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RESEARCH ARTICLE

HYDROGEOCHEMICAL ASSESSMENT OF GROUNDWATER ALONG THE VEPPANTHATTAI BLOCK – PERAMBALUR, TAMILNADU, INDIA

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ABSTRACT

Perambalur is an administrative district in the state of Tamilnadu, India. It has 4 blocks, of which Veppanthattai block has historical importance and is blessed with good agricultural land. The people are used the groundwater for drinking and agricultural purposes. Groundwater samples of bore wells were collected from different locations in Veppanthattai block in Perambalur district and were analyzed for their physico-chemical characteristics. The study was carried out during post-monsoon season from forty four different villages. The present study was undertaken to characterize the physico-chemical parameters such as pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total Hardness (TH), Total Alkalinity (TA), Calcium Hardness (CH), Magnesium Hardness (MH), Chloride, Sulphate, Nitrate, Iron, Dissolved Oxygen (DO), Chemical Oxygen Demand (COD) and Phosphate. Each parameter was compared with the standard permissible limit as prescribed by World Health Organization (WHO, 2005). The study revealed that groundwater from few stations is not suitable for drinking with respect to total hardness, calcium and magnesium content. Proper maintenance and treatment of water can improve the quality of drinking water and thereby provide a safer life.

INTRODUCTION

Groundwater is a precious and the most widely distributed resource of the earth and unlike any other mineral resource, it gets is annual replacement from the metric precipitation. The world's total water resources are estimated at 1.36×10^8 million. Of these global water resources about 97.2% is sea water, mainly in oceans, and only 2.8% is available as fresh water on the planet earth. Out of this 2.8% about 2.2% is available as surface water and 0.6% as groundwater. Even out of this 2.2% of surface water, 2.15% is fresh water in glaciers and ice caps and only of the order of 0.01% is available in lakes and streams; the remaining 0.04% being in other forms. Out of 0.6% of stored groundwater only about 0.25% can be economically extracted with the present drilling technology (Ramkumar *et al.,* 2010). Groundwater is used for drinking and agricultural purposes. About 10% of the rural and urban population does not have access to regular safe drinking water and many more are threatened. Most of them depend on unsafe water sources to meet their daily needs. Even though water pollution is an old problem in the modern age, the problem like growing population, sewage disposal, industrial wastage, radioactive waste, etc. have polluted our water resources so much that about 70% rivers and streams, not only of India but of all the countries, contain polluted water (Kudesia, 1996). The present study was therefore undertaken to investigate the qualitative analysis of some physicochemical parameters at Veppanthattai Block in Perambalur District, Tamilnadu, India.

Study Area

Perambalur district is a centrally located inland district of Tamilnadu, (spread over 3, 69,007 ha) which was formed on 1 November 1995. Geographically Perambalur lies with latitude of 11°14′ N and longitude of 78°56′ E. The district is bounded by Cuddalore district in the north, Tiruchirappalli district in the south, Thanjavur in the east and Namakkal district in the west. The total geographical area of the district is 3, 69,007 ha, and net sown area and gross sown area are 2, 16,422 ha and 2, 37,136 ha, respectively. The net area under irrigation is 71,624 ha. The district lies in the Southern plateau & hill zone of Agro-climate regional planning with characteristics of semi-arid climate. The soil is predominantly red loamy and black soil (Pure environ engineering pvt Ltd, 2011). Veppanthattai is one of the prominent block in Perambalur district of state of Tamilnadu. This town is located 13 km away from Perambalur on the way to Attur. The town faces Krishnapuram in the northern side, Esanai in the southern side and Valikandapuram in the eastern side. The average rainfall of the district is 908 mm. The study area gets about 52% annual rainfall during Northeast monsoon, about 34% in the Southwest monsoon season and approximately 14% in the winter and summer season.

