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ORIGINAL ARTICLE

A comparison of the physicochemical parameters of groundwater in the Nagaur district of Rajasthan, India

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Abstract
The current research work examines the physicochemical parameters of groundwater for pre and post-monsoon variations in selected locations of Nagaur district from March 2021 to October 2022. Twenty samples are obtained from various sampling sites for groundwater evaluation during two seasons, before and after monsoon. Temperature, pH, conductance, total dissolved solids, total hardness, turbidity, fluoride, nitrate, chloride, and alkalinity, among other characteristics, were studied. It has been discovered that the value of certain parameters is higher during the post-monsoon season than during the pre-monsoon season. Because current regulatory practise based on spot samples of water and comparisons of measured levels of priority pollutants with environmental quality standards will not provide data of the required reliability, the aim of this study is to confirm the quality of ground water as well as compare it to water standards.
***Key words:** Physicochemical parameters, Ground water, Fluoride, Pre monsoon and Post monsoon*

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INTRODUCTION

Environment is the outer periphery of living existence made up by biotic and abiotic substance that helps in providing conditions and strengthen the survival of all human, animal and Plant life. Air, Water, Soil, Sun radiation and Food are the fundamental elements of it for the living things to carry out their functioning properly. Natural Environment consist of Air, Water, Soil, Flora and Fauna etc., these are based on self-regulating mechanisms and affect the remaining components.

Anthropological Environment belongs to man-made processes responsible for changes in living organism. It is the mixture of Physical, Chemical, Biological, social and cultural factors. Components of Environment are broadly classified biotic, abiotic and energy component. These balance the natural process by maintaining the equilibrium in nature. Lithosphere- Earth (solid), Hydrosphere- water component (liquid) and Atmosphere - gases (gaseous) are three major sub division of Abiotic component.

Water's qualities make it possible for humans to survive in a variety of weather circumstances. Water has unique properties that set it apart from other substances. Because of its polar nature and high di-electrical constant water is the universal solvent. It has the dissolving, absorbing and separating properties for a wide range of chemical substances. Physico-chemical, radiological and biological characteristics are unique combination of water that makes it universal solvent. Water is an essential component and a significant contributor for maintaining a healthy ecosystem and a sustainable environment[4].

Water is a crucial component for all kinds of living things. One of the most important natural resources, groundwater promotes biological diversity, economic growth, and human health. It is a valued dynamic, replenishable, and finite natural resource in the modern era. The assessment of a region's groundwater resources entails a thorough investigation of the subsurface water, including geology and hydrogeology, monitoring, and the generation of well data. Each parameter for drinking water has a limit value specified by the water quality recommendations. Since the human population contracts many water-borne diseases as a result of using contaminated drinking water, it is imperative that the quality of the water be regularly assessed. The availability of safe drinking water is critical for illness prevention and quality of life improvement. It is vital to understand the various physicochemical characteristics used for water quality testing, such as colour, temperature, acidity, hardness, pH, sulphate, chloride, DO, BOD, COD, alkalinity, and so on. Heavy metals like as Pb, Cr, Fe, Hg, and others are of particular concern since they induce chronic poisoning in humans and aquatic species. Guidelines for various physicochemical parameters have also been provided for comparing the value of a genuine water sample. World Health Organisation (WHO), Indian Standard (IS 12500:2012), Environmental Protection Agency (EPA), and Environmental Quality Standards (EQA), among others, are essential water analysis standards.

The list of environmental challenges that humanity is currently facing includes topics specific to areas (forest degradation) and activities (chemical risk) as well as global topics (climate change) that highlight three basic components of the current environmental crisis: a population boom, resource depletion, and pollution. Like in the majority of emerging nations, urbanisation and industrialization have not kept up with environmental pollution, leading to a host of issues. Accessibility to drinking water has become a big concern because of a lack of protection of environment. The water must be free of pathogens and potentially toxic chemicals before it can be used for human consumption.

