Original Research Paper

Assessment of Groundwater Quality in Coimbatore South Taluk, Coimbatore District, India: A WQI Approach

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ABSTRACT

The developmental activities in Coimbatore cause depletion and degradation of groundwater. The present investigation is aimed to calculate Water Quality Index (WQI) of groundwater to assess the impact of pollutants due to mining operations, agriculture and human activities on the water quality. Nine physico-chemical parameters were taken for calculation of WQI. Quality of water was found to be good in all the sampling stations except at Vellalore, Chettipalayam and Natchipalayam.

INTRODUCTION

The modern civilization, rapid industrialization and increased population have led to fast degradation of our environment. Water is indispensable and one of the precious natural resources of our planet. Groundwater is an important source of water supply throughout the world. Its use in irrigation, industries and domestic usage continues to increase where perennial surface water sources are absent (Mariappan et al. 2005). The geology of particular area has a greater influence on the occurrence and quality of water and its movement. Groundwater carries a higher mineral content than the surface water. Change in quality of groundwater with the passage of time has hydrologic influences. The quality also varies due to change in chemical composition (Rajmohan 2003). With this background, the study on physico-chemical characteristics of groundwater and its quality at various locations in the South Taluk of Coimbatore, Coimbatore district in Tamilnadu was carried out.

STUDY AREA

The study area is located between the latitudes 11°00' to 11°10' north and longitudes 76°40' to 77°00' east. Geologically the area is mainly covered by wide range of high grade metamorphic rocks of the peninsular gneissic complex. The prevailing climatic condition in the study area is subtropical. The maximum temperature ranges from 36°C to 41°C, and the minimum from 14°C to 31°C. The mean daily temperature during summer varies from 33°C to 40°C, and during winter from 15°C to 31°C. Rain occurs during south-west and north-east monsoons. The land use pattern of the study area is classified into five types such as agricultural fields, built-up lands, forest covers, mining and quarry, and industrial and commercial areas.

MATERIALS AND METHODS

The present investigation is aimed to calculate Water Quality Index (WQI) of groundwater sources in Coimbatore South Taluk, Coimbatore district. Water samples were collected from 2004 to 2009 at twenty seven locations during the months of January-February every year. Two litre plastic bottles were used to collect water samples. These bottles were instantly sealed and capped with the wax and transported to the laboratory for chemical analysis. The tests were carried out as per the standard methods (APHA 1995, Trivedy & Goel 1986). Locations of groundwater sampling are presented in Table 1. Fourteen parameters, which are important for water quality, were selected for the analysis. The physico-chemical parameters included for analysis were pH, electrical conductivity (EC), total dissolved solids (TDS), calcium, magnesium, sodium, potassium, carbonate, bicarbonate, chloride, nitrate, sulphates, total hardness and fluoride.

Water Quality Index (WQI): Water Quality Index is an indicator which reflects the composite influence of a number of water quality parameters that are significant for a specific beneficial use. This management tool helps to assess the overall quality of water (Ajit Pratap Singh 1999). Parameter selection has a great importance for calculation of water

quality index, since various parameters depend on the intended use of water (Guru Prasad 2003). WQI based on some important parameters can provide a simple indicator of water quality. It gives a general idea of possible problems within a particular region.

The water quality index can be obtained by the Brown's equation as mentioned below.

$$WQI = \Sigma_{(i = 1\ to\ n)} (W_i\ Q_i) \qquad ...(1)$$

Where,

$$W_i = (K/S_i);\ K = 1/(\Sigma_{(i = 1\ to\ n)} (1/S_i)) \qquad ...(2)$$

S_i = the standard value for the ith parameters presented by the standards

Q_i = the quality rating for i^{th} parameter,

$$Q_i = (C_i - C_{id})/(C_s - C_{id}) \times 100 \qquad ...(3)$$

C_i = measured concentration for i^{th} parameter which is estimated value

C_{id} = ideal concentration/value for i^{th} parameter

C_s = standard concentration for i^{th} parameter recommended by standard (S_i)

The suitability of groundwater was analysed based on the water quality index range as presented in Table 2 (Veera Bhaadram et al. 2004).

