Poll Res. 42 (2) : 274-280 (2023)

ISSN 0257–8050

DOI No.: http://doi.org/10.53550/PR.2023.v42i02.015

STUDY OF PHYSICO-CHEMICAL PARAMETERS OF GROUND WATER IN SELECTED AREAS OF NORTH TALOD TALUKA (GUJARAT), INDIA

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(Received 10 December, 2022; Accepted 11 February, 2023)

ABSTRACT

Water is the most significant in forming the land and directing the atmosphere. It is one of the most significant aggravates that significantly impacts life. The nature of water typically portrayed by its physical nature, contents and organic attributes. Fast industrialization and unpredictable utilization of composts and pesticides in agriculture are causing substantial contamination in degrading water quality. Because of utilization of tainted water, human populace experiences water borne infections. The quality parameters of water resources in north Talod taluka have been evaluated.

KEY WORDS : Physico - Chemical Parameters**,** Ground **w**ater

INTRODUCTION

The quality of ground water near some industrial areas is a matter of great concern from environmental point of view as it directly affects human health and irrigation. Water sources for drinking and other domestic purposes must have high degree of purity, and these must be free from any chemical contamination and microorganisms. But as the population and industrialization are increased rapidly, they have led to the deterioration of quality of water; thus, resulting in polluted water. Groundwater is considered the most valuable and one of the essential prerequisites for survival of humankind giving them the extravagances and solaces not withstanding and satisfying fundamental necessities of life and furthermore for agricultural and industrial advancements and in this manner, it is a vital constituent of our eco-system. Assessment and mapping of groundwater is necessary, because the physical and chemical characteristics of any sample of groundwater decides its suitability for agricultural, domestic, and industrial usages.

Bhagat *et al*. (2017) determined physicochemical parameters of well water in the six villages of Roha Tahsil in the period 2015-16. Water moving through underground rocks and soils may pick up natural contaminants, and become polluted in that area even with no human activity. Water is also polluted by some human activities, such as dumping garbage, poor agricultural practices, open defecation, and chemical spillage at different industrial sites. Six villages of Roha taluka, selected were- Khamb, Nadavali, Shiravali, Talavali, Devkhane and Chilhe, where the well water is the second major source of drinking water. The samples of water were analyzed for some parameters such as pH, temperature, sulphates, total dissolved solids, chemical oxygen demand, total suspended solids, iron, etc. They concluded that water from these wells can be used for the drinking purpose, but after a suitable treatment.

Varade *et al.* (2018) carried out hydro geochemical characterization of some groundwater samples from urbanized and industrialised parts of Nagpur district in pre-monsoon season of 2011. They evaluated groundwater quality parameters of these

samples such as study pH, TDS, EC, Na^+, K^+, Ca^{2+}, Mg^{2+}, HCO_3^-, Cl^- and SO_4^{2-}. They concluded that the groundwater quality was useful drinking and irrigation purposes. The cations and anions in these samples followed the order.

$Ca^{2+} > Mg^{2+} > Na^+ > K^+$, and $HCO_3^- > Cl^- > SO_4^{2-} > NO_3^- > F^-$

Thangamalathi and Anuradha (2018) studied presence of heavy metals with reference to other parameters in the seven lakes- Ambattur lake, Korattur lake, Chembarambakkam lake, Pulicat lake, Porur lake, Retteri lake, and Puzhal lake of Chennai, Tamilnadu, in the period April to November 2017. They collected surface water samples from these seven different lakes in pre-monsoon, monsoon, post-monsoon, and summer seasons. The quality of water samples was analyzed for physico–chemical parameters such as pH, colour, odour, turbidity, EC, TH, BOD, TDS, DO, COD, Ca^{2+}, Mg^{2+}, Fe^{2+}, Mn^{2+}, Cl^-, F^-, and SO_4^{-2}. The results indicated higher level of heavy metal concentrations in these water samples like Cd, Pb, As, Al, Ni and Cr and it was observed that concentrations of these metals were above the permissible limits except zinc and aluminum.