Ground water Quality

Groundwater is an important natural drinking water supply. Although the chemical and biological properties of ground water are suitable for most uses, human activity degrades its quality. The natural quality of groundwater alters as it flows from springs or rivers to replenish places. Sodium, potassium, magnesium, calcium, bicarbonate, chloride, and sulphate are the most common dissolved mineral compounds found in groundwater[6]. A range of elements, including the levels of dissolved minerals and organic compounds found in groundwater, impact the suitability of groundwater for various applications. Some constituents are harmless, while others are dangerous, and a few are severely toxic. A slew of variables, including population growth, influence to the increase in solid waste. Where intensive methods are used, agriculture has a profound influence on groundwater quality. An enormous impact of urbanization and industrialization on the quality of groundwater has a serious issue [7].

Groundwater quality is influenced by atmospheric conditions in many parts of the world. If the amount of dissolved minerals in groundwater exceeds the allowed level, it is not considered safe to drink. When dissolved minerals are found in groundwater, it is classified as saline. In high concentrations, dissolved minerals can be harmful to animals and plants.

Pollution has been defined by WHO as "An unavoidable change in physico-chemical and biological characteristics of our land and water that may affect human life or that of other desirable species and pollution is a modification of the physical, chemical and biological properties of water, restricting or preventing its use in the various applications where it normally plays a part." Not only groundwater but also the surface water available for drinking purpose is polluted with different source of contamination such as sewage and agricultural runoff, which leads waterborne diseases. [5].The source of contamination can further divide in two broad parts classified as point source and non-point source

Groundwater Scenario of Rajasthan

According to the latest annual report of Dynamic Ground Water Resources of India the coastal Konkan, Goa, and Karnataka and North-East India the meteorological subdivisions that get more than 250 cm of rainfall annually while west Rajasthan barely receives approximately 30 cm (IMD). Rajasthan is a desert state with a severe water shortage. The state of Rajasthan falls under semi-arid and climatic conditions and in general, it has a scarcity of enough surface water resources[2].

Rajasthan's scarce groundwater supplies are rapidly being used for agricultural, industrial, and home purposes. Changes in water levels and groundwater quality in the State are a result of these pressures, which are compounded by non-uniform rainfall. Its geographical expanse includes plains, hills, and sand mounds, and it is therefore a component of the vast Indian Thar Desert. Rajasthan is divided into 33 districts and 16560 villages.

The position of Nagaur district in Rajasthan is as nucleus in cell. Frequency in North with latitudes 26°25' & 27°40' and in East with longitudes 73°10' & 75°15'. 17778 square km2 is the total area of Rajputana state. Out of this 17448.5 square km2 are of rural with 269.5 km2 are of urban.

Nagaur district ranks fourth in inhabitants, fifth in area, and 23rd in population size. Bikaner and Churu district are north side coordinate while east direction has Jaipur and Sikar, Ajmer and Pali on the South and the district Jodhpur on the west. Bikaner and Churu districts are adjoining districts facing north side, Sikar and Jaipur adjoining districts facing east side, Ajmer and Pali adjoining districts facing south side, and Jodhpur districts facing west side. Nagaur district is just 5.18 percent of the state's total area.

The district's 13 tehsil headquarters are Nagaur, Khinwsar, Jayal, Degana, Didwana, Ladnun, Parbatsar, Makarana, Nawa, Kuchaman, Riyanbadi, and Mundwa. Census data's indicate that the district's total population is 3307743, with 637204 urban populations and 2670539 rural population of. Systematic framework and Lithology is considered as different sedimentary, igneous, and metamorphic rocks from the Super Group of Bhilwara, Super Group of Delhi, Super Group of Marwar, Palana formation and Quaternary alluvium and these are make up the district's geomorphological setting.

Post-monsoon and pre--monsoon water level variation and block-wise susceptibility to reservoir pressure plays a vital role. In the long term, a dropping pattern of level of ground water all across the range of 0 to 0.25 m/year has been documented in the majority of the district, with the exception of sections of Mundwa, Didwana, Merta and Parbatsar blocks, where a rising pattern of 0 to 0.5 m/year has been noted.

In groundwater of Nagaur district in Rajasthan there is continues increases of different chemical components like as lead, arsenic, fluorides, nitrates, soluble salts, chlorinated solvents, petrochemicals and heavy metals etc. these affects the living organisms such as human beings, plants, pet animals, vegetable, fishes, birds and so on and generate different types of diseases. Thus, safe and sufficient drinking water supply is a critical issue in rural and many urban regions in developing countries.

MATERIAL AND METHODS

Every one of the reagents included in this research was of the highest analytical purity (SRL or Merck, India) and were used exactly as prescribed.

All of the chemicals utilised in this experiment were of the highest analytical purity (SRL or Merck, India), and they were used exactly as supplied. Water was double-distilled throughout the project, with the second distillation occurring over alkaline permanganate. The glassware utilised in this study was of the Borosil quality.

The present study included following points in the textual sequences

1. Initially, water samples were obtained in both pre-monsoon and post-monsoon seasons from the selected site of specified block. These are grab samples that were collected at distinct intervals in the same sampling point. Should yield more uniform sampling of heterogeneous mixtures where the concentration of the mixture varies over time. At the instant time of testing, non-conservable characteristics like pH, temperature, and electrical conductivity (EC) were determined.
2. Every sample was analyzed in twice and the mean of results was reported. data were gathered according to the studies performed in our departmental laboratory and private sector laboratory. The parameters include Total Dissolve Solids (TDS), Electrical Conductance (EC), pH, Turbidity, Biological Oxygen Demand (BOD), Total Alkalinity (TA), Bicarbonate, Dissolve Oxygen (DO), Ca2+ Hardness, Total Hardness (TH), Mg2+ Hardness, Chloride, Sulphate, Nitrate and Fluoride.
3. The adequacy of ground and surface water for drinking and other uses was determined by assessing the physical and chemical factors in the research region to WHO, (ICMR) Indian Council of Medical Research and (BIS, 2012) Bureau of Indian Standards criteria, among others. Water chemical analysis was done by using standard analytical procedures of well-known reference books named as "American public Health Association (APHA 2017) and Standard methods for the examination of water and wastewater 23thedn".
4. Monthly variation in physico-chemical parameters was also evaluated.

Study Area

The study region has been depicted using latitudes and longitudes. The local climate was mentioned. Water samples were collected in plastic or glass bottles for analysis. Several water quality measures were selected and determined using established methods. Different seasons play an important role for the physicochemical properties variations. Ground water quality of Nagaur district was studied. Ground water samples were collected from twenty different locations of Nagaur region of Rajasthan. These samples were collected in winter and summer season during the study period from March2021 to October 2021. The ground water samples were collected from different tube wells of different villages as Alay (N1), Barani(N2), Sewari (N3), Kumari (N4), Rohini (N5), Sinod (N6), Raidhanu (N7), Bhadana (N8), Unthwaliya (N9) and Satheran (N10) of the study area.

The studied area located within the Nagaur district of Rajasthan. All the sampling stations selected for the study represents average water quality of underground water. Temperature, colour, odour, pH, fluoride hardness, turbidity, electric conductivity, alkalinity, DO, BOD, NO3-sulphate, chloride, turbidity, bicarbonate, and other parameters were measured in the samples. The procedures used to evaluate this parameter were given by the APHA (American Public Health Association) 2017 standard method for analysis of water and waste sample 23rd edition Washington D.C., USA. The sample parameters were determined by titrimetricaly, spectro-photometrically and chromatographically. The research work aims to investigate the impact of various chemicals used in agriculture on water quality of surface and underground water of Nagaur district. The water samples were collected from various sample sites to assess the impact of agricultural chemicals on water quality of Nagaur region. Modern agriculture practices increase geometrically the use of various in chemicals in crop field to enhance the productivity and the quality of the crops.

Table 1: Different analytical water quality parameters with their analytical technique and guideline values as per WHO and Indian standard

S. No.	Parameters	WHO Standards	BIS: 10500-2012	Indian Standard	EPA guidelines
2	Colour		Transparent	5 Hazan unit	
4	Electrical Conductivity				2500us/cm
4	pH	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
5	Solid (TDS)	1000			
6	Turbidity		5 NTU		
7	Alkalinity		200		
8	B.O.D	6	5	30	5
9	C.O.D	10	-	-	40
10	Chloride	250		250	250
11	Hardness	200 ppm		300 ppm	< 200 ppm
12	Maganesium	150 ppm		30ppm	
13	Ammonia	0.3 ppm		0.5 ppm	0.5 ppm
14	Nitrate	3 ppm		45ppm	0.5ppm
15	Sodium	200ppm		180ppm	200ppm
16	Sulphate	250ppm		200ppm	250ppm

Ref.:- [WHO, USEPA, Indian Standard, National Primary Drinking Water Regulations, Drinking Water Contaminants US EPA]

RESULT AND DISCUSSION

Mean values of selected significant parameters from monitoring stations of Nagaur block is represented in table 2 and 3.

Table 2 Data of Pre-Monsoon of Nagaur Block

		Nagaur	Pre	Monsoon			
	Max	Min	Range	Mean	SD	SE	CV%
Fluoride	6.2	0.17	6.03	2.337	2.01	0.63	85.83
Nitrate	130	8	122	56.4	42.85	13.55	75.97
Chloride	2800	40	2760	1033	869.86	275.08	84.21
pH	9.1	7.3	1.8	8.08	0.53	0.17	6.65
TDS	8100	175	7925	3559.8	2850.54	901.42	80.08
Alk.	1100	50	1050	327	299.445	94.69	91.57
Ca	400	24	376	151.4	106.85	33.79	70.58
Mg	580	20	560	180.7	164.36	51.98	90.96
Hardness	1350	80	1270	616.5	434.44	137.38	70.47
Sulphate	358	246	112	319.6	37.653	11.91	11.78
Turbitity	4.8	3.5	1.3	4.13	0.3917	0.12	9.48
EC	1878	742	1136	1421.3	334.21	105.69	23.51
DO	5	4	1	4.5	0.52	0.17	11.71
HCO3-	458	264	194	355.8	58.14	18.39	16.34
BOD	4.9	3.3	1.6	4.16	0.51	0.16	12.37

In Nagaur block we have selected 10 villages and compare the physico-chemical parameters village wise. Literature review revel that this area is highly influenced by fluoridecontamination[1].In Alay village the Fluoride concentration was lowest (0.17mg/l) while in Unthwaliya village its concentration was highest (5.40mg/l) during the study period. In Alay village the Nitrate concentration was lowest (8mg/l) while in Satheran village its concentration was highest (130mg/l) during the study period.

In Alay village the Chloride concentration was lowest (40mg/l) while in Bhadana village its concentration was highest (2800mg/l) during the study period. In Kumari village the pH concentration was lowest (7.3mg/l) while in Satheran village its concentration was highest (9.1mg/l) during the study period.

In Alay village the TDS concentration was lowest (175mg/l) while in Satheran village its concentration was highest (8100mg/l) during the study period. In Rohini village the Calcium concentration was lowest (24mg/l) while in Sinod village its concentration was highest (400mg/l) during the study period.
In Rohini village the Magnesium concentration was lowest (20mg/l) while in Sinod village its concentration was highest (580mg/l) during the study period.

Table 3 Data of Post-Monsoon of Nagaur Block

		Nagaur	Post	Monsoon			
	Max	Min	Range	Mean	SD	SE	CV%
Fluoride	6.28	0.19	6.09	2.40	2.02	0.64	84.24
nitrate	139	11	128	61.80	43.56	13.77	70.48
chloride	2687	38	2649	984.80	848.70	268.38	86.18
pH	9.2	7.5	1.7	8.33	0.54	0.17	6.48
TDS	8386	194	8192	3648.50	2903.04	918.02	79.57
Alk.	1128	58	1070	338.9	306.06	96.78	90.31
Ca	440	28	412	165.00	118.27	37.40	71.68
Mg	585	22	563	187.80	165.39	52.30	88.07
Hardness	1366	89	1277	635.5	433.89	137.21	68.27
Sulphate	384	255	129	333.10	39.54	12.50	11.87
Turbitity	4.9	3.8	1.1	4.46	0.37	0.12	8.20
EC	1899	803	1096	1448.30	325.79	103.02	22.49
DO	5	4	1	4.60	0.52	0.16	11.23
HCO3-	507	302	205	398.10	63.95	20.22	16.06
BOD	5	4.1	0.9	4.59	0.33	0.11	7.29

In Alay village the Hardness concentration was lowest (80mg/l) while in Bhadana village its concentration was highest (1350mg/l) during the study period. In Alay village the Sulphate concentration was lowest (246mg/l) while in Satheran village its concentration was highest (358mg/l) during the study period.
In Raidhanu village the Turbidity concentration was lowest (3.5mg/l) while in Satheran village its concentration was highest (4.8mg/l) during the study period. In Raidhanu village the EC concentration was lowest (742mg/l) while in Bhadana village its concentration was highest (1878mg/l) during the study period.
In Sewari village DO concentration was lowest (4mg/l) while in Bhadana village its concentration was highest (5mg/l) during the study period. In Alay village the HCO3- concentration was lowest (264mg/l) while in Satheran village its concentration was highest (458mg/l) during the study period.
In Satheran village the BOD concentration was lowest (3.3mg/l) while in Sewari village its concentration was highest (4.9mg/l) during the study period.
From the observation, the range in mg/l of F- is 6.03 with the max. 6.20 and min. 0.17. Mean and SD are 2.33 ± 2.01 respectively. The range in mg/l of NO3- is 122 with the max. 130 and min. 8. Mean and SD are 56.40 ± 42.82 respectively. The range in mg/l of chloride is 2760 with the max. 2800 and min.40. Mean and SD are 1033 ± 869.86 respectively.
The range of pH is 1.80 with the max. 9.1 and min. 7.30. Mean and SD are 8.08 ± 0.53 respectively. The range in mg/l of TDS is 7925 with the max. 8100 and min. 175. Mean and SD are 3559.80 ± 2850.54 respectively. The range in mg/l of alkalinity is 1050 with the max. 1100 and min.50. Mean and SD are 327 ± 299.44 respectively. The range is mg/l of calcium is 376 with the max. 400 and min. 24. Mean and SD are 151.40 ± 106.85 respectively. The range in mg/l of magnesium is 560 with the max. 580 and min. 20. Mean and SD are 180.70 ± 164.36 respectively. The range in mg/l of hardness is 1270 with the max. 1350 and min. 80. Mean and SD are 610 ± 439.41 respectively. The range in mg/l of sulphate is 112 with the max. 358 and min. 246. Mean and SD are 319.6 ± 37.65 respectively. The range in mg/l of turbidity is 1.3 with the max. 4.8 and min. 3.5. Mean and SD are 4.13 ± 0.39 respectively. The range in mhos/cm of EC is 1136 with the max. 1878 and min. 742. Mean and SD are 1421.3 ± 334.22 respectively. The range in mg/l of DO is 1 with the max. 5 and min.4. Mean and SD are 4.5 ± 0.53 respectively. The range in mg/l of HCO3- is 205 with the max. 507 and min.302. Mean and SD are 398.1 ± 63.94 respectively and the range in mg/l of BOD is 1.6 with the max. 4.9 and min.3.3. Mean and SD are 4.16 ± 0.52 respectively.
Regression Analysis: Simple linear regression analyses the correlation between the two variables, one of which is the response (y), and one of which is the predictor (x). It is possible to predict a response value from a predictor value with better than random reliability when the two variables are linked together[3]. (Table 4 and 5).

Table 4 Table of Regression and T-value of Nagaur Block (Pre-Monsoon)

Parameters	**Parameters**	**R**	**T value**
Fluoride	Nitrate	0.67453	2.220472
	Sulphate	0.687091	2.279923
	HCO3-	0.932008	4.378728
Nitrate	pH	0.409817	1.213662
	Sulphate	0.221583	0.634669
	HCO3-	0.657838	2.143979
Chloride	TDS	0.951757	4.859662
	Calcium	0.338904	0.988253
	Magnesium	0.433902	1.292956
pH	Sulphate	0.017142	0.048488
	HCO3-	0.332537	0.968519
TDS	Alkalinity	0.669648	2.197815
	Calcium	0.433429	1.291384
	Magnesium	0.523225	1.603113
Alkalinity	Calcium	-0.08847	-0.25072
	Magnesium	0.048178	0.136347
	Turbidity	0.424272	1.261063
Calcium	Magnesium	0.948481	4.766041
	Hardness	0.604972	1.917593
	Turbidity	-0.24426	-0.70158
Magnesium	Hardness	0.501592	1.525321
	Turbidity	-0.24663	-0.70861
Hardness	Turbidity	-0.27125	-0.78201
	EC	0.368044	1.079563
	DO	0.025476	0.072069
Sulphate	EC	0.332224	0.967551
	DO	0.453506	1.358712
	HCO3-	0.822156	3.082074
EC	DO	0.279752	0.807544
	HCO3-	0.044246	0.125208

Table 5 Table of Regression and T-value of Nagaur Block (Post-Monsoon)

Parameters	**Parameters**	**R**	**T values**
Fluoride	Nitrate	0.673888	2.217479
	Sulphate	0.53159	1.633728
	HCO3-	0.925263	4.249167
Nitrate	pH	0.349131	1.020109
	Sulphate	0.115871	0.328842
	HCO3-	0.594777	1.876293
Chloride	TDS	0.950189	4.813982
	Calcium	0.343652	1.003018
	Magnesium	0.467276	1.40561
pH	Sulphate	-0.08919	-0.25277
	HCO3-	0.399477	1.180084
TDS	Alkalinity	0.680569	2.248841

	Calcium	0.431997	1.286627
	Magnesium	0.551984	1.709725
Alkalinity	Calcium	-0.07856	-0.22255
	Magnesium	0.095696	0.271292
	Turbidity	0.159072	0.452816
Calcium	Magnesium	0.944925	4.671733
	Hardness	0.596555	1.883447
	Turbidity	-0.21885	-0.62664
Magnesium	Hardness	0.515048	1.573481
	Turbidity	-0.18989	-0.54204
Hardness	Turbidity	-0.31818	-0.92429
	EC	0.367584	1.078108
	DO	-0.27895	-0.80513
Sulphate	EC	0.40064	1.183847
	DO	-0.22092	-0.63272
	HCO3-	0.342997	1.000978
EC	DO	-0.27594	-0.79608
	HCO3-	-0.04633	-0.13111

In Nagaur block Fluoride has highly positive correlation with Nitrate, Sulphate, HCO3- (r is 0.674, 0.687, 0.932) in both monsoons. Mildly positive correlation occurs between Nitrate with pH, Sulphate, HCO3 (r is 0.409, 0.221, 0.657). Chloride has highly positive correlation with TDS, Calcium, Magnesium (r is 0.951, 0.338, 0.433) in both monsoons. pH has positive correlation with sulphate, HCO3- (r is 0.017, 0.332) in both monsoons.

TDS has highly positive correlation with Alkalinity, Calcium, Magnesium (r is 0.669, 0.433, 0.523) in both monsoons. Alkalinity has positive correlation with Magnesium, Turbidity (r is 0.048, 0.424) in both monsoons. Calcium has highly positive correlation with Magnesium, Hardness (r is 0.948, 0.604) in both monsoons. Magnesium has highly positive correlation with Hardness (r is 0.501) in both monsoons. Hardness has lowly positive correlation with EC, DO (r is 0.368, 0.025) in both monsoons. Sulphate has highly negative correlation with EC, DO, HCO3- (r is 0.332, 0.453, 0.822) in both monsoons. EC has highly positive correlation with DO, HCO3- (r is 0.279, 0.044) in both monsoons.

CONCLUSION

Most water sources are poisoned because of their proximity to sewage lines or the presence of waste water nearby. In addition to seepage from sewage lines, bacterial contamination also occurs. Water-borne illnesses such as diarrhoea, cholera, jaundice, typhoid, and dysentery can result from the municipal tap water supply pipeline crossing sewage water. Based on the findings of the study, it is recommended that drinking water in the research area be treated before being used for drinking and other domestic purposes.

Traditional rainwater harvesting in homes such as Tanka and community surface water should be encouraged, which also helps to reduce ground water withdrawal. Filters groundwater recharge structure should be developed and controlled throughout the rainy season. Ground water reserves are becoming more and more depleted as surface water sources have become too polluted for human use due to industrial and agricultural pollutants. Most human activities such as agricultural or industrial have an impact on water quality. Poor environmental management systems have led to discharge polluted water. This resulted in pollution of the surface and groundwater sources. NGO's, individuals and governments organizations must contribute to preventing pollution effects on various water sources.

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