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Study of Physico-Chemical Parameters of Ground Water in Selected Areas of South Talod Taluka (Gujarat)

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ABSTRACT

Water is the most essential as it significantly impact human, wild and aquatic lives. The quality of water depends mainly on its contents, physical properties and as well as organic attributes. Rapid growth of industrialization and more utilization of chemical pesticides in agriculture played a major role in degrading quality of water through contamination. Because of using this polluted water, human population experiences some water borne infections. In the present work, quality parameters of water in south Talod taluka have been determined.

Keywords: Ground water**,** pH, TDS, Electrical Conductivity.

INTRODUCTION

The ground water quality in some industrial areas is important from environmental point of view because directly affected human health. Water for drinking and other purposes should have high degree of purity, and therefore, water must be free from any chemical microorganisms and contamination. As the growth of population supported by increased industrialization at a rapid pace, it resulted in deterioration of quality of water. The groundwater is the most valuable and one of the essential prerequisites for survival of life on this planet Earth. Water is a vital constituent of our eco-system and therefore, its evaluation and mapping is necessary, as physical and chemical characteristics of groundwater samples determines its suitability for domestic, agricultural, and industrial purposes.

Kumar and James [1] invetigated physicochemical characteristics of groundwater in Thirupathur area (Tamil Nadu) India. A wide seasonal variation was there in majority of the samples and higher concentration was observed in the pre-monsoon season. It was reported that the fluoride concentration was quite alarming in number of locations. Groundwater was found to be dominated by Na^+, Ca^+, HCO_3 and Cl^-. Gibbs plot showed the dominance of rock–water interaction. The fluoride minerals were considered responsible as major source of fluoride in groundwater.

Mahananda *et al.* [2] studied ground water as well as surface water quality of Bargarh (Orissa) India. They monitored two types of ground water (i) Dug well water and (ii) Bore well water of town as well as three types of ponds: (i) Temple Pond, (ii) Small community pond and (iii) Large community pond. The pH, temperature, total dissolved solids, total suspended solids, dissolved oxygen, alkalinity, chemical oxygen demand, chloride, nitrate, potassium, sodium, fluoride, and phosphate were all below the pollution limit for ground water, and water can be used for domestic, agricultural, and industrial purposes, but the water quality of small community pond was above the permissible limit in case of surface water.

Jinwal and Dixit [**3**] investigated the ground water quality of Bhopal (Madhya Pradesh) India in pre-and post-monsoon periods. It was reported that water quality was better in post-monsoon season as compared to pre-monsoon season. Over exploitation of ground water, urbanization industrialization and anthropogenic activities were considered responsible for water pollution.

Groundwater quality of Ambattur industrial area in Chennai was monitored by Saravanakumar and Kumar [**4**]. They selected ten different locations for this study. Various parameters were studied and it was observed that there was a slight fluctuation in the physico-chemical parameters among these water samples. It was also revealed that groundwater of these areas were above the permitted limit of WHO and ICMR. It was highly contaminated and health hazardous for human use as the quality parameters were above the permissible limits.

Acharya *et al.* [**5**] have collected groundwater samples from different areas of Bhiloda taluka of Sabarkantha district (Guj.) India. They reported results of physico-chemical studies of water samples from thirteen bore wells in Bhiloda taluka. Sodium adsorption ratio (SAR), residual sodium carbonate (RSC) and soluble sodium percentage (SSP) were also estimated along with other quality parameters.

Selvakumar *et al.* [**6**] collected twenty groundwater samples from both; dug well and bore wells of Southern Tiruchirappalli district (Tamil Nadu) India and analyzed for various quality parameters. It was indicated that the groundwater samples of this area was slightly alkaline. It was also revealed that 55 % of the samples were suitable for drinking, while remaining 45% samples were not suitable for drinking. It was reported that groundwater quality of majority of water samples have high medium salinity with low alkali hazards.

Sonkar and Jamal [**7**] observed that groundwater was contaminated around Singrauli coalfield area, which may be attributed to disposal of industrial waste. They analyzed groundwater quality (physicochemical parameters) of Singrauli coalfield region, Singrauli district (Madhya Pradesh) India. Eight groundwater samples were collected from this area: (i) Hand pump and (ii) Dug-wells in pre- and post-monsoons seasons.

Sultan *et al.* [**8**] investigated physicochemical parameters of water samples of Julana and Safidon blocks of district Jind (Haryana) India. Water samples were collected from different localities and quality parameters were compared with permissible limits of Bureau of Indian Standard (BIS), World Health Organization (WHO), and Indian Council of Medical Research (ICMR) standards. The correlation coefficients were also calculated between different parameters and the t-test was used for observing significance. The results showed significant variations in water quality parameters in the study areas.

Anwar and Vanita [**9**] evaluated the groundwater quality of Aligarh city (U.P.) India. They collected groundwater samples from forty wells and these were analyzed for 20 water quality parameters in post-monsoon season. A strong correlation was observed between total hardness and Mg^{2+} (0.99), total hardness (0.88), total dissolved solid (TDS), and chloride (0.87). It was observed that almost all samples have higher alkalinity and magnesium concentrations than the permissible limit by BIS. It was also reported that pH, total dissolved solids, hardness, concentrations of cadmium, iron, and lead, were also above the standard limits of BIS. It was suggested that regular monitoring of groundwater should be done in areas of Aligarh city.

Abubakr *et al.* [10] collected ten underground water samples in down town Srinagar, (Kashmir) India and evaluated their water quality. It was found that ground waters were alkaline in nature and have high total alkalinity, electrical conductivity (EC), magnesium, calcium, iron, nitrate-nitrogen total phosphorus and COD values by contamination of aquifiers due to seepage of nutrient rich domestic sewage. It was revealed that electric conductivity had a positive correlation with total hardness & nitrate-nitrogen sulphate, while there was negative correlation with chloride, iron, ammonical nitrogen, and ortho-phosphate.

Arulnangai *et al.* [11] collected twelve ground water samples from different areas in Ariyalur district (Tamil Nadu) India and analyzed for their physicochemical parameters. Water quality index indicated that the majority of these groundwater samples were not suitable for drinking purpose.

Shaibur *et al.* [12] investigated drinking water quality of Jashore University of Science and Technology (JUST) campus and nearby four villages. Total thirty-seven water samples were collected from shallow as well as deep tube wells. It was indicated that the concentrations of all parameters except Mn were within the permissible limits of Bangladesh and World Health Organization. It was reported that Mn and As concentrations were relatively much higher than the recommended limits for samples collected from Belermath, Shamnagor and Sajiali villages; however, concentration of arsenic in groundwater at Islampur village was lower than maximum permissible limit, and Mn concentration was higher in samples of all the tube wells in this village.

Popoola *et al.* [13] investigated groundwater quality of samples collected from two industrial and residential locations in Lagos metropolis. It was reported that physicochemical parameters of these samples were within the permissible ranges prescribed by WHO and NSDWQ except pH, EC, TDS, Mn, Pb, and Fe for groundwater samples from industrial locations and pH, Mn, Pb, and Fe from residential locations. It was revealed that higher EC and TDS of samples from industrial locations may be due to heavy discharge of effluents from industrial treatment plants and also heavy metals from industrial activities.

MATERIALS AND METHODS

Sample Collection: Samples were collected in pre-cleaned 500 mL polyethylene bottles. The water samples were collected from 20 villages of South 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:

Table 1. Site of samples

Sample Name	Villages	Sample Name	Villages
S1	Kalmipura	S11	Sagpur
S2	Balishna	S12	Dolatabad
S3	Sultanpur	S13	Karmipura
S4	Gobarjini Muvadi	S14	Mahiyal Talod
S5	Nani Siholi	S15	Salatpur
S6	Tantarda	S16	Vaktapur
S7	Nava Vas	S17	Ujediya
S8	Ankhol	S18	Toraniya
S9	Ranipura	S19	Mahekal
S10	Padusan	S20	Jasajini Muvadi

RESULTS AND DISCUSSION

pH: In general, groundwater has a pH between 7 and 8. Water with a pH below 6.5 is regarded as acidic, soft, and corrosive. Additionally, water with an acidic pH denotes the presence of high levels of toxic metals. The pH is now a crucial parameter to watch because of this reason. Low pH in the water can result in premature piping damage and aesthetic issues like a metallic or sour taste. The pH of samples is reported in table 2.

Table 2. Variations of pH in south Talod taluka

Sample	Summer	Winter	Monsoon	Sample	Summer	Winter	Monsoon
S1	7.30	7.23	7.19	S11	7.83	7.77	7.69
S2	7.77	7.72	7.68	S12	7.63	7.66	7.52
S3	7.72	7.66	7.63	S13	7.57	7.60	7.42
S4	7.73	7.76	7.61	S14	7.74	7.72	7.59
S5	7.85	7.82	7.68	S15	8.00	8.02	7.80
S6	7.52	7.56	7.41	S16	7.89	7.92	7.71
S7	7.94	7.84	7.78	S17	8.14	8.07	7.88
S8	7.76	7.73	7.61	S18	7.89	7.84	7.73
S9	7.36	7.39	7.20	S19	8.00	8.01	7.88
S10	7.40	7.43	7.27	S20	7.90	7.93	7.73

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

Total Dissolved Solids (TDS): Any minerals, salts, metals, cations, or anions that have been dissolved in water are referred to total dissolved solids. The TDS is made up of dissolved organic matter and small amounts of inorganic salts, primarily calcium, magnesium, potassium, sodium, bicarbonates, chlorides, sulphates, and phosphate. Total dissolved solids analysis serves as an indicator test to assess the overall water quality because it gives a qualitative measurement of the amount of dissolved ions but does not convey their nature or ion relationship. According to Indian Standards, the acceptable limit of TDS is 500 mg L^{-1}, and the maximum permissible limit is 2000 mg L^{-1}. Table 3 presents the TDS values for various samples. The overall concentration of TDS ranged between 249 and 1645 mg L^{-1}. Although groundwater quality of this area is good, but water samples from S2, S9, S10, S13, S18, S19, and S20 sites have higher TDS levels.

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

Total Dissolved Solids (mg L^{-1})							
Sample	Summer	Winter	Monsoon	Sample	Summer	Winter	Monsoon
S1	484	490	494	S11	474	479	482
S2	661	669	672	S12	337	340	346
S3	407	415	419	S13	607	609	606
S4	249	257	261	S14	303	310	312
S5	424	430	437	S15	399	402	406
S6	379	386	390	S16	341	348	349
S7	497	502	508	S17	438	443	448
S8	359	368	371	S18	1109	1115	1117
S9	988	990	995	S19	620	627	629
S10	1398	1399	1402	S20	1633	1641	1645

Total Hardness (TH): Total hardness is equal to the sum of the Ca^{2+} and Mg^{2+} concentrations in mg L^{-1} equivalent $CaCO_3$. It primarily results from the weathering of sedimentary rock, calcium-bearing minerals, and limestone. It may be present locally in groundwater due to chemical and mining industry effluents or excessive use of fertilizer in nearby agricultural areas. According to Indian Standards, 200 and 600 mg L^{-1} of TH is the acceptable and permissible limit, respectively. The maximum overall was reported between 220 and 1550 mg L^{-1} as total hardness concentration (Table 4). Water samples from sites S1, S2, S3, S6, S9, S10, S18, S19, and S20 had total hardness levels above the permitted level.

Table 4. Variations in total hardness in south Talod taluka

Total Hardness (mg L^{-1})							
Sample	**Summer**	**Winter**	**Monsoon**	**Sample**	**Summer**	**Winter**	**Monsoon**
S1	920	932	940	S11	330	345	350
S2	800	840	848	S12	550	560	560
S3	770	800	810	S13	600	610	620
S4	600	623	630	S14	350	360	370
S5	500	500	510	S15	310	330	340
S6	1000	972	980	S16	470	470	537
S7	220	237	240	S17	500	530	1267
S8	570	580	588	S18	1270	1270	1110
S9	1350	1330	1330	S19	1100	1120	1273
S10	1520	1540	1550	S20	1270	1260	1260

Calcium: The human body needs calcium for good health. Calcium boosts bone mass, prevents some types of cancer, and possibly block the absorption of heavy metals by body. The calcium and water hardness are directly related. The calcium concentrations ranged from 39 to 475 mg L^{-1} (Table 5). The calcium levels have higher values in than the WHO's from Sites S1, S2, S4, S6, S8, S9, S11, S12, S13, S18, S19, and S20 samples of ground permissible limit in water (mg L^{-1}). Site S10 had the highest calcium concentration.

Table 5. Variations in calcium in south Talod taluka

Calcium (mg L^{-1})							
Sample	**Summer**	**Winter**	**Monsoon**	**Sample**	**Summer**	**Winter**	**Monsoon**
S 1	252	247	240	S 11	105	99	98
S 2	147	146	140	S 12	126	120	112
S 3	67.2	62	60	S 13	113	107	109
S 4	117	117	105	S 14	76	68	64
S 5	59	56	52	S 15	42	39	41
S 6	113	112	107	S 16	92	87	85
S 7	42	41	42	S 17	71	64	67
S 8	134	129	126	S 18	315	302	302
S 9	260	261	242	S 19	231	217	212
S 10	476	470	443	S 20	302	289	291

Chloride: A common component of water sources is chloride, particularly in ground water and underground water. Sodium chloride is frequently associated with chloride. A range of 50.7 to 794 mg L^{-1} chloride was found in water samples of this area (Table 6). All ground water samples, except from sites S9, S10, and S18, had chloride values that were higher than the WHO and BIS permissible limit (250 ppm) where as sample from site S20 had the highest chloride levels.

Table 6. Variations in chloride in south Talod taluka

Chloride (mg L^{-1})							
Sample	**Summer**	**Winter**	**Monsoon**	**Sample**	**Summer**	**Winter**	**Monsoon**
S1	141.8	138.4	184.0	S11	99.3	78.6	120.1
S2	184.3	180.1	200.0	S12	106.4	102.0	116.8
S3	99.3	89.2	120.0	S13	212.7	208.7	223.0
S4	56.7	50.7	78.6	S14	156.0	134.4	181.1
S5	85.1	82.7	107.8	S15	70.9	73.8	104.0
S6	106.3	101.0	132.7	S16	85.1	81.0	103.2
S7	106.3	110.0	138.0	S17	70.9	68.7	83.8
S8	70.9	69.2	108.7	S18	638.1	613.8	588.2
S9	425.4	416.0	455.0	S19	191.4	182.0	190.5
S10	602.6	592.0	628.2	S20	794.1	778.0	755.0

Electrical Conductivity (EC): Ionic content of water is quantified by EC. Unit S cm^{-1} is commonly used to express conductivity. The concentration of total amount of ionized substance in water is related to this property. When there are more dissolved salts, the current flow is stronger and the electric conductivity is higher. It is clear that the total alkalinity and the mobility of ions in solution are closely related. The amount of hydroxide ions (alkalinity) in the water is inversely proportional to its flow. Such water sites can be found in densely populated areas. The relatively higher values may be attributed to concentrated dissolved salts disposed of by human activity. The permissible limit is 2250 mg L^{-1} (BIS) but the EC values of the water samples from this area ranged from 530 to 3475 mg L^{-1} (Table 7). The water samples from sites S10 and S18 just exceeds this threshold, but much higher at site S20.

Table 7. Variations in EC in south Talod taluka

Electrical Conductivity (μS cm^{-1})							
Sample	**Summer**	**Winter**	**Monsoon**	**Sample**	**Summer**	**Winter**	**Monsoon**
S1	1290	1284	1303	S11	1012	1023	1007
S2	1420	1407	1401	S12	719	722	707
S3	866	855	842	S13	1029	1037	1023
S4	530	542	530	S14	647	631	646
S5	901	877	898	S15	846	829	834
S6	805	787	764	S16	779	798	764
S7	1056	989	1014	S17	931	1001	948
S8	762	770	758	S18	2356	2327	2397
S9	2099	2058	2117	S19	1319	1337	1346
S10	2972	2956	2968	S20	3475	3441	3467

Fluoride: Ground water contains fluoride more frequently than surface water. The acceptable and permissible range of fluoride is between 1.0 and 1.5 mg L^{-1} (as prescribed by the Indian Standards). Drinking water with a fluoride concentration between 0.4 and 2.8 mg L^{-1} is beneficial to human health, but if the concentration exceeds the permissible limit, it may result in dental fluorosis, skeletal fluorosis or more seriously bone fractures. The fluoride level was found to be higher at S2, S5, S7, S11, S15, and S17, while in other samples, it was within the allowable limits (Table 8).

Table 8. Variations in Fluoride in south Talod taluka

Fluoride (mg L^{-1})							
Sample	**Summer**	**Winter**	**Monsoon**	**Sample**	**Summer**	**Winter**	**Monsoon**
S1	1.3	1.4	1.2	S11	1.8	2.0	2.1
S2	1.8	1.9	1.6	S12	1.0	1.1	1.1
S3	0.9	1.0	1.0	S13	1.1	1.2	1.1
S4	0.6	0.9	0.6	S14	0.6	0.6	0.6
S5	1.8	1.9	1.6	S15	2.7	2.8	2.7
S6	0.8	1.0	1.0	S16	1.0	1.1	1.0
S7	1.7	1.9	1.5	S17	1.5	1.6	1.4
S8	0.5	0.5	0.4	S18	0.9	0.9	0.9
S9	0.8	0.8	0.8	S19	0.8	0.8	0.8
S10	0.6	0.6	0.6	S20	0.9	1.0	0.6

Magnesium: Magnesium in drinking water may have many positive effects, but at very high levels, it may also have some adverse effects on health. Magnesium is a component that is necessary for cardiac and vascular health, but when it is present in drinking water, it can have a laxative effect also. Magnesium and hardness go hand in hand. Magnesium and calcium are frequently found together in all types of waters, but the concentration of magnesium is typically lower than that of calcium. Magnesium is necessary for the production of chlorophyll and limits the growth of phytoplankton. According to Indian Standards, the maximum amount of magnesium in water is 100 mg L^{-1}. Table 9 displays the results. The majority of samples contain enough magnesium ions within limits, but only samples from sites S2, S3, S6, S9, S18, S19, and S20 have levels of magnesium that are high.

Table 9. Variations in magnesium in south Talod taluka

Magnesium (mg L^{-1})							
Sample	**Summer**	**Winter**	**Monsoon**	**Sample**	**Summer**	**Winter**	**Monsoon**
S1	70.49	68.72	65.89	S11	16.40	20.68	18.29
S2	105.14	102.24	98.49	S12	57.12	60.17	54.68
S3	146.34	143.88	139.21	S13	74.09	75.80	68.55
S4	74.38	71.36	67.34	S14	39.13	40.72	35.68
S5	85.81	86.73	81.45	S15	49.83	46.29	41.46
S6	174.18	170.12	164.65	S16	58.10	60.71	57.62
S7	27.95	30.89	28.27	S17	29.53	32.65	29.79
S8	56.88	55.42	51.32	S18	270.44	264.72	252.68
S9	169.92	162.98	150.76	S19	127.01	130.32	122.34
S10	81.07	84.72	76.18	S20	124.90	128.60	122.76

CONCLUSION

Water samples from twenty different sites were collected from south Talod taluka (Guj.) 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 S2, S9, S10, S18, S19, and S20 were found slightly above the limits. Therefore, water in this area is selectively good, expect these six sites.

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