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RESEARCH ARTICLE

EFFECTS OF INDUSTRIAL EFFLUENTS IN GROUND WATER – TIRUCHIRAPPALLI CORPORATION

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ABSTRACT

The Effects of Industrial Effluents in Ground Water – Tiruchirappalli Corporation. The Tiruchirappalli Corporation in Tiruchirappalli district of Tamil Nadu was chosen as the study area. Tiruchirappalli is one of the special grade municipal corporation towns of TamilNadu. It is the first biggest town in Tiruchirappalli district with a population above 24 lakhs (27, 18, 366, and 2011). The software Like Arc GIS are used to demarcate the Effects of Industrial Effluents In Ground Water Tiruchirappalli Corporation. Tiruchirappalli town is located in the central part of Tamil Nadu State in India. It is bounded by Thanjavur, Pudukkottai and Perambalur Districts of TamilNadu. It is situated 10˚0N to 11˚30' North latitude and 77˚45'E to 78˚50' East longititude. It is located about 325 kilometers away from Chennai. Tiruchirappalli is situated on the banks of the River Cauvery. In the present study the pollution status of chosen villages are in the following decreasing order. Tiruvalarchipatti > Sempattu > Kundur > Ayanpatti> Ayanputhoor > Mathur. However, ground water quality of Tiruvalarchipatti has been severely affected. Among the parameters tested the levels of TA, TH, CL, TDS, are highly varying.

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INTRODUCTION

Today the awareness of environment has reached the nook and corners of the world and pollution has become a major threat to the very existence of mankind of this earth. It is now becoming an intellectually challenging problem of mankind. The pollution of various resources were gone to such an extent that human beings are unable to breath fresh air and drink clean water. In general, major environmental pollution problems arise from houses and industrial activities particularly from distillery, paper mills, tannery, sugar factory, dairy, fertilizer unit, refineries, petrochemical industries etc. Ground water is used for domestic water supply and for irrigation and other purpose. Ground water is the source of life in many places of the world. Rapid withdrawal of ground water has seriously imparted the environment in many places. Increased urban populations and industrial developments require larger water supplies. To fill these needs, vast numbers of wells using powerful pumps draw huge volumes of ground water to the surface, greatly altering nature's balance of ground water discharge and recharge. Water pollution can be defined as the presence of any toxic substance in water which affects temporarily or permanently its quality to its required need. The presence of any foreign material which changes either physical or chemical properties of water is called water pollution. Pollution can be divided in to many types. They are physical, organic, inorganic oil, biological, Garbage, pesticide, and radioactive pollution. The ground water quality problems are more commonly related to

I. water soluble products that are stored or spread on the land surface,
II. Substance that are deposited or stored in the ground above the water table, and
III. Material that is stored or disposed of or extracted from below the water table.

Tiruchirappalli is one of the active centers for tanning industries in Tamil Nadu. Out of 13 functioning tanning industries of Tiruchirappalli 10 have established in Sempattu area. Hence in the present study an attempt has been made to study the impact on the environment around tanning industries in Tiruchirappalli.

Review of Literature

A number of researchers have attempted to evaluate the groundwater potential, groundwater chemistry, and developed groundwater modeling relating to agriculture both at national and international levels. In India Lloyd (1976) attempted a study on hydro-geochemistry and groundwater flow patterns in the Saidapur Tahsil, Ghazipur District, Uttar Pradesh to find

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out the chemical variation. He used Durov's method, to differentiate the major ionic constituents of groundwater and had also used isotopic analysis to trace the groundwater. Authors have also attempted on hydro-geochemistry and its relationship to agriculture by considering the individual or paired ionic concentration. Kelly (1940), Wilcox (1955) and Eaton (1950) have proposed certain indices to find out the alkali hazards and Residual sodium carbonate (RSC) which could be used as criteria for finding out the suitability of irrigation waters. However several searches have observed that water classified as suitable for a particular use may not reach the same classification tag of other workers because of differences in the parameters chosen for classification. Hence, it was later realized, that by considering the entire chemistry rather than the individual ionic or grouped ionic character in pairs, the results obtained would be better (Doneen, 1966 and Handa, 1979).

