Assessment of Quality of Groundwater in Kandarvakottai and Karambakudi Areas of Pudukkottai District, Tamilnadu, India

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Abstract: Various samples of groundwater were collected from different areas of Kandarvakottai and Karambakudi of Pudukkottai District, Tamilnadu and analyzed for their physicochemical characteristics. The results of this analysis were compared with the water quality standards of ISI, WHO and CPHEEO. In this analysis the various physicochemical parameters such as pH, electrical conductivity, turbidity, total dissolved solids, Cl^- , F^- , SO_4^{2-} , PO_4^{3-} , NO_3^- , NO_2^- , CN^- , Na^+ , K^+ , NH_3 , Mn, Fe, Ca & Mg hardness *etc.*, were determined using standard procedures. The quality of groundwater samples were discussed with respect to these parameters and thus an attempt were made to ascertain the quality of groundwater used for drinking and cooking purposes in and around Kandarvakottai and Karambakudi areas.

Keywords: Water quality standards, Physicochemical parameters, Quality of groundwater.

Introduction

Water sources available for drinking and other domestic purposes must possess high degree of purity, free from chemical contamination and microorganisms. But the rapid increase in population and industrialization together with the lack of wisdom to live in harmony with nature has led to the deterioration of good quality of water thus resulting in water pollution. Therefore, pollution of water resources needs a serious and immediate attention through periodical checkup of water quality.

The present study aims at the assessment of water quality in Kandarvakottai and Karambakudi areas of Pudukkottai District, where about 23,000 and 25,000 peoples are living respectively. Agriculture is the main occupation of the people residing there. They cultivate coconut, paddy, banana *etc.* Bore well water is used for irrigation as well as

drinking and cooking purposes. Even though all kinds of requirements are met by the ground water, the status of the water is a factor to be considered. Even though there are no major industries to concern, this area lacks proper drainage system and all the domestic sewage are drained in to the nearby canals, which are closer to the bore-well point at some places. Also, the use of fertilizers and pesticides may leave their residual amounts, which along with the domestic wastes percolate in to the ground, getting mixed with groundwater and may affect the quality in a severe manner. Hence, it becomes essential to assess the quality of drinking water in this area.

In this present study, water samples were collected from the bore wells of different areas in and around the Kandarakottai and the various villages of Karambakudi union in Pudukkottai District and various physical and chemical parameters were determined and the results were compared with the values of various water quality Standards such as Indian Standard Institute (ISI), World Health Organization (WHO), and Central Public Health and Environmental Engineering Organization (CPHEEO).

Experimental

The samples were collected from the bore wells of various localities of Kandarakottai and Karambakudi areas and during this collection the distance between one and other location was maintained at a minimum of one kilometer in order to carry out a broad study on the quality of water in this area.

Collection of samples

Various water samples from different sites were collected in clean and dry polyethylene bottles during July – August 2007. After the collection the samples are immediately preserved in dark boxes and processed for the different analysis within 6 hours after collection.

Physicochemical analysis

The samples collected were analyzed for important physical and chemical parameters such as pH, Electrical conductivity (E.C.), turbidity, total dissolved solids (T.D.S.), total hardness (T.H.), Ca^{2+} , Mg^{2+} , Cl^- , F^- , SO_4^{2-} , PO_4^{3-} , NO_3^- , NO_2^- , CN^- , Na^+ , K^+ , NH_3 , Mn, and Fe as per the procedures given in “Standard methods for the examination of water and waste water”, American Public Health Association (APHA)¹. The parameters seen in the samples of water were determined by following various methods²⁻⁴. The pH and fluoride ion concentration were measured as per the procedures given in Vogel’s Textbook of Quantitative Chemical Analysis⁵. Electrical conductivity was measured using an Elico CM- 180 conductivity meter and sulphate concentration by turbidimetric method using a spectronic-20 (Bosch and Lamb, USA)⁶.