RESULTS AND DISCUSSION

The results of the study are given in Tables 3 and 4. Generally pH of water is influenced by geology of catchment area and buffering capacity of water (Achutha Nair et al. 2005). The pH has no direct adverse effect on health, but alters the taste of water. The groundwater samples in all the stations varied in pH from 7.1 to 8.0 and acceptable for drinking. The permissible limit of pH value of drinking water is specified as 6.5 to 8.5 as per IS: 10500 standards. Electrical conductivity is used to measure the ability of water to carry an electric current. Absolutely pure water is a poor conductor of electricity. Water shows higher conductivity when dissolved salts are present. The conductivity is proportional to the amount of salts dissolved in water (Abdul Jameel 2002). The groundwaters of 12 out of 27 sampling stations have conductivity more than the permissible limit of 1500 mmhos/cm as specified by BIS. TDS is an important parameter for drinking water and other uses. Water with high solid content is of inferior palatability and may produce an unfavourable physiological reaction in the transient consumer (Abdul Jameel 2002). TDS was found in the rage of 196 mg/L to 3020 mg/L in the study area. The permissible limit of TDS is specified as 500 mg/L to 1500 mg/L as per WHO standards.

Table 1: Location of groundwater sampling.

No.	Locations	No.	Locations
1	Kovaipudur	15	Podanur
2	Sugunapuram	16	Vellalore
3	Madukkarai	17	Chettipalayam
4	Natchipalayam	18	Poondi
5	Thondamuthur	19	Alandurai
6	Perur	20	Boluvampatti
7	Kalampalayam	21	Pachapalayam
8	Pichanur	22	Telungupalayam
9	Madukkarai market	23	Veerakeralam
10	Vedapatti	24	Vadavalli
11	Palathurai	25	Maruthamalai
12	Malumatchampatti	26	Madhampatti
13	Kuruchi SIDCO	27	Theetipalayam
14	Sundarapuram		

Table 2: Water Quality Index (WQI) range.

Numerical Value of WQI in the scale of 0-100	Water quality standard as per study
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
100 and above	Unsuitable for Drinking

Total hardness of water is characterized by contents of calcium and magnesium salts. The total hardness in the study area ranged from 175 mg/L to 1962 mg/L. The calcium hardness was observed with minimum of 8 mg/L to maximum of 143 mg/L. The magnesium hardness was observed with minimum of 20 mg/L to maximum of 88 mg/L. Higher values of hardness were observed in the area where solid waste dumping of Coimbatore city was carried out, and due to low water level and high pumping rate. Similar observation is given by Veera Bhaadram et al. (2004). Chlorides impart a salty taste and sometimes high concentration causes laxative effect in human beings. The chloride content ranged from 63 mg/L to 436 mgL. The permissible limit of chlorides is specified as 250 mg/L to 1000 mg/L as per IS:10500 standards. The sulphate is one of the important ions present in natural waters and produce cathartic effect in human beings when present in excess amounts. The sulphate ion concentration ranged from 21 mg/L to 292 mg/L. The permissible limit of sulphate is 200 mg/L to 400 mg/L as per IS:10500 standards.

Water Quality Index (WQI) is a useful method to understand the quality of water in order to determine the suitability for various uses. The value of WQI in all the sampling locations was reported to be less than 100 indicating that the water is suitable for human use. Quality of water

Table 3: Water quality parameters and their concentration (minimum and maximum values).

