DETERMINATION OF PHYSICO-CHEMICAL NATURE AND WATER QUALITY INDEX OF GROUNDWATER IN NORTHERN PARTS OF PERUNDURAI, ERODE DISTRICT ON SEASONAL VARIATION

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ABSTRACT

This paper presents the study on the physico-chemical parameters of Groundwater samples collected at nine stations at the radius of 10km as center as SIPCOT industries and location are chosen in northern part of Perundurai in Erode district. The quality of Ground Water samples are compared to the water quality index for the drinking purpose. The water quality index is calculated by the help of parameter sample results like Turbidity, Electrical Conductivity, Total dissolved solids, Total Alkalinity, Sodium, Iron, Calcium, pH, Total Hardness, Magnesium, Manganese, Nitrate, Chloride, Fluoride, Sulphate, Ammonia, Phosphate through formulae. Finally, the comparison of quality of Groundwater on basis of Water quality index done on collected sample stations. The calculated water quality index results shows that 22.22% falls in the Excellent to Good water category. On the otherhand 44.44% falls in the poor to very poor water category indicating the water is not suitable for drinking and need further treatment. This work has been carried over in the summer, where the data has to be collected in the other seasons to make the comparative study in further.

KEYWORDS: Physico-Chemical, Ground Water Samples, Water Quality Index, Seasonal Variation, Perundurai.

Water is important natural resource and is secondary requirement to sustain the life on the earth after the fresh air. Approximately 60-65 percent of human body is composed of water. Groundwater is used for domestic and industrial water supply and also for irrigation purposes in all over the world. In the last few decades, there has been a tremendous increase in the demand for fresh water due to rapid growth of population and industrialization. Human health is threatened by most of the agricultural development activities in excessive application of fertilizers and unsanitary conditions. According to WHO organization about 80% of all the diseases in human beings are passed by water. Once the Ground water contaminated, its quality cannot be restored by stopping the pollutant source.

The quality of water is generally defined in terms of its physical, chemical and biological parameters and measured as Water Quality Index (WQI) to assess water portability. Water Quality Index is one of the most effective tool used to identify the standard of water based on several water quality parameters. WQI is defined as the rating reflecting the composite influence of different water quality parameters. In this index a mathematical equation used to transfer large number of water quality into a single number which is simple and easy to understandable for decision makers about quality and possible uses of any water quality. It serves the understanding of water quality for the possible uses by integrating complex data and generating a score that describes status of water quality.

The objective of present work is to discuss the suitability of groundwater for human consumption based on computed water quality index values.

STUDY AREA

In Tamilnadu, Erode is famous for its textile industries situated in the center part of Tamilnadu. Perundurai is a developing town because of the advent of SIPCOT which is fully supported by Tamilnadu government. The exact study area lies between 77°30' 55" E and 11° 15'22" N to between 77° 35'32"E and 11°11'41" N . It is situated on NH-47 between Salem and Coimbatore. It is 19km from Erode and 80km from Salem and Coimbatore. It is situated 25km towards West from District headquarters Erode, 410kms from state capital Chennai towards East. SIPCOT consist of 109 industries in which 71 are textile industries, 6 chemical industries and 32 other general type industries. A lot of textile industries were relocated from Tirupur to Perundurai. Most of the villages around SIPCOT depend on agricultural lands the sources of irrigation are streams, tanks and wells. Groundwater plays a major role for irrigation and domestic use. The key plan of study area is shown in Figure 1.

Figure 1: Key map showing the location of the study area

MATERIALS AND METHODOLOGY

The methodology adopted in this study includes field data collection, laboratory testing of samples and assessment of ground water quality using water quality index. An overview of the methodology adopted for this study.

Sample Collection

In our study area there are 9 number of sample location are selected within 10 km radius around SIPCOT industries mainly in northern part Perundurai, Erode. All the samples are collected from the bore wells in the pre-monsoon season. The location of sample wells is shown in Table 1.

Table 1: Location of sample stations.

Sample No.	Location of sample stations
S1	Tiruvachi
S2	Thudupathi
S3	Sullipalayam
S4	Kullampalayam
S5	Mettupudur
S6	Vijayapuri
S7	Moongilpalayam
S8	Ponmudi
S9	Madathupalayam

The ground water samples were analysed for different physico-chemical parameters such as Appearance, Colour, Odour, Turbidty, Electrical conductivity, Total dissolved solids, pH, Total alkalinity, Total hardness, calcium, Magnesium, Sodium, Potassium, Iron, Manganese, Ammonia, Nitrite, Nitrate, Chloride, Fluoride, Sulphate, Phosphate are tested using standard testing procedure and the physic-chemical analysis was carried out as per the standard methods and the results were compared with the IS 10500-2012.