Results and Discussion

The various physical and chemical parameters determined for the water samples were given in Tables 1 and 2 respectively. The samples 1-10 represent the water samples collected from Kandarakottai area while the samples 11-20 are that of collected from Karambakudi union area. From the analyzed results it was found that the quality of water considerably varies from location to location. As far as the physical parameters are concerned all the twenty samples were appeared colorless and have a relatively constant pH of around 6.5 to 8.1 (Figure 1). This shows that all the samples are existed within the minimum and maximum tolerable limits of ISI, WHO and CPHEEO standards. The water samples collected near Narikollaipatti and Sempattaviduthi were found to be slightly basic. The turbidity level of all the samples were also seen well below the permissible limits of various standards.

Table 1. Physical parameters of water samples collected in and around Kandarakottai and Karambakudi areas.

S. No	Parameters / Samples	Aravampatti North	Aravampatti East	Aravampatti South	Aravampatti West	Aravampatti Middle	Narikollaipatti	Uriyampatti	Ramaudayanpatti	Vadugapatti	Narangianpatti	Periyar nagar	Kathan viduthi	Nambanpatti	Sempattividuthi Nalroad	Alangudi	Kallangudi	Kummangulam	Mankottai	Karambakudi	Sempattividuthi	ISI	WHO	CPHEEO
1	Temp oC	31	31	30	32	31	34	33	31	30	32	27	28	28	29	27	30	31	31	30	32	-	-	-
2	Turbidity (NTU)	0	0	1	0	2	0	3	0	0	0	2	2	2	2	1	1	1	2	0	1	-	5	10
3	E.C. µscm-1	1108	1009	894	376	868	968	1230	1089	2046	1150	970	200	425	649	333	222	225	360	290	920	-	-	-
4	PH	7.9	7.5	7.3	7.8	7.1	8.1	7.6	7.2	7.5	6.8	6.72	6.5	6.96	6.5	7.6	7.7	7.8	7.8	7.9	8.1	6.0-9.0	6.5-8.5	6.5-9.2

Table 2. Chemical parameters of water samples (The values are expressed in the unit of ppm).

S.No.	Parameters / Samples	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	S-10	S-11	S-12	S-13	S-14	S-15	S-16	S-17	S-18	S-19	S-20	ISI	WHO	CPHEEO
1	T.D.S, ppm	790	718	626	344	630	932	948	1160	1524	378	679	140	297	454	215	162	171	243	268	651	-	500-1500	500-1500
2	Total Alkalinity	321	319	312	319	311	325	320	314	318	286	314	69	135	184	114	85	73	158	194	295			
3	Total Hardness	372	263	224	102	284	386	318	64	370	418	188	73	151	229	115	89	97	138	125	146		100-500	200-600
4	Calcium Hardness	118	86	73	28	102	135	94	20	189	132	46	16	40	36	35	24	80	60	80	10	100-500		200
5	Magnesium Hardness	18	12	11.5	7.2	9.6	19	22	3	13	20	17	8	12	33	27	8	10	21	23	32	30-50		150
6	Sodium	72	42	102	100	79	76	133	66	144	65	118	14	32	58	13	12	12	13	12	29		200	
7	Potassium	3	3	1	2	2	4	4	3	3	4	8	1	2	3	3	4	3	4	3	4			
8	Iron	0	0	0	0	0	0	0	0.4	0	0	0	0	0	0	0	0	0	0	0	0		< 0.1	1
9	Manganese	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0.1	0.5
10	Free Ammonia	0	0.33	0	0.21	0	0	0	1.3	0.3	0	0	0	0	0	0.02	0.01	0.01	0	0.02	0			
11	Nitrite	0	0	0.1	0	1	0	0	0	0	0.07	0.06	0	0.01	0	0	0	0	0.05	0	0.09		< 0.1	
12	Nitrate	13	4	2	0	35	15	13	1	4	57	2	0	2	1	0	1	3	2	1	4		45	45
13	Chloride	112	164	103	45	118	126	130	80	168	114	111	24	36	87	30	20	30	30	30	50	600	200-600	1000
14	Fluoride	0.9	0.4	0.1	0.1	0.2	0.9	0.4	0.2	0.4	0.8	1.5	0	0.2	0.2	0.04	0.06	0.1	1.0	0.5	0.15	3		1.5
15	Sulphate	10	36	18	5	18	14	45	6	37	6	39	5	10	19	32	8	24	16	4	12	1000	200-400	400
16	Phosphate	0	0.21	0	0	0.2	0	0.3	0	0	0	0	0.10	0	0.05	0	0	0.025	0	0.09	0.018

Figure 1. pH of water samples collected from Kandarakottai (S1 to S10) and Karambakudi (S11 to S20) areas.

The chemical parameters of these samples were mostly found to be remaining within the permissible limits of various standards. The values of total dissolved solids (TDS) determined for these samples showed that most of the samples collected from the Kandarakottai area crossed the minimum tolerance limit of 500 ppm of both WHO and CPHEEO standards (Figure 2). But, only the sample collected near Vadugapatti exceeds the maximum permissible limit of TDS of 1500 ppm of WHO and CPHEEO standards. Among the samples collected from Karambakudi union, only a very few samples crossed the minimum tolerance limit of TDS and most of the samples from these area got TDS values lesser than the minimum tolerance limit.

Figure 2. Total dissolved solids (ppm) of water samples collected from Kandarakottai (S1 to S10) and Karambakudi (S11 to S20) areas.

Approximately 98% of world's groundwater is dominated by calcium and bicarbonate ions due to the weathering of lime stones in the rain catchments and groundwater beds⁷. The maximum permissible limit for Mg hardness as per the ISI and CPHEEO standards are 50 and 150 ppm respectively. All the samples analyzed have the Mg hardness well below these limits. As far as the Ca hardness is concerned the maximum tolerance limit is 500 and 200 ppm for

ISI and CPHEEO respectively. But none of these samples analyzed exceeds these limits. However fewer samples of Kandarakottai area exceeded the minimum tolerance limits of Mg and Ca hardness (Figure 3) when compared to the samples of Karambakudi area.

Figure 3. Calcium and magnesium hardness (ppm) of water samples collected from Kandarakottai (S1 to S10) and Karambakudi (S11 to S20) areas.

The water samples from Kandarakottai area mostly exceeded the minimum tolerance limit for total hardness of 100 and 200 ppm of WHO and CPHEEO standards respectively. But none of the samples cross the maximum permissible limits of 500 and 600 ppm of WHO and CPHEEO standards (Figure 4).

Figure 4. Total Hardness (ppm) of Water Samples Collected from Kandarakottai (S1 to S10) and Karambakudi (S11 to S20) areas.

Even though the samples of Kandarakottai area having the concentrations of Na^+ and Cl^- ions (Figure 5) comparatively higher than the samples of Karambakudi union, none of them exceeded the minimum permissible limits of various standards. Similarly the concentrations of other ions such as F^- , SO_4^{2-} , PO_4^{3-} , NO_3^- , NO_2^- , K^+ , NH_3 , Mn, and Fe were seen well below the permissible limits of various standards for water quality.

Figure 5. Concentration of sodium and chloride ion (ppm) of water samples collected from Kandarakottai (S1 to S10) and Karambakudi (S11 to S20) areas.

Due to the absence of chemical industries in the near by places of this study area, no cyanide was identified even in trace amounts. The fluoride ion concentrations of these samples were very low and all these facts showed a good sign for the usage of this water for drinking and cooking purposes.

Conclusion

The groundwater samples collected from the various places in and around Kandarakottai and Karambakudi areas of Pudukkottai district of Tamilnadu were analyzed for various physicochemical parameters such as pH, Electrical conductivity (E.C.), turbidity, total dissolved solids (T.D.S.), total hardness (T.H.), Ca^{2+} , Mg^{2+} , Cl^- , F^- , SO_4^{2-} , PO_4^{3-} , NO_3^- , NO_2^- , CN^- , Na^+ , K^+ , NH_3 , Mn, and Fe. Almost all the parameters for most of the samples were reported with lower than the permissible limits of ISI, WHO and CPHEEO standards. The level of these low concentrations of these ions does not have any considerable impact for this water to use for drinking and cooking purposes. According to this study, the groundwater in and around Kandarakottai and Karambakudi areas is suitable for drinking and other purpose. Generally the water in these study area is not harmful to human beings and however the quality of water in Karambakudi is slightly superior to that of Kandarakottai.

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