Kumaraswamy *et al*. (1996) have evaluated hydro-geochemical characteristics of the Vaippar estuary, Tamil Nadu and have found that the excessive use of the groundwater to supplement the surface water resource of the area has resulted in the intrusion of seawater into coastal fresh water aquifers and has rendered the fertile land unsuitable for cultivation. Durov's method of diagnosing the saltwater intrusion has been used for this study. The study has revealed that seawater has contaminated the, aquifers of the study area at an alarming proportion. Sankaragururaman *et al.* (1999) has attempted an integrated approach towards the development of groundwater resources of the Nambiyar watershed of Tirunelveli District of Tamil Nadu State which includes detailed study realting to geomorphology, lithology, geological structures, hydrological characteristics and hydro-geochemistry. Gangai Reddy *et al.* (2000) in their study, have identified groundwater potential zones in the hard rock areas of Cuddapah District in Andhra Pradesh. They have used vertical electrical sounding data to demarcate various geological formations and the depth of groundwater in them.

Kumar *et al.* (2000) have developed a GIS based groundwater information system for Upper Barkar of Bihar. GRAM GIS software was used for analyses of various spatial and non-spatial data related to groundwater resources analyses for storing data creating hydrographs, well logs, various chemical diagrams, cross section, fence diagram, contour map etc. The information system developed by them provides information about water table fluctuation geology, geomorphology, and aquifer characteristics, electrical lithology, topography, location and administrative details, aquifer's hydro – geological parameters, cross section of the aquifer etc... Ramalingam and Shanthakumar (2000) have made use of remote sensing and GIS techniques for delineating potential areas for groundwater recharge for the entire state of Tamil Nadu. Thematic maps of geomorphology, runoff isolines, depth to water table zone, groundwater level fluctuation and water quality were used for the analysis. Field verification revealed that areas identified for groundwater recharge using this approach is in agreement with the observed cases and the success rate is more than 90%. Sree Devi *et al.* (2001) to investigate the groundwater exploration of the Pageru river basin, Cuddapah District of Andhra Pradesh State. Electrical resistivity method was carried out in 112 different location of the study are VES interpretations that were used to generate a top- layer contour map and a depth- to- basement map. Finally, a groundwater quality / potential map for the study area were generated using the depth to bedrock map, a water – level fluctuation map, and the second – layer thickness. Furthermore, this groundwater potential map was classified into three sectors i.e poor, moderate and zones with respect to the prospects of finding groundwater in the study area. Aravindan *et al.* (2003), have made an attempt to model the principal chemistry of groundwater in the hard rock area of Gadilam river basin, Tamil Nadu. They have made use of 'Statgraph' – a statistical package to carry out principal component analysis. In their study they have found that in the study area, the Ca HCO3 Facies of summer changes to Na Cl facies during winter. Further their study shows that during winter, Na+ K is closely correlated with C1 but in summer the Concentration of Na+k is not very high. Malini *et al.* (2003) have analyzed the groundwater quality around Mysore, Karnataka. These analyses were carried out to changes of groundwater quality, rock water interaction and saturation characteristics of geochemical data. From the analysis of groundwater quality it has been observed that sixty percent of water samples had higher nitrate concentration with respect of WHO limit of 45mgL1 whereas, 86 percent of the samples had fluoride concretion less than 1.0 mg L1.