Locations		Parameters								
		pH	EC	TDS	TH	TA	Ca	Mg	SO$_4$	Cl
Kovaipudur	Min	7.3	980	968	465	140	50	24	65	158
	Max	7.6	1520	1130	585	172	61	31	78	186
Sugunapuram	Min	7.8	1710	563	320	346	27	21	81	172
	Max	8	2030	1086	575	547	34	30	96	226
Madukarai	Min	7.6	976	595	300	170	65	23	21	86
	Max	7.9	1175	950	412	314	80	28	34	104
Natchi Palayam	Min	7.6	1114	776	660	260	72	24	40	130
	Max	7.9	1250	896	692	458	94	33	74	182
Thondamuthur	Min	7.6	1379	965	310	280	84	24	31	182
	Max	7.8	1710	1197	485	430	116	41	68	282
Perur	Min	7.6	1445	968	600	107	83	20	99	77
	Max	7.8	1900	1040	865	174	91	26	180	91
Kalam Palayam	Min	7.3	1450	960	480	165	48	21	70	175
	Max	7.6	1680	1058	548	189	80	28	92	190
Pichanur	Min	7.4	1412	1010	626	217	42	27	29	162
	Max	7.6	1620	1456	800	296	50	32	44	185
Madukarai Market	Min	7.5	940	684	330	164	36	26	36	124
	Max	7.9	1786	928	520	194	51	32	43	151
Vedapatti	Min	7.1	1475	915	680	121	36	26	38	148
	Max	7.4	1580	1095	796	154	48	30	43	160
Malumatchampatti	Min	7.7	986	755	290	38	30	25	41	100
	Max	7.9	1420	845	325	52	36	30	56	112
Palathurai	Min	7.6	1285	1245	986	35	38	30	24	112
	Max	7.8	1460	1690	1120	46	42	32	28	126
Kuruchi	Min	7.1	1376	589	520	38	29	21	37	186
	Max	7.2	1460	725	686	50	38	27	43	196
Sundarapuram	Min	7.4	2260	1120	890	35	48	56	42	178
	Max	7.6	2400	1270	926	48	56	64	51	194
Podanur	Min	7.4	2560	1035	290	72	16	60	112	345
	Max	7.6	2840	1680	386	98	24	76	126	436
Vellalore	Min	7.6	2870	2430	1856	38	48	54	148	296
	Max	7.8	3020	2773	1962	45	53	60	182	462
Chetti Palayam	Min	7.5	1292	2562	475	35	18	62	268	121
	Max	7.8	1610	2850	526	42	29	72	292	135
Poondi	Min	7.2	209	229	186	8	8	60	35	43
	Max	7.4	230	260	210	16	15	72	46	62
Alandurai	Min	7.7	1270	196	365	30	28	21	48	103
	Max	8.1	1430	210	425	42	39	23	62	120
Boluvampatti	Min	7.4	976	2765	275	30	28	22	196	63
	Max	7.8	1020	2925	325	42	40	40	212	78
Pacha Palayam	Min	7.5	1286	1225	396	35	12	47	55	126
	Max	7.8	1480	1325	415	42	24	57	62	145
Telungu Palayam	Min	7.4	1130	880	412	38	80	40	74	84
	Max	7.6	1180	910	436	45	91	52	82	92
Veera Keralam	Min	8	840	455	175	42	98	60	97	64
	Max	8.4	980	565	205	54	143	88	124	88
Vada Valli	Min	7.2	1840	840	560	32	48	39	84	198
	Max	7.5	1920	876	610	48	57	44	92	220
Marutha Malai	Min	7.4	1130	745	425	35	36	27	78	78
	Max	7.7	1160	782	445	41	45	40	84	86
Madhampatti	Min	7.4	596	450	198	40	126	70	187	42
	Max	7.8	610	486	205	48	136	82	196	51
Theeti Palayam	Min	7.4	989	785	275	30	69	71	109	67
	Max	7.8	1018	821	286	41	76	80	124	72

All values are in mg/L except pH and EC (mmhos/cm)

Table 4. Values of Water Quality Index (WQI) at sampling locations.

Locations	2004	2005	2006	2007	2008	2009
Kovaipudur	41.47	45.87	32.55	42.95	31.65	37.52
Sugunapuram	59.26	55.51	56.91	61.9	57.19	57.17
Madukkarai	53.68	55.34	47.97	52.52	51.43	48.64
Natchipalayam	59	58.15	50.96	47.77	53.84	51.5
Thondamuthur	55.12	51.12	53.57	46.17	49.7	45.18
Perur	47.88	54.49	49.81	55.89	46.54	52.26
Kalampalayam	39.76	34.06	44.7	41.03	33.76	38.52
Pichanur	48.97	40.97	49.25	46.76	33.8	45.71
Madukkarai market	42.05	34.04	50.77	43.85	36.07	38.62
Vedapatti	25.83	22.27	34.56	27.59	30.26	30.91
Palathurai	47.33	43.83	43.68	49.32	48.78	47.12
Malumatchampatti	42.75	38.24	42.47	46.28	43.1	43.37
Kuruchi SIDCO	22.65	16.48	20.51	18.57	20.45	21.47
Sundarapuram	39.5	46.73	41.35	42.55	36.56	43.2
Podanur	36.5	46.75	38.68	43.68	44.53	41.35
Vellalore	62.61	54.12	58.97	64.85	56.45	60.91
Chettipalayam	55.51	50.22	46.5	67.47	51.22	56.67
Poondi	28.195	21.68	24.94	29.14	22.97	25.22
Alandurai	42.77	52.96	50.01	47.21	38.59	42.58
Boluvampatti	59.55	55.25	51.39	44.3	51.26	48.1
Pachapalayam	44.28	36.24	40.78	36.78	35.28	37.85
Telungupalayam	41.32	33.5	36.05	41.41	37.98	42.67
Veerakeralam	73.64	79.53	76.29	62.16	62.04	68.3
Vadavalli	33.59	39.71	27.48	28.36	32.65	37.29
Maruthamalai	33.37	43.96	39.27	36.47	40.12	40.3
Madhampatti	55.02	46	38.09	45.88	41.38	47.26
Theetipalayam	38.9	46.34	31.78	39.63	32.97	40.35

was found to be good in all the sampling stations except at Vellalore, Chettipalayam and Natchipalayam. The reason for high index values may be due to dumping of solid wastes, agricultural run-off and greater human interference.

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