MATERIALS AND METHOD

Groundwater samples were collected from 44 representative bore wells during November 2012. Samples were collected in the polythene bottles which were previously cleaned. Each bottle was rinsed thrice to avoid any possible contamination with distilled water. The analysis was carried out systematically both volumetrically and by instrumental techniques. The Procedures were followed from standard books and manuals (Sunitha Hooda *et al.,* 1999; APHA, 2005; BIS, 2003). The analysis was carried out immediately for pH, EC, odour and DO within three hours of sampling time. All concentrations are expressed in milligrams per litre (mg/l) except pH and EC in µS/cm.

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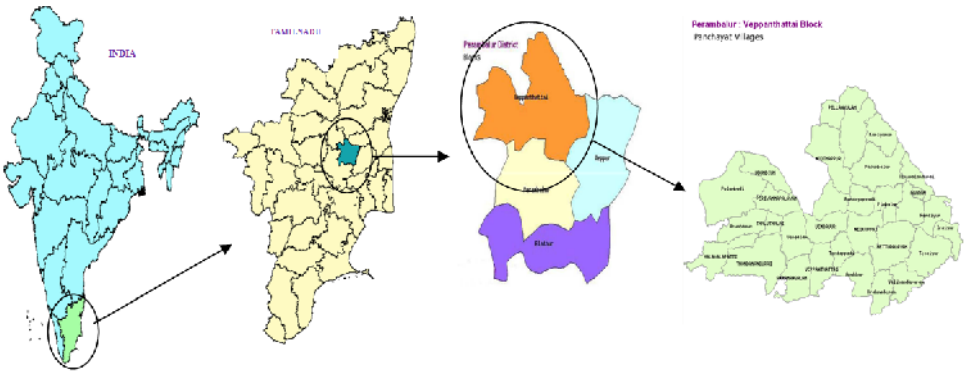

Figure 1. Location map of the Study Area

The temperature of water samples were recorded on the spot by using thermometer. pH meter (Systronics digital model 335) was used to determine the hydrogen ion concentration. The samples were analyzed for EC using Conductivity meter. Total Alkalinity (TA) was estimated by neutralizing with standard HCl. Salinity and Total Dissolved Solids (TDS) were estimated using Systronics water analyzer. Total Hardness (TH), Calcium Hardness (CH) as $CaCO_3$ and Sulphate were determined titrimetrically, using standard EDTA. The calculation of Magnesium Hardness (MH) was done by subtracting the Calcium Hardness (CH) from Total Hardness (TH) value. Phosphate and Nitrate were determined by using colorimetry. Dissolved Oxygen (DO) was estimated by precipitation method using BOD bottles and Chloride by titrimetrically by using standard $AgNO_3$.

RESULTS AND DISCUSSION

The results of the analysis were presented in the Table 1. The pH value of all the samples falls within the permissible limit. Minimum value is 6.9 and maximum is 7.9. The groundwater samples were found to be within the permissible limit of WHO (2005). The Electrical Conductivity (EC) values for all the groundwater samples are recorded within the range of 59.75 – 581.03 µS/cm. The electrical conductance is a good indication of total dissolved solids which is a measure of salinity that affects the taste of potable water. Several factors like temperature, ionic mobility and ionic valences also influence the conductivity. The Total Dissolved Solids (TDS) in water are due to the presence of sodium, potassium, calcium, magnesium, manganese, carbonates, bicarbonates, chlorides,

