



Quality Assessment of water samples of open wells (Pre and Post Monsoon Season) at Godhra, Panchmahal District, India.

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ABSTRACT:

This study was intended to assess degree of hydrogeochemical contamination of the ground water in and around Godhra campus and the industrial estates. Beginning the financial year 2018-2019 up to the financial year 2020-2021, a comparative study was made to determine the underground well water quality. Surface water samples were obtained from selected stations in different war areas before and after two successive monsoon periods. It was established from the results that there was an equivalence of the pre and post monsoon pH values which reflected values of 6. 4 to 7. 95. Nevertheless, significant shift was recorded with regard to the TDS which varied between 393 and 640 mg/L. Other parameters like TH, Chloride, DO, COD and BOD remained almost unchanged and observed concentrations were observed in the range of 95-286 mg/L for TH and 8-52 mg/L for Chloride. 8-24 mg/L for Chloride, 6 iodine/VAC. 5 to 8. 1 mg/L for DO, 1. 2 to 2. 8 ‘mg/L for COD, and 0. 8 to 2. 9 mg/L for BOD. Nevertheless, the Electrical Conductivity or EC value has a large variation reaching from 779 to 1100 μ S/cm. All the physicochemical parameters measured were within the acceptable limits set by the World Health Organization (WHO) and IS:15100 samples of groundwater compliance with Australian Standard 10500:2012 for drinking water implying that there was no chemical contamination by hazardous chemicals in the groundwater of the study area.

Keywords: Ground water, water quality standards, physico-chemical parameters, Water Quality

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Introduction

Hydrogen within water is responsible for forming landforms, weather condition, and climatic changes, becoming an important element for life. Of all the forms of water, groundwater serves a great purpose in domestic usage, industries, and for irrigation all over the world. Over the past few decades the consumption of fresh water has rapidly grown greatly because of increase in population as well as industrialization. Once water has been poisoned, it is next to impossible to reverse the effect thus the need to protect groundwater. The water soluble compounds are primarily derived from the soils and sedimentary rocks which dissolve them



in the water. While evaluating the drinking water quality, most often it is qualified according to its fitness for use and most of the classification systems include factors such as specific conductance, sodium and boron content.

MATERIALS AND METHODS

The area of focus is Panchmahal district in the eastern part of Gujarat which receive high levels of rainfall and has sub-tropical climate with moderate humidity (K. M Nayak, Personal Communication April 2014). There are few underground CAET wells located in the Dholakuva area of the Godhra city in Gujarat which forms the basis of the study. In all, four water samples were taken from the underground wells in the CAET compound as well as the sample collected from Kanelav Talav. The tube well water samples were collected in clean, dry glass bottles as the samples were let to flow for five minutes. To minimize the possibility of contamination during sample collection the samples were preserved in black containers and analysis was done within a maximum of 24 hours from the time they were collected. This study measured various physical and chemical parameters of the water samples, with the results compared to established water quality standards, including those set by the World Health Organization (WHO), Central Public Health, and IS: P60 PUG award 10500-2012. In analysis, only Analytical Reagent (AR) quality chemicals were used, and distilled deionized water was used for preparation of reagents. The water quality characteristics determined in the present study were pH, dissolved oxygen, total alkalinity, TDS, calcium and magnesium bicarbonate, chlorides, and effective calcium.

RESULTS AND DISCUSSION

Table 1: Pre and Post Monsoon Analysis Results (2018-19)

Sample taken from	pH pre	pH post	TDS pre (ppm)	TDS post (ppm)	TH pre (ppm)		Chlorid e pre (ppm)	Chlorid e post (ppm)	DO pre (ppm)	DO post (ppm)	EC pre (Micro Siemens/cm)	EC post (Micro Siemens/cm)	COD pre (ppm)	COD post (ppm)	BOD pre (ppm)	BOD post (ppm)
Is:10500:2012 Standard Value Of Drinking Water	6.5-8.5		Less than 500		Less than 250		Less than 250		Greater than 5		Lesser than 2500		Upto 10		Upto 5	
Pond	7.86	7.2	500	502	208	286	8.8	10.1	8	7.8	779	896	2.8	2.2	1.1	1.6
Open Well No.1	6.73	6.4	406	396	198	212	10.3	10.7	8.1	8.3	788.3	815.1	1.6	1.8	0.8	0.8
Open Well No.2	7.05	6.91	455	459	203	216	10.6	11.4	7.4	7.2	906.3	921.4	1.4	1.8	1.1	1.2
Open Well No.3	6.74	7.22	473	472	200	209	11.7	11.7	7.9	6.9	938.8	929.1	1.6	1.6	1	1.5
Open Well No.4	7.24	7	467	491	196	255	10.8	11	7.4	7.8	875.5	883	1.8	1.9	1.1	1.7



Table 2: Pre and Post Monsoon Analysis Results (2019-20)

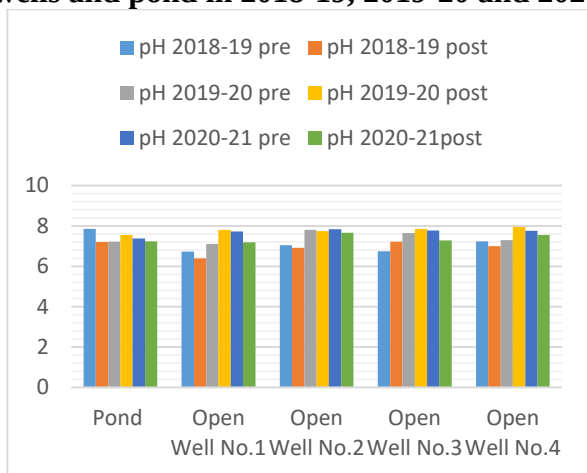
Sample taken From	pH pre	pH post	TDS pre (ppm)	TDS post (ppm)	TH pre (ppm)	TH post (ppm)	Chloride pre (ppm)	Chloride post (ppm)	DO pre (ppm)	DO post (ppm)	EC pre (Micro Siemens/cm)	EC post (Micro Siemens/cm)	COD pre (ppm)	COD post (ppm)	BOD pre (ppm)	BOD post (ppm)
Is:10500:2012 Standard Value Of Drinking Water	6.5-8.5		Less than 500		Less than 250		Less than 250		Greater than 5		Lesser than 2500		Upto 10		Upto 5	
Pond	7.22	7.55	488	512	202	207	17.8	10.3	6.8	8	983	999	1.5	1.7	2.1	2
Open Well No.1	7.1	7.81	458	640	260	120	19.2	10.6	7.1	7.2	878	898	1.8	1.6	1.9	1.7
Open Well No.2	7.8	7.75	393	576	280	205	21.7	19.4	7.7	8.1	1087	1096	1.2	1.2	1.7	1.9
Open Well No.3	7.65	7.85	483	492	266	125	23.6	23.3	7	7.4	1047	1055	1.4	1.5	1.8	1.9
Open Well No.4	7.3	7.95	479	576	160	95	12.8	18.5	6.5	6.6	978	1063	1.6	1.8	1.6	1.6

Table 3: Pre and Post Monsoon Analysis Results (2020-21)

Sample taken from	pH pre	pH post	TDS pre (ppm)	TDS post (ppm)	TH pre (ppm)	TH post (ppm)	Chloride pre (ppm)	Chloride post (ppm)	DO pre (ppm)	DO post (ppm)	EC pre (Micro Siemens/cm)	EC post (Micro Siemens/cm)	COD pre (ppm)	COD post (ppm)	BOD pre (ppm)	BOD post (ppm)
Is:10500:2012 Standard Value Of Drinking Water	6.5-8.5		Less than 500		Less than 250		Less than 250		Greater than 5		Lesser than 2500		Upto 10		Upto 5	
Pond	7.38	7.23	601	599	212	218	24	20.4	7	7.7	1110	1033	2.1	2	2.5	2.9
Open Well No.1	7.72	7.18	560	565	190	200	21.1	22	6.9	7.2	880	926	1.9	1.8	2.2	2.5
Open Well No.2	7.84	7.66	538	542	165	173	22.2	23	6.6	6.8	1018	1069	1.7	2.2	2.3	2.4
Open Well No.3	7.78	7.28	595	598	208	197	19	21.4	7	7.4	947	1008	2.4	2.3	2.3	2.3
Open Well No.4	7.76	7.56	589	592	180	178	20.4	18.8	7	7.5	1056	1067	2	1.9	2	2.6

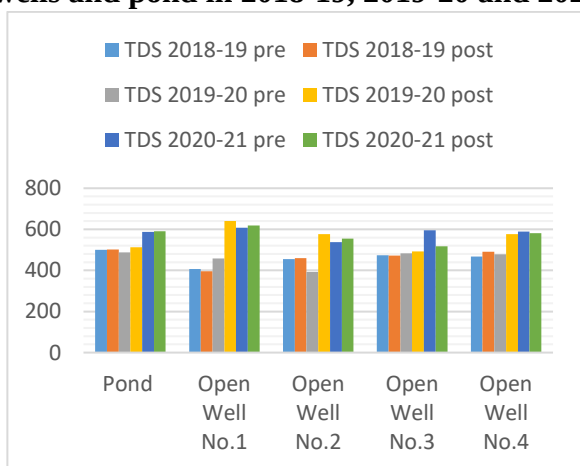


Fig.1 Graphical representation of pH of Pre and Post monsoon water of all the four wells and pond in 2018-19, 2019-20 and 2020-21.



The pH value of drinking water is actually one of important quantitative estimates of how acidic or all interactions are between the minerals and organic com the water. In the wells analysed, pH fell between 6. 4 t pH below 6. 5 can often cause the corrosion of pipe an posionous to health. However, in all the water samf from both wells and the pond, the pH levels were fo within the acceptable range set by the IS: For drinking standard is the 10500:2012.

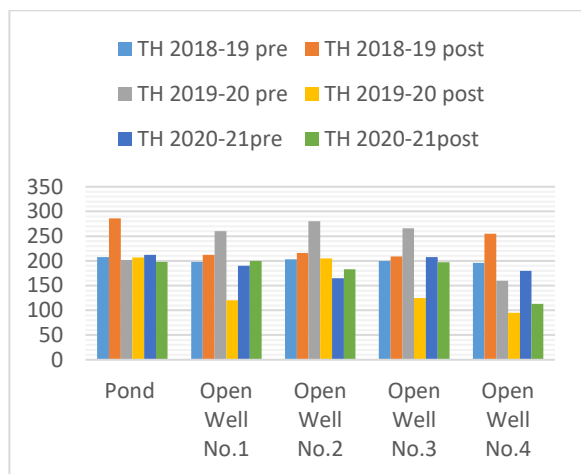
Fig.2 Graphical representation of TDS of Pre and Post monsoon water of all the four wells and pond in 2018-19, 2019-20 and 2020-21.



In other words, TDS is sum of the cations and anions concentration.

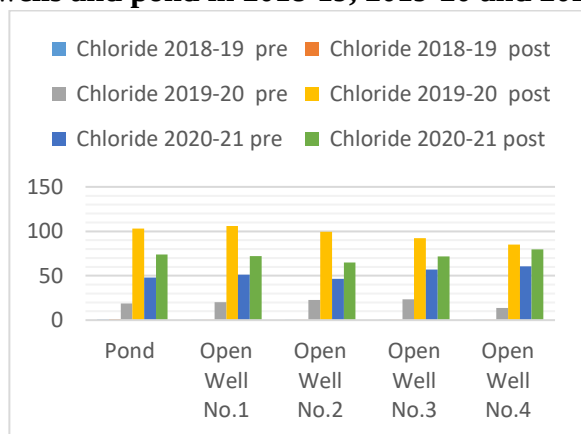
In 2020-21 water samples from all the wells in pre and post monsoon TDS is found between 393 and 640 mg/L, well below the accepted limit given by IS:10500:2012 Standard value for drinking water in majority of wells, except in pond and all wells in post monsoon 2020-21 & 2019-20, but still below the permissible limit. Increase in TDS during pre monsoon is due to evaporation effect while in post monsoon increase is contributed by dissolution of salt and industrial discharge by rain water.([R.V.kupwade etal, Sep. 2013](#))

