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(RESEARCH ARTICLE)



# Cluster analysis of water quality parameters of water samples from Colachel to Melmidalam in Kanyakumari district

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#### **Abstract**

A methodical study has been carried out to explore physico-chemical parameters of drinking water from well and bore hole in and around the villages from Colachel to Melmidalam of Kanyakumari District. Water samples from well and bore hole in four sites namely Colachel, Kurumbanai, Midalam, Melmidalam were collected in pre monsoon and post monsoon seasons during 2019 ad 2020 and analyzed for temperature, sodium, potassium and oxidation & reduction potential. pH, turbidity, alkalinity, hardness, salinity, fluoride, chloride, total dissolved solids, dissolved oxygen, BOD, electrical conductivity, total nitrogen, nitrate, sulphate, ammonia, phosphate, total phosphorus. The physico-chemical parameters were analyzed and the results were compared with water quality standards described by WHO. Statistical techniques, calculation of basic statistics, Correlation matrix, and Hierarchical Cluster analysis were simultaneously applied to the physico-chemical parameters of water samples taken from in different sites. The above study will be useful to know the water quality and their fitness for drinking purposes at various stations undertaken. Overall water quality was found satisfactory for drinking purpose without prior treatment.

**Keywords:** Bore hole; well water; Colachel; Kurumbanai; Midalam; Melmidalam; Physico-chemical parameters; Basic statistics: Pearson Correlation matrix: Dendrogram

#### 1. Introduction

Drinking water or potable water is defined as that having acceptable quality in terms of its physical, chemical, bacteriological and acceptability parameters so that it can be safely used for drinking and cooking <sup>[1]</sup>. Surface waters are primary and limited water resources to meet agricultural industrial and domestic water needs of human and living beings. Polluted waters contain significant levels of pollutants, usually at levels above WHO certified drinking water quality standards and these are able to cause significant problems when ingested by humans <sup>[2]</sup>. According to Buchholz<sup>[3]</sup>, point sources are those that come from industrial facilities and municipal sewage systems The natural cleansing ability of oxygen contained in the water is compromised and the water can no longer breakdown organic pollutants<sup>[3]</sup>. Thus, they can be said to be pollution that can be traced to a particular source. Cairncross and Cliff <sup>[4]</sup> have shown that soakage pits and pit latrines can extend their influence on ground-water quality up to 10m or more as

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groundwater flow is either lateral or vertical. Additionally, filtration does not occur during lateral flow and could carry feacal pollution for much longer distances possibly resulting in contamination of well water with pathogens <sup>[5,6]</sup>. Pye and Patric <sup>[7]</sup> have shown that land disposal of sewage sludge, illegal dumping of septic tank pumpage, improper toxic waste disposal and run off from agricultural operations all contributed to surface and ground water contamination with chemicals and microorganisms.

#### 2. Material and methods

## 2.1. Physico-Chemical Analysis

Samples collected from all the stations were analyzed for physico-chemical analysis using standard methods [8]. The following physico-chemical parameters such as temperature, pH, turbidity, alkalinity, hardness, salinity, fluoride, chloride, total dissolved solids, dissolved oxygen, BOD, electrical conductivity, total nitrogen, nitrate, sulphate, ammonia, phosphate, total phosphorus, sodium, potassium and oxidation & reduction potential have been analyzed. The temperature of the water samples was measured by mercury thermometer. The pH measurement of the water samples was carried out using digital pH meter (Elico pH-13 model). A conductivity meter was used to measure EC. Volumetric method using sulfuric acid as titrant and phenolphthalein and methyl orange as indicators was used to determine alkalinity. EDTA (complexometric) method was used to determine calcium, magnesium and total hardness titremetrically. Flame photometer was used to identify sodium and potassium. Mohr's method was used to measure chloride by titration with silver nitrate. UV-Vis Spectrophotometer was used to analyze nitrate. Salinity was estimated by Argentometric titration method. The dissolved oxygen was estimated by Winkers method. The findings of the present investigation were summarized and compared with standards [9, 10].

## 2.2. Statistical Analysis

The correlation between various physic-chemical parameters of water samples analyzed statistically conducting basic statistics (mean, standard deviation (SD), median, minimum, maximum, variance (V), Kurtosis (K), Skewness (S), Hierarchical cluster analysis, Pearson correlation analysis with the help of SPSS (Statistics Package for the Social Sciences) software (Windows version 19).

#### 2.3. Descriptive statistics

In the forms of mean, SD, median, minimum, maximum, variance (V), Kurtosis (K), Skewness(S), standard error of kurtosis (SEK), standard error of skewness (SES) were calculated and summarized in Tabular forms in Tables 2, 5, for well water and Table 8, 11 for bore hole water samples respectively.

#### 2.4. Dendrogram studies

Cluster analysis (CA) [11, 12] was used for multivariate modeling of the input data. The main goal of the Hierarchical Agglomerative cluster analysis to spontaneously classify data into groups of similarity (cluster) searching objects in the n-dimensional space located in closest neighbourhood and to separate a stable cluster from other clusters. In figure 1 to 8, the hierarchical dendrogram for the clustering of determined physical and chemical parameters for all the studied stations is plotted (Ward's method of linkage, squared Euclidean distance as similarity measure, standardization of the input data). For clustering altogether 22 physical and chemical parameters were chosen. It could be concluded that the one big cluster and three small clusters are formed additionally sub clusters are also formed. Statistical Analysis of Ground water quality parameters in Erode District, Tamilnadu was studied by M.Jamuna et al [13]. Spatial and Temporal changes in water quality at AsiRiver using Multivariate Statistical Techniques was studied by Ece et al [14]. Statistical assessment of water quality parameters for pollution source identification in Bektas Pond was extended by Aydin et al [15].

The Pearson correlation analysis was performed for measured parameters to determine the relation between these variables and given in Tables 3, 6, 9, 12. A correlation analysis is a bivariate method applied to describe the degree of relation between two hydro chemical parameters. A high correlation coefficient (near 1 or -1) means a good relationship between two variables and its value around zero means no relationship between them at a significant level of <0.05. More precisely it can be said that parameters showing coefficient >0.7 are considered to be strongly correlated whereas coefficient between 0.5 and 0.7 shows moderate correlation.

#### 3. Results and discussion

For our research studies, the name of the villages are abbreviated, Colachel as CO, Kurumbanai as Ku, Midalam as MI, Melmidalam as MM. The water samples drawn during the period 2019 in pre monsoon season are abbreviated as PRA19CO, PRA19KU, PRA19MI and PRA19MM. The water samples drawn from well are abbreviated as WPRA19PO, WPRA19KU, WPRA19MI and WPRA19MM. The water samples drawn during the period 2020 in pre monsoon season are abbreviated as PRA20CO, PRA20KU, PRA20MI and PRA20MM. The water samples drawn from well are abbreviated as WPRA20CO, WPRA20KU, WPRA20MI and WPRA20MM.

Table 1 Comparison of water quality parameters of well water in Pre monsoon and Post monsoon season during 2019

1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9 110 111 112 113 114 115 115 116 117 118					Sampl	e code			
S.No	Parameters	WPRA19CO	6 WPRA19KU	WPRA19MI	6.7 WPRA19ME	WPON19CO	WPON19KU	WPON19MI	% WPONI9ME
1	pH	7.8	7.9	7.8	7.9	7.8	7.6	7.0	6.8
2	Turbidity (NTU)	6.8	8.2	8.2	8.9	6	8	7.3	7.3
3	Dissolved oxygen (DO) (ppm)	8	8	8	9	7.7	8	7	4.9
4	Biological Oxygen Demand (BOD) (ppm)	7	6.6	7	6	4.9	7.6	9	9
5	Hardness Mg (mg/L)	42	76	40	42	42	12	3	4.9
6	Sulphate (mg/L)	7	8	8	8	0.1	6.6	7	5.7
7	Total Nitrogen (mg/L)	4.6	4.8	4.8	4.5	0.4	3.9	3.8	4.9
8	Nitrate (mg/L)	0.3	0.6	0.9	0.5	8	0.4	0.4	0.9
9	Ammonia (mg/L)	0.8	0.7	0.7	0.1	0.9	0.9	0.5	0.6
10	Phosphate (mg/L)	0.5	0.9	0.8	0.4	0.8	0.8	0.5	0.9
11	Total Phosphorous (mg/L)	0.9	0.8	0.3	0.8	0.8	0.3	0.8	0.9
12	Fluoride (ppm)	0.1	0.4	7.6	0.4	3.4	0.5	0.2	0.5
13	Chloride (ppm)	260	830	250	360	470	211	230	290
14	Total dissolved solids (TDS) (ppm)	415	460	390	392	419	421	530	480
15	Electrical conductivity (Mics/cm)	472	560	570	460	570	472	510	510
16	Oxidation-Reduction Potential (mV)	560	581	582	571	562	581	691	671
17	Temperature (°C)	28	28	27	27	30	30	29	29
18	Sodium (mg/L)	32.1	33.5	33.4	33.8	33.2	16.8	21.5	21.6
19	Potassium (mg/L)	12.4	13.4	13.3	13.1	13.1	16.1	13.9	13.9
20	Alkalinity (mg/L)	168	180	231	231	231	181	180	180
21	Hardness Ca (mg/L)	61	70	56	54	56	34	65	66
22	Salinity (ppm)	94	91	41	74	74	86	90	91

The water samples drawn during the period 2019 in post monsoon season are abbreviated as PON19CO, PON19KU, PON19MI and PON19MM. The water samples drawn from well are abbreviated as WPON19CO, WPON19KU, WPON19MI and WPON19MM. The water samples drawn during the period 2020 in pre monsoon season are abbreviated as PON2OCO, PON2OKU, PON2OMI and PON2OMM. The water samples drawn from well are abbreviated as WPON2OCO, WPON2OKU, WPON2OMI and WPON2OMM.

The water samples drawn from bore hole are abbreviated as BPRA19CO, BPRA19KU, BPRA19MI and BPRA19MM. The water samples drawn during the period 2020 in pre monsoon season are abbreviated as PRA20CO, PRA20KU, PRA20MI

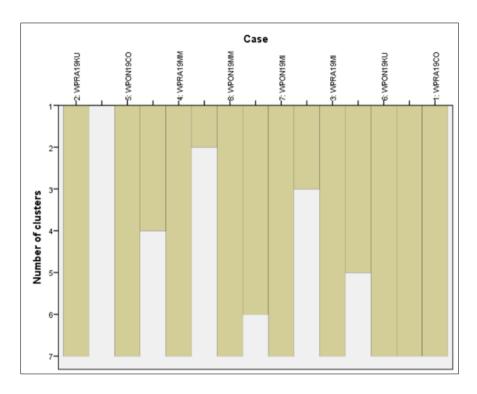
and PRA20MM. The water samples drawn from bore hole are abbreviated as BPRA20CO, BPRA20KU, BPRA20MI and BPRA20MM.

The water samples drawn during the period 2019 in post monsoon season are abbreviated as PON19CO, PON19KU, PON19MI and PON19MM. The water samples drawn from bore hole are abbreviated as BPON19CO, BPON19KU, BPON19MI and BPON19MM. The water samples drawn during the period 2020 in pre monsoon season are abbreviated as PON20CO, PON20KU, PON20MI and PON20MM. The water samples drawn from bore hole are abbreviated as BPON20CO, BPON20KU, BPON20MI and BPON20MM.

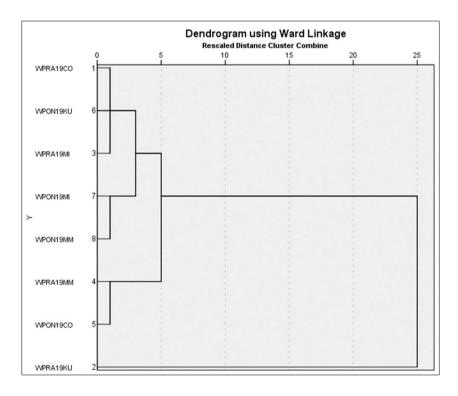
**Table 2** Descriptive Statistics of water quality parameters of well water in Pre monsoon and Post monsoon season during 2019

# **Descriptive Statistics**

	N	Dangs	Minimure	Mavinaure	ш.	an	Otal Daviation	Variance	17	onio.
		Range	Minimum	Maximum		an	Std. Deviation			osis
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error
Temp	8	3	27	30	28.50	.423	1.195	1.429	-1.456	1.481
рH	8	1.1	6.8	7.9	7.575	.1521	.4301	.185	.110	1.481
Turbidity	8	2.9	6.0	8.9	7.588	.3259	.9219	.850	140	1.481
Alkalinity	8	63	168	231	197.75	9.845	27.845	775.357	-2.147	1.481
HardnessCa	8	36	34	70	57.75	3.931	11.119	123.643	2.914	1.481
HardnessMg	8	73.0	3.0	76.0	32.738	8.7332	24.7012	610.151	207	1.481
Salinity	8	53	41	94	80.13	6.220	17.594	309.554	3.765	1.481
Fluoride	8	7.5	.1	7.6	1.638	.9329	2.6387	6.963	4.234	1.481
Chloride	8	619	211	830	362.63	73.076	206.690	42720.839	4.303	1.481
TDS	8	140	390	530	432.88	16.956	47.960	2300.125	1.602	1.481
D0	8	4.1	4.9	9.0	7.575	.4279	1.2104	1.465	3.977	1.481
BOD	8	4.1	4.9	9.0	7.138	.4960	1.4030	1.968	393	1.481
EC	8	110	460	570	515.50	16.282	46.053	2120.857	-1.987	1.481
TotNitrogen	8	4.5	.4	4.9	3.963	.5295	1.4976	2.243	6.217	1.481
Nitrate	8	.6	.3	.9	.600	.0845	.2390	.057	-1.834	1.481
Sulphate	8	7.9	.1	8.0	6.300	.9310	2.6333	6.934	5.819	1.481
Ammonia	8	.8	.1	.9	.650	.0926	.2619	.069	2.417	1.481
Phosphate	8	.5	.4	.9	.700	.0707	.2000	.040	-1.729	1.481
Totphosphorus	8	.6	.3	.9	.775	.0701	.1982	.039	6.572	1.481
Sodium	8	17.0	16.8	33.8	28.238	2.4824	7.0214	49.300	-1.461	1.481
Potassium	8	3.7	12.4	16.1	13.650	.3891	1.1006	1.211	4.137	1.481
ORP	8	131	560	691	599.88	18.054	51.064	2607.554	.152	1.481
Valid N (listwise)	8									



**Figure 1** Cluster Diagram of water quality parameters of well water in Pre monsoon and Post monsoon season during 2019



**Figure 2** Dendrogram of water quality parameters of well water in Pre monsoon and Post monsoon season during 2019

**Table 3** Pearson Correlation Coefficient (r) of water quality parameters of well water in Pre monsoon and Post monsoon season during 2019

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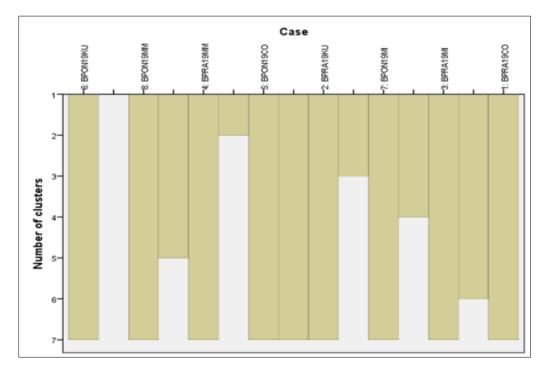
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 $\textbf{Table 4} \ \textbf{Comparison of water quality parameters of bore hole water in Pre monsoon and Post monsoon season during 2019$ 

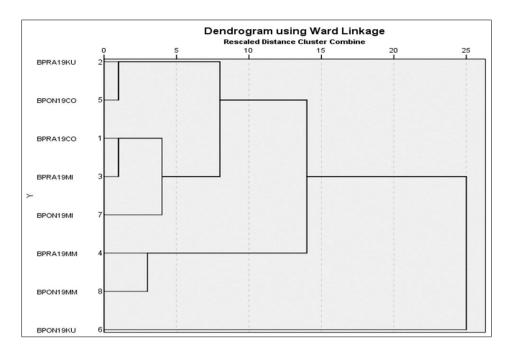
2 3 1 4 1 5 1 5 1 6 6 7 7 8 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1					Sampl	e code			
			Pre mo	on Seaso	n	Ť	Post mo	on Seaso	n
S.No	Parameters	BPRA19CO	BPRA19KU	BPRA19MI	BPRA19ME	6.BPON19CO	BPON19KU	BPON19MI	- BPON19ME
1	pН	7.1	8.0	7.2	7.8	7.9	8	6.8	7
2	Turbidity (NTU)	6.0	7	8.2	6	8.9	7.4	6	6
3	Dissolved oxygen (DO) (ppm)	8	9	9	8	6.0	7	7	7
4	Biological Oxygen Demand (BOD) (ppm)	9	7	6.6	7.7	0.5	8.5	8	5.4
5	Hardness Mg (mg/L)	61	41	70	71	71	10	4.5	3
6	Sulphate (mg/L)	7.8	6.8	6.9	9	0.5	7.7	5.6	8.0
7	Total Nitrogen (mg/L)	4.7	4.2	4.2	4.9	0.9	2.1	4.3	3.9
8	Nitrate (mg/L)	0.5	0.9	0.9	4.9	9	0.3	0.3	0.4
9	Ammonia (mg/L)	1.4	1.5	1.5	0.5	1.5	0.4	0.4	0.9
10	Phosphate (mg/L)	0.6	0.3	1.1	1.5	0.9	0.6	0.8	0.5
11	Total Phosphorous (mg/L)	0.8	0.3	0.8	0.9	0.5	0.4	0.4	0.8
12	Fluoride (ppm)	0.8	0.3	0,1	0.4	3.6	0,4	0.4	0.2
13	Chloride (ppm)	230	390	240	340	392	180	280	240
14	Total dissolved solids (TDS)(ppm)	370	390	390	270	378	381	480	230
15	Electrical conductivity (Mics/cm)	500	490	570	570	460	521	510	640
16	Oxidation-Reduction Potential (mV)	632	630	631	681	640	672	721	721
17	Temperature (°C)	30	27	28	28	29	30	28	30
18	Sodium (mg/L)	33.1	26.3	26.8	32.8	32.8	17.8	18.3	18.9
19	Potassium (mg/L)	11.4	12.4	12.3	12.2	12.4	15	20.1	19
20	Alkalinity (mg/L)	221	231	180	180	180	176	178	171
21	Hardness Ca (mg/L)	54	56	70	71	71	26	60	65
22	Salinity (ppm)	76	76	70	92	92	381	85	91

**Table 5** Descriptive Statistics of water quality parameters of bore hole water in Pre monsoon and Post monsoon season during 2019

				Descr	iptive Statis	tics				
	N	Range	Minimum	Maximum	Me	an	Std. Deviation	Variance	Kurl	osis
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error
Temp	8	3	27	30	28.75	.412	1.165	1.357	-1.613	1.481
рH	8	1.2	6.8	8.0	7.475	.1760	.4979	.248	-2.223	1.481
Turbidity	8	2.9	6.0	8.9	6.938	.4049	1.1451	1.311	810	1.481
Alkalinity	8	60	171	231	189.63	8.064	22.809	520.268	.291	1.481
HardnessCa	8	22	54	76	65.38	2.815	7.963	63.411	-1.446	1.481
HardnessMg	8	68.0	3.0	71.0	41.438	11.0006	31.1143	968.103	-2.207	1.481
Salinity	8	311	70	381	120.38	37.351	105.645	11160.839	7.848	1.481
Fluoride	8	3.5	.1	3.6	.775	.4100	1.1597	1.345	7.252	1.481
Chloride	8	212	180	392	286.50	27.905	78.927	6229.429	-1.410	1.481
TDS	8	250	230	480	361.13	27.404	77.510	6007.839	.476	1.481
DO	8	3	6	9	7.63	.375	1.061	1.125	940	1.481
BOD	8	8.5	.5	9.0	6.588	.9576	2.7084	7.336	4.199	1.481
EC	8	180	460	640	532.63	20.321	57.478	3303.696	.420	1.481
TotNitrogen	8	4.0	.9	4.9	3.750	.4590	1.2984	1.686	3.453	1.481
Nitrate	8	8.7	.3	9.0	2.150	1.1199	3.1677	10.034	2.946	1.481
Sulphate	8	8.5	.5	9.0	6.538	.9323	2.6371	6.954	4.850	1.481
Ammonia	8	1.1	.4	1.5	1.013	.1837	.5194	.270	-2.345	1.481
Phosphate	8	1.2	.3	1.5	.788	.1342	.3796	.144	.601	1.481
Totphosphorus	8	.6	.3	.9	.613	.0833	.2357	.056	-2.197	1.481
Sodium	8	15.3	17.8	33.1	25.850	2.3919	6.7652	45.769	-2.083	1.481
Potassium	8	8.7	11.4	20.1	14.425	1.1800	3.3376	11.139	423	1.481
ORP	8	91	630	721	666.00	13.800	39.031	1523.429	-1.454	1.481
Valid N (listwise)	8									



**Figure 3** Cluster Diagram of water quality parameters of bore whole water in Pre monsoon and Post monsoon season during 2019

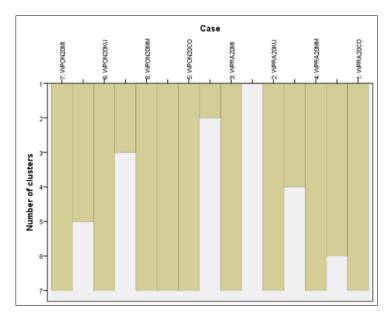


 $\textbf{Figure 4} \ \text{Dendrogram of water quality parameters of bore whole water in Pre monsoon and Post monsoon season during 2019$ 

**Table 6** Pearson Correlation Coefficient (r) of water quality parameters of well water in Pre monsoon and Post monsoon season during 2019

										C	सार्व होतात्रे												
		Term	ai .	Tunklik	kalab	:hxwm0i	Latrosia	Salin S	Facilia	Chica da	то	00	200	0.	Teáthracan	Navk	Subma	ATTE A	Pharatet	apaceptors	Set un	'shake	082
"irit	Nation Condition	1	-196	. 24	1.60	16	- 29	767	394	-115	+3'2	- 500	1713	315	4397	-16	X1	-11.8	-42	.23	-100	14	A.
	20(4)(420)		35	u s	348	221	392	123	281	641	2/2	313	213	27.9	785	412	63	1-1	388	793	281	34	917
h.	Massinskin	-405		(1)	.10	A21	XI	.435	.000	440	-107	307	-344	404	-435	470	-10	X1	.020	-362	.312	- 553	- 462
	Sic. (Lealist)	áh		118	.63	19	29	.10	512	400	416	494	.30	402	.10	316	165	416	478	19	590	197	155
Jan A	Pearson Constitution	E.M.	4/2	١.	147	+31	617	193	6.7	2.00	2/2	140	673	487	171	9.75	n.	V 4	181	777	3.1	411	111
	Sep (1 min)	AX	/10		.365	.400	152	.20	.050	275	357	31:	.005	.159	.00	.00	325	X)	7.5	.20	.390	100	X)
A call the	Nation Condition	-594	198	-147	- 1	-78	207	4.00	-0.00	535	216	9.1	27.9	~478	303	-537	117	511	~440	- 333	288	- 578	- 119
	2(0.0/2016)	715	7.70	31		£15	397	243	421	10	377	314	21	PA	795	211	31.	101	178	79.7	162	2/3	ъ.
Hamme (Ca	Market Strokens	48	42	X.	-162	1	272	.97	.312	<125	-3%	- 353	-305	2.9	-477	.134	-125	- 347	312	.1:1	-120	- 117	114
	Statisticalism	521	100	10	013		63	.271	315	315	234	155	.751	301	4.3	488	254	2.1	200	363	280	65	24
нихинатр	Pearson Constitution Sec 41 July 10	2/2	19	117	787	101		179	417	10	1/1	718 214	797	311	185	F 10	714	V1	FII	197	130	807	127
Spirally	Name Constrain	253 456	225	152	.262	400	-61	.140	-697	421	434	- 214	.30	-069	A33	-18	267	- 202 - 204	274	.10	.000 -480	107	113
20.00	Signification	18	120	103	283	171	128	'	410	127	49	277	218	430	30	5.76	24	311	5178 236	183	128	61	97
	Mayor Conde or	.450	130	514	-305	200	40	-267	- 1	312	715	- 528	-303	-307	-040	XX	-30	25	70.	40	477	- 307	-23
	Sic. (Logilye)	3%	213	23	.01	516	10	.00	'	637	336	365	365	263	.001	125	X-	155	410	.353	310	316	259
07.0%	Pearson Constitute	110	410	21	0.5	19	127	101	277	1	13	¥1	9.5	428	781	177	111	94	138	79.7	818	28	7/1
	Sep (1 whet)	14	127	215	.223	340	133	.20	703		472	181	.275	.145	.265	(0)	265	10	.370	.273	.05	226	25
*25	Pearson Convincers	-215	- 197	272	.213	-3%	-373	.30	316	13	- 1	201	153	-,789	417	-15	-103	10	-160	-063	-152	276	-20
	Signification)	2.0	410	267	0.7	190	104	125	289	4.0		613	523	125	282	29	191	638	247	195	281	417	25
IV:	Massinskin	-3%	107	-143	.50	151	323	-30	-435	XX	133		.50	.157	.40	-451	90	347	.022	.19	.200	- 44	- 165
	Sks. (1-callys)	.68	494	10.	.021	.5%	214	.57	445	486	46		363	355	.037	423	70	2.1	479	.251	317	197	152
500	Pearson Constitution	111	204	511	225	29	79.7	203	235	+0		V11	1	181	818	19	01	97	0.7%	191	271	216	197
	Seg (1 who)	AX.	200	205	.20	201	30	.275	.015	.77	375	20		.307	780.	.010	X5	143	A30	,4.5	.359	411	273
03	Person Constitution	5X	- 404	-107	473	516	- 20	4309	-0.00	-43	-736	107	.199	- 1	240	-516	119	- 2.	400	.032	-549	406	201
	26 ((400))	212	198	193	115	231	7-1	128	183	19	1.8	21	97		197	111	ъ.	217	237	ML	191	198	97
Winder.	Mayor Stock on	-28	- 425	- (17)	.20	-47	- 365	4234	-049	-39	< 27	701	.515	741	- 1	-853	344	- 213	.405	.131,	-040	900	171
	Sky (Leaflyr)	330	24	313	.53	216	- 68	.20	3.00	38	36	107	307	137		100	X4	Xi	400	.10	490	424	N1
Hitch	Pearson Constitution	r p	4/2	V:1	70.7	210	9.4	193	281	10	.79	97	(2.0	283	79.7	1	0.	7.0	244	197	171	319	77.7
	Sq (f. alm)	ALC:	/10	X2	.512	.457	20	.525	.00	.00	399	127	.212	.111	.040		323	X1		,442	.040	100	80
Suishak	Named Construction	1.00	198	- 10	417	-120	- 254	103	-510	-111	+405	9.2	.65	.019	.041	-031	Ι΄	- 267	.025	792	422	200	233
form.	Mg (PMM)	19	10	T.I	91	240	207	91	(11	11	1/61	1/1	374	194	HEL	121		112	177	141	191	677	21
*****	Sk. (Lallyr)	<180	190	50	.90	-,347	50	- 51k	.195	39	120	347	4437	-391	30	230	-007 173		-200	.057	.455	-534	-707
Ebopohale	Pearson Consists on	200	116	207	363	330 801	X2	128		18	416	X1	30	342 183	283 183	2X	102	29	385	247 90	117	216	313 311
F 000 XF 000	Reg (Challe)	28	473	40	.110	(2)	314	.005	410	373	317	(1)	.433	.332	.402	.114	67	205	'	.074	.120	310	49
"akwaatan		375	- 355	- 217	-353	201	163	1367	-180	-355	1656	193	.50	100	786	411	62	2.7	181	300	321	-196	365
as tomat at the	Signification)	19	188	20	767	29	129	193	236	20	10	Tid	116	140	101	46	129	67	172	'	116	177	J13
Parla r	Mayor Color or	~150	302	21	.20	-123	205	-402	471	318	-/5	23	.271	-,340	-,040	821	- 222	515	,,,,,,	,516	1	-315	- 99
	Sic. (Louby)	38	136	XI	.10	380	XI	310	310	133	336	207	33	189	260	16	28	317	139	.101		106	261
Fefrankum	Pearson Constitution	19	80	411	123	111	97	101	387	28	13	40	20	488	197	279	D1	24	188	101	271		117
	No (Calle)	.39	117	133	.30	405	30	.405	345	38	472	137	, (1)	.150	,424	.100	62	345	310	.327	.08		20
0011	Nation Condition	331	+ 455	- 515	-1/19	314	-742	.00	-480	-356	-125	- 105	.157	133	371	-315	23	-37	.043	.045	-6.59	107	
	96 ((498))	211	178	21	21	210	315	97	121	19	2.9	112	818	187	245	18	21	313	291	288	638	2.0	

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**Figure 5** Cluster Diagram of water quality parameters of well water in Pre monsoon and Post monsoon season during 2020

Table 7 Comparison of water quality parameters of well water in Pre monsoon and Post monsoon season during 2020

					Sample	code			
S.No	Parameters	o WPRA20CO	∞ WPRA20KU	o WPRA20MI	WPRA20ME	% WPON20CO	WPON20KU	WPON20MI	WPON20ME
1	pH	7.5	8.1	6.5	7.3	7.8	7.9	7.8	7.8
2	Turbidity (NTU)	8.1	7.0	9.0	9.0	8.0	7.0	8.0	7.0
3	Dissolved oxygen (DO) (ppm)	8	8	7.5	7.0	8.1	9	8	8
4	Biological Oxygen Demand (BOD) (ppm)	9	9	8	8.1	7	8	7	7
5	Hardness Mg (mg/L)	4.5	4.5	20	7	104	90	77	70
6	Sulphate (mg/L)	5	5	2.5	0.9	7	7	7	6.9
7	Total Nitrogen (mg/L)	4.5	4.9	4.8	4.9	4.1	4.9	4.9	4.9
8	Nitrate (mg/L)	0.2	0.6	0.3	0.8	0.1	0.9	0.2	0.9
9	Ammonia (mg/L)	0.9	0.8	0.4	0.9	0.8	0.7	0.8	0.9
10	Phosphate (mg/L)	0.2	0.5	0.8	0.1	0.4	0.4	0.4	0.8
11	Total Phosphorous (mg/L)	0.5	1.5	0.5	0.5	0.9	0.3	0.3	0.9
12	Fluoride (ppm)	0.8	0.8	0.3	0.9	0.2	0.9	0.9	0.4
13	Chloride (ppm)	237	237	300	180	32.5	390	398	330
14	Total dissolved solids (FDS)(ppm)	582	592	190	580	480	480	472	490
15	Electrical conductivity (Mics/cm)	631	692	420	620	480	490	490	490
16	Oxidation-Reduction Potential (mV)	765	760	561	770	570	570	560	561
17	Temperature (°C)	30	30	30	28	27	28	25	29
18	Sodium (mg/L)	26.1	29.1	19.3	25.6	33.5	32.6	39.5	33.1
19	Potassium (mg/L)	19.6	16.1	11.3	16.3	12.4	12.5	12.4	14.1
20	Alkalinity (mg/L)	170	192	240	185	230	330	270	231
21	Hardness Ca (mg/L)	54	61	40	60	70	77	80	56
22	Salinity (ppm)	92	92	85	110	90	80	92	91

 $\textbf{Table 8} \ \ \text{Descriptive Statistics of water quality parameters of well water in Pre monsoon and Post monsoon season during 2020$ 

				Descr	iptive Statis	tics				
	N	Range	Minimum	Maximum	Me	an	Std. Deviation	Variance	Kur	tosis
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error
Temp	8	5	25	30	28.38	.625	1.768	3.125	.522	1.481
pH	8	1.6	6.5	8.1	7.588	.1777	.5027	.253	3.102	1.481
Turbidity	8	2.0	7.0	9.0	7.888	.2961	.8374	.701	-1.465	1.481
Alkalinity	8	160	170	330	231.00	18.304	51.771	2680.286	.780	1.481
HardnessCa	8	40	40	80	62.25	4.632	13.101	171.643	228	1.481
HardnessMg	8	99.5	4.5	104.0	47.125	14.9214	42.2042	1781.196	-2.236	1.481
Salinity	8	30	80	110	91.50	3.047	8.619	74.286	3.576	1.481
Fluoride	8	.7	.2	.9	.713	.0934	.2642	.070	.896	1.481
Chloride	8	218	180	398	299.63	27.244	77.058	5937.982	-1.038	1.481
TDS	8	402	190	592	483.25	45.734	129.354	16732.500	4.551	1.481
DO	8	2.0	7.0	9.0	7.950	.2000	.5657	.320	2.036	1.481
BOD	8	2.0	7.0	9.0	7.888	.2961	.8374	.701	-1.465	1.481
EC	8	272	420	692	539.13	33.615	95.078	9039.839	-1.161	1.481
Totf\itrogen	8	.8	4.1	4.9	4.738	.1034	.2925	.086	3.153	1.481
Nitrate	8	.8	.1	.9	.500	.1195	.3381	.114	-2.202	1.481
Sulphate	8	6.1	.9	7.0	5.163	.8287	2.3440	5.494	088	1.481
Ammonia	8	.5	.4	.9	.775	.0590	.1669	.028	4.175	1.481
Phosphate	8	.7	.1	.8	.450	.0886	.2507	.063	652	1.481
Totphosphorus	8	1.2	.3	1.5	.675	.1436	.4062	.165	1.532	1.481

29.850

14.338

639.63

2.1899

.9894

36.744

38.366

7.831

10800.839

6.1940

2.7984

103.927

.208

.222

-2.227

1.481

1.481

1.481

Sodium

ORP

Potassium

Valid N (listwise)

8

8

8

20.2

8.3

210

19.3

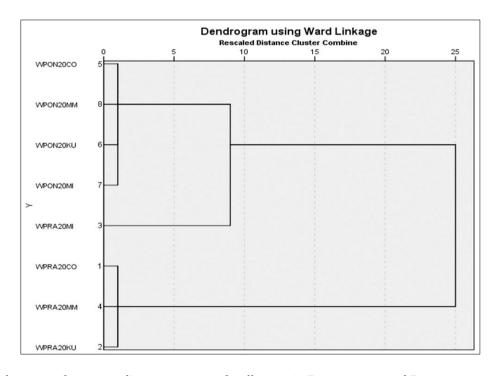
11.3

560

39.5

19.6

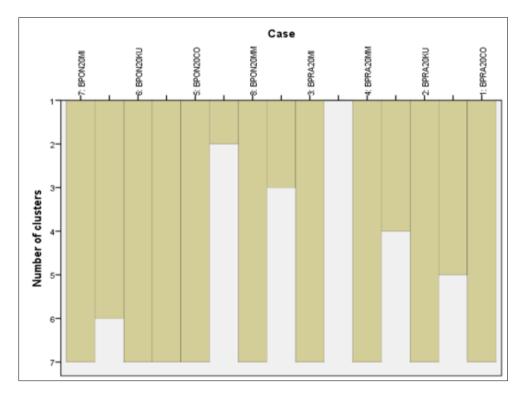
770



 $\textbf{Figure 6} \ \text{Dendrogram of water quality parameters of well water in Pre monsoon and Post monsoon season during } \\ 2020$ 

 $\textbf{Table 9} \ \text{Pearson Correlation Coefficient (r) of water quality parameters of well water in Pre \, monsoon \, and \, Post \, monsoon \, season \, during \, 2020$ 

										Go	miatiens."												
		tens	CH CH	BEEFY	AG 17	-210906903	FarmessMg	5000	FROME	CNODES	108	00	80.3	50	offs (90cm)	90.00	5,00000	Armena	PERSONAL	AMESEROU 1	510km	40000.00	046
Terro	Featron Core at on		,819	0.05	0.5	807	387	. 35	2.0	.589	190	188	.403	261	6.9	216	.413	229	274	A' 3	7.00	147	43
	Sig (f-called)		258	438	126	000	695	400	16.5	622	420	374	025	530	420	314	163	51.7	214	165	015	151	13
pil .	Featpor Done at on	- 316		- 622	168	729	461	- 656	- 205	262	739	995	-062	250	- 629	222	310	660	- 225	411	781	176	- 62
	Sig (I-called)	225		600	376	070	162	410	385	273	618	364	431	170	470	294	627	633	296	163	111	358	47
Tart dis	Peacon Consider	- 3/10	-852	1	-34	24</td <td>-263</td> <td>430</td> <td>207</td> <td>-467</td> <td>- 398</td> <td>- 767</td> <td>.023</td> <td>- 150</td> <td>-157</td> <td>- 415</td> <td>751</td> <td>-219</td> <td>- 256</td> <td>-433</td> <td>- 552</td> <td>-014</td> <td>.15</td>	-263	430	207	-467	- 398	- 767	.023	- 150	-157	- 415	751	-219	- 256	-433	- 552	-014	.15
	Sig 11-at add	456	.005		300	.147	.475	: 22	.381	.459	2.57	212	461	331	245	151	£1.5	.223	371	.139	873	767	39
Alle In te	Fower Concal on	- 465	.420	- 240	- 1	.543	.733	- 855	.100	.070	- 336	505	~473	- 870	329	221	2.3	-400	202	455	417	-753	75
	5 K (1 to 50)	123	.359	205		.003	.019	806	.405	.002	7.72	330	.123	105	292	296	.004	.150	349	.139	100	.015	K
Hartinessea	Pearson Coincation	- 907	.729	- 434	510		.001	- 890	.006	.550	425	557	~377	- 026	025	335	821	.375	- 400	~192	873	-,224	-23
	Right Tallock	300	.023	.1 GT	300		.037	416	.466	.075	7.67	.316	.173	475	475	457	.053	.100	163	.724	830	.257	29
Hartnessung	Financian Colon of on	- 967	.401	- 337	733	.561	1	- 495	- 512	.023	-7.00	513	-884	- 850	-295	- 325	.273	K. 5	. 35	-211	730	-90	-834
	Rig (firm) with	775	.162	375	215	.037		1.25	.207	.005	277	.252	.003	0.00	237	457	K1.5	.427	320	.315	120	.027	.00
Sailt ly	Featron Cores at an	108	.084	498	905	.050	.485	- 1	.116	.714	421	788	.083	531	.034	31.	.815	.555	555	3.73	1.24	.451	
	Sig (f-called)	400	.443	3.72	798	.419	.123		2.0	.023	1.08	310	.423	1.98	418	201	3.53	878	367	A25	7.9:	.103	.04
Fluoride	Feature Core at on	350	203	236	102	.028	.618	116		.144	0.91	367	3.27	230	877	190	.425	.193	354	.425	2.52	.23	270
	Sig (I-railed)	0.0	800	211	0.0	28.9	197	2.07		287	471	616	1185	2.07	ER	374	145	228	2.6	144	240	811	161
Children de	Feature Done of on	- 506	262	- 437	875	60.8	898	- 714	-144	1	- 372	866	-645	- 738	co	- 381	777	-571	615	-259	6.71	- 751	- 679
	Sig (I-called)	377	273	159	302	075	005	8.23	367		1.80	376	042	620	472	424	0.0	358	168	193	816	002	co
TD5	Feature Dans allon	- 398	.727	- 395	- 386	405	-123	431	12:	-372	- 1	360	.267	632	- 029	340	.143	\$12	+ 577	217	378	573	650
	Significations	425	.013	457	177	.147	372	7.00	171	.462		910	.223	200	473	378	200	.01	334	.339	- 76	.022	(3)
UD.	Fower Greeken	+106	.565	- 257	500	.527	812	- 730	- 361	.065	090		07+	- 230	032	120	.633	-615	121	055	510	-223	-403
	Sec (Clares)	374	.064	810	330	.075	.050	210	.415	.020	416		201	315	420	306	.015	.405	300	340	196	.37	.150
80.3	Pearson Correlation	700	002	.020	. 470	5,277	-004	106	.507	-845	297	- 274	1	236	.140	356	-,149	-810	- 330	231	- 591	.581	.783
	EXCITATION	325	,424	421	120	.173	200	420	.005	.042	230	.42		.019	.353	425	.132	490	212	210	851	.000	X10
EC	Filterson Control at an	347	.362	150	- 510	-325	-853	521	.204	-723	832	- 203	.725	- 1	.115	155	-513	.534	- 557	473	-125	.551	540
	Fig. (1-ra) with	200	.175	251	325	,415	.023	5.80	.230	.023	8.00	.315	37.9	-	393	357	243	.034	301	.11.5	221	.004	.00
Tehlingen	Featron Core at an	3/3	.005	150	275	-005	355	134	.517	.023	820	.302	.143	.115	1	525	-530	£25	325	-,111	18	.044	. KS
-	Sig (firm) and	6.75	473	286	2.0	419	327	413	.352	4/2	473	672	283	239		79	388	411	312	297	4.0	36.9	441
Nittale	Featron Core at on	216	327	419	7.0	JP5	.025	118	162	191	245	100	.003	7.96	895	- 1	.103	188	100	185	126	.044	1.0
	Sig (I-called)	9.4	288	231	2.0	97	497	211	204	474	270	0.5	421	257	£11		411	215		422		9.5	419
Submit	Featror Done ston	- 600	(0)	- 754	515	961	778	- 630	- 1.79	722	118	411	-443	- 548	- 537	- 108	1	571	776	(0)	1.0	-263	-64
	Significatives	109	027	816	394	000	0:2	6.90	146	0.2	318	306	152	218	290	404		287	296	425	136	X1	Cit
ATERIA	Feature Date along	- 206	60	- 218	- 400	375	0:2	550	-156	-271	\$12	- 315	-013	163	- 035	202	231	- 1	- 510	210	430	662	463
	Six III-ali v.0	312	.023	220	163	.163	469	870	325	253	101	166	463	258	41	310	287		301	317	110	.063	.125
Physicials	Forest Octobra	274	-221	- 255	200	-10	.467	- 555	- 324	40	- 872	12:	-203	- 257	225	101	.225	-245	- 1	267	- 136	-505	03
	to it and	258	.259	271	3/5	.10	.323	577	206	.101	101	200	212	173	3:3	406	285	(1)		362	417	.072	
000000000		912	464	-430	- 455	-152	-21	570	- 122	-355	337	- 255	.224	470	-411	303	(1)	233	357		- 027	.207	.313
	FIG. 15 74 747	155	.163	.129	125	.324	30	420	.140	.153	229	.48	.203	7.15	397	422	425	317	352		475	.211	223
2010-011	Filamon (2010) at an	-778	.781	- 552	617	.073	.723	-0.34	- 200	.851	379	515	-351	.7.29	629	- 305	K13	400	- 305	-827	111	-223	-38
	EK ITCH YE	212	.011	872	133	.002	503	335	200	.042	1.70	215	.081	231	472	495	X13	31.5	417	475		.285	370
Potossia m	Feminar Oxini stran	847	.173	- 514	-750	-724	-883	430	200	-721	270	- 272	.651	251	141	348	-517	.1 2 £42	- 505	207	- 225	.262	893
	Elg (I call est	199	323	437	316	327	327	120	311	302	520	257	3023	£34	490	495	283	143	10	211	22		X15
Q2P	Femnor Core of on	100	3375	351	768	.21	201	12	311	879	898	807	.753	200	195	10	243	492	851	215	19	.95	A 80
	Sig (I-called)	139	427	2.91	312	760	103	864	199	307	100	11.0	004	630	461	415	E82	324	32.7	324	1.00	182	Ι '
s.Laphs 9		1.00	900	Sali	44.5	.41	245		152	2000	4.90	100	1,000	4.96			5.50	1000	***	201	- 1	196.0	



 $\textbf{Figure 7} \ \textbf{Cluster Diagram of water quality parameters of bore hole water in Pre monsoon and Post monsoon season during 2020$ 

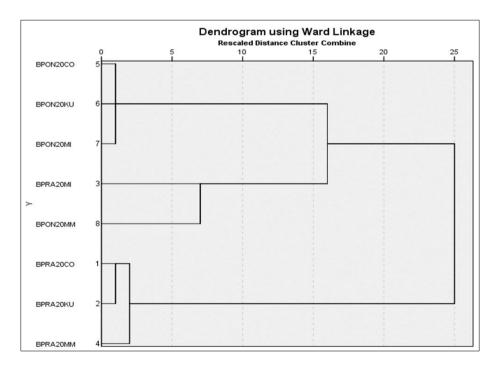
 $\textbf{Table 10} \ \textbf{Comparison of water quality parameters of bore hole water in Pre monsoon and Post monsoon season during 2020$ 

	*				Sampl	e code			
1 2 3 4 4 5 5 6 6 7 8 8 9 10 11 12 13 14 15 16 17 18 19 20 21	8	-	Pre mo	on Season	n		Post mo	on Seaso	n
S.No	Parameters	BPRA20CO	BPRAZOKU	BPRA20MI	BPRA20ME	7BPON20CO	CBPON20KU	6-BPON20MI	BPON20ME
1	рН	7.2	7.3	7.4	7.9	7,2	7.5	7,9	7.2
2	Turbidity (NTU)	6	8.1	11	7.0	8.2	9.2	8.9	8.2
3	Dissolved oxygen (DO) (ppm)	7	6	6.5	8.1	8.0	8.0	9.0	9.0
4	Biological Oxygen Demand (BOD) (ppm)	6.2	9.1	6.3	6.3	6.6	6.9	6.9	6.6
5	Hardness Mg (mg/L)	6	6	40	7	60	40	48	41
6	Sulphate (mg/L)	7.2	7.8	4.8	7:4	6.5	6.5	6.9	0.6
7	Total Nitrogen (mg/L)	4	9	2.8	5	4.8	4.8	4.6	4.6
8	Nitrate (mg/L)	0.2	0.9	0.1	0.4	0.8	0.5	0.1	0.6
9	Ammonia (mg/L)	0.3	0.3	0.3	0.3	1.9	0.1	1.2	1.6
10	Phosphate (mg/L)	0.1	0.1	0.8	0.7	0.2	0.2	0.2	0.5
11	Total Phosphorous (mg/L)	0.6	6.1	0.9	0.9	0.5	0.7	0.7	0.6
12	Fluoride (ppm)	0.2	0.2	0.2	0.7	0.3	0.4	0.2	0.3
13	Chloride (ppm)	185	185	170	240	380	360	380	380
14	Total dissolved solids (TDS)(ppm)	691	691	380	580	390	390	380	390
15	Electrical conductivity (Mics/cm)	537	592	375	530	570	580	540	136
16	Oxidation-Reduction Potential (mV)	791	792	491	714	680	680	670	578
17	Temperature (°C)	29	29	29	29	29	29	27	30
18	Sodium (mg/L)	21.4	12.1	19.8	11.4	29.8	21.9	31.8	26.1
19	Potassium (mg/L)	18	19	12.8	19	11.6	11.8	11.9	13.1
20	Alkalinity (mg/L)	215	154	230	185	180	189	210	180
21	Hardness Ca (mg/L)	61	60	30	50	55	58	56	70
22	Salinity (ppm)	112	161	55	95	75	65	85	96

**Table 11** Descriptive Statistics of water quality parameters of bore hole water in Pre monsoon and post monsoon season during 2020

## Descriptive Statistics

	N	Range	Minimum	Maximum	Me	an	Std. Deviation	Variance	Kurl	osis
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error
Temp	8	3	27	30	28.88	.295	.835	.696	4.970	1.481
pН	8	.7	7.2	7.9	7.450	.1052	.2976	.089	781	1.481
Turbidity	8	5.0	6.0	11.0	8.325	.5260	1.4878	2.214	.992	1.481
Alkalinity	8	76	154	230	193.50	8.424	23.827	567.714	069	1.481
HardnessCa	8	40	30	70	55.00	4.110	11.625	135.143	3.433	1.481
HardnessMg	8	40	30	70	55.00	4.110	11.625	135.143	3.433	1.481
Salinity	8	106	55	161	95.50	11.055	31.268	977.714	2.765	1.481
Fluoride	8	.5	.2	.7	.313	.0611	.1727	.030	4.062	1.481
Chloride	8	210	170	380	285.00	34.834	98.525	9707.143	-2.517	1.481
TDS	8	311	380	691	486.50	50.534	142.931	20429.143	-1.539	1.481
D0	8	3.0	6.0	9.0	7.700	.3905	1.1045	1.220	-1.118	1.481
BOD	8	2.9	6.2	9.1	6.863	.3332	.9425	.888	6.163	1.481
EC	8	456	136	592	482.50	54.984	155.519	24186.286	3.813	1.481
TotNitrogen	8	6.2	2.8	9.0	4.950	.6299	1.7817	3.174	5.010	1.481
Nitrate	8	.8	.1	.9	.450	.1086	.3071	.094	-1.412	1.481
Sulphate	8	7.2	.6	7.8	5.963	.8296	2.3464	5.506	4.689	1.481
Ammonia	8	1.8	.1	1.9	.750	.2493	.7051	.497	-1.218	1.481
Phosphate	8	.7	.1	.8	.350	.0982	.2777	.077	-1.106	1.481
Totphosphorus	8	5.6	.5	6.1	1.375	.6768	1.9144	3.665	7.869	1.481
Sodium	8	20.4	11.4	31.8	21.788	2.6353	7.4538	55.558	-1.014	1.481
Potassium	8	7.4	11.6	19.0	14.625	1.2001	3.3944	11.522	-2.092	1.481
ORP	8	301	491	792	674.50	35.858	101.421	10286.286	.277	1.481
Valid N (listwise)	8									



 $\textbf{Figure 8} \ \text{Dendrogram water quality parameters of bore hole water in Pre monsoon and Post monsoon season during } 2020$ 

**Table 12** Pearson Correlation Coefficient (r) of water quality parameters of bore hole water in Pre monsoon and Post monsoon season during 2020

											Correlat	mn"											
		IEYa	30-	втку	ra m	HCMR000	-21	100.7	HC.	1100	:0000	Harmen	83 W)	-conveyors	Hadrasica	D-0006	24 37 73	STEER	- wearan	Trushnachuru K	600E-Y	PROMAT	0.49
2000	Most can storic at an	1	- 851	-147	- 304	.034	- 500	031	< 201	7.40	-,165	21	.110	.121.	191	474	~523	012	377	.051	- 361	7.8	-:140
	Sig. (1-to led)		841	281	2.5	088	2.0	444	CI II	2/7	284	2.0	281	30.5	2.0	113	194	40	25.6	49.7	199	210	281
-	Mostron Compation	561	1	.011	143	075	205	-,125	.373	< 21	.112	514	-,130	-,264	- 254	-450	.363	- 225	377	-150	-103	.040	.005
	Sig. (1-to led)	1897		625	0.1	523	20.7	280	119	2/2	284	2.6	221	20.0	214	123	183	2.6	29.5	261	884	496	490
AND My	Most can Come at an	<147	821	- 1	307	-250	- 217	.040	-301	- 201	.101	- 205	500	~511	- 811	-,101	-,274	00	401	-,034	204	- 855	~702
	Sig. (1-to led)	20.4	4.0		201	200	1.0	482	125	1.0	600	267	647	0.4	854	225	29.0	441	167	484	0.4	1.0	10.0
es: ey	Most son Corre at an	-334	150	.387		073	-117	-210	.327	- 217	~175	- 255	-230	√507	- 507	-510	050	< 21	.332	840	345	- 340	-,474
	Sign (1-to led)	.7.4	316	233		16.6	3.0	6.28	1.15	2.70	224	24"	0.20	1913	10	6.01	0.0	275	21	040	202		11.6
Late drag tra	Most can come at an	.024	- 175	-250	- 310	1	350	.534	- 305	243	~123	- 326	.034	.423	420	.735	.30	-3.14	-,415	.905	- 645	537	.639
	Sign (1-to led)	19.6	4-00	284	8.3		196	0.00	70.0	10	287	518	0.07	10	1.00	61.4	183	24	17.7	500	120	**	1917
H:	Most can come at an	-503	305	-317	-117	.363		.390	< 200	370	-,160	390	259	-123	- 120	.110	.963	- 252	-333	.284	- 193	345	.679
	Sign (1-to led)	10.4	21.1	>84	0.1	10.0		2.29	213	1.0	280	514	2.00	:04	10	401	100		197	244	0.0	2.0	197
MI:	Most can Corre stran	061	1.24	.040	- 713	.934	300	- 1	-,143	395	171	- 206	291	.265	255	2.5	.202	< 50	-,487	.990	- 353	322	.434
	Sign (1-to led)	440	3.44	497	202	163	2.9		124	18	244	208	610	200	7.9	654	295	234	127	00.0	198	215	141
DC	Most can come at an	< 201	370	-310	227	~335	- 330	-,445		- 506	490.	215	430	,412	412	-,122	-,471	.600	.031	-,639	525	- 400	~221
	Sign (1-to led)	80.8	. 15	425	1.15	1904	212	100		8.84	10.6	224	184	10.5	104	271	10.0	0.54	46.7	045	319		294
380	Most can come at an	.143	-121	-787	- 217	.540	310	.395	- 503	- 1	-,655	347	832	.224	224	.410	.5.2	- 225	-31.2	.510	- 900	514	.787
	Sign (1-to led)	3077	312	125	202	19.7	. 49	787	8.4		123	9.6	0.00	207	241	228	194	. 11	225	583	357	1.8	12.3
Code note	Most can come at an	-165	115	.111	- [15	~120	- 160	-371	.084	- 895	1	207	234	.467	457	.131	~251	212	-324	-,447	746	- 721	~102
	Sig. (1-to led)	366	3.0	400	0.8	29.7	378	244	8.1	0.76		510	2.09	122	1.00	225	107	0.24	287	124	217	1.7	224
Flaggraph	Mission Correspond	.211	514	-315	- 255	-,025	390	-295	.215	E12	.057		-3115	-000	- 120	,C31	.121	-,100	A32	-232	- 407	205	.055
	Sig. (1-in led)	30.4	14	297	71"	278	414	240	224	496	6.3		288	491	4/2	417	287	2.0	144	29.3	128	211	6.1
sc my	Progress Correspon	.110	- 190	-333	- 703	.064	255	.791	-40	.000	~334	-115	- 1	.553	553	.533	.30	- 256	-,535	.033	- 505	725	.759
	Sig. (1-in led)	201	3.76	1.07	201	1002	219	610	16.3	0.0	204	80		0.14	1/2	186	224	270	005	0.05	107	1.7	37.1
Hardring	Progress Corns at an	.151	- 254	-811	- 507	.409	- 120	295	.412	234	.467	- 326	.550	1	1.000	472	-205	345	-834	.121	200	7.00	37.4
	Sig. (1-to led)	305	214	1.61	3.3	145	2-9	5 8 8	14.5	240	127	512	678		800	319	2.7	231	1944	287	u.	277	190
HARRIST CO.	Medican Correlation	.151	- 254	-811	- 507	.409	- 120	295	.412	224	.487	- 326	.550	1,003	1	A72	~205	245	-,834	.121	200	7.00	37.4
	Sig. (1-to led)	365	214	1.61	36.3	345	200	510	165	240	122	513	0.78	.003		31.8	2.7	231	.019	287	in:	277	.000
No. 5 to	Medican Correlation	,474	- 453	~101	- 81	.725	103	819	<120	7.00	.151	394	.500	,472	413	- 1	-0.3	234	-352	.557	- 193	7.98	.345
	Sign (1-to led)	.118	. 90	525	×.	.019	404	.031	.37*	376	225	912	138	119	116	l	793	515	46)	.079	373	3%	261
St. phone	Medican Correlation	~525	353	-374	- 250	.340	950	290	4,441	512	-,381	121	.330	~203	- 206	-813	- 1	- 454	-,41.5	.327	- 325	415	.850
	Sig. (1-to led)	.069	. 36	359	16.3	.163	300	345	16.6	1.6	197	367	578	312	312	483		2.75	.153	2* 5	213	1.91	.023
AT INCIDEN	Medican Correction	<.012	- 225	-813	-12	×110	- 353	~150	.502	- 505	.71.2	- 102	-255	.345	345	314	-,484	1	-310	~305	745	- 520	-,242
	Sig. (1-in led)	.169	230	497	218	263	196	357	.367	1.34	.021	\$10	570	.001	201	543	123		283	221	217	196	291
PERSON	Program Corns at an	.277	217	401	322	-,465	- 503	-,457	.25"	- 212	-334	400	536	-,574	- 824	252	-,415	< 2.00	'	-302	- 200	-125	-,734
	Sign () - In leaf,	-303	2.54	462	211	312	387	422	.162	2.%	287	143	136	.019	116	489	103	586	l	373	24.6	416	.021
District seasons	Program China at an	.051	- 150	-834	- 541	.905	304	.550	- 523	500	-,447	- 230	830	.121	. 51	.557	.307	- 205	-310	1	- 550	520	.443
	Sig. (1-in led)	762	354	463	341	.001	316	.000	.364	886	123	266	630	367	387	679	2.5	201	323		33.	154	123
ex turn	Medican Corn stran	< 361	-103	214	345	-,445	- 193	-352	.575	- 830	.745	407	535	.203	200	-333	~300	245	-312	583		810	-37.1
	Sign (1-in ledf)	.163	434	5.1	30.3	.125	375	.190	.368	1.91	42.7	126	-131	301	311	533	2.3	617	349	4071		137	297
PCTSS BY	Mark an Colin Strain	.153	140	-,615	- 341	.507	346	.322	-,462	346	-,781	205	229	.122	1.00	.155	,419	- 520	023	.529	- 910	1	.655
	Sign (1-in ledf)	.219	436	.033	158	40	276	518	.103	100	.023	347	820	-307	377	559	461	1.6	463	.081	307		.039
1144	Programm Correct at an	143	106	~713	. 614	.839	515	434	1221	731	-,182	306	250	.514	214	.345	.653	(24)	-,724	.443	- 311	855	
	Sig. (1-in led)	364	496	411	118	.047	236	.141	.368	210	353	411	814	.068	196	581	.059	531	.031	433	227	18	

#### 4. Conclusion

The physico-chemical analysis of well and bore hole water samples in and around the villages from Colachel to Melmidalam of Kanyakumari District was done. Water samples from well and bore hole in four sites namely Colachel, Kurumbanai, Midalam, Melmidalam were collected in pre monsoon and post monsoon seasons during 2019 and 2020 were carried out. The statistical assessment is also carried out for the Physico-chemical parameters. Most of the parameters are well within the permissible limits. It is concluded that from the results of the present study, it may be said that the water from well and bore hole in and around the villages from Colachel to Melmidalam of Kanyakumari District collected in pre monsoon and post monsoon seasons during 2019 ad 2020 fits for domestic purpose. Statistical analysis results showed that the CA technique is useful in classification of water samples in the study region and the number of parameters. The application of cluster analysis proved that one major group of similarity between twenty two physicochemical parameters are formed in the water samples of well and bore hole in and around the villages namely Colachel, Kurumbanai, Midalam, Melmidalam.

# Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest.

Author's contribution

The first author is a research scholar. The second author is supervisor. The third author is joint supervisor. The fourth author is also encouraging and promoting the research carrier to the students.

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