Calculation Of Water Quality Index

WQI was computed by following 3 steps. In the first step, each of the 17 parameters has been assigned a weight (w_i) according to its relative importance in the overall quality of water for drinking purposes(Table 2).In the second step, the relative weight (W_i) is computed from the following equation:$W_i = w_i/\sum w_i$

Where, W_i is the relative weight, wi is the weight of each parameter. Calculated relative weight (W_i) values of each parameter are also given in (Table 2).In the third step, a quality rating scale (q_i) for each parameter is assigned by dividing its concentration in each water sample by its respective standard according to the guidelines laid down in the BIS and the result multiplied by 100:$q_i = (C_i / S_i) \times 100$

where q_i is the quality rating, C_i is the concentration of each parameter in each water sample in mg/L, and S_i is the Indian drinking water standard for each chemical parameter in mg/L according to the guidelines of the BIS 10500,2003. For computing the WQI, the SI is first determind for each chemical parameter, which is then used to determine the WQI as per the following equation

$$SI_i = W_i \times q_i$$

$$WQI = \sum SI_i$$

SI_i is the subindex of its parameter; qi is the rating based on concentration of its parameter and n is the number of parameters. The computed WQI values are classified into five types, "Excellent water" to "Water unsuitable for drinking".

Table 2: Relative weight of chemical parameters

Sl. No.	Chemical Parameters	IS (S_i)	Weight (w_i)	Relative weight (W_i)
1	Turbidity(N.T.U)	1-5	2	0.05
2	Electrical Conductivity(μmhos/cm)	1500	4	0.1
3	Total Dissolved Solids(mg/L)	500-2000	2	0.05
4	pH	6.6-8.5	2	0.05
5	Total Alkalinity(mg/L)	200-600	2	0.05
6	Total Hardness(mg/L)	200-600	3	0.075
7	Calcium(mg/L)	75-200	2	0.05
8	Magnesium(mg/L)	30-100	2	0.05
9	Sodium(mg/L)	200	3	0.075
10	Iron(mg/L)	0.3	2	0.05
11	Manganese(mg/L)	0.1-0.3	3	0.075
12	Ammonia(mg/L)	0.5	2	0.05
13	Nitrate(mg/L)	45	2	0.05
14	Chloride(mg/L)	250-1000	2	0.05
15	Fluoride(mg/L)	1-1.5	2	0.05
16	Sulphate(mg/L)	200-400	2	0.05
17	Phosphate(mg/L)	0.05-0.1	3	0.075

RESULTS AND DISCUSSION

The values of various physico-chemical parameters for calculation of WQI are presented in Table 3, quality rating in Table 4, sub index values in Table 5, WQI values in Table 6, status of water quality based on WQI in Table 7. The concentration range of physicochemical parameters observed for groundwater samples were Turbidity(0.75-2.4 N.T.U),Electrical Conductivity(1009-2900 μmhos/cm), Total Dissolved Solids(706-2030 mg/L), pH(7.28-8.02), Total Alkalinity(192-400 mg/L), Total Hardness(300-784 mg/L), Calcium(67-205 mg/L), Magnesium(32-106 mg/L), Sodium(84-300 mg/L), Potassium(10-36 mg/L), Iron(0-0.3 mg/L), Manganese(0-0.3 mg/L), Ammonia(0-0.35 mg/L), Nitrite(0.01-0.18 mg/L), Nitrate(12-32 mg/L), Chloride(152-404 mg/L), Fluoride(0.2-1 mg/L), Sulphate(25-440 mg/L), Phosphate(0-1.6 mg/L) during this study. Out of above physic-chemical parameters, we have selected 17 parameters with significant influence in determining the WQI. The WQI values of the 9 sample stations in Perundurai region ranges from 36.10 to 205.16 mg/L. In the present study, application of WQI gives a comparative evaluation of water quality at different sampling places. WQI data from the Table 6 indicates that the index value is maximum for Moongilpalayam village location and minimum for Ponmudi village location. It can be conclude from the study that the water quality at various locations in the Perundurai region is inthefollowingdecreasingorder:Ponmudi>Sullipalayam>Thudupathi>Mettupudur>Vijayapuri>Tiruvachi>Madathupalayam>Kullampalayam>Moongilpalayam. Hence the calculated water quality index results shows that 22.22% falls in the Excellent to Good water category. On the otherhand 44.44% falls in the poor to very poor water category and 33.33% falls in unsuitable for drinking purposes. These result are based on the data obtained for the nine northern locations of Perundurai taluk around the SIPCOT industries of erode district.

Table 3: Water quality parameters of borewell samples.

S. No.	Physical Chemical Parameters	S1	S2	S3	S4	S5	S6	S7	S8	S9
1	Appearance	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
2	Colour(Hazen unit)	CL	CL	CL	CL	CL	CL	CL	CL	CL
3	Odour	None	None	None	None	None	None	None	None	None
4	Turbidity(N.T.U)	1	1.8	2.1	0.8	1	0.9	2.4	1	0.75
5	Electrical Conductivity(μmhos/cm)	1351	1303	1474	2300	2020	2320	2900	1009	2550
6	Total Dissolved Solids(mg/L)	946	912	1032	1613	1414	1624	2030	706	1785
7	pH	7.55	7.28	7.39	7.31	7.29	7.46	7.56	8.02	7.94
8	Total Alkalinity(mg/L)	244	192	236	392	248	400	280	240	296
9	Total Hardness(mg/L)	392	388	312	612	548	396	952	300	784
10	Calcium(mg/L)	90	86	67	126	117	82	205	67	173
11	Magnesium(mg/L)	40	41	35	71	61	46	106	32	85
12	Sodium(mg/L)	116	112	152	200	172	300	240	84	210
13	Potassium(mg/L)	14	10	28	24	14	30	36	12	24
14	Iron(mg/L)	0	0.1	0.2	0.2	0.1	0.3	0.1	0.1	0.3
15	Manganese(mg/L)	0.2	0.3	0.2	0.1	0.3	0	0.1	0.1	0.3
16	Ammonia(mg/L)	0.25	0.3	0	0.2	0.35	0	0.3	0.15	0.25
17	Nitrite(mg/L)	0.16	0.18	0.06	0.17	0.1	0.14	0.09	0.02	0.01
18	Nitrate(mg/L)	14	12	16	20	21	25	32	14	21
19	Chloride(mg/L)	208	196	212	236	280	252	404	152	384
20	Fluoride(mg/L)	0.6	0.8	0.2	1	0.4	0.8	0.6	0.2	0.2
21	Sulphate(mg/L)	137	125	124	295	25	293	440	85	385
22	Phosphate(mg/L)	0.5	0	0	1.2	0	0	1.6	0	1

Table 4: Water quality rating (Q_i) of Borewell samples, Perundurai.

Sl. No.	Chemical Parameters	S1	S2	S3	S4	S5	S6	S7	S8	S9
1	Turbidity	20.00	36.00	42.00	16.00	20.00	18.00	48.00	20.00	15.00
2	Electrical Conductivity	90.07	86.87	98.27	153.33	134.67	154.67	193.33	67.27	170.00
3	Total Dissolved Solids	47.30	45.60	51.60	80.65	70.70	81.20	101.50	35.30	89.25
4	pH	88.82	85.65	86.94	86.00	85.76	87.76	88.94	94.35	93.41
5	Total Alkalinity	40.67	32.00	39.33	65.33	41.33	66.67	46.67	40.00	49.33
6	Total Hardness	65.33	64.67	52.00	102.00	91.33	66.00	158.67	50.00	130.67
7	Calcium	45.00	43.00	33.50	63.00	58.50	41.00	102.50	33.50	86.50
8	Magnesium	40.00	41.00	35.00	71.00	61.00	46.00	106.00	32.00	85.00
9	Sodium	58.00	56.00	76.00	100.00	86.00	150.00	120.00	42.00	105.00
10	Iron	0.00	33.33	66.67	66.67	33.33	100.00	33.33	33.33	100.00
11	Manganese	66.67	100.00	66.67	33.33	100.00	0.00	33.33	33.33	100.00
12	Ammonia	50.00	60.00	0.00	40.00	70.00	0.00	60.00	30.00	50.00
13	Nitrate	31.11	26.67	35.56	44.44	46.67	55.56	71.11	31.11	46.67
14	Chloride	20.80	19.60	21.20	23.60	28.00	25.20	40.40	15.20	38.40
15	Fluoride	40.00	53.33	13.33	66.67	26.67	53.33	40.00	13.33	13.33
16	Sulphate	34.25	31.25	31.00	73.75	6.25	73.25	110.00	21.25	96.25
17	Phosphate	500.00	0.00	0.00	1200.00	0.00	0.00	1600.00	0.00	1000.00

Table 5: Calculated subindex ($Q_iW_i^)$) values of different parameters of Borewell samples, Perundurai.

