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Physico-chemical characteristics of ground water of Ariyalur district, Tamilnadu, India

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ABSTRACT

This study was conducted to evaluate factors regulating ground water quality in an area with agriculture as main use. Ariyalur is one of the districts in Tamil Nadu. It is rich in limestone resource. Ground water acts as reservoir and source of water for bore wells. The increase in Human population and fast Industrial development to the scarcity of drinking water in this district. Ten ground water samples were collected from different stations around Ariyalur area. The Ariyalur District covers an area of approximately 681.19km.² The analyzed for various Physico-chemical parameters such as p^H, Electrical Conductivity, Total Dissolved Solid, Dissolved Oxygen, Biological Oxygen Demand, Chemical Oxygen Demand, Total Hardness, Calcium, Magnesium, Chloride, Sulphate, Nitrate and Fluoride were analyzed (APHA, 1998). The results were compared with standards prescribed by BIS (Bureau of Indian Standard) and suitable suggestion were made. The correlation coefficients were calculated for water quality assessment. The study indicates that the water quality parameters slightly excess the permissible limits and not suitable for drinking purposes.

Keywords: Ground water, Physico-Chemical Parameters, water Quality and Correlation co-efficient.

INTRODUCTION

Water is essential to the existence of man and all living things. Ground water is used for Agricultural, Industrial, Domestic, Recreational and Environmental activities in Ariyalur district. The most of populations is dependent on ground water as the only source of drinking water and agricultural uses. In the last few decades these has been a tremendous increase in the demand for fresh water due to rapid growth of populations and the accelerated place of industrialization [1]. Potable water is the water that is free from disease producing micro-organism and chemical substances. Most of them depend on unsafe water resource to meet their daily needs. Water chemistry differ depending on the sources of water, the degree to which it has evaporated, the types of rock and mineral it has encountered, and the time it has been in contact with reactive minerals[2-3]. Understanding the potential influences of human activity on ground water quality is important for protection and sustainable use of ground water resources, as well as ground water extraction has been increasing continuously to keep pace with agricultural development in rural areas hence the hydro geochemistry study was undertaken by randomly collected 10 ground water samples from bore wells covering Ariyalur area to understand the sources dissolved ions, and to assess the chemical quality of the ground water through Physico-chemical analysis.

STUDY AREA

Geographical covering area in Ariyalur District 681.19 Sq.Km and having population 384,800 per 2011 census. It lies between 10°54' to 11°03' of North latitude and 78°40' to 10°54' of East longitude. The area experiences Tropical Climate. The Alluvial soil 70% present in the Ariyalur area. It is rich in limestone resources. The major crops growths in the district are Paddy, Sugarcane, Black gram, Sunflower, Cotton, Ragi, Chillies, Ground nut, Cashew nut and Vegetables. Bore wells water is generally using for drinking and irrigation purposes in this district.

MATERIALS AND METHODS

The current study was designed to investigate the conditions of ground water contamination in the study areas. The hydro geochemistry study was undertaken by randomly collected 10 ground water samples from bore wells in around Ariyalur limestone region in Ariyalur district, Tamil Nadu, were selected for testing portability of drinking water sources. Samples were

drawn with a pre-cleaned plastic polyethylene bottle. Prior to sampling, all the sampling containers were washed and rinsed thoroughly with the ground water. Water quality parameters such as p^H and electrical conductivity (EC) were analyzed immediately [4-6]. The Physico-chemical parameters like pH, TDS, Alkalinity, Total Hardness, Chloride, Nitrate, Calcium Magnesium, Sulphate, BOD, COD, DO and Fluoride were analyzed and each parameters was compared with standard values given by BIS. In the present investigation the Ground water samples were collected during the month of April to July (2012).

ARIYALUR TALUK MAP:

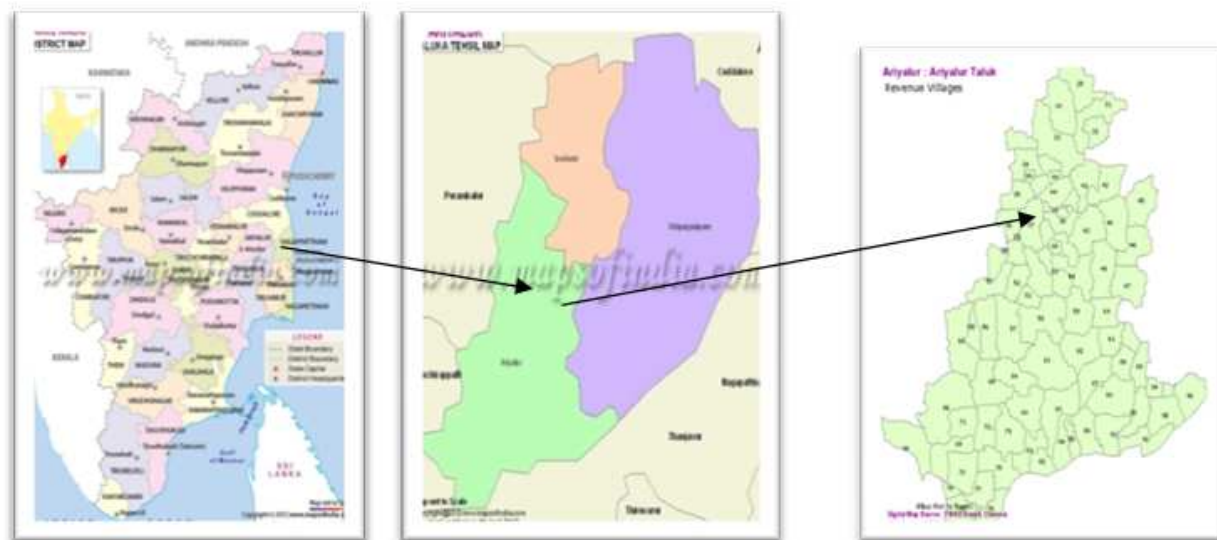


Fig. 1. Sampling location and map of study area

Table-1: Details of the Sampling Locations

Samples	Sampling location	Taluk	Population		Total
			Male	Female	
1	Mandaiyankudisal	Ariyalur	1201	892	2093
2	Austhinapuram	“	1159	834	2032
3	Manaleri	“	1160	876	2036
4	Kallankuirchi	“	1987	2012	3999
5	Srinivasapuram	“	820	1010	1830
6	Pallackaveri	“	710	690	1400
7	Thamarikulam	“	860	1025	1885
8	Ottackovil	“	990	880	1870
9	Poyadanallur	“	1015	985	2000
10	Rayampuram	“	1030	895	1925

RESULTS AND DISCUSSION

The Physico-chemical characteristics of the analyzed Ground water samples are presented in table 2 and 4.

1. Variation of pH in the Ground water samples

The pH is within the permissible limit for all the water samples in our study. There is no much variation in the ion exchange reactions of the rock and surface area [7]. The maximum permissible limit for p^H is 6.5- 8.5. In our study, the range of pH value was between 7 and 7.4 during April 2012 and in the month of July, 2012 it was 9.1 and 9.8. The latter value was alkaline in nature.

2. Variation of Electrical Conductivity in Ground water samples

According to the table 2 and 4 the average electrical conductivity values of ground water samples ranged from 646 to 5622 $\mu\text{s}/\text{cm}$ and 543 to 6152 $\mu\text{s}/\text{cm}$. Higher the concentration of ions in water, higher will be the conductivity. Besides, these effects water with electrical conductivity change soil structure, permeability which ultimately affects plant growth and crop yield considerably [8].

3. Total Dissolved Solid

It indicates the quality of dissolved solids available in water [9]. The permissible limit of TDS is 500 mg/l. In our study all the ten stations were shown values more than permissible limit of TDS. The table 2 and 4 indicates TDS value of ground water samples which were varied from 442 to 3149 mg/l and 496 to 3401 mg/l. The high values of TDS indicate the percolation of external solid substances in to the water bed during the rainy season. High value of TDS resulted in high electrical conductivity.

Table-2: Ground water samples in Ariyalur Region during April- 2012

Physical Parameters	BIS standards	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Appearance	Clear	C	C	C	C	C	C	C	C	C	C
Color	Colorless	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
Odour	Odorless	OL	OL	OL	OL	OL	OL	OL	OL	OL	OL
EC	750-2250	1497	821	119	661	538	5622	646	904	3621	3822
TDS	500	12	665	923	538	442	457	741	3124	3140	3130
Chemical Parameters	BIS standard										
Ph	6.5-8.5	7.3	7.1	7.3	7.2	7.2	7.0	7.3	7.4	7.4	7.1
Alkalinity	200	10.5	9.2	11.5	8.5	8.0	7.2	8.5	12.0	11.8	12.5
TH	300	402	310	278	324	290	556	370	146	676	980
Calcium	75	74	68	63	67	62	68	63	24	34	-
Magnesium	50	80	59	53	63	55	110	75	30	155	230
Sulphate	200	3	0.5	8	99	9	5	2	7	14	21
Nitrate	100	0.3	0.7	0.8	0.8	0.8	0.9	0.9	1.0	1.0	0.1
Fluoride	1	0.4	0.5	0.6	0.5	0.6	0.2	0.4	1.4	0.4	0.1
Chloride	250	447	156	106	113	142	99	127	92	450	674
Biological Parameters	BIS standard										
DO	5	6.7	5.9	3.8	4.4	5	4.5	5.5	4.8	5.9	3.9
BOD	4	1.9	2.3	0.4	1.6	0.3	3.9	0.5	0.4	0.8	0.9
COD	10	8	4	12	32	28	4	16	36	8	20

All parameters are expressed in (mg/l), except p^H and electrical conductivity (EC)

4. Total Alkalinity

The alkalinity values were found to be higher in most of the stations in our study [10]. It is due to the presence of salts of carbonates and bicarbonates which are the common components of alkalinity in natural water. The maximum permissible limit of alkalinity is 200 mg/l in our study, the table-2 represent the lowest value of 360 mg/l in Pallackavri and the highest values of 625 mg/l in Rayampuram. The table-4 represents the lowest value of 360 mg/l in Pallackaveri and the highest value of 525 mg/l Manaleri and Ottackovil.

Table-3: Correlation coefficient of Ground water samples in Ariyalur Region during April 2012

	EC	TDS	PH	TA	TH	Ca	Mg	SO ₄ ²⁻	NO ₃ ²⁻	Fl ⁻	Cl ₂ ⁻	DO	BOD	COD
EC	1													
TDS	0.303	1												
PH	-0.451	0.362	1											
TA	-0.002	0.770**	0.525	1										
TH	0.750*	0.444	-0.344	0.306	1									
Ca	-0.331	-0.934**	-0.153	-0.730*	-0.578	1								
Mg	0.718*	0.516	-0.282	0.376	0.996**	-0.644*	1							
SO ₄ ²⁻	-0.132	-0.064	-0.076	-0.145	-0.002	0.038	.000	1						
NO ₃ ²⁻	-0.140	0.009	0.337	-0.314	-0.548	0.267	-0.544	0.006	1					
Fl ⁻	-0.529	0.258	0.585	0.250	-0.727*	-0.112	-0.671*	-0.059	0.485	1				
Cl ₂ ⁻	0.478	0.584	0.226	0.584	0.761*	-0.551	0.788**	-0.068	-0.369	-0.401	1			
DO	-0.101	-0.225	0.306	-0.101	-0.160	0.354	-0.168	-0.333	0.000	-0.008	0.268	1		
BOD	0.586	-0.416	-0.701*	-0.509	0.158	0.402	0.085	0.018	-0.071	-0.427	-0.143	0.132	1	
COD	-0.423	0.267	0.294	0.104	-0.315	-0.337	-0.262	0.496	0.132	0.602	-0.279	-0.391	-0.553	1

5. Dissolved Oxygen (DO):

The necessary limit of DO is 5 mg/l. The table 2 indicates DO values which were ranged from 3.1 to 6.73 mg/l and 1.1 to 4.8 mg/l. DO values are most important limiting factor of aquatic organisms. A measurement of DO is important in aquatic life ecology and it depends on temperature, pressure and salinity of water

6. Total Hardness

Naturally hard water contains calcium and magnesium salts [11]. It is generally defined as the calcium carbonate equivalent of calcium and magnesium ions present in water. There is evidence that death rates from cardiovascular disease, cancer and heart diseases are directly proportional to the amount of hardness. The permissible limit of hardness is 300 mg/l. In our study the lowest values of hardness 146 to 180 mg/l were found in Ottakovil and the highest values of 984 to 1024 mg/l were recorded in April and July 2012.

Table-4: Ground water samples in Ariyalur Region during July- 2012

Physical parameters	BIS Standard	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Appearance	Clear	C	C	C	C	C	C	C	C	C	C
Colour	Colourless	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL
Odour	Odourless	OL	OL	OL	OL	OL	OL	OL	OL	OL	OL
EC	750-2250	1761	887	1215	9148	6152	5435	692	944	3609	3623
TDS	500	1374	716	988	596	496	443	567	777	3401	2946
Chemical parameters	BIS standards										
PH	6.5-8.5	9.2	9.1	9.1	9.6	9.3	9.4	9.8	9.6	9.5	9.3
Alkalinity	200	425	360	525	325	310	300	320	525	510	520
TH	300	614	450	390	410	396	354	550	180	940	240
Calcium	75	116	110	105	115	100	109	101	34	44	-
Magnesium	50	121	82	69	73	72	59	525	171	218	249
Sulphate	200	52	36	12	19	40	48	45	52	42	24
Nitrate	100	0.2	0.7	1.8	1.7	2.3	2.1	2.2	2.2	1.2	2.7
Fluoride	1.5	0.4	0.6	0.8	0.4	0.6	0.4	0.3	1.6	0.5	0.7
Chloride	250	360	113	198	85	71	56	106	49	850	781
Biological parameters	BIS standards										
DO	5	4.8	3.6	2.8	3.2	3.2	4.4	2.4	2.7	3.6	1.1
BOD	4	2.3	1.1	0.8	1.2	1.6	3.2	0.8	1.2	3.2	1.6
COD	10	80	10	12	32	84	4	44	28	88	40

All parameters are expressed in (mg/l), except p^H and electrical conductivity (EC)

7. Calcium:

The permissible limit of calcium in drinking water is 75 mg/l. The table 2 represent the highest concentration in Pallackaveri and Austhinapuram 68 mg/l. The lowest concentration of 24.05mg/l in Ottakovil. The table 4 represents the lowest value 116 mg/l in Mandaiyankudisal and the highest value of 34.5mg/l in Ottackovil. Calcium is one of the principle components in ground water and it is the most abundant element in human body. The higher concentration of calcium in human body leads to heart problem.

8. Magnesium

The permissible limit of Magnesium is 30 mg/l. In our study, the table 2 shows the highest values of 230 mg/l in Rayampuram and the lowest value of 29 mg/l. The table 4 indicates the highest value of 525 mg/l in Thamaraiikulam and the lowest value 59.6 mg/l in Pallackaveri. A low concentration of magnesium is not harmful, but higher concentration of Magnesium has laxative effect.

9. Nitrate:

The maximum permissible limit Nitrate is 45 mg/l. In our study, the table-2 represents the lowest value of 0.3 mg/l in Mandaiyankudisal and the highest value of 1.7 mg/l in Rayampuram. The table 4 represents the lowest value of 0.2 mg/l in Mandaiyankudisal and the highest value of 2.3 mg/l in Srinivasapuram. The nitrate values were found to be within the permissible level in all study station.

10. Sulphate:

The BIS value of ground water sulphate is 200 mg/l. In our study the table 2 represents the lowest value of 0.48mg/l in Austhinapuram and the highest value of 21mg/l in Rayampuram. The table – 4 represent the lowest value of 4.81 mg/l in Poyadanallur and the highest value of 52.94 mg/l in Mandaiyankudisal. In our study, the sulphate values are within the permissible limit. Sulphate is essential plant nutrient. High concentration of sulphate increases the hardness and electrical conductivity.

11. Chloride

The desirable level of chloride is 200 mg/l. In our study, the table 1 indicates the lowers value of 92 mg/l in Ottackovil and the highest value of 908 mg/l in Poyadanallur [12]. The table 2 indicates the lowest value of 49 mg/l in Ottackovil and the highest value of 1597.5mg/l in Poyadanallur. Young children may suffer if they consume water with high chloride concentration as their delicate kidney tissues may be damaged by the higher osmotic pressure brought about by the presence of high concentration of salts.

12. Fluoride:

According to Bureau of Indian standard (BIS) the permissible limit of fluoride is 1.5 mg/l in drinking water. In our body we have estimated fluoride by ion selective method. The table 2. Represent the lowest value of 0.18 mg/l in Rayampuram and the highest value of 1.4 mg/l in Ottackovil. The table 4 represents the lowest value of 0.2 mg/l in Rayampuram and the highest value of 1.6 mg/l Ottackovil and at level above 1.5 mg/l molting of the teeth and bones has been reported and above 3.0mg/l skeletal fluorosis may be observed.

13. Chemical Oxygen Demand (COD):

The permissible limit of COD is 10 mg/l. The table 2 indicates the values of COD in ground water were varied from 4 to 36 mg/l. The table 4 indicates the lowest value of 4.0 mg/l was found in Pallackaveri and the highest value of 100mg/l in Austhinapuram, large quantities of domestic sewage and other wastes may contribute to the high value of COD.

14. Biological Oxygen Demand:

The permissible limit of BOD is 4 mg/l. In our study the table 2 represent the lowest value of 0.4 mg/l was found in Manaleri and Thamaraiikulam. The highest value 3.1 mg/l in Pallackaveri. The table 4 represent the lowest values of 0.8 mg/l were found in Manaleri and the highest value of 3.2 mg/l in Pallackaveri. The BOD in general gives a qualitative index of organic substance which is degraded quickly in a short period.

Table-5: Correlation coefficient of Ground water samples in Ariyalur Region during July- 2012

	EC	TDS	PH	TA	TH	Mg	SO ₄ ²⁻	NO ₃ ²⁻	Fl ⁻	Cl ²⁻	DO	BOD	COD
EC	1												
TDS	-0.071	1											
PH	0.174	0.074	1										
TA	-0.447	0.659*	-0.208	1									
TH	-0.048	0.458	0.087	0.004	1								
Mg	-0.402	0.209	0.648*	0.032	0.218	1							
SO ₄ ²⁻	-0.281	-0.106	0.301	-0.199	0.199	0.229	1						
NO ₃ ²⁻	0.239	-0.054	0.402	0.010	-0.572	0.278	-0.219	1					
Fl ⁻	-0.346	-0.026	0.004	0.602	-0.539	-0.143	0.088	0.279	1				
Cl ²⁻	-0.018	0.951**	0.012	0.536	0.675*	0.200	-0.015	-0.155	-0.136	1			
DO	0.101	-0.280	-0.225	-0.376	0.431	-0.474	0.470	-0.722*	-0.326	-0.093	1		
BOD	0.276	0.430	-0.032	-0.018	0.480	-0.214	0.448	-0.219	-0.292	0.547	0.549	1	
COD	-0.137	0.274	-0.258	0.083	0.556	0.010	0.280	-0.581	-0.227	0.357	0.251	0.119	1

Source of measured parameters in ground water were examined through the analysis of linear correlation [13-14]. The correlation coefficients for all samples are given in table 3. We considered the correlation as good $r > 0.6$ and marginal of $0.4 < r < 0.6$. Since the alkalinity with total hardness, Mg($r = 0.79$) has good correlation as well as TDS and Ca ($r = 0.73$). Hence 'it makes ground water more alkaline. p^H has good correlation with Nitrate($r = 0.65$). Total hardness and chloride ($r = 0.68$) has good correlation. Ca with Mg, chloride ($r = 0.71$ and $r = 0.65$) indicating that it is in the form of $CaCl_2$ and $CaSO_4$ So as to produce permanent hardness. Mg and Sulphate ($r = 0.67$) has good Correlation. Sulphate and Nitrate ($r = 0.75$), as well as Nitrate with Fluoride ($r = 0.69$). Since the alkalinity with BOD ($R = 0.71$) and then total hardness with DO ($R = 0.76$), Similarly, the Ca has good correlation with DO, BOD, COD, ($r = 0.76, r = 0.72$ and $r = 0.64$).

The Correlation Coefficient (r) among various water quality parameters have been calculated and presented in table 5. We considered the correlation as good $r > 0.6$. Since the TDS with Alkalinity ($r = 0.65$) has good correlation. Hence it makes ground water more alkaline. P^H has good correlation with Magnesium ($r = 0.64$).

CONCLUSION

Among the 10 bore well water samples analyzed all the stations are having excess of TDS, Alkalinity, TH, Ca, Mg and Cl. Particularly S1, S2, S6, S9 and S10 have high values of all the important parameters when compared to standards prescribed by BIS. In my study area the ground water samples except above parameters all other parameters are found to be within the permissible limit. The values of water quality parameters and the correlation coefficient will help in selecting proper treatment to minimize ground water pollution.

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