e-ISSN No.: 2582-4228

Journal of Indian Association for Environmental Management

Journal homepage: www.http://op.niscair.res.in/index/php/JIAEM/index

HydrochemicalAnalysis of the Physico-chemical Parameters of the Water Quality for Domestic and Irrigation Purposes in the Kishangarh Block in Alwar District of Rajasthan

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Submitted:21 February 2024 Revised: 17 March 2024 Accepted: 04 April 2024

***Abstract*:An evaluation of groundwater quality is crucial as it directly impacts its suitability for drinking purposes. The investigation involved analyzing the physical, chemical, and biological aspects of groundwater to determine its appropriateness for consumption. Various factors such as pH levels, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total Hardness (TH), as well as the presence of specific cations like Na+, K+, Ca+2, Mg+2, anions such as Cl-, F-, NO-3 and heavy metals like Zn, Fe, and As were examined across samples collected during different seasons - Pre-monsoon, Monsoon, and Post-monsoon. The recorded values for each parameter were compared against the drinking water standards established by the World Health Organization (WHO) and the Bureau of Indian Standards (BIS) as per IS 10500: 2012. This comprehensive study aims to accurately assess potential health risks and determine the need for effective management strategies and essential water treatment to ensure the safety of water sources.**

***Keywords*:Bureau of Indian Standards, Total Dissolved Solids, Cations, Anions, Heavy Metals**

I. INTRODUCTION

India is at present dealing with a critical crisis of water pollution. The Central Pollution Control Board has identified a multitude of factors, including industrialization, urbanization, and agricultural activities, that lead to the deterioration of quality of water in India[1]. Water quality in dense regions, is regrettably deteriorating and unfit for human consumption as a result of industrial expansion, wastewater and chemical effluents discharge into canals and other water sources, and rapid population growth.[2,3]

Water quality of Rajasthan area is deteriorating condition of the ground water and drinking water sources over the time periods. Quality metrics of water are used to evaluate the appropriateness of water for several uses, including industrial, drinking, and irrigation. Water quality parameters may be chemical, biological, or physical in nature. Several parameters that are frequently assessed include biological oxygen demand, temperature, pH, dissolved oxygen, turbidity, and total dissolved particulates.[8,10,11]

As a result, most of the residents in the research area have been challenged by a variety of health problems. Water contamination was primarily caused by inadequate solid waste disposal, the use of municipal water, and excessive fertilizer application. The impact of contaminated irrigation water on groundwater quality of the community and its potential is to induce health complications. In order to future investigations, utilize a sophisticated parameter interaction, and scientific and technological advancement. Therefore, the primary aim of this research is to evaluate the quality of groundwater and its impact on densely populated areas in the city of Kishangarh Block of Alwar District (Rajasthan) is used for both agricultural and drinking purposes.

Groundwater serves as a primary water source crucial for sustaining the domestic, industrial, and agricultural sectors within this block. Over recent decades, escalating demands for water, attributed to the amplified requirements of water and energy across these sectors alongside population growth, have led to both water scarcity and a decline in water quality.

The sourcing of drinking water varies, relying on the availability of surface water such as rivers, lakes, reservoirs, ponds, and groundwater from aquifers.[1,4] In countries like India, groundwater plays a pivotal role as the primary source for drinking, irrigation, and industrial purposes, catering to the needs of both rural and urban populations.

Approximately two-thirds of the world's freshwater resources are constituted by groundwater. If polar ice caps and glaciers are excluded, groundwater essentially accounts for all usable freshwater. However, due to extensive use of harmful chemicals in agriculture, pollution from industrial effluents, and other sources like sewage and agricultural runoff, groundwater is increasingly becoming contaminated by various pollutants. The influx of different pollutants and nutrients alters the physicochemical properties of water, impacting crop production, food safety, and the overall ecosystem.[5,7] For instance, pollutants disrupt the food chain, while heavy metals, particularly iron, adversely affect fish respiratory systems. Iron accumulation in fish gills can be fatal for the fish, and consumption of these contaminated fish can lead to major health issues in humans, such as hair loss, liver cirrhosis, renal failure, and neural disorders.[17,18]

Water, whether in the form of surface or groundwater, is an indispensable resource crucial for life on Earth. It stands as nature's most valuable, abundant, and vital compound, forming the foundation of all life forms. Its significance spans across multiple purposes, necessitating thorough physicochemical analysis to assess water quality for optimal usage in activities like drinking, irrigation, fishing, and industrial operations. Unplanned industrial and urban development contributes additional anthropogenic sources to groundwater, underscoring the urgency to evaluate groundwater quality for drinking and irrigation purposes, vital for current and future management and sustainability of this resource.[19,20,21]

Various researchers have conducted extensive studies focusing on groundwater quality and its suitability for diverse purposes. These studies have introduced methodologies such as Modified Water Quality Index (MWQI), Integrated Water Quality Index (IWQI), and Entropy-weighted Water Quality Index (EWQI) for comprehensive water quality assessment.16 Research has also been carried out to identify suitable groundwater areas for pumping to meet drinking and agricultural needs in specific regions.

II. Material & Methods

Study area

Kishangarh Bas is a Block situated within the Alwar district in Rajasthan, specifically within the urban region of the state. It stands as one among the 14 blocks that constitute the Alwar district. According to administrative records, Kishangarh Bas is identified by the block code 41.

Geographically, the Kishangarh Bas Block spans an area of 526.46 square kilometers and is positioned in the northern-central part of the Alwar district. Its coordinates lie between North latitudes 27°35’ to 27°56’ and East longitudes 76°37’ to 76°55’. The collection of groundwater samples was conducted at 15 distinct locations across various seasons, including pre-monsoon, monsoon, and post-monsoon periods.

Water sampling and analysis

Water samples of various water sources were analyzed for determination of degree of contamination various physico-chemical parameters for investigations. The water quality parameters (Table-2) analysed included: 1. General parameters (pH, EC, TDS & TH) 2. Cations ($Ca^{+2,}$ Mg^{+2}, Na^{+}& K^{+}) 3. Anions (Cl^{-}, F^{-}&NO^{-3}) 4. Pesticides 5. Heavy Metals 6. BOD & COD Ground water samples were taken in well cleaned polythene containers (bottles), which were previously soaked in 10% nitric acid and thoroughly rinsed with deionized distilled water. Glass containers were not preferred because trace metals are absorbed on to the walls of the containers. The Physico-chemical parameters play a significant role in classifying and assessing water quality. The observation of physical parameters like pH, EC and TDS were done at the site itself using a portable water quality analyzer. For remaining of the analysis, water samples were preserved and bought to the laboratory. Calcium (Ca^{+2}), Magnesium (Mg^{+2}), Chloride (Cl^{-}), were analysed by volumetric titration methods; Nitrate (NO^{-3}) using by spectrophotometry; while Fluoride (F^{-}) by ion selective electrode method and; Sodium (Na^{+}) and Potassium (K^{+}) by flame photometry. Biochemical Oxygen Demand and Chemical Oxygen Demand are determined by volumetric titration methods. All the parameters were analysed as per APHA standard methods.

III. Results & Discussion

Fifteen water samples were systematically collected from various villages, namely Ghasoli, KhanpurMewan, KhohraPeepli, Kolgaon, and Moosakheda within the Kishanghar block of Alwar, Rajasthan. These samples were specifically gathered for domestic purposes. The collection spanned across different seasons, including Pre-Monsoon, Monsoon, and Post Monsoon periods, as detailed in Table1. Subsequent to collection, the water samples underwent comprehensive analysis to assess their chemical characteristics, as highlighted in Table2.

TABLE 1
Sampling Sites and Sampling Code

Sampling sites	Sampling period	Sampling Code
Kolgoan (Govt. hospital)	Pre Manson	S1
KhanpurMewan(PNB Bank)	Pre Manson	S2
Ghasoli(Govt School)	Pre Manson	S3
Moosakhera(Govt Hospital)	Pre Manson	S4
KhoraPeepli (Govt school)	Pre Manson	S5
Moosakhera(Masjid)	Manson	S6
Kolgaon(Govt School)	Manson	S7
Khanpurmewan(Near Govt School)	Manson	S8
KhoraPeepli(rain water)	Manson	S9
Ghasoli(Tank no 7)	Manson	S10
Kolgoan (Masjid)	Post Manson	S11
Ghasoli(Near Busstand)	Post Manson	S12
MoosaKhera (near Grudwara)	Post Manson	S13
Khanpurmewan	Post Manson	S14
KhoraPeepli(Govt water Tank)	Post Manson	S15

TABLE 2

Physico chemical Parameters of Ground Water of Sampling Sites of Kishanghar Block and its nearby Villages

Sample Code Parameters	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	AVG
BOD	2.9	4.2	1.3	1.5	1.1	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	2.2
COD	6	4.2	5	5	3	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	4.64
pH	6.8	6.8	6.3	8.2	7.36	7.5	7.4	7.37	8.5	6.9	7.32	4.6	7.6	7.8	7.4	7.19
EC	1456	1202	1584	1364	1318	3841	1365	1088	3584	1056	1331.2	1116	1258	1258.2	3754.2	1771.707
TDS	966	566	456	955	856	787	988	707	957	568	988	745.6	1452	756.2	2435.2	945.5333
Ca2+	23	30	59	35	36.8	360	43.6	49.5	65	38	32.5	36.2	56.2	43.2	365.2	84.88
Mg	27	21	14	12	11.66	129	28.8	37.3	74	23.5	32.6	35.2	38.6	36.2	129.2	43.33733
Na+	32.1	56	59	59	29.8	214.8	64.8	42.4	24.6	47	59.4	34.5	144	45.3	42.2	63.66
K+	7.6	6.5	25.2	5.2	7.1	68	12.6	10.9	64	22	16	6.8	86.2	12.3	10.9	24.08667
Cl-	56.52	85	214	174.2	141.84	1195.5	77.2	104.1	87.5	95.2	85.2	48.6	87.2	116.2	327.5	193.0507
Fe	0.12	0.05	0.09	0.02	0.11	0.38	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.128333
No3	2.3	4.6	9.3	13.5	2.4	48.2	12.9	10.4	36.4	6.5	12.5	7.3	3.2	9.3	8.8	12.47857
CaCo3	156	121	258	158	140	1456.2	227.7	277.2	245	35.5	225.6	247.2	264.2	263.2	1254.2	355.2667
As	BDL	BDL	BDL	BDL	BDL	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	#DIV/0!
Zn	BDL	BDL	BDL	BDL	BDL	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	#DIV/0!
F	0.22	0.66	0.6	0.9	0.13	1.49	0.83	0.62	0.56	0.56	0.59	0.47	0.35	0.053	0.062	0.539667
So4	8.4	56	87	19.5	8.1	32.5	36.4	36.4	58.2	32.4	40.4	27.6	25.4	28.6	184.2	45.40667
Pesticide	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D	N.D

The primary focus of the water analysis encompassed two key objectives:

1. **Suitability for Drinking:** Evaluating the quality of the water samples to determine their appropriateness for consumption by humans.
2. **Suitability for Irrigation:** Assessing the quality of the water samples with regard to their suitability for use in irrigation practices.

Elucidations of Various Water Quality Parameters:

From the physico–chemical data of the Table2, Table3 and Table 4 of various sampling sitesS1,S2,S3,S4,S5,S6,S7,S8,S9,S10,S11,S12,S13,S14&S15) it can be inferred that:

1. **pH:** The determination of pH was conducted using an electronic pH-meter. The average pH value derived from the analysis is 7.19. Specifically, the pH of the sample under consideration is slightly alkaline, measuring at 7.4. Importantly, this pH level falls within the permissible limits set by both the World Health Organization (WHO) and the Bureau of Indian Standards (BIS). All recorded pH values, including the sample's pH of 7.4, conform to the recommended range of 6.5 to 8.5 as provided by BIS guidelines (referenced in Table -5) for the designated best use of water.

TABLE 3

Irrigation water quality Analysis of Kishanghar Block and its nearby Villages

Sampling Code	Na %	SAR
S1	44.25863991	5.31323
S2	55.0660793	8.799551
S3	53.56234097	7.262398
S4	57.73381295	9.214252
S5	43.22867854	4.564136
S6	36.641617	10.42546
S7	51.66889186	8.508657
S8	38.0442541	5.136094
S9	38.92794376	2.435763
S10	52.87356322	6.663483
S11	53.66548043	8.503085
S12	36.64596273	4.703574
S13	70.83076923	16.57254
S14	42.04379562	5.785861
S15	9.698630137	2.035538

Avg.	45.65936398	7.061575

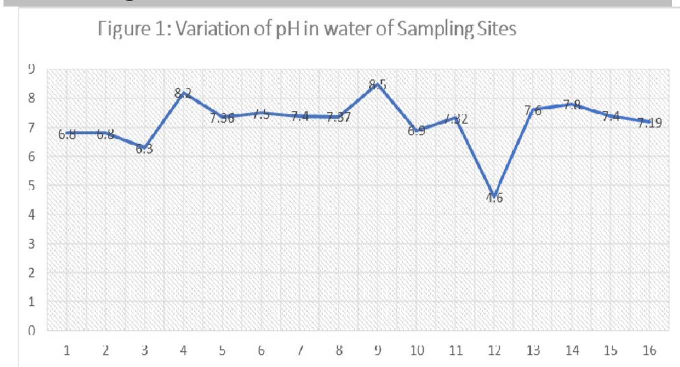

Figure 1: Variation of pH in water of Sampling Sites

TABLE 4
Irrigation Water Quality Parameters

Parameters	Range	Water class	Water samples
	<20	Excellent	S15
	20-40	Good	S6, S8, S9 & S12
Na%	40-60	Permissible	S1, S2, S3, S4, S5, S7, S10, S11 & S14
	60-80	Doubtful	S13
	>80	Unsuitable	NIL
SAR	<10	Low Sodium Water (S1) Excellent	All Sample Expect S6 & S13
	10-18	Medium Sodium Water (S2) Good	S6 & s13
	18-26	High Sodium Water (S3) Doubtful	NIL
	> 26	Very High sodium Water (S4) Unsuitable	NIL
	<250	Low Salinity Water (C1)	NIL
	250-750	Medium Salinity Water (C2)	NIL
Salinity Hazard	750-2250	High Salinity Water (C3)	NIL
	> 2250	Very High Salinity Water (C4)	All water samples
	< 1000	Satisfactory	All water sample expect S13 & S15
TDS	1000-2000	Fair	S13
	> 2000	Inferior	S15

2. **Electrical conductance (EC):**Conductivity refers to a water's ability to conduct electrical current, primarily influenced by the quantity and types of ions present in the solution. In simpler terms, it measures the presence and mobility of ions, their total concentration, valence, relative concentration, and also the temperature of the liquid. Generally, solutions containing inorganic acids, bases, and salts exhibit good conductivity. For instance, distilled water typically has a conductivity of less than 1 microsiemens per centimetre (µS/cm). Based on the Bureau of Indian Standards (BIS) guidelines for Designated Best Use, the acceptable range for conductivity is between 500 and 2000 micro siemens per centimetre (µS/cm), as outlined in Table-5. In the conducted analysis, the Conductance measurements (as depicted in Figure 2) varied across sampling water sites, ranging from 1056 µS/cm at sampling water site S10 to 3841 µS/cm at sampling water site S6, with an average value of 1771.707 µS/cm (as shown in Table-2). It's noteworthy that all the water samples in this analysis exceed the maximum permissible limit stipulated by BIS (as per IS10500:2012). The higher Electrical Conductivity (EC) observed at the sampling water sites indicates a higher concentration of dissolved ionic salts in the water samples, which surpass the accepted limit set by BIS guidelines.

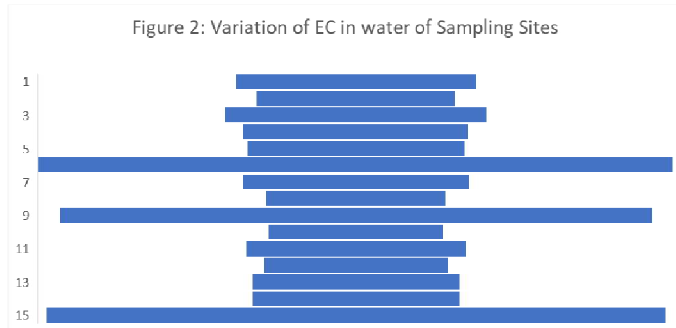

Figure 2: Variation of EC in water of Sampling Sites

3. **Total Dissolved Solids (TDS):** Total Dissolved Solids (TDS) represent the collective measure of all inorganic and organic substances present in a liquid, whether in a molecular, ionized, or micro-granular suspended form. Typically measured in parts per million (ppm), TDS in water can be determined using a digital meter. A sudden increase in TDS content often signals pollution from external sources. Additionally, harmful and potentially hazardous heavy metals can exist in water as dissolved solids.

According to the Indian Standard guidelines outlined in BIS 10500:2012, the recommended TDS value for drinking water should not exceed 500 milligrams per liter (mg/L), as presented in Table-5 for reference. Throughout the study period, the measured TDS values varied significantly (as depicted in Figure-3) across different sampling sites, ranging from 456 mg/L at sampling site S3 to 2435.2 mg/L at sampling site S15. The average TDS value observed across all sampling sites during this period was 945.53 mg/L (as detailed in Table-2)

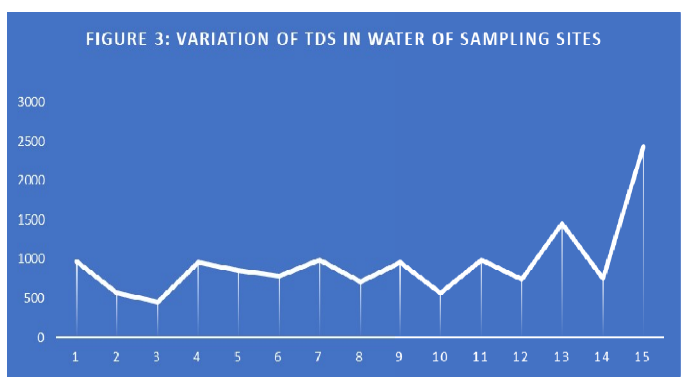

Figure 3: Variation of TDS in water of Sampling Sites

4. **Major Cations:** The analysis conducted on magnesium and calcium concentrations revealed values ranging from 11.66 to 129.2 mg/L and 23 to 365.2 mg/L, respectively. These values were found to be within the permissible range recommended for drinking water by WHO standards. Magnesium plays a crucial role in various bodily functions across all types of cells, body tissues, and organs. Similarly, calcium holds significant importance in human cell physiology and is particularly essential for bone health.

Studies conducted in Ethiopia and Turkey have also indicated acceptable levels of these metals in drinking water, aligning with the findings observed here.

Moreover, the levels of potassium (ranging from 5.2 to 86.2 mg/L) and sodium (ranging from 24.6 to 214.8 mg/L) were within the permissible limits set by WHO standards, indicating that these concentrations are unlikely to cause health-related issues. Sodium plays a vital role in regulating body fluid and electrolytes, as well as in the proper functioning of nerves and muscles. However, excessive sodium intake may lead to increased risks of high blood pressure, cardiovascular diseases, and kidney damage.

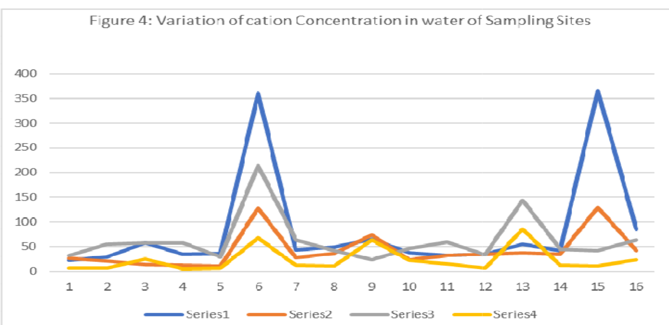

Figure 4: Variation of cation Concentration in water of Sampling Sites

Potassium is essential for protein synthesis and carbohydrate metabolism, contributing significantly to normal growth and body development in humans. Yet, an excessive amount of potassium in the body, known as hyperkalemia, is associated with symptoms such as irritability, decreased urine production, and even cardiac arrest. Thus, the levels of both sodium and potassium found in the analyzed water samples are within safe limits, minimizing the likelihood of adverse health effects.

5. **Major Anions:**The analysis included the evaluation of anions such as chloride (Cl^-), fluoride (F^-), and nitrate (NO_3^-) across different sampling sites, as indicated in Table-2.

The concentration of fluoride in water exhibited variation (as depicted in Figure-5) ranging from 0.053 mg/L at site S14 to 1.49 mg/L at site S6, with an average value of 0.539 mg/L. Chloride concentration in the water samples ranged from 48.6 mg/L at site S12 to 1195.5 mg/L at site S6, with an average value of 193.05 mg/L. Notably, all samples, except for sample S6, fell within the permissible limit defined by BIS guidelines.

Nitrate concentration in the water samples showed variability, spanning from 2.4 mg/L at site S5 to 48.2 mg/L at site S6, with an average value of 12.47 mg/L. Nitrate pollution remains a widespread issue impacting groundwater resources, primarily attributed to intensive fertilization practices, septic tank effluents, urban domestic sewage, and waste from both animals and humans.

The variations in chloride and nitrate concentrations across different sampling sites are depicted in Figure-6, illustrating the range of concentrations observed at each site.

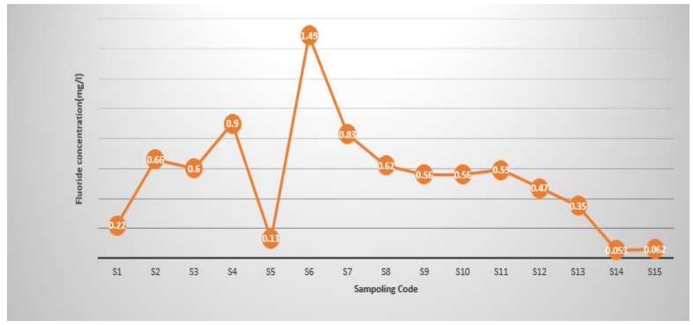

Figure 5: Variation of Fluoride Concentration in water of Sampling Sites

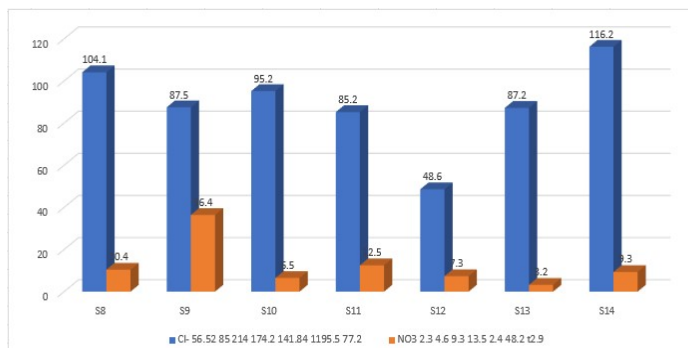

Figure 6: Variation of Chloride & Nitrate Concentration in water of Sampling Sites

6. **Total Hardness (TH):** Total hardness in water is determined by the combined concentrations of calcium and magnesium, both expressed as calcium carbonate and measured in milligrams per liter (mg/L). Across the sampling sites (as indicated in Table-2), the hardness values ranged from 35.5 mg/L at site S10 to 1254.2 mg/L at site S15. However, it's important to note that samples at sites S6 and S15 fell outside the range of the Maximum Permissible Limit outlined by BIS guidelines, while the remaining samples were within the acceptable range.

In most water sources, the vast majority of hardness is attributed to the presence of calcium and magnesium ions.

7. **Heavy metals:**In this particular study, the concentration of iron in the collected water samples ranged between 0.02 to 0.38 mg/L. Additionally, the concentrations of arsenic (As) and zinc (Zn) were reported to be less than 0.01 mg/L for both metals. The presence of heavy metals in the environment is a

significant concern due to their toxicity, posing threats to human health and the surrounding ecosystem. Although the concentrations of arsenic and zinc were reported to be below 0.01 mg/L in this study, it's essential to monitor and manage heavy metal contamination diligently due to their potential adverse effects on human life and the environment.

8. **Biochemical Oxygen Demand (BOD):**Biochemical Oxygen Demand (BOD) is a crucial parameter used to evaluate pollution levels in aquatic environments. It serves as an indicator of the intensity of domestic and industrial contamination within water bodies. Throughout the study period, the observed BOD values (as listed in Table-2) remained consistently below 5 mg/L across most of the water samples collected from various sampling sites (S1 to S15). This indicates that the BOD levels in these water samples were relatively low, suggesting minimal organic pollution from domestic and industrial sources in these aquatic environments.

9. **Chemical Oxygen Demand (COD):**Chemical Oxygen Demand (COD) serves as a crucial parameter for quantifying pollutants present in water, wastewater, and aqueous hazardous wastes. It is commonly utilized as a measure of the oxidizable organic and inorganic substances within water bodies, municipal wastewater, and industrial effluents. Throughout the study, the observed COD concentrations (as detailed in Table-2) predominantly remained below 5 mg/L across most water samples obtained from various sampling sites (S2 to S15). The highest recorded values were 6 mg/L at site S1. These values indicate relatively low levels of oxidizable organic and inorganic materials present in the water samples, showcasing minimal susceptibility to oxidation across most of the tested sites.

10. **Pesticides**: From the analysis results of Pesticides for Sampling sites, it has been observed that pesticide concentrations were found to be non-detectable limit. (Table 2)

11. **Irrigation water quality:** The suitability of groundwater for agricultural uses has been determined by calculating indices like %Na (Sodium Percentage) and SAR (Sodium Adsorption Ratio).

Sample No.	Parameters of Water Samples	Methods	Bureau of Indian Standards (BIS) for drinking water (IS 10500: 2012)	
			Highest Desirable limit	Maximum permissible limit
1	pH	pH meter	6.5	8.5
2	EC(μS/cm)	Conductivity meter	500	2000
3	Total dissolved solids (TDS) (mg/l)	Conductivity meter	500	2000
4	Ca^{2+}(mg/l)	Titrimetric (volumetric titration method)	75	200
5	Mg^{2+}(mg/l)	Titrimetric (volumetric titration method)	30	100
6	Na^{+}(mg/l)	Flame Photometry Method	-	-
7	K^{+} (mg/l)	Flame Photometry Method	-	-
8	Chloride(mg/l)	Argentometric (volumetric titration methods)	250	1000
9	Fluoride(mg/l)	Ion selective electrode Method	1.0	1.5
10	Nitrate(mg/l)	spectrophotometry	45	No relaxation
11	Total Hardness(mg/l)	Titrimetric	200	600
12	COD	Titrimetric	20	No relaxation
13	BOD	Titrimetric	5	No relaxation
14	Fe(mg/l)	AAS	0.3	No relaxation
15	Zn(mg/l)	AAS	5	15
16	As(mg/l)	AAS	0.01	0.05

TABLE 5
Physico Chemical Water quality parameters

i. **Sodium Percentage (%Na):** - The sodium concentration is important in classification of irrigation water quality. When sodium content is high in the irrigation water,it is adsorbed by the clay particles of the soil. This results in exchange of Na+ in water and displacing Ca+2 and Mg +2 from soil.The sodium percent (%Na) is calculated by the following equation:

$$\% Na = \frac{(Na^{+} + K^{+}) \times 100}{(Na^{+} + K^{+} + Ca^{+2} + Mg^{+2})}$$

all concentrations are expressed in meq/L. According to Wilcox (1955), groundwater can be categorized into five water classes (Table-4). The classes are 0–20%, 20–40%, 40–60%, 60–80%, and 80–100% which correspond to excellent, good, permissible, doubtful and unsuitable irrigation water, respectively. Based on this classification 6% sample belongs to Excellent category (S15), 26% belongs to Good category (S6,S8,S9,S12), 60% samples belongs to permissible category (S1,S2,S3,S4,S5,S7,S10,S11,S14) and 6% sample belongs to unsuitable category (S13). %Na values (Table-3) varied from 9.69 (S15) to 70.83(S13) and average value of %Na was noticed 45.65.

ii. **Sodium Adsorption Ratio (SAR):** The Sodium Adsorption Ratio (SAR) is a critical parameter used to assess the suitability of irrigation water. It's a dimensionless ratio that determines the likelihood of sodium replacing calcium and magnesium in soils, influencing soil structure and quality for agricultural purposes.

The formula for calculating the Sodium Adsorption Ratio (SAR) is as follows:

$$SAR = \frac{\text{Sodium } (Na^{+})}{\sqrt{\frac{\text{Calcium } (Ca^{2+})}{2} + \text{Magnesium } (Mg^{2+})}}$$

Sodium (Na^{+}), Calcium (Ca^{2+}), and Magnesium (Mg^{2+}) concentrations are measured in milliequivalents per liter (meq/L).

The SAR value provides insights into the potential impact of sodium on soil structure, helping to classify irrigation water. For instance, the United States Department of Agriculture (USDA) in 1954 established classifications based on SAR values to determine the suitability of water for irrigation purposes.

All concentrations are expressed in mg/L. According to this index, groundwater can be classified (Richards, 1954) into four water classes. The classes are 0–10, 10–18, 18–26 and >26 which correspond to excellent, good, fair and unsuitable water for irrigation uses, respectively. The calculated SAR values belong to the excellent class (0−10) and goodclass (10-18) as reported in Table-4. Sodium absorption ratio varied (Table 3) from 2.03(S15) to 16.57 (S15) and average value of SAR was detected

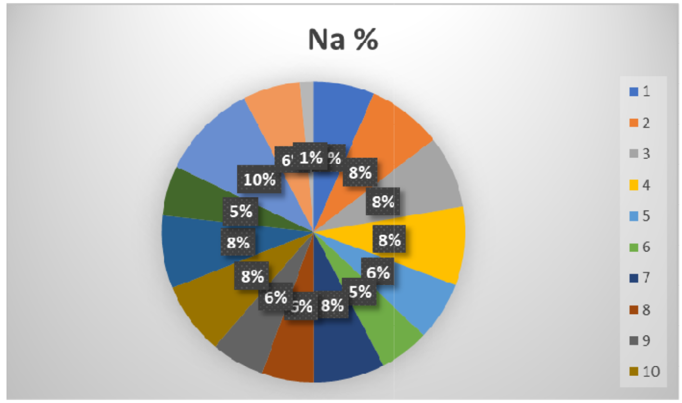

Figure 7: Na % of Sampling Sites

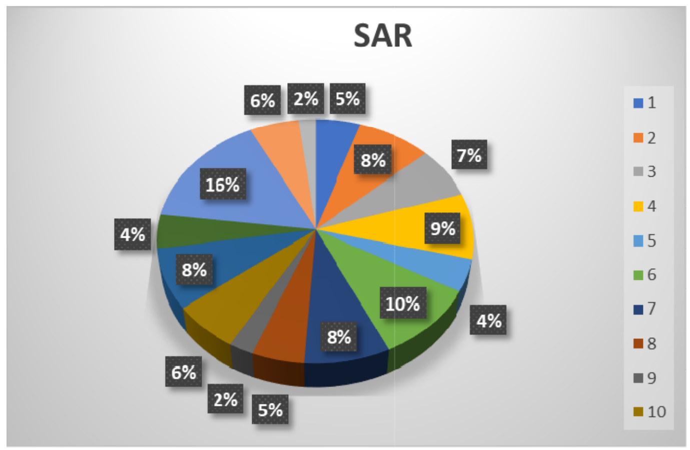

Figure 8: SAR of Sampling Sites

IV. Conclusion

Based on the assessment of groundwater in Kishangarh (Alwar, Rajasthan) and different villages viz. (Ghasoli, KhanpurMewan, MoosaKhera, KhoraPeepli, Kolgaon) Kishanghar Block, several key findings have emerged regarding the chemical composition and suitability of this water for household and irrigation purposes.

The dominant ions found in the water were observed in the following descending order for cations: $Ca^{+2} > Mg^{+2} > Na^{+} > K^{+}$ and for anions: $Cl^{-} > NO^{-3} > F^{-}$. This provides a clear insight into the predominant chemical elements present in the water samples.

In terms of irrigation suitability, various indicators such as SAR (Sodium Adsorption Ratio) and Na% were utilized to evaluate the water's potential for agricultural use. These parameters are crucial in determining the water's compatibility with soil and crops.

Moreover, the study also focused on assessing the suitability of this water for domestic use by comparing its physicochemical levels with the recommended standards set by authoritative bodies such as the World Health Organization

(WHO) and the Bureau of Indian Standards (BIS) for potable water. This comparison helps in understanding whether the water meets the established guidelines for safe consumption.

Overall, the findings of this study provide valuable insights into the chemical composition and suitability of the groundwater in the studied area for both irrigation and household purposes. The data collected and analyzed serve as a basis for understanding the water quality in this region and could potentially inform decision-making regarding its usage in agriculture and households, ensuring the health and well-being of the local population.

V. Acknowledgement

The authors are thankful to Prof. (Dr.) Gopi Chand Khatik , Principal, Government R. R. College, Alwar, Rajasthan (India) and Dr. Seema Gulati, HOD, Department of Chemistry, Government R.R. College, Alwar, Rajasthan (India) for providing overall financial support and necessary laboratory facilities to fulfil the present research work. Authors are extremely grateful to Dr.Vijay Singh Yadav for co-operation and constant suggestions throughout the research work. Authors are also grateful to Dr. Ramanand Yadav ,Dr. Akhalesh Kumar and Dr. Rajesh Yadav to help in preparation of manuscript and suggestions.

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