The concentration of all the trace metals except iron and zinc were close to the detection limit at most of the sampling sites. Aravindan *et al.* (2004) has investigated the groundwater quality in the hard rock area of the Gadliam river basin, Tamil Nadu State. In their study they have found that rainfall, aquifer lithology, hydrodynamics, hydraulic character and land use play a vital role in influencing the chemistry of groundwater of the basin. The study has helped to characterize the chemical quality of groundwater and also to determine the possible source of dissolved constituents in them. Babu and Sankana Pitchiah (2004) have studied the hydro- chemical characteristics of Brahmanapalle – Vemulla nine water Cuddapah District, Andhra Pradesh State using multivariate analysis. The positive factor are found loaded on Mg, NO3,CL,HCO,F and negative on P^H. Strong positive correlation has been observed between TDS and C1. Anbazhan and Nair (2004) have developed GIS based groundwater quality mapping in Panvel basin of Maharastra State. The geo-chemical analyses of groundwater indicated the level of quality for drinking and irrigation purpose. The chemical parameter such as chloride, hardness, TDS and salinity were pictorially represented using GIS.

MATERIALS AND METHODS

The main aim and objectives of the present study is to analyze the impact of tanning industry on the ground water quality around tanning industries in Tiruchirappalli. To analyse the water quality study sample surveys have been made. Simple graphs were also presented in this study.

Study Area

The Tiruchirappalli Corporation in Tiruchirappalli district of Tamil Nadu was chosen as the study area. Tiruchirappalli is

one of the special grade municipal corporation towns of TamilNadu. It is the first biggest town in Tiruchirappalli district with a population above 24 lakhs (27, 18, 366, and 2011). Tiruchirappalli town is located in the central part of Tamil Nadu State in India. It is bounded by Thanjavur, Pudukkottai and Perambalur Districts of TamilNadu. It is situated '10˚0N to 11˚30' North latitude and 77˚45'E to 78˚50' East longitude. It is located about 325 kilometers away from Chennai. Tiruchirappalli is situated on the banks of the River Cauvery (Fig 2.1, 2.2).

Now the town is governed by the corporation. The town is divided into 60 wards and four circles for the administrative convenience of the corporation. Tiruchirappalli Corporation Area, surrounding the city is endowed with many big tanks which are linked with each other. The excess of storm water during monsoon period used to flow through surplus channels of these tanks and discharge into river Cauvery from the northern side and also to a series of tanks on the southern side. Uyyakodan channel is the main channel passing through the city which flow West to East.

