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Monitoring the Quality of Groundwater Contamination in and Around Tiruppur Region, Tamilnadu, India

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ABSTRACT

Most of the water requirement for Tiruppur is met from surface and groundwater supplies. The aim of this present study is to assess the levels of physico – chemical and biochemical water quality parameters in the Tiruppur region of Tamilnadu. The study was carried out during November 2011. Groundwater samples were collected at different locations of Tiruppur town for their physico – chemical studies. All parameters were determined using standard procedures. Laboratory tests were performed for physico – chemical analysis of samples for Temperature, pH, Electrical conductivity, Total dissolved solids, Total hardness, Carbonate, Bicarbonate, Sodium, Potassium, Calcium, Magnesium, Chloride, Nitrate, Fluoride, Sulphate, Phosphate, Biochemical Oxygen demand, Chemical oxygen demand and Dissolved oxygen. The present study showed that most of the physico – chemical parameters were higher in concentration at most of the groundwater samples.

Keywords: Groundwater; Tiruppur; Total hardness; Tamilnadu; India.

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INTRODUCTION

Water is very important for nature. Without a well functioning water supply, it is very difficult to run human life. Water quality is important to quantify any groundwater supply. The chemical behavior of any groundwater determines its quality and utilization.

Several factors like discharge of agricultural, domestic and industrial wastes, land use patterns, geological formation, rainfall pattern and infiltration rate are reported to affect the quality of groundwater in an area. As groundwater moves along flow lines from recharge to discharge areas, its chemistry is altered by the effect of a variety of geochemical processes [1].

Groundwater is a replenishable source and has inherent advantages over surface water. There has been a tremendous increase in the demand for fresh water due to urbanization, industrialization and increasing population. Pollution of groundwater increases steadily due to industrialization, population growth and urbanization. Groundwater has been used for various purposes since ancient times. Groundwater is used for agricultural, industrial and domestic purposes in most part of Tiruppur area of Coimbatore district.

Tiruppur is a fast growing industrial city in Coimbatore district of Tamilnadu, also known as the “Baniyan city” of India. It is located on the bank of the Noyyal River, a tributary of the river Cauvery. Most of the industries present in Tiruppur are textile industries. Tiruppur is a corporation town situated about 50 kilometers east of the city of Coimbatore in Tamilnadu. As a textile city, Tiruppur is full of dyeing and garments. About 765 dying and bleaching industries operate in Tiruppur. The southern part of the city enjoys more rainfall due to the surrounding of Western Ghats of the city. The study area map is shown in Fig (1). The rapid growth of the industry has resulted serious environmental problems, especially from bleaching and dyeing units.

Hence there is evidence to suggest that these units extract considerable quantity of groundwater from the peripheral areas and discharge the effluents without adequate treatment. The discharge of effluents has caused severe pollution of both the surface and groundwater in the region and has also contaminated agricultural land.

Hence the present study has been undertaken to investigate the physico – chemical analysis in and around Tiruppur town.

EXPERIMENTAL METHODS

The place of study at which water samples were collected is referred to as “Stations”. Groundwater samples were collected from 10 stations in and around Tiruppur town. Some sampling stations are located nearer to the textile industry. The sampling stations are represented as Karumanthampalayam (S1), Chinnakarai S2, Karaipudur (S3), Aarumuthaampalayam (S4), Thanneer panthal (S5), Ganapahipalayam (S6), Iduvai (S7), Upplipalayam (S8), MGR Nagar (S9) and Tirupur old bus stand (S10). The samples were collected in 2 liters polythene cans with its necessary precautions. The physico – chemical parameters such as Temperature, pH, Electrical conductivity, Total dissolved solids, Total hardness, Carbonate, Bicarbonate, Sodium, Potassium, Calcium, Magnesium, Chloride, Nitrate, Fluoride, Sulphate, Phosphate, Biochemical Oxygen demand, Chemical oxygen demand and Dissolved oxygen were analyzed using standard procedure as per standard method of APHA [2,3]

RESULTS AND DISCUSSION

The results obtained for physico – chemical parameters of groundwater samples are tabulated in table (1) and the results are discussed and compared with the standard values.

pH

The pH of the groundwater samples vary between 6.9 and 8.2 (Table 1). The pH value for all the samples are found to be within the permissible limit of WHO (6.5 – 8.5). There is no abnormal change in groundwater samples. The slight alkalinity may be due to the presence of bicarbonate ions which is formed by combination of CO_2 with water to form carbonic acid that affects the pH of the water [4]. Carbonic acid undergoes dissociation and produce hydrogen and bicarbonate ions [5]. The mild alkalinity indicates the presence of weak basic salts in the soil [6]. There is no much distinct variation of pH in the present study.

Electrical Conductivity (EC)

The EC values are within the range of 990 to 9943 µ mhos/cm in the groundwater samples. EC is a measure of salinity which greatly alters the taste and has a significant impact of the user acceptance of the water as potable [7]. The EC values for all the groundwater samples are well above the permissible limit of WHO (600 µ mhos/cm). High EC values are encountered at all stations except S4 and S10. This may be due to higher rate of groundwater pollution by textile effluent. The groundwater samples which are very near to the textile industry have maximum EC value and samples which are far away have lower EC.

Total dissolved solids (TDS)

The total dissolved solids (TDS) are recorded within the range of 965 to 1020 ppm for the groundwater samples. All the groundwater samples show higher TDS values and exceed the permissible limit of WHO (500 ppm). The maximum TDS value is observed at station S10 and minimum is at station S4. The high TDS value is recorded at station S10 that is located nearer to the textile industry. The increase of TDS in groundwater is due to high concentration of salts [8]. The high level of TDS in the groundwater is due to discharge from polluting industries and untreated wastes. The same result was inferred by Thahir [9].

Total Hardness (TH)

One of the principal sources of cations that impart hardness is Calcium and Magnesium and the anions are Carbonate, Bicarbonate, Sulphate, and Chloride [6]. The total hardness values are found to be in the range of 175 to 772 ppm. The values are exceeded the desirable limit of WHO (200 ppm) at all stations except S5. This means that groundwater at stations S1 to S4 and S6 to S10 are very hard. The high value of hardness is observed at station S9 which are nearer to textile industry and low value at S5 that are far away from textile industry. The high value of total hardness may be due to percolation of textile effluent.

Water having hardness up to 60 ppm is soft, 61 to 120 ppm is moderately hard, 121 to 180 ppm is hard and above 180 ppm is very hard. Hence the present study indicates that all the groundwater samples come under the category of very hard except S5. High value of hardness between 150 to 300 ppm can cause kidney problem [6].
Carbonate (CO_3) and bicarbonate (HCO_3)

The carbonate values are not detectable in all the groundwater samples, since the observed pH is below 8.6. The same result was observed by [6]. The bicarbonate values are found to be in the range of 315 – 695 ppm (Table 1). Higher values (695 ppm) are observed at stations S1 and S10. All the groundwater samples are exceeded the acceptable limit of bicarbonate values of WHO (500 ppm) except S4 and S5. Bicarbonates are produced by the decomposition and oxidation of organic pollutants [10]. Large amount of alkalinity imparts a bitter taste to water. Excess alkalinity in water is harmful for irrigation which leads to soil damage and reduce crop yields [11].

Sodium (Na)

The values of sodium are recorded between 127 and 315 ppm. The most of the groundwater samples are exceeded the desirable limit of WHO (200 ppm). The maximum value of sodium is observed at station S2 and minimum value is observed at S10. The groundwater samples collected near the textile industry have high sodium values than the sample collected far away from the industry. Percolation of industrial effluent and the intrusion of domestic sewage may enhance the concentration of sodium. The concentration of sodium more than 50 mg/l makes the water unsuitable for domestic use and causes severe health problems [12].

Potassium (K)

The potassium values are observed from 17 to 37 ppm for the groundwater samples. A slight variation of potassium is noted station wise. All the groundwater samples are exceeded the permissible limit of WHO (12 ppm). High concentration of potassium in the groundwater sample is due to presence of silicate minerals from igneous and metamorphic rocks [13].

Calcium (Ca)

The calcium values lie between 72 – 298 ppm for the groundwater samples. The calcium values are exceeded the permissible limit of WHO (200 ppm) at stations S2, S3, S5, S7, S8 and S9. The higher concentration of calcium indicates the presence of hardness in water. The low value at stations S4 and S10 may be due to reverse cationic exchanges with sodium [14]. The excess of calcium causes concretions in the body such as kidney or bladder stones and irritation in urinary passages.

Magnesium (Mg)

The magnesium values are found between 61 and 173 ppm in the groundwater samples. The groundwater samples collected from stations S2, S3, S8 and S9 are exceeded the standard value of magnesium of WHO (150 ppm).

Chloride (Cl)

The chloride values are recorded between 81 and 815 ppm in the groundwater samples. All natural waters contain chloride with widely varying concentrations. The highest value (815 ppm) is observed at station S2 and lowest value (81 ppm) at station S6. The origin of chloride in surface and groundwater may be from diverse sources such as weathering and leaching of sedimentary rocks and soils, domestic and industrial waste discharge, etc. Excessive chloride in potable water is not particularly harmful and also leads to potentially high corrosiveness [15]. The chloride values are well within the permissible limit of WHO (250 ppm) for samples collected at stations S1, S3, S4, S5, S6 and S10. The values are exceeded the permissible limit at stations S2, S7, S8 and S9. Excess of chlorides (>250 mg/l) imparts a salty taste to water and people who are not accustomed to high chlorides may be subjected to laxative effects [16].

Nitrate (NO_3)

The nitrate values are found to be in the range of 53 to 122 ppm. Nitrate values are exceeded the permissible limit of WHO (45 ppm) for all the groundwater samples. Penetration of industrial effluent, dumping of garbage, sewage, leakage of septic tanks and the open toilet of animal and human being may enhance the concentration of nitrate in the groundwater [6]. Higher concentration of nitrate in drinking water causes goiter, cancer and methemoglobinemia [3].

Fluoride

The values of fluoride lie between 0.1 to 0.6 ppm for the groundwater samples. In the present study, the fluoride values are well within the permissible limit of WHO (1.5 ppm) for all the groundwater samples. The sources of fluoride in these groundwater samples may be weathering of rocks, fertilizers used for agriculture or the sewage [17].

Sulphate (SO_4)

The sulphate values are recorded in the range of 139 to 442 ppm. The values of sulphate are exceeded the prescribed limit of WHO (250 ppm) at all stations except S4 and S10. The excess content of sulphate may be due to anthropogenic activity, deposition of soluble salts in the soil. The sulphate content more than 200 mg/l is objectionable for human consumption. More than this limit can cause gastro intestinal irritation particularly when magnesium and sodium are also present in groundwater [18].

Phosphate (PO_4)

The values of phosphate are found to be in the range of 0.8 to 2.7 ppm in the groundwater samples. In this present study, it is observed that all the groundwater samples are exceeded the standard value of WHO (0.1 ppm). High phosphate content is observed at station S8 and low phosphate content is observed at S6. High values of phosphate may be due to leaching from minerals or ores, agricultural run-off and domestic sewage [19].

Biochemical oxygen demand (BOD)

The BOD values are found in the range of 0 to 8 ppm. The BOD values at stations S2 and S3 are exceeded the permissible limit of WHO (5 ppm). High BOD value is found to be at station S2 which is due to heavy pollution load near the textile industry. Excess values of TDS are responsible for higher BOD (20). The high value of BOD may be due to maximum biological activity at elevated temperature and low value of BOD may indicate lower biological activity [21].

Chemical oxygen demand (COD)

The COD values are found between 16.6 and 37.9 ppm in the groundwater samples. The maximum value of COD is observed at station S2 and S9. The higher value of COD is observed for the groundwater samples which are collected near the textile industry. Heavy pollution load with the dumping of garbage and other wastes increase the COD value [6]. Water with COD of less than 1.0 mg/l is assumed not to be caused by anthropogenic influence. Drinking water should not exceed 2.5 ppm and having COD higher than 7.5 mg/l is regarded as poor [22].

Dissolved oxygen (DO)

The DO values are recorded in the range of 1.52 – 14.61 ppm in the groundwater samples. The DO values are exceeded the permissible limit of WHO at stations S2, S3, S6, S8, S9 and S10. The main source of dissolved oxygen is the diffusion from the atmosphere and the photosynthetic evolution. Dissolved oxygen in water is also enhanced by the decomposition of organic matter by the microorganisms. The permissible limit of DO is 5.0 ppm in drinking water and should not be more than 5 ppm [23].

CONCLUSION

Ten groundwater samples were collected in and around Tiruppur area and subjected to physico – chemical parameters such as Temperature, pH, Electrical conductivity, Total dissolved solids, Total hardness, Carbonate, Bicarbonate, Sodium, Potassium, Calcium, Magnesium, Chloride, Nitrate, Fluoride, Sulphate, Phosphate, Biochemical Oxygen demand, Chemical oxygen demand and Dissolved oxygen as per the standard procedure. The groundwater quality parameters were compared with standard values. The result of this work shows that most of the physico – chemical parameters like electrical conductivity, total dissolved solids, total hardness, sodium, potassium, calcium, nitrate, sulphate, phosphate, chemical oxygen demand and dissolved oxygen are well above the permissible limit.

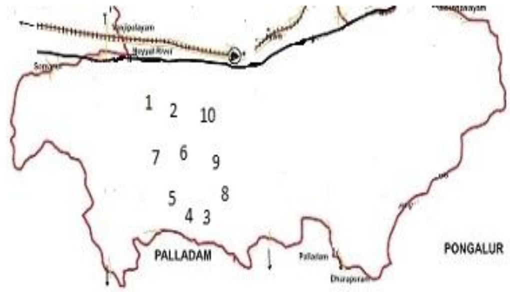
The results show that most of the groundwater sampling stations near the textile industry are polluted. This may be due to percolation of textile effluent, dumping of waste material and intrusion of domestic sewage. From the above study, it is confirmed that the groundwater quality is affected in some parts of Tiruppur. Hence the results suggest that the underground water may be altered in future due to excess population, urbanization and rapid industrialization of this catchment area. Therefore, it is recommended that there should be a proper disposal of solid slurry after treatment as well as recycling of waste water along with periodical monitoring of the underground water.

Table – 1 Physico - Chemical Parameters of various water samples collected in and around Tiruppur.

S. No	Parameter	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
1.	Temperature	32	38	34	32	32	31	32	36	37	35
2.	pH	7.2	7.0	6.9	8.2	7.3	7.1	7.2	7.4	7.1	7.5
3.	EC	4159	9943	9878	990	3845	3170	5231	4873	4751	1689
4.	TDS	1018	985	990	965	970	1010	1014	1020	1002	996
5.	TH	280	550	460	224	175	237	592	347	772	498
6.	Carbonate	0	0	0	0	0	0	0	0	0	0
7.	Bicarbonate	695	510	640	345	315	560	610	660	540	695
8.	Sodium	271	315	298	157	185	247	268	238	265	127
9.	Potassium	28	19	32	30	19	18	26	37	23	31
10.	Calcium	190	273	295	72	220	157	298	212	263	65
11.	Magnesium	115	173	169	94	88	61	90	153	167	72
12.	Chloride	238	815	226	109	98	81	431	375	664	145
13.	Nitrate	107	85	122	96	117	75	98	114	65	53
14.	Fluoride	0.1	0.2	0.4	0.6	0.3	0.2	0.1	0.2	0.4	0.4
15.	Sulphate	343	367	294	140	378	442	228	321	283	139
16.	Phosphate	1.3	2.6	1.9	1.1	1.1	0.8	2.2	2.7	1.8	1.4
17.	BOD	4.0	8.0	6.0	2.0	2.0	0	4.0	4.0	6.0	2.0
18.	COD	20.1	35.7	29.5	19.1	17.6	16.6	33.4	25.3	37.9	31.1
19.	DO	1.52	13.27	12.59	1.99	1.78	10.32	9.7	8.76	14.61	8.15

All parameters are expressed in ppm except, pH and EC- μ mho/cm

Fig. 1 Location map of the Study Area



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