144 to 542 mg/L in rainy season. Maximum value was recorded during summer season in site 10 (563 mg/L) and minimum value during rainy season (144 mg/L) in site 14 (Table 3 and 4). The reason for higher hardness value in summer season is mainly attributed to rising temperature thereby increasing the solubility of calcium and magnesium salts [31]. Ground water pollution, which usually happens when wastewater from homes and hospitals with smaller dyeing units is dumped into pits and ponds and allows the waste to seep down to the water table, may be the cause of the high TDS values. The development of kidney stones and other kidney-related disorders can result from drinking water with a high concentration of dissolved solids and a high hardness level. Reduced aquifer water levels and sedimentary effects could be the cause of the high TDS levels. The discharge of wastewater from homes, hospitals, and small dyeing units into pits and ponds, which allows the waste to seep into the water table, is the usual cause of groundwater contamination, which could be the cause of the elevated TDS levels. Kidney stone formation and other related conditions can result from drinking water with high levels of dissolved solids and hardness. It might taste metallic, salty, or bitter, and it might smell bad. The ability of water with high TDS levels to slake thirst is diminished. Food and drink flavors are negatively impacted by elevated TDS, making them less palatable for consumption. There are several health risks associated with specific mineral salts that make up TDS. The substances that cause the most problems are fluoride, nitrates, sodium, sulfates, barium, cadmium, and copper. Most are eliminated through excretory channels, but some stay in the body and cause stiff joints, hardened arteries, kidney and gallstones, and blockages in arteries, tiny capillaries, and other passageways that carry body fluids.

TABLE 3
GroundWaterSamplesin SummerSeasonfromFeb2024to May2024

SampleNo.	Type	Temp. °C	pH	TDS mg/L	EC µ mho/cm	TH mg/L	Cl mg/L	Ca mg/L	Mg mg/L	DO mg/L	Alkalinity mg/L	Na mg/L	K mg/L
S1	OW	41.2	8.5	451	1010	478	122.12	55.3	47.48	5.7	463	92	4.4
S2	BW	40.7	8.4	945	1424	445	246.30	67.85	42.23	5.3	487	83	4.9
S3	BW	40.4	8.5	892	1420	412	178.9	85.22	65.14	4.6	496	87	5.4
S4	OW	41.5	8.2	729	1200	472	187.52	52.3	47.7	4.4	483	85	4.7
S5	BW	40.4	8.4	448	2240	325	315.23	47.3	43.2	5.6	457	89	8.1
S6	OW	41.1	8.1	847	1490	335	272.65	65.14	452.8	4.7	464	82	5.4
S7	BW	40.1	7.4	854	1444	444	261.54	78.9	42.5	4.6	487	88	7.2
S8	BW	40.5	8	774	1244	456	125.64	94.3	52.2	5.3	268	87	4.4
S9	BW	40.2	7.8	912	1722	489	266.81	175.28	72.3	4.7	453	77	4.5
S10	OW	40.5	8.1	842	2700	563	658.57	97.6	87.4	4.4	428	85	4.2
S11	OW	40.1	8.4	1029	1740	472	244	54.7	44.63	3.8	557	65	7.9
S12	BW	29.8	7.9	1040	2910	492	484.3	82.74	43.94	5.2	438	85	5.7
S13	OW	40.4	8.4	742	1270	436	175.12	83.41	43.52	5.6	447	83	7.4
S14	OW	40.8	7.9	447	1244	464	268.9	89.4	47.8	5.3	463	92	4.5
S15	OW	41.4	8.2	718	1449	457	282.44	92.85	63.33	5.7	585	85	5.1

TABLE 4
GroundWaterSamplesin First RainySeasonfromJune2023toSept 2023

SampleNo.	Type	Temp. °C	pH	TDS mg/L	EC µmho/cm	TH mg/L	Clmg/L	Camg/L	Mg mg/L	DO mg/L	Alkalinitymg/L	Na mg/L	K mg/L
S1	OW	27.4	7.5	541	1150	178	99.4	40.08	28.48	4.4	200	74	2.4
S2	BW	27.4	7.5	804	1244	248	184.4	44.09	44.24	**7.2**	254	48	1.4
S3	BW	27.8	7.4	824	1280	242	144.9	58.12	45	5.4	408	82	4.1
S4	OW	28.2	7.4	570	1028	194	145.55	44.08	24.74	5.9	452	79	2.1
S5	BW	27.5	7.7	149	2100	154	241.4	10.02	24.25	4.1	572	91	4.4
S6	OW	27.2	7.8	784	1100	148	154.2	54.11	44.04	5.8	474	48	2.5
S7	BW	27.4	7.1	714	1518	204	174.95	48.14	28.19	4.4	152	94	4.2
S8	BW	27.5	7.5	447	1189	212	88.75	92.18	44.44	4.5	192	84	4.5
S9	BW	27.8	7.4	855	1808	442	181.05	142.24	44.17	5.5	180	44	2.4
S10	OW	27.1	7.5	502	**4441**	542	702.9	110.22	99.47	4.7	420	57	1.7
S11	OW	27.4	7.7	924	1425	204	144.85	50.1	45	5.4	454	42	4.1
S12	BW	27.5	7.4	749	2840	294	445.45	42.12	52.02	4.2	448	71	2.9
S13	OW	28.4	7.4	447	1258	144	110.05	44.14	49.59	4.1	248	54	4.4
S14	OW	28.1	7.2	588	1148	244	240.75	54.11	41.45	4.7	409	72	4.2
S15	OW	27.9	4.9	414	1209	222	170.4	82.14	44.04	5.8	452	44	1.8

TABLE5
StandardsforDrinkingWater

S. No.	Characteristics	WHO(2004)	ISO (10500-1994)
1.	pH	4.5-9.5	4.5-8.5
2.	TDS	500.00	500
3.	ElectricalConductivity	1400.00	-
4.	TotalHardness	500.00	400
5.	Chloride	250.00	250
6.	Calcium	200.00	75
7.	Magnesium	40-150	40
8.	Dissolved Oxygen	5	-
9.	Alkalinity	200	200
10.	Sodium	250	-
11.	Potassium	45	-

IV. CONCLUSION

To evaluate the quality and suitability of the groundwater for human consumption, samples were taken from bore and open wells in and around Rewari City. Their pH, total hardness, Na^+, K^+, Ca^{2+}, and Cl^- concentrations are all within the acceptable ranges set by the WHO and ISI. Household, industrial, and sewage effluents have reduced the potability of water samples. As a result, we suggest building a suitable monitoring system, conserving groundwater by putting a thorough groundwater reservoir management plan into action, and starting a public awareness campaign to inform people about the dangers of drinking such groundwater.

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