Table 1. Groundwater Quality Parameters of Study Area

S. No	Name of the Sampling Stations	pH	EC	TDS	TH	TA	Ca	Mg	Cl	SO_4	NO_3	Fe	DO	COD	PO_4
1	AGARAM	7.7	169.98	118.31	74	1075	12.02	15.12	745.5	12.03	0.36	0.385	0.61	68	2.4
2	ANUKKUR	7.6	188.53	131.21	418	410	100.20	77.54	124.9	16.85	0.11	0.077	3.67	48	0.1
3	ARASALUR	7.7	185.44	129.06	510	500	72.14	106.84	98.9	62.58	0.74	0.077	1.43	68	0.9
4	ERAIYUR	7.7	96.84	67.40	340	300	104.21	57.53	336	51.50	0.86	0.077	3.47	24	0.8
5	K PURAM	7.3	183.38	127.63	444	400	110.62	81.34	113.1	20.22	0.34	0.308	1.22	52	0.7
6	KADAMBUR	7.1	239.01	166.35	660	525	125.85	130.33	573.2	46.69	1.03	0.154	3.67	56	0.4
7	KOTTARAKUNRU	7.8	130.84	91.06	494	400	132.26	88.26	426.7	62.09	0.56	0.154	3.47	68	0.6
8	KUDIKADU	7.6	581.03	404.40	652	340	62.52	143.83	265.4	30.81	0.27	0.000	2.86	52	0.7
9	MALAYALAPATTI	7.6	59.75	41.59	220	260	104.21	28.25	567.4	17.81	1.24	0.077	5.10	100	1.89
10	MANGALAMEDU	7.3	125.68	87.48	614	405	113.83	122.04	127.3	32.25	0.35	0.538	4.90	20	0.4
11	METTUPALAYAM 1	7	221.49	154.16	492	445	76.95	101.27	220.1	2.89	0.33	0.154	0.20	48	0.4
12	METTUPALAYAM 2	7.4	101.99	70.98	280	425	34.07	60.01	63.9	1.93	0.49	0.077	0.41	76	0.7
13	METTUPALAYAM 3	7.2	355.42	247.37	332	410	58.12	66.83	71	0.96	0.17	0.231	0.41	52	1
14	NEIKUPPAI	7.2	180.29	125.48	610	285	80.16	129.28	307.6	16.85	0.19	0.077	1.43	64	1.5
15	NERKUNAM	7.5	252.40	175.67	220	550	36.87	44.68	156.2	1.93	0.09	0.231	0.41	28	2.2
16	NOOTHAPUR	7.2	140.11	97.51	240	50	61.72	43.50	672.4	30.33	0.71	0.077	2.24	36	1
17	P DESAM	7.3	164.83	114.72	1364	700	76.15	314.23	324.1	16.37	0.41	0.231	1.84	56	0.5
18	P PALAYAM	7.4	244.16	169.93	780	445	168.34	149.25	527.6	39.47	0.65	0.231	3.27	44	0.5
19	P VADAGARAI	7.2	196.77	136.95	900	465	109.02	193.00	158.3	9.15	0.47	0.154	4.08	56	1
20	PANDAGAPADI	7.1	169.98	118.31	314	385	159.52	37.69	89.3	36.10	0.39	0.077	2.65	96	0.5
21	PASUMBALUR	7.4	138.05	96.08	246	465	28.06	53.18	134.9	6.26	0.09	0.077	0.41	92	8
22	PIMBALUR	7.3	198.83	138.38	270	290	52.10	53.17	92.3	10.11	0.09	0.077	0.61	36	1.15
23	PUTHUR	7.5	350.27	243.79	992	365	98.60	217.99	193.7	37.06	0.45	0.846	1.84	16	0.4
24	RAYAPPA NAGAR	7.6	121.56	84.61	268	625	52.10	52.68	296.4	30.33	0.64	0.077	1.63	60	0.2
25	T THURAI	7.9	265.79	184.99	510	525	64.13	108.79	96.2	40.91	0.37	0.000	4.29	32	0.5
26	THALUTHALAI 1	6.9	145.26	101.10	542	615	104.21	106.82	639	6.74	0.3	0.077	0.20	56	1.7
27	THALUTHALAI 2	7.1	135.99	94.65	392	555	52.10	82.93	447.3	3.85	0.71	0.154	0.20	28	1.45
28	THALUTHALAI 3	6.6	160.71	111.85	742	510	120.24	151.71	156.7	7.70	1.26	0.077	0.41	56	2
29	THAMBAI	7.2	186.47	129.78	790	460	28.06	185.91	612.4	21.66	0.36	0.077	10.61	52	1.34
30	THIRUVALANDURAI	7.5	243.13	169.22	212	890	32.06	43.90	447.3	8.66	0.49	0.154	0.41	28	0.8
31	THONDAPADI	7.1	120.53	83.89	428	420	52.10	91.72	514.7	39.95	0.36	0.000	3.27	92	0.3
32	UDUMBIAM	7.7	126.71	88.19	320	405	111.42	50.89	236.2	16.37	0.72	0.077	5.92	68	0.6
33	V MATHAVI	7.4	141.14	98.23	498	435	56.11	107.82	283.3	13.96	0.42	0.154	2.65	84	0.61
34	V R S PURAM	7.6	146.29	101.82	324	400	64.13	63.41	345.1	50.54	0.57	0.000	2.24	68	0.9
35	V.KALATHUR	7.3	260.64	181.41	450	465	62.52	94.54	195.7	30.81	0.42	0.154	4.69	36	0.4
36	VALIKANDAPURAM	7.1	235.92	164.20	444	560	119.44	79.19	348.6	32.25	0.24	0.077	4.08	56	1
37	VALLAPURAM	7.2	135.99	94.65	460	360	81.76	92.29	97.5	30.33	0.63	0.154	2.65	96	0.8
38	VALLIYUR	7.4	172.04	119.74	370	570	60.12	75.61	298.7	37.06	0.61	0.000	2.65	16	1.15
39	VANNARAMPOONDI	7.7	126.71	88.19	14	990	4.81	2.24	198.8	16.37	0.19	0.154	0.41	44	1.45
40	VENBAVUR	7.8	212.22	147.71	386	500	78.56	75.02	171.5	27.44	0.78	0.308	2.65	48	1.23
41	VENGALAM	7.2	177.19	123.33	232	325	117.84	27.86	317.6	18.29	0.37	0.077	1.63	28	0.9
42	VEPANTHATTAI	7.2	162.77	113.29	356	500	57.72	72.78	87.6	21.18	0.71	0.231	2.45	60	0.3
43	VGR PURAM 1	7.1	226.64	157.74	500	345	100.20	97.55	253.2	29.36	0.47	0.077	4.29	60	0.4
44	VGR PURAM 2	7.1	97.87	68.12	724	400	92.18	154.16	78.1	28.40	0.59	0.000	4.49	56	0.5

All the values are expressed in mg/l, except pH and EC in µS/cm

phosphate, bicarbonates, chlorides, phosphate, organic matter, and other particles (Bhattacharya *et al*., 2012). The values of the total dissolved solids for all the groundwater samples vary between 442 and 998 mg/l. The maximum allowable limit of total dissolved solids in groundwater for domestic purpose is 1500 mg/l (WHO, 2005). The minimum value is 41.59 mg/l and maximum value is 404.40 mg/l. According to classification of drinking water on the basis of TDS values, all the groundwater samples are found to be non-saline. In this study, the TDS value for all the groundwater samples are well within the permissible limit of 1500 mg/l. Total Hardness (TH) is the measure of the capacity of water to precipitate soap. The hardness is more than 50 mg/l will cause the Renal Calculi formation of kidney stone (medterms.com). The minimum and maximum values recorded were 14 and 1364 mg/l respectively. Most of the samples are within the permissible limit (200mg/l) of WHO (2005). Maximum level of the total hardness is may be due to the presence of carbonate and non carbonate hardness. Total Alkalinity (TA) ranges from 50 to 1075 mg/l in the study area. Alkalinity of water is the capacity to neutralize acidic nature and is characterized by the presence of hydroxyl ions. Alkalinity around 150 mg/l has been found conductive to higher productivity of any water bodies (Ball, 1994). The high alkalinity is may be due to the usage of basic fertilizers. Calcium (Ca) plays an important role in human body. Regulatory action is exercised by calcium and magnesium. The flux of these ions through cell membranes and other boundary layers sends signals that tur metabolic reactions on and off. Calcium is very essential for nervous system and for the formation of bones and teeth. The concentration of calcium in potable water ranges from 75 to 200 mg/l. In the study area, minimum and maximum recorded value of calcium is 4.81 to 168.34 mg/l. Magnesium (Mg) is a beneficial metal, but it is toxic at high concentration. Higher the concentration of magnesium in drinking water gives unpleasant taste to the water. The concentration of magnesium in potable water ranges from 30 to 150 mg/l. The minimum and maximum recorded values of magnesium were 2.24 to 314.23 mg/l. The Chloride ions are ranged from 63.9 to 745.5 mg/l.

It may be due to the presence of domestic sewage disposal and the presence of soluble chlorides from the rocks. Most of the groundwater samples show chloride values out of the acceptable limit (250 mg/l) of WHO (2005). Excessive chloride in potable water is particularly not harmful but the criteria set for chloride value is based on its potentially high corrosiveness. Soil porosity and permeability also play an important role in building up the chloride value (Chari *et al.*, 1994). Increase of chlorine level in water is injurious to people suffering due to heart and kidney diseases. Sulphate (SO_4) values for the groundwater samples are exhibited between 0.96 to 62.58 mg/l. The sulphate values for all the groundwater samples are well within the permissible limit (200 mg/l) of WHO (2005). High concentration of sulphate may cause gastro – intestinal irritation, particularly when magnesium and sodium ions are also present in drinking water resources (Indrani Gupta *et al.*, 2011). The value of Nitrate (NO_3) in all the groundwater sampling stations is found between 0.09 and 1.26 mg/l. The acceptable limit of nitrate is 45 mg/l according to WHO (2005). The presence of nitrate in groundwater may be due to leaching of nitrate with the percolating water. The contamination of groundwater may be due to sewage and other wastes rich in nitrates (Venkateswara., 2011). Toxicity of nitrates in infants causes methaemoglobiaemia (Basic Information in Nitrates in Drinking Water, 2012). Iron (Fe) is biologically important element which is essential to all organisms and present in haemoglobin system (Kumar *et al*., 2001). The value of iron ranges from 0.00 – 0.846 mg/l. Most of the samples are well within the permissible limit of WHO (2005). High concentration of iron causes slight toxicity. Dissolved Oxygen (DO) values in the groundwater samples have observed from 0.2 to 10.61 mg/l. The concentration of dissolved oxygen in clean water is 8 – 10 mg/l. In this investigation, the DO is very low in all the groundwater samples except thambai. It indicates that the deoxygenation is may be due to the biological decomposition of organic matter. The dissolved oxygen is a regulator of metabolic activities of organisms. Oxygen is generally reduced in the water due to respiration of biota, decomposition of organic matter, rise in temperature, oxygen demanding wastes and inorganic reluctant (Sahu *et al.*, 2000). Chemical Oxygen Demand (COD) is a measure of the oxygen required for the chemical oxidation of organic matter. The values of COD in the groundwater samples are found to be in the range of 16 - 100 mg/l. The COD values at all sampling stations are exceeded the permissible limit (10 mg/l) according to WHO (2005). High COD may cause oxygen depletion on account of decomposition of microbes to a level detrimental to aquatic life (Sivakumar *et al* 2002). The value of phosphate (PO_4) in the groundwater samples are lies between 0.1 and 2.4 mg/l. Normally groundwater contains only a minimum phosphorus level because of the low solubility of native phosphate minerals and the ability of soils to retain phosphate (Rajmohan *et al.*, 2005). The phosphate values of all the groundwater samples do not pose any water quality problem. The higher concentration may cause bone loss.

Conclusion

The study was carried out in the Veppanthattai block, Perambalur district, Tamilnadu, India. The values of all the groundwater samples were compared with the standard permissible value, by analyzing 44 samples. Total hardness, magnesium and chemical oxygen demand are exceeding the permissible limit in most of the groundwater samples, this may be due to indiscriminate disposal of domestic and agricultural wastes. The study is recommended to monitor the groundwater quality and assess periodically to prevent the further contamination.

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