The ground water quality in the vicinity of industrial areas of Guntur was studied by Lamma and Swamy (2018) from June 2015 to May 2017. The water samples were collected and analyzed for different physico-chemical parameters like pH, turbidity, electrical conductivity, total alkalinity, total dissolved solids, total hardness , Ca^{2+}, Mg^{2+}, Na^+, K^+, NO_2^-, Cl^-, and $F^-$with some heavy metals such as zinc, nickel, and cadmium every month. They observed that most of the parameters were more than acceptable limits set by IS 10500 (drinking water quality standards). It was revealed that these groundwater samples were contaminated with industrial effluents and out of the three stations selected, water samples from two stations were found contaminated, and, therefore, it was concluded that these water samples were not potable.

Saxena and Sharma (2017) investigated physicochemical characteristics of ground water samples in and around Tekanpur in Gwalior city, M.P. India. They collected water samples from five different collecting points of this area. They analyzed physico-chemical parameters and obtained values were compared with standard values of WHO and ISI. The corresponding water quality indices were also worked out. The pH, total dissolved solid, odour, colour, temperature, electrical conductivity, total alkalinity, total hardness, calcium, magnesium, chloride, and dissolved oxygen were recorded. Almost all these parameters satisfied the guidelines of drinking water at many places but not all. The water quality index of these samples was found to be in the range of 58.66 to 93.75. It was concluded that the ground water of this area needs some treatment before consumption.

The quality of ground water has been regularly deteriorating due to industrial activities and pollution in Punjab. Shukla *et al.* (2019) studied groundwater quality parameters around Jalandhar-Phagwara region in Punjab. They collected samples from different villages of this area and these samples were analyzed for pH, TDS, TSS, alkalinity, hardness and chloride content in groundwater. It was indicated that values of pH, TSS, TDS, alkalinity, hardness and chloride content were 7.2-7.8, 0-200, 0-200, 14-71, 225-260 and 35.5-578.65 mg , respectively. The obtained results were compared with permissible limits of Indian water quality standard (IS: 10500-2012) and it was suggested that water quality in this region may be improved so as to make the ground water fit for drinking purpose.

Arulnangai *et al.* (2021) collected twelve groundwater samples from different areas in Ariyalur district, Tamil Nadu. These water samples were then analysed for physico-chemical parameters such as pH, total dissolved solids, electrical conductivity, magnesium, calcium, total hardness, bicarbonate, nitrate, chloride, and sulphate for understanding the geochemical processes responsible for deteriorating groundwater quality of this area. The results were compared with WHO standards and water quality index was also calculated to predict the water quality. It was concluded that the majority of groundwater samples from this region were not suitable for drinking purpose.

Jena and Sinha (2017) assessed physico-chemical parameters of groundwater samples from Raipur city in the period 2015-2016. They observed different physico-chemical parameters of groundwater samples and compared with values recommended by WHO for drinking water to find out the extent of pollution. It was found that sewage and industrial effluents were the main sources for deteriorating water quality in this region.

Praveen and Roy (2022) evaluated groundwater

quality in the command area of Paliganj in two different seasons in 2020 (pre-monsoon and post-monsoon). They collected 40 groundwater samples from hand pumps and dug wells in the study area. The chemical characteristics of groundwater samples were determined according to American Public Health Association approved process. They determined pH, EC, TDS, SO_4^{2-}, Cl^-, F^-, HCO_3^- Ca^{2+}, Mg^{2+}, Na^+ and K^+. It was reported that all these samples were found excellent to good for drinking purposes during the pre-monsoon period, but only 75% of the samples fell into the excellent to good group in post-monsoon season, while the remaining 25% were relatively poor for drinking purposes. It was revealed that 80% of the samples were found highly suitable for irrigation while 20% fall under medium category based on irrigation quality index.

Singh *et al.* (2018) investigated groundwater samples from mining region of East Singhbhum district. The hydrochemical analysis of these samples indicated that Na^+, K^+, and Ca^{2+} ions were the main cations in the groundwater, while, F'', Cl'' and HCO_3'' ions were major anionic part of the groundwater samples. They found the presence of Pb, Cr, and Cd as the heavy metals in these samples. Source of these metals was through anthropogenic inputs from mining activities and mineral processing units. The hazard quotient (HQ) was found in the following order:

$$Cr > As/ > Cd > Pb$$

It was also revealed that hazard index (HI) for heavy metals was found to be significantly high (> 1) and it was considered as a threat for human population because of their tendency to accumulate in the body. It may cause kidney problems, dysfunction of liver and renal cortex as well as developing cancer.

MATERIALS AND METHODS

Sample Collection

Samples were collected in pre-cleaned 500 mL polyethylene bottles. The water samples were collected from 20 villages of Talod taluka, Gujarat during the winter, summer and monsoon seasons. Physicochemical parameters such as pH, TDS, total hardness, electrical conductivity, calcium, magnesium, chloride, fluoride, etc. were determined. Samples from these villages were collected in the period 2016 to 2019 and labeled as:

METHOD OF ANALYSIS

pH

pH of groundwater generally ranges between 7 and 8. The water with a pH < 6.5 is considered acidic, soft, and corrosive; moreover, water with acidic pH also signifies the presence of elevated levels of toxic metals. This makes the pH, an important parameter to be monitored. Low pH in water can cause premature damage to metal piping, and have associated aesthetic problems such as a metallic or sour taste. The pH of samples are reported in Table 1.

Table 1. Sites of sample collections

Sample Name	Villages
S1	Mota chekhla
S2	Punshri
S3	Gundiya
S4	Kathvada
S5	Modhuka
S6	Antroli dolji
S7	Moteshri
S8	Mahelav
S9	Gora
S10	Rupal
S11	Chandpur
S12	Badarni muvadi
S13	Madhavgadh
S14	Umedni muvadi
S15	Harsol
S16	Tajpur camp
S17	Vav
S18	Rojad
S19	Dhadhvashna
S20	Gambhirpura

Overall pH of the samples was found to be within the permissible limits of Indian Standards for drinking water.

Total Dissolved Solids (TDS)

Total Dissolved Solids (TDS) refer to any minerals, salts, metals, cations, or anions dissolved in water. TDS comprises of inorganic salts (mainly calcium, magnesium, potassium, sodium, bicarbonates, chlorides, sulfates, phosphate, etc.) and some small amounts of organic matter that are dissolved in water. Therefore, the total dissolved solids analysis provides a qualitative measure of the amount of dissolved ions but does not communicate the nature or ion relationships; hence, it is used as an indicator

Table 2. Variations of pH in north Talod taluka

	pH		
Sample	Summer	Winter	Monsoon
S 1	7.72	7.69	7.64
S 2	7.69	7.63	7.58
S 3	7.82	7.74	7.71
S 4	6.97	6.92	6.8
S 5	7.77	7.7	7.64
S 6	7.89	7.81	7.78
S 7	7.66	7.67	7.48
S 8	7.85	7.79	7.69
S 9	7.80	7.76	7.64
S 10	7.89	7.81	7.72
S 11	7.81	7.73	7.70
S 12	7.69	7.71	7.60
S 13	7.57	7.51	7.40
S 14	7.66	7.62	7.52
S 15	7.94	7.88	7.81
S 16	7.85	7.83	7.68
S 17	7.94	7.91	7.79
S 18	7.88	7.83	7.70
S 19	7.67	7.6	7.52
S 20	7.90	7.85	7.76

test to determine the general quality of the water. The acceptable limit of TDS is 500 mg l^{-1} and maximum permissible limit is 2000 mg l^{-1} according to the specifications of Indian Standards. The value of TDS for different samples are reported in Table 3. The overall concentration of TDS was reported between 150 and 1267 mg l^{-1}. The overall quality of groundwater of the area is good but TDS is high in water samples S1, S6, S8, S9, S13, S15, S16, S18 and S20, where it is much higher in the sample S16 (> 1200 mg l^{-1})

Total Hardness (TH)

Total hardness is the total concentration of Ca^{2+} and Mg^{2+} in mg L^{-1} equivalent $CaCO_3$. It mainly occurs from weathering of limestone, sedimentary rock, and calcium bearing minerals. Locally, it may be there in groundwater from chemical and mining industry effluent or excessive application of fertilizers to the soil in agricultural areas. The acceptable and permissible limit of TH by Indian Standards is 200-600 mg l^{-1}. The overall concentration of total hardness was reported between 200 and maximum 860 mg l^{-1} (Table 4). The total hardness was above the limit in water samples from sites S3, S8, S9 and S20, out of which TH of water sample at S9 was on higher side.

Table 3. Variations of total dissolved solids in north Talod taluka

	Total Dissolved Solids (mg l^{-1})		
Sample	Summer	Winter	Monsoon
S 1	729	737	739
S 2	497	503	507
S 3	415	420	423
S 4	369	372	378
S 5	315	322	326
S 6	713	720	727
S 7	150	158	158
S 8	907	911	917
S 9	880	889	892
S 10	325	332	339
S 11	318	328	329
S 12	366	373	378
S 13	607	614	618
S 14	399	407	416
S 15	736	742	747
S 16	1256	1260	1267
S 17	358	367	370
S 18	794	798	800
S 19	293	300	306
S 20	814	823	825

Table 4. Variations in total hardness in north Talod taluka.

	Total Hardness (mg l^{-1})		
Sample	Summer	Winter	Monsoon
S 1	250	266	210
S 2	420	430	437
S 3	650	672	680
S 4	560	584	595
S 5	300	300	310
S 6	300	320	320
S 7	240	247	250
S 8	660	670	680
S 9	830	850	860
S 10	300	318	330
S 11	200	221	230
S 12	390	400	415
S 13	450	467	470
S 14	600	620	630
S 15	200	220	234
S 16	270	280	290
S 17	500	511	520
S 18	290	310	323
S 19	550	566	570
S 20	700	720	732

Calcium

Calcium is essential for human health. Calcium may block the absorption of heavy metals in the body and is thought to increase bone mass and prevent

certain type of cancers. The calcium is directly related to hardness of water. Calcium content in the water samples ranged between 20 -231 ppm (Table 5). The calcium values for ground water samples of sites S2, S4, S8, S9, S13, S14, and S19 were found above the permissible limit of WHO (100 ppm). The highest value of calcium was found at site S8.

Table 5. Variations in calcium in north Talod taluka

	Calcium (mg l^{-1})		
Sample	Summer	Winter	Monsoon
S 1	84	79	76
S 2	147	142	140
S 3	105	99	102
S 4	138	136	134
S 5	71.4	71	63
S 6	75.6	71	68
S 7	46.2	40	39
S 8	231	230	220
S 9	142	137	136
S 10	46.2	47	42
S 11	42	42	39
S 12	84	82	78
S 13	117.6	112	116
S 14	189	189	180
S 15	25.2	20	22
S 16	63	54	55
S 17	71.4	70	70
S 18	67.2	59	60
S 19	126	120	119
S 20	46.2	45	41

Chlorides

Chloride is often associated with sodium since sodium chloride is a common constituent of some water sources, especially ground water and underground water. Chloride values of water samples varied between 42.18 to 522 ppm (Table 6). Chloride values for all the ground water samples were found above the permissible limit of WHO and BIS (250 ppm) except water sample from sites S1, S6, S8, and S16, out of which it was highest at site S16.

Electrical Conductivity (EC)

EC is a measure of ionic content of water. Conductivity is typically reported in units of µs cm^{-1}. This property is related to the total concentration of ionized substances in water. More is the dissolved salts, stronger is the current flow and higher is electric conductivity. The mobility of ions in solution can be seen to be closely related with the total alkalinity. This is not surprising as the flow of water would be proportional to the concentration of the hydroxide ion (alkalinity) in the water. These water points are located within the densely populated areas. Hence, the relatively higher values may be associated to concentrated dissolved salts as a result

Table 6. Variations in chloride in north Talod taluka

	Chloride (mg l^{-1})		
Sample	Summer	Winter	Monsoon
S 1	276.51	266.28	289
S 2	106.35	101	132.4
S 3	85.08	82.2	119.4
S 4	77.99	82	105
S 5	63.81	57.18	75.72
S 6	460.85	452.72	484.19
S 7	49.63	42.18	76.13
S 8	311.96	323.17	389
S 9	319.05	302	338
S 10	92.17	90.34	112.18
S 11	85.08	81.7	131.17
S 12	85.08	80.4	99.68
S 13	184.34	175	208
S 14	141.8	143	176.53
S 15	141.8	128.5	177.2
S 16	496.3	482	522
S 17	77.99	79.02	102.8
S 18	198.52	204.6	229.72
S 19	127.62	119.19	150
S 20	221.7	215.76	241

Table 7. Variations in EC in north Talod taluka

	Electrical Conductivity (µs cm^{-1})		
Sample	Summer	Winter	Monsoon
S 1	1542	1597	1525
S 2	1056	1032	1045
S 3	881	856	840
S 4	774	794	742
S 5	675	672	662
S 6	1499	1476	1489
S 7	319	322	307
S 8	1934	1911	1920
S 9	1874	1856	1862
S 10	692	657	702
S 11	671	657	660
S 12	771	761	757
S 13	1290	1276	1286
S 14	846	834	864
S 15	1566	1546	1534
S 16	2667	2651	2343
S 17	762	784	768
S 18	1690	1687	1667
S 19	623	633	620
S 20	1734	1723	1741

of human activities. EC values of water samples varied between 307 to 2667 ppm (Table 7), while permissible limit is 2250 ppm as specified by the BIS. The water sample from site S16 slightly cross this limit.

Fluoride

Fluoride is more commonly found in ground water than in surface water. The permissible and acceptable range of fluoride are 1.0 and 1.5 mg l^{-1} (as prescribed by the Indian Standards). The fluoride concentration of approximately less than 0.5 to 3.9 mg l^{-1} in drinking water is beneficial to human health, but if the fluoride concentration is more than the permissible limit, then it may cause dental fluorosis, bone fractures, and more seriously skeletal fluorosis. Even though, the concentration ranged have remained same for both season samples. The level of the fluoride was found within the permissible limits except at sites S1, where it is on higher limit (Table 8).

Table 8. Variations in Fluoride in north Talod taluka

	Fluoride		
Sample	Summer	Winter	Monsoon
S 1	3.6	3.9	3.5
S 2	0.5	0.5	0.5
S 3	1.1	1.1	1.0
S 4	1.2	1.3	1.2
S 5	0.8	1.0	0.8
S 6	1.0	1.0	1.0
S 7	0.6	0.6	0.5
S 8	1.5	1.8	1.8
S 9	1.0	1.0	1.0
S 10	1.2	1.3	1.2
S 11	0.9	1.0	1.0
S 12	1.5	1.7	1.4
S 13	1.0	1.1	1.0
S 14	0.9	0.9	0.9
S 15	1.7	1.9	1.6
S 16	1.7	1.8	1.7
S 17	2	1.9	1.9
S 18	2	1.9	1.9
S 19	1.0	0.9	0.8
S 20	1.0	0.9	0.8

Magnesium

Magnesium in the drinking water may have much beneficial effects but at very high levels, it can have some adverse health effects. Magnesium is an essential element in cardiac vascular functions but when present in the drinking water, it may have some laxative effect. Magnesium is also directly related to hardness. Magnesium is often associated with calcium in all kinds of waters, but its concentration remains generally lower than the calcium. Magnesium is essential for chlorophyll and it acts as a limiting factor for the growth of phytoplankton. The permissible limit of magnesium in water in 100 mg l^{-1} by Indian standards. The results are shown in Table 9. The magnesium ions are available in majority of samples within limit, but it exceeds the permissible limit in sample from sites S9 and S20 only.

Table 9. Variations in Magnesium in north Talod taluka

	Magnesium (mg l^{-1})		
Sample	Summer	Winter	Monsoon
S 1	36.46	34.18	29.4
S 2	12.76	17.18	15.11
S 3	94.2	93.2	89.73
S 4	51.9	50.72	45.68
S 5	29.53	31.57	28.17
S 6	26.98	23.67	20.27
S 7	30.26	32.23	29.13
S 8	102.49	103.79	98.92
S 9	144.98	147.7	140.18
S 10	44.97	45.36	41.73
S 11	23.09	20.12	18.42
S 12	43.75	40.72	36.65
S 13	37.92	40.76	38.74
S 14	30.99	28.54	25.82
S 15	33.3	35.32	31.68
S 16	27.34	25.76	22.34
S 17	78.15	74.62	70.24
S 18	29.65	26.38	22.32
S 19	57.12	55.78	52.75
S 20	142.21	137.61	130.4

CONCLUSION

Water samples from 20 sites were selected from north Talod taluka (Gujarat). It was observed that pH, TDS, total hardness, calcium, chloride, electrical conductivity, fluoride, and magnesium from majority of sites were within permissible limits; however, the water samples from sites, S1, S8, S9, and S13 were found slightly above the limits. Therefore, water in this area is reasonable good, except these four sites.

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