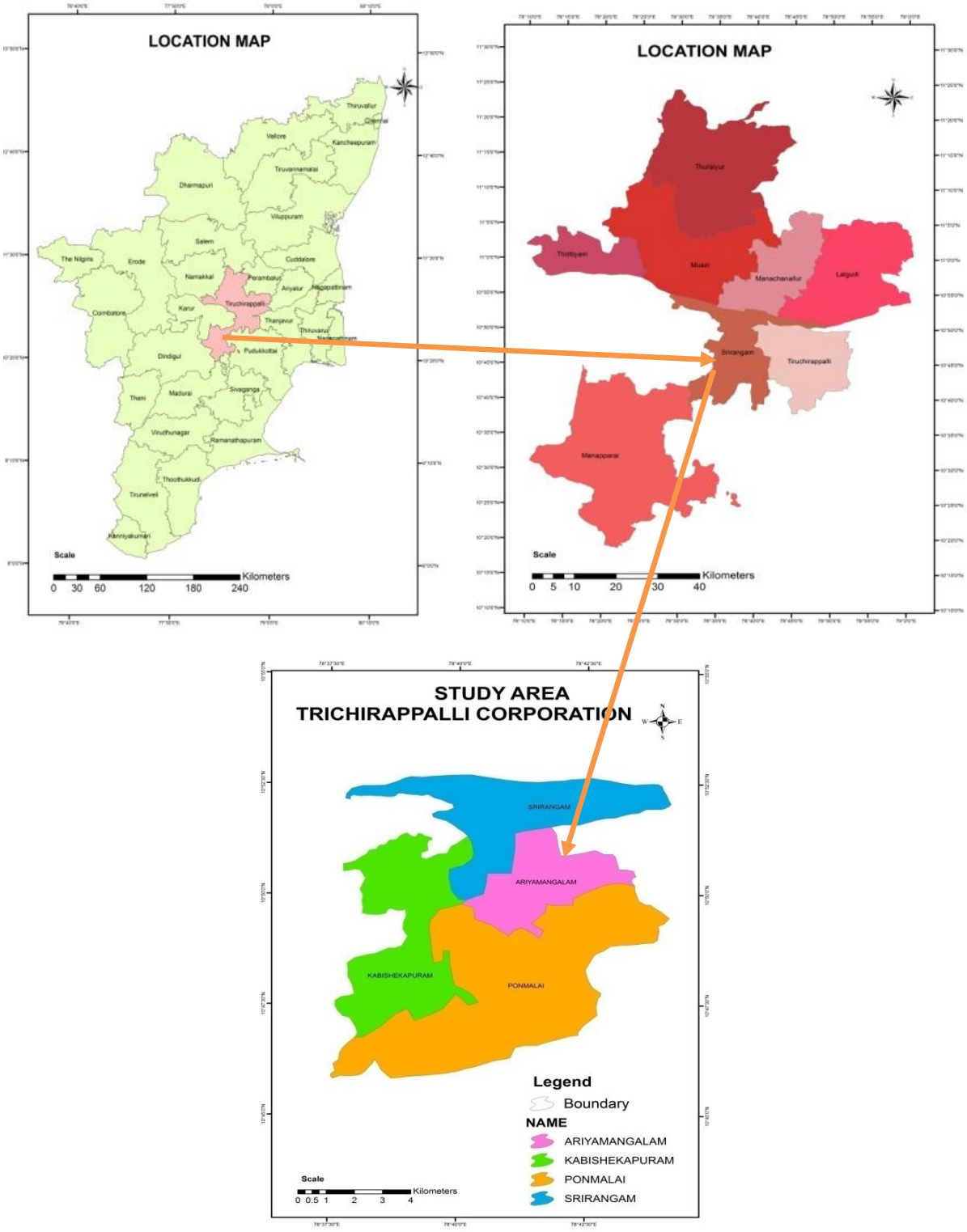


Fig 2.1

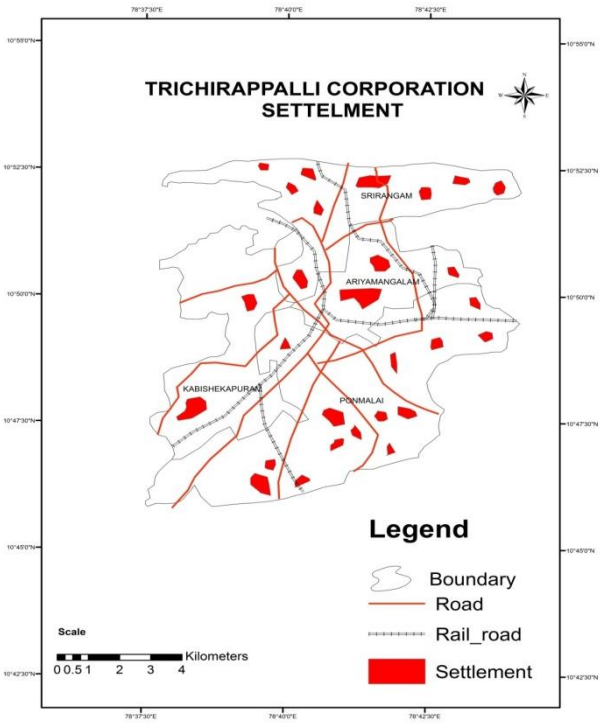


Fig. 2.2.

Cauvery River, the only major natural water course passing through the centre of the city from West to East also got heavily silted up. It remains almost dry throughout the year. However, during heavy monsoons it becomes fully surcharged with the upland flow. Due to very many encroachments and dumping of solid waste as well as heavy siltation, the flow in the main channels passing through the city also got restricted. This remains surched during monsoon season. Uyyakodan River flow is in the middle of the city. Tiruchirappalli Town area is a plain region. Only few hills seen within this corporation limits. These are Ponmalai, Khajamalai, and Rock Fort etc. The river Cauvery mainly drains this region. The other rivers namely kollidam which flows on the Northern part of this town, Kodamurutