
ANALYSIS OF GROUND WATER QUALITY USING PHYSICOCHEMICAL PARAMETERS AND WATER QUALITY INDEX FROM ELURU MANDAL, WEST GODAVARI DT, AP, INDIA.

Dr CA Jyothirmayee

Associate Professor in Chemistry, Ch SD St Theresa's College for Women, Eluru, AP

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Abstract: "Eluru" is the headquarters of the West Godavari district, one of the nine coastal districts of Andhra Pradesh State. Agriculture is the main stay of population in the district. The district is having both surface and ground water resource potential. The delta area is mainly served by surface irrigation, whereas in the upland areas of the district the irrigation is chiefly by ground water. Physio graphically the district is divided into 2 natural regions. viz., Alluvial plain and upland areas. The different type of soils encountered in the district are red soils, black cotton soils, deltaic alluvial soils and coastal sands. In general, the ground water is suitable for drinking and irrigation purposes in crystallines, sedimentaries while that occurring in alluvium the water is not suitable for drinking purpose and irrigation purpose under ordinary conditions.

Water pollution is one of the major and most critical issues in India, as almost 70 per cent of the surface water resources and various groundwater reserves are contaminated by biological, toxic, organic and inorganic pollutants. Deep tube wells, hand pumps and private bore wells are the main sources for extraction of groundwater in the Eluru mandal to cater the water demand of the population. It is in this context, the ground water quality is determined in twelve mandals in the upland area of the West Godavari dt. In Physico-chemical analysis, various quality parameter are measured including pH, turbidity, electrical conductivity (EC), total dissolved solids (TDS), total hardness (TH), content of calcium (Ca^{2+}), magnesium (Mg^{2+}), chloride (Cl^-), sulphate (SO_4^{2-}), Iron (Fe), DO, BOD, COD, Total alkalinity (TA) and Nitrate (NO_3^-) concentration present in ground water. Also all parameters were compared with ICMR standards of water quality. In the present research paper water samples of Eluru mandal was classified on the basis of TDS and TH.

Keywords: Ground Water, Physico-Chemical Analysis, TH, TDS, Eluru Mandal.

Introduction: Water plays an essential role in human life. Although statistics, the WHO reports that approximately 36% of urban and 65% of rural Indian were without access to safe drinking water. Fresh water is one of the most important resources crucial for the survival of all the living beings. It is even more important for the human being as they depend upon it for food production, industrial and waste disposal, as well as cultural requirement. Human and ecological use of ground water depends upon ambient water quality. Human alteration of the landscape has an extensive influence on watershed hydrology. Ground water is considered as one of the purest forms of water available in nature and meets the overall demand of rural as well as urban population. Ground water plays a vital role in human life. Increase in urbanization, industrialization, agriculture activity and various human activities increase the pollution of surface water & ground water. Once the groundwater is contaminated, its quality cannot be restored back easily and we need to devise ways and means to protect it (Maniyar, 1990). Consequently number of cases of water borne diseases has been seen which cause health hazards [Elizabeth and Naik, 2005; Aremu et al., 2011].

An understanding of water chemistry is the bases of the knowledge of the multidimensional aspect of aquatic environmental chemistry which involves the source, composition, reactions and transportation of water. The quality of water is of vital concern for the mankind since it is directly linked with human welfare. Therefore, monitoring the quality of water is one of the essential issues of drinking water

management (Shama et al., 2011). Considering the above aspects of groundwater contamination, the present study was undertaken to investigate the impact of the groundwater quality water samples at Eluru mandal of West Godavari district, A.P, India. To communicate information on the quality of water to the concerned citizens and policy makers, analysis of water is utmost important. It is thus, becomes an important factor for the assessment and management of ground water. Thus, in this research work an attempt has been made to assess the physical and chemical parameters of ground water. As the safe & potable drinking water is needed. various treatment methods are adopted to raise the quality of drinking water. Water should be free from the various contaminations viz. Organic and Inorganic pollutants, Heavy metals, Pesticides etc. as well as all its parameter like pH, Electrical Conductivity, Calcium, Magnesium, Total Hardness, Carbonate, Bicarbonate, Chloride, Total Dissolved Solid, Alkalinity, Sodium, Potassium, Nitrate, DO should be within a permissible limit. During last decade, this is observed that ground water get polluted drastically because of increased human activities. Consequently number of cases of water borne diseases has been seen which a cause of health hazards.

Study Area: Eluru is the headquarters of the West Godavari district, one of the nine coastal districts of Andhra Pradesh State. Agriculture is the main stay of population in the district. The district is having both surface and ground water resource potential. The delta area is mainly served by surface irrigation, whereas in the upland areas of the district the irrigation is chiefly by ground water. The main source of drinking water is ground water except in very few places where it is surface water.

Water Sampling: In present investigation water samples were collected in polythene bottles which were cleaned with acid water, followed by rinsing twice with distilled water. The water samples are chemically analyzed. The analysis of water was done using procedure of standard methods.

Methodology:

- The pH and Turbidity was measured by using nephelometrically using Systronics.
- EC was measured by using Elico.
- TDS was measured by using EUTECH(digital).
- Total hardness, calcium and magnesium were measured by EDTA Complexometric titration.
- Chloride was measured volumetrically by silver nitrate(precipitation) titrimetric method.
- Iron, Fluoride, Sulphate, phosphate, Nitrite was measured by using Systronics Spectrophotometer.
- Total alkalinity is determined by Acid Base titration.
- DO is measured by using Winkler's method.
- BOD is measured by using dilution method.
- COD by using Redox titration.

Results and Discussion: The water from the study area has no colour and odour. Taste of the water of the water sample in most of the locations pleasant in taste. Names of the 20 villages are represented in Table 1. The results of the physico-chemical analysis for 20 different villages in different seasons i.e., Pre monsoon, Monsoon and Post monsoon are represented in 1(a), 1(b) and 1(c). Physicochemical characteristics and WQI Values of water samples in Eluru mandal including 20 villages and in three consecutive seasons were shown in Table 1(a), 1(b) and 1(c) respectively and compared with IS and WHO standards.

The pH of water shows variation in its ranges. It indicates that they are in range of water quality parameter permissible limits. The EC of water samples shows wide variation in all the samples. TA within the limits. Chloride content in water is low, the fluoride content in water is low due to this no dental and Skelton problem arises in the study area. The value of DO, BOD, COD were in limits. Turbidity was higher of all the observed parameters of almost all the samples. The Ca^{2+} was showed wide variation in all the accepted limits. Mg^{2+} values were within the limits. Sulphate data was low. Also classification on the basis of Total hardness shows that maximum samples contain higher values of hardness. TDS were in permissible limits except very samples where it is high.

Seasonal variations of WQI in 20 villages of Eluru mandal were represented in Fig 1. Correlation Matrix is usually used to measure the strength of a linear relationship. In this present study, Correlation Matrix among different water quality parameters are represented in Table 2(a), 2(b) and 2(c). Table -3 represents the hardness of water in different villages of Eluru mandal in 3 seasons.

Table 1(a): Physicochemical Characteristics and WQI Values of Water Samples in Elurumandal (Premonsoon season)

S. No	Name of village	pH	EC mS	TDS ppm	Alkalinity ppm	Total Hardness ppm	Calcium ppm	Magnesium ppm	Chloride ppm	Nitrate ppm	Sulphate ppm	DO ppm	BOD ppm	WQI	Rating
1	Chataparr	7.2	430	290	190	90	20	9.7	80	0.1	7	7	4.2	51.21	Good
2	Chodimel	7.75	1700	1140	260	210	49.6	20.9	275.7	0.17	19.09	11	8.1	80.15	Good
3	Eluru (M)	7.4	350	230	100	50	12	4.8	45	0.05	6	8.2	5	51.61	Good
4	Eluru (R)	7	1600	1070	330	240	52.1	26.7	340	0.1	27	5	2.4	60.84	Good
5	Gavaravar	7.1	1350	900	320	172	36.8	19.4	240	0.08	22	7	3.8	59.68	Good
6	Gudivakala	8.13	410	270	182.28	76.26	13.6	10.2	5.423	0.06	5.68	8.8	7.2	70.32	Good
7	Jallipudi	7.65	930	620	260	104	20	13.1	105	0.29	9.09	7	5	64.87	Good
8	Kalakuru	7.86	2150	1440	260.4	160	17.6	27.7	37.97	0.09	63.84	3.2	4.4	81.37	Good
9	Katlampu	4.4	750	500	82	58	13.6	5.8	65	0	7.2	8.4	6.4	61.81	Good
10	Kokkiralala	7.3	620	420	65	70	16	7.3	65	0.065	4.8	9.6	7.2	60.68	Good
11	Komadav	7.6	3210	2150	570	280	60.1	31.6	520	0.17	86	9.6	5.4	87.85	Good
12	Madepalle	7.58	4160	2790	388	320	60.1	41.4	774.7	0.2	44.54	7.5	4.7	97.32	Good
13	Malikapuri	7.4	300	200	110	62	12.8	7.3	50	0.058	1.2	6.4	3.2	47.22	Excellent
14	Ponangi	7.24	4140	2780	466	280	24	53.6	850.8	0	82.22	8.4	6	100.26	Poor
15	Prathikoll	7.95	410	270	141.06	66.64	11.2	9.2	6.103	0.065	50.95	8.8	7.6	69.81	Good
16	Pydichint	7.7	450	300	120	58	9.6	8.3	45	0	0	8	5.2	57.62	Good
17	Sanivarap	7.55	2360	1580	275	308	62.5	37	393.9	0.23	18.18	4.5	3.7	81.83	Good
18	Satrampad	7.67	1410	1410	272	160	76.6	20.9	203.3	0.22	11.81	5.5	0.5	53.19	Good
19	Sree parru	7.75	1490	1000	240	128	22.4	17.5	177.2	1.12	33.87	9	7.5	79.05	Good
20	Tangellam	7.75	910	610	236	104	32	5.8	91.9	0.28	13.63	6.5	5	66.06	Good

Table 1(b): Physicochemical Characteristics and WQI Values of Water Samples in Elurumandal (Monsoon Season)

S. No	Name of the village	pH	EC mS/cm	TDS ppm	Alkalinity ppm	Total hardness ppm	Calcium ppm	Magnesium ppm	Chloride ppm	Nitrate ppm	Sulphate ppm	DO ppm	BOD ppm	WQI	Rating
1	Chataparru	7.7	330	350	112	50	17.6	3.7	76	0	6.5	7.2	4.4	57.55	Good
2	Chodimella	7.6	1660	1090	358	108	44	23.6	303	0	23.1	6	6.1	72.26	Good
3	Eluru (M)	7.3	340	260	90	54	12	7.3	48	0	7	8.4	3	51.36	Good
4	Eluru (R)	6.6	1600	1000	320	230	60.1	36.6	360	0	25	5	2.4	62.67	Good
5	Gavaravaram	7	1400	940	330	136	36.6	22.4	236	0	26	7	3.8	59.71	Good
6	Gudivakalanka	7.1	280	170	90	70	16	9.7	60	0	6	10.5	6.6	45.72	Good
7	Jallipudi	7.3	570	360	164	66	11	7.3	66	0	10	6.6	6.6	67.28	Good
8	Kalakuru	8.3	4330	2920	372	320	96.1	58.4	1046	0	80.6	8.4	6.4	106.9	Poor
9	Katlampudi	7.6	590	390	136	70	16	9.7	105	0	6.1	9.2	6.6	63.66	Good
10	Kokkiralanka	7.2	620	350	60	66	9.6	6.3	60	0	4.6	10	6.6	50.34	Good
11	Komadavole	7.5	3170	2130	670	266	54.5	33.1	610	0	36	9.6	7.2	86.3	Poor
12	Madepalle	8.1	700	480	170	82	24.4	8.7	123	0	13.3	8.4	3.6	63.66	Good
13	Malapuram	7.3	290	190	120	62	8.6	6.3	42	0	1.1	6	3.6	50.92	Good
14	Ponangi	7	4230	2840	466	404	66.7	62.1	1001	0	72.3	6	6	100.3	Poor
15	Prathikollanka	6.6	250	170	60	50	6	4.6	33	0	7	12.4	7.4	46.3	Excellent
16	Pydichintapadu	7.6	330	220	120	58	9.6	6.6	48	0.025	0	6	6.2	55.12	Good
17	Sanivarapudela	7.3	1140	760	230	176	32.2	16	200	0	22	6.2	3.6	66.79	Good
18	Satrampadu	7.9	1280	860	314	160	90.1	21.9	226	0	13.7	9.6	6.4	65.08	Good
19	Sreeparru	7.6	1610	1060	362	166	44	29.6	366	0.7	103.4	6	6.6	76.47	Good
20	Tangellamudi	7.8	3480	2600	512	174	33.2	21.9	249	0	16.2	6.6	6	74.33	Good