Fig.3 Graphical representation of TH of Pre and Post monsoon water of all the four wells and pond in 2018-19, 2019-20 and 2020-21



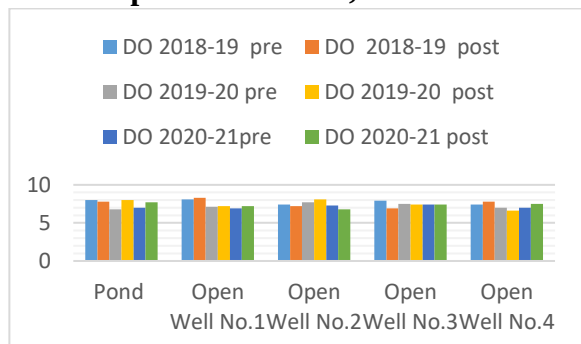
Total Hardness, indicates calcium and magnesium content which here ranges from 95 to 286 mg/L, which is well below accepted value of 250 mg/L in majority of cases except bit higher in pond in post monsoon 2018-19 and in pre monsoon well no. 1,2 and 3. Variation in hardness is due to leaching of carbonate and bicarbonate salts in rainy season. (R.V.kupwade et al, Sep. 2013)

Fig.4 Graphical representation of Cl^- of Pre and Post monsoon water of all the four wells and pond in 2018-19, 2019-20 and 2020-21



The World Health Organization (WHO) and IS: The NZidendri: 10500:2012 does not have a defined health based guideline value for chloride in drinking water. Thus, concentrations of chloride greater than 250 ppm causes a definite taste in the water. In the present investigation, the sum of chloride concentrations varied from 8. from 8 to 24 mg/L, which did not influence the taste perception and exceeded the concentration that can be detected by human senses only slightly.

Fig.5 Graphical representation of DO of Pre and Post monsoon water of all the four wells and pond in 2018-19, 2019-20 and 2020-21.

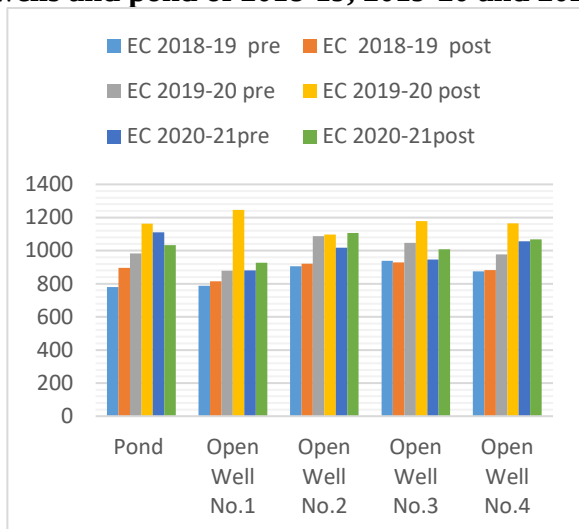


It ranged from 6.5 to 8.1 mg/L. Dissolved oxygen is used as an indicator of the health of a water body.

According to prescribed limit by WHO, DO content of water should be greater than 5mg/L and which is found so in case of all the four wells and pond water samples. Dissolved Oxygen (DO) levels in natural and wastewater waters are determined by various physical, chemical, and biochemical processes occurring within them. (Ramakrishnaiah et al., 2009).

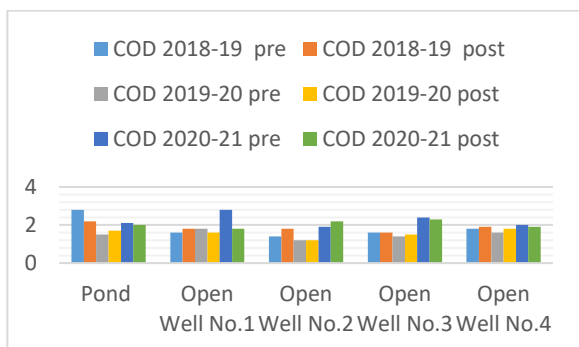


Fig.6 Graphical representation of EC of Pre and Post monsoon water of all the four wells and pond of 2018-19, 2019-20 and 2020-21.



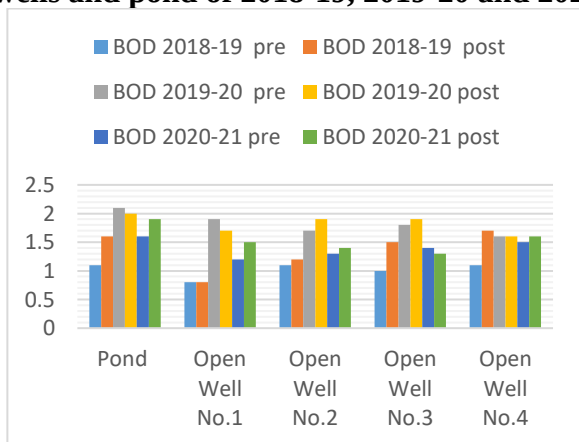
Conductivity provides a quick and straightforward method to identify water's ionic content (Mayur C. Shah et al., July 2008). In this study, electrical conductivity values ranged from 779 to 1110 microsiemens/cm, all of which fell within the permissible limits set by the IS:10500:2012 is the standard for drinking water.

Fig.7 Graphical representation of COD of Pre and Post monsoon water of all the four wells and pond of 2018-19, 2019-20 and 2020-21.



Chemical Oxygen Demand (COD) measurements taken from both wells and the pond ranged from 1.2 mg/L to 2.8 mg/L, well below the acceptable limits set forth by IS:10500:2012 Standard for drinking water.

Fig.8 Graphical representation of BOD of Pre and Post monsoon water of all the four wells and pond of 2018-19, 2019-20 and 2020-21.



The BOD of water samples from the pond and wells was found to be between 0 and 6; 8 to 2.9 mg/L, which is well within the permissible limits set by the IS:10500:2012 Standard: Drinking water.



Results (based on statistical analysis):

Table 4:

pH 6.5–8.5	2018-19		2019-20		2020-21		pooled	
	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon
Average	6.94	6.88	7.46	7.82	7.78	7.42	7.39	7.37
Std. dev	0.21	0.33	0.32	0.13	0.05	0.21	0.19	0.22
CV%	3.10	0.35	4.29	0.04	0.64	0.23	2.64	3.04
* t stat							0.17	

The minimum variance value (% CV=1.62) in case of pH was found in Post monsoon in 2019-20 and maximum variance value (% CV=6.46) was found in Pre monsoon in 2018-19(Table 4)

Table 5:

TDS < 500	2018-19		2019-20		2020-21		Pooled	
	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon
Average	450.25	454.5	453.25	571.00	570.5	574.25	491.33	533.25
Std. dev	30.43	41.15	41.64	60.70	26.51	25.85	42.57	42.57
CV%	6.76	9.05	9.19	10.63	4.65	4.50	8.66	7.98
* t stat							2.04	

Statistical analysis shows that the lowest (% CV=4.31) for TDS was found in Post monsoon season in 2020-21 and maximum variance(% CV=10.07) in Pre monsoon in 2019-20 (Table 5).