Sl. No.	Chemical Parameters	S1	S2	S3	S4	S5	S6	S7	S8	S9
1	Turbidity	1.00	1.80	2.10	0.80	1.00	0.90	2.40	1.00	0.75
2	Electrical Conductivity	9.01	8.69	9.83	15.33	13.47	15.47	19.33	6.73	17.00
3	Total Dissolved Solids	2.37	2.28	2.58	4.03	3.54	4.06	5.08	1.77	4.46
4	pH	4.44	4.28	4.35	4.30	4.29	4.39	4.45	4.72	4.67
5	Total Alkalinity	2.03	1.60	1.97	3.27	2.07	3.33	2.33	2.00	2.47
6	Total Hardness	4.90	4.85	3.90	7.65	6.85	4.95	11.90	3.75	9.80
7	Calcium	2.25	2.15	1.68	3.15	2.93	2.05	5.13	1.68	4.33
8	Magnesium	2.00	2.05	1.75	3.55	3.05	2.30	5.30	1.60	4.25
9	Sodium	4.35	4.20	5.70	7.50	6.45	11.25	9.00	3.15	7.88
10	Iron	0.00	1.67	3.33	3.33	1.67	5.00	1.67	1.67	5.00
11	Manganese	5.00	7.50	5.00	2.50	7.50	0.00	2.50	2.50	7.50
12	Ammonia	2.50	3.00	0.00	2.00	3.50	0.00	3.00	1.50	2.50
13	Nitrate	1.56	1.33	1.78	2.22	2.33	2.78	3.56	1.56	2.33
14	Chloride	1.04	0.98	1.06	1.18	1.40	1.26	2.02	0.76	1.92
15	Fluoride	2.00	2.67	0.67	3.33	1.33	2.67	2.00	0.67	0.67
16	Sulphate	1.71	1.56	1.55	3.69	0.31	3.66	5.50	1.06	4.81
17	Phosphate	37.50	0.00	0.00	90.00	0.00	0.00	120.00	0.00	75.00

Table 6: Water quality index (WQI) of Borewell samples, Perundurai.

Sl. No.	Location Of Sample	WQI
1	Tiruvachi	83.65
2	Thudupathi	50.61
3	Sullipalayam	47.23
4	Kullampalayam	157.84
5	Mettupudur	61.68
6	Vijayapuri	64.07
7	Moongilpalayam	205.16
8	Ponmudi	36.10
9	Madathupalayam	155.33

Table 7: Status of water quality based on WQI. (Chatterjee & Raziuddin 2002)

Sl. No.	WQI	Status
1	0-25	Excellent
2	26-50	Good
3	51-75	Poor
4	76-100	Very Poor
5	100 and above	Unsuitable for drinking

REFERENCES

Srivastava A.K., Mishra D.K., Tripathi S. and Singh P., 2007. Determination of water quality index and suitability of groundwater in a college in Balrampur, U.P. Nature Environment and Pollution Technology, **6**(2):315-319.

Ramakrishnaiah C.R., Sadashivaiah C. and Ranganna G., 2009. Assessment of water quality index for the Groundwater in Tumkur Taluk, Karnataka state, India. Journal of chemistry, **6**(2):523-530.

Dohare D., Deshpande S. and Kotiya A., 2014. Analysis of Groundwater quality parameters: A review, Research journal of Engineering Sciences, **3**(5):26-31.

Kumari S. and Rani J., 2014. Assessment of water quality index of ground water in Smalkhan, Haryana. International Journal of Latest Research in Science and Technology, **3**(6):169-172.

WHO (World Health Organisation) 1992, Geneva, Switzerland. Guidelines for drinking water quality.

APHA(American Public Health Association) 1998, Standard method for examination of water and wastewater, NW, DC 20036.

BIS (Bureau of Indian Standards) 10500, 2003, Indian standard drinking water specification.