Table 1(c): Physicochemical Characteristics and WQI Values of Water Samples in Eluru Mandal (Post Monsoon Season)

S.No	Name of the village	pH	ECmS	TDSppm	Alkalinity ppm	Total Hardness ppm	Calciumppm	Magnesiumppm	Chlorideppm	Nitrate ppm	Sulphateppm	DOppm	BODppm	WQI	Rating	
1	Chetapanu	8.11	0.49	330	168	84	16.4	9.2	93	0	9.2	8.8	8	84.84	Good	
2	Chodimella	7.12	1.91	1030	250	125	25.0	12.4	383	0	38.3	8.8	8	87.04	Good	
3	Eluru (M)	7.93	0.26	170	90	45	9.0	7.8	47	0	4.7	8.08	8.8	8	80.56	Good
4	Eluru (R)	8.82	1.88	1060	350	175	35.0	17.8	374	0	37.4	9.1	1.8	86.8	Good	
5	Gavaravaram	7.03	1.47	990	340	170	34.0	17.4	282	0	28.2	7.1	4	80.95	Good	
6	Gubivisalanika	7.29	0.28	190	93	46.5	9.3	12	7.8	9.2	0	4	11.1	8.8	48.49	Excellent
7	Jalipudi	7.48	0.92	350	140	70	14.0	7.7	73	0	7.3	8.8	8.2	49.7	Excellent	
8	Kaakuru	8.2	1.8	1070	328	164	32.8	16.4	290	0	29.0	8	8	79.8	Good	
9	Katampudi	7.24	0.28	190	93	46.5	9.3	12	7.8	9.2	0	4.2	8.4	8	81.33	Good
10	Kokivisalanika	7.03	0.92	330	98	49	9.8	11.6	9.8	0	4.8	10.4	8	48.44	Excellent	
11	Komavola	7.48	1.89	1060	324	162	32.4	16.2	381	0	38.1	8.8	8.4	71.84	Good	
12	Machapalle	7.29	0.6	400	180	90	18.0	9.2	99	0	9.9	10.7	8	81.35	Good	
13	Makapuram	7.29	1.88	1060	492	246	49.2	24.6	377	0	37.7	8	8	89.05	Good	
14	Ponang	7.48	1.17	2800	380	190	38.0	19.0	1080	0	108.0	8.4	8.4	88.84	Good	
15	Predhikollanka	8.64	0.29	200	80	40	8.0	11	8.8	9.8	0	7.19	12.8	8.1	26.1	Excellent
16	Pychinrasadu	7.69	0.93	320	110	55	11.0	9.8	48	0.18	0	8	8	48.14	Excellent	
17	Sarivarapeta	7.92	1.16	780	230	115	23.0	11.6	197	0	19.7	8.4	4.4	89.78	Good	
18	Satampadu	7.29	1.27	850	270	135	27.0	13.8	11.9	0	11.9	8	8	88.46	Good	
19	Sreedam	7.08	0.77	920	270	135	27.0	13.7	128	1.4	13.7	8.8	4.4	88.92	Good	
20	Tangalimudi	7.11	1.42	980	328	164	32.8	16.4	285	0	28.5	8.4	8.8	88.1	Good	

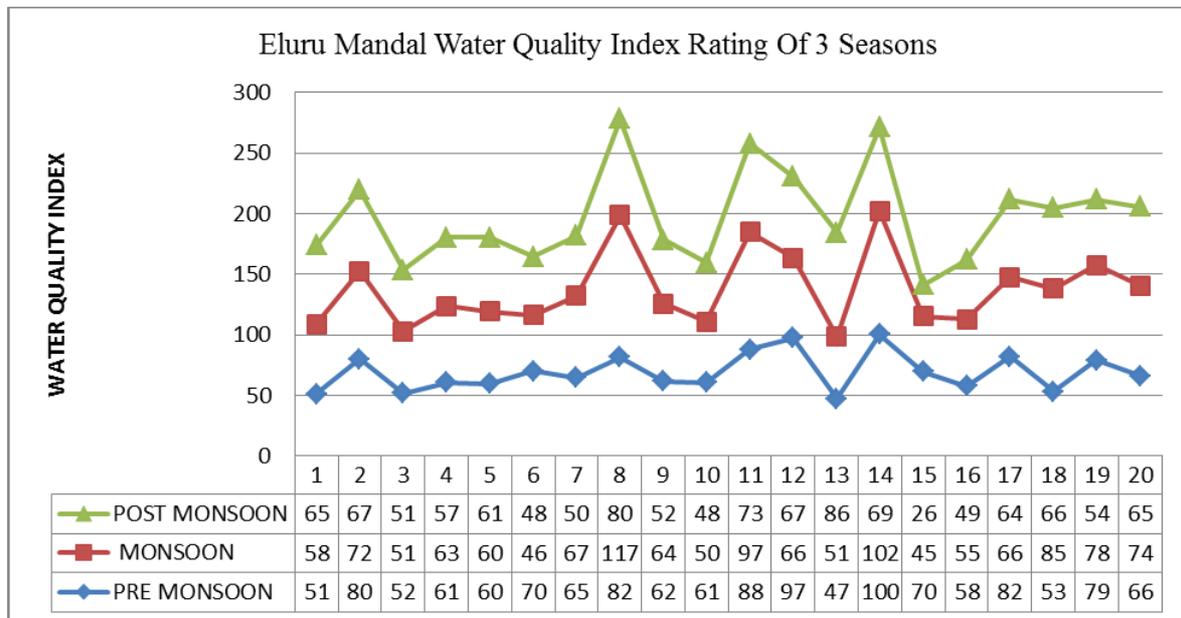


Fig 1

Table 2(a): Eluru Mandal Correlation Matrix of Premonsoon Season

	pH	EC	TDS	Turbidity	Alkalinity to Hardness	Sodium	Potassium	Calcium	Magnesium	Chloride	Fluoride	Sulphate	DO	COD	BOD	
pH	1															
EC	-0.11294	1														
TDS	-0.10095	0.991777	1													
Turbidity	0.096919	0.149294	0.245598	1												
Alkalinity	-0.11758	0.849989	0.849992	0.022278	1											
Total Hardness	-0.18996	0.901234	0.908629	0.107714	0.851792	1										
Sodium	-0.16401	0.101591	0.060215	-0.28841	0.139441	-0.04864	1									
Potassium	-0.46866	0.108928	0.064711	-0.45479	0.159044	0.060449	0.953895	1								
Calcium	-0.10593	0.568729	0.630848	-0.487584	0.69639	0.767797	-0.30996	-0.15946	1							
Magnesium	-0.16677	0.950148	0.947712	0.106902	0.819542	0.926229	0.06125	0.080298	0.566034	1						
Chloride	-0.29626	0.938895	0.930589	0.14108	0.814346	0.888777	0.023527	0.114823	0.57378	0.811281	1					
Fluoride	-0.00719	0.461353	0.460583	-0.082	0.272632	0.338241	0.070919	0.100983	-0.09899	0.482059	0.477394	1				
Sulphate	-0.06117	0.856218	0.85644	-0.11544	0.849591	0.70796	0.817019	0.317611	0.325032	0.798463	0.7322	0.45478	1			
DO	0.024887	-0.03931	-0.06852	-0.15987	-0.05964	-0.18959	0.095474	0.251907	-0.28167	-0.17362	0.019825	0.196665	0.057198	1		
COD	0.010599	0.080892	0.05784	-0.25704	0.007449	-0.10972	0.076829	0.269607	-0.40163	0.111099	0.033495	0.326988	0.306439	0.240014	1	
BOD	0.99626	-0.07881	-0.14842	-0.42132	-0.19123	-0.22956	0.08437	0.164956	-0.4978	-0.17099	-0.10345	0.194909	0.018808	0.891717	0.399922	1

Table 2(b): Eluru Mandal Correlation Matrix of Monsoon Season

	pH	EC	TDS	Turbidity	Alkalinity	Calc Hardness	Sodium	Potassium	Calcium	Magnesium	Chloride	Fluoride	Sulphate	DO	COD	BOD
pH	1															
EC	0.110808	1														
TDS	0.11014	0.999992	1													
Turbidity	-0.28228	-0.81999	-0.81991	1												
Alkalinity	0.098972	0.940788	0.841984	-0.41613	1											
Total Hard	-0.08782	0.887473	0.887898	-0.37988	0.847998	1										
Sodium	0.239888	0.239149	0.232887	-0.08488	0.118092	0.098288	1									
Potassium	0.29117	-0.14133	-0.14201	-0.88048	-0.00687	-0.18781	0.068282	1								
Calcium	-0.28808	0.788398	0.789087	-0.38991	0.688011	0.99888	-0.02298	-0.17818	1							
Magnesium	0.047078	0.988211	0.987788	-0.38187	0.787844	0.888478	0.172072	-0.09918	0.810487	1						
Chloride	0.148048	0.888482	0.888248	-0.80288	0.780238	0.802882	0.238488	-0.14884	0.718187	0.888382	1					
Fluoride	0.088117	-0.38888	-0.38878	-0.10408	-0.4288	-0.6027	-0.84402	0.084101	-0.48088	-0.88488	-0.37988	1				
Sulphate	0.042718	0.780018	0.780808	-0.0408	0.802878	0.898788	0.878488	-0.09828	0.828288	0.898771	0.898382	-0.87188	1			
DO	-0.048	-0.18088	-0.18888	0.188874	-0.18188	-0.30218	-0.11878	-0.28818	-0.32888	-0.28788	-0.18738	0.288408	-0.08278	1		
COD	0.224878	0.088387	0.084072	0.288888	0.148892	-0.04088	0.18184	-0.118041	-0.10888	0.088828	0.01881	-0.07771	0.320027	0.22084	1	
BOD	0.320018	0.188138	0.140788	0.181048	0.128838	-0.02007	0.088808	-0.18848	-0.07487	0.020887	0.187788	0.084802	0.148888	0.808388	0.284884	1

Table 2(c): Eluru Mandal Correlation Matrix of Postmonsoon Season

	pH	EC	TDS	Turbidity	Alkalinity	Calc Hardness	Sodium	Potassium	Calcium	Magnesium	Chloride	Fluoride	Sulphate	DO	COD	BOD
pH	1															
EC	-0.05573	1														
TDS	-0.05688	0.999988	1													
Turbidity	-0.10306	-0.48204	-0.48017	1												
Alkalinity	-0.14125	0.801897	0.800827	-0.58867	1											
Total Hard	-0.12857	0.844408	0.844101	-0.54148	0.838418	1										
Sodium	0.148208	0.080984	0.080288	-0.02898	0.015414	0.082588	1									
Potassium	0.019581	0.06882	0.062882	-0.38188	0.084417	0.111814	0.39041	1								
Calcium	-0.20002	0.844488	0.845241	-0.48812	0.828902	0.837577	-0.18188	-0.01684	1							
Magnesium	-0.0775	0.841521	0.84118	-0.50878	0.811854	0.888018	0.108781	0.148884	0.775878	1						
Chloride	-0.02897	0.95024	0.949998	-0.44182	0.757428	0.841838	0.108488	0.147192	0.717191	0.950281	1					
Fluoride	-0.228	-0.42088	-0.41808	0.541227	-0.50484	-0.42181	-0.3408	-0.02848	-0.32808	-0.4172	-0.40854	1				
Sulphate	0.078423	0.878788	0.872728	-0.48844	0.778028	0.864117	0.178012	0.162081	0.588421	0.887008	0.848828	-0.42217	1			
DO	-0.02188	-0.38288	-0.38078	0.608384	-0.48888	-0.48808	-0.38808	-0.28882	-0.48788	-0.48088	-0.28782	0.677018	-0.20828	1		
COD	-0.1478	0.412884	0.412788	-0.01788	0.288888	0.37888	-0.08828	0.01887	0.048817	0.48088	0.547407	0.172288	0.80188	0.388888	1	
BOD	0.447808	-0.08788	-0.08788	0.187814	-0.28878	-0.12042	-0.28888	-0.18708	-0.28812	-0.11128	0.082481	0.148488	0.188188	0.588188	0.310788	1

Table 3: Eluru Mandal- Hardness of Water in Three Seasons

Description	Hardness	No of samples premonsoon	No of samples Monsoon	No of samples Postmonsoon
Soft	0-75	6	8	7
Moderately Hard	75-150	5	2	3
Hard	150-300	7	8	8
Very Hard	>300	2	2	2

Conclusion: This study shows that ground water is the only source for people in the study area and the results indicate not much considerable variation. In few areas TDS is comparatively high, thus if people drink water then health problems like stomach diseases and gastric troubles may arise. Total hardness is the main problem in this area. Also the contamination is found to be due to both anthropogenic as well as from geological sources. It must be noted that a regular analysis must be done to ensure that the quality of water in this area is not contaminated.

Observed results shows that the technology to be applied for the treatment of ground water is source dependent and in most cases, effective and simple treatment solutions are sufficient without blindly implementing RO Technologies.

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