Table 6:

TH < 500	2018-19		2019-20		2020-21		Pooled	
	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon
Average	199.25	223	241.75	136.25	185.75	187	208.92	182.08
Std. dev	2.99	21.53	55.21	41.29	18.04	13.49	25.41	25.43
CV%	1.50	9.65	22.84	30.30	9.71	7.21	12.16	13.97
t stat							1.45	

The Total Hardness measurements taken from the water samples were, therefore, highly variable. It was seen that the post monsoon period of 2019-20 has the highest variance having the % CV of 30. 93%. On the other hand % CV was lowest in pre-monsoon period of 2018-19 with 2 only. 33 (Table 6).

Table 7:

Chloride < 250	2018-19		2019-20		2020-21		Pooled	
	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon
Average	10.85	11.2	19.33	17.95	20.675	21.3	16.95	16.82
Std. dev	0.60	0.44	4.71	5.32	1.34	1.79	2.22	2.52
CV%	5.56	3.93	24.36	29.66	6.48	8.42	12.13	14.00
t stat							0.14	



Samples of Post monsoon in 2018-19 showed lowest variance (% CV=5.67) for chloride value and of Post monsoon in 2019-20 showed highest variance (% CV=34.97) among all the underground wells of CAET (Table 7).

Table 8:

DO >5	2018-19		2019-20		2020-21		pooled	
	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon
Average	7.7	7.55	7.33	7.35	6.875	7.225	7.30	7.38
Std. dev	0.36	0.62	0.33	0.62	0.19	0.31	0.29	0.52
CV%	4.62	8.27	4.51	8.50	2.75	4.28	3.96	7.02
t stat							0.60	

Statistical analysis shows that the lowest (% CV=2.51) for DO value was found in Pre monsoon season in 2020-21 and maximum variance (% CV=8.21) in Post monsoon in 2019-20 (Table 8).

Table 9:

EC <2500	2018-19		2019-20		2020-21		pooled	
	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon
Average	877.23	887.15	997.50	1171.25	975.25	1017.5	949.99	1025.30
Std. dev	64.67	52.09	91.51	61.54	67.49	67.24	74.56	60.29
CV%	7.37	5.87	9.17	5.25	6.92	6.61	7.85	5.88
* t stat							2.41	

Highest variance (% CV=8.30) for EC showed in Pre monsoon water samples of 2018-19 and lowest variance (% CV=4.57) shown by water samples of Post monsoon in 2019-20 (Table 9).

Table 10:

COD up to 10	2018-19		2019-20		2020-21		pooled	
	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon
Average	1.6	1.78	1.50	1.53	2	1.48	1.70	1.59
Std. dev	0.16	0.13	0.26	0.25	0.29	0.25	0.24	0.21
CV%	10.21	7.09	17.21	16.39	14.72	16.95	14.04	13.11
t stat							0.96	

Chemical Oxygen Demand (COD) values for water samples under study displayed different degrees of variance. Pre-monsoon 2020-21 saw the lowest variance, with an annual coefficient of variation (% CV) rate of 12.81% while underground wells at CAET experienced highest variance with 30.16% in 2018-19 (Table 10).

Table 11:

BOD up to 5	2018-19		2019-20		2020-21		pooled	
	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon	Pre Monsoon	Post Monsoon
Average	1	1.3	1.75	1.775	2.2	1.45	1.65	1.51
Std. dev	0.14	0.39	0.13	0.13	0.14	0.13	0.14	0.22
CV%	14.14	30.12	7.38	7.32	6.43	8.90	8.32	14.38
t stat							0.95	



Statistical analysis shows that the lowest (% CV=8.04) was found for BOD in Pre monsoon season in 2020-21 and maximum variance (% CV=26.82) in Post monsoon in 2018-19 (Table 11).

Conclusion:

Analysis of various drinking water parameters collected from underground wells over three years reveals that their physical-chemical characteristics generally meet or surpass WHO and IS:10500:2012 standards for drinking water quality. Yet despite this agreement, analytical results show that most groundwater samples may still not be suitable for consumption (R. Arulnangai et al., 2021).

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Published in Volume 02, Issue 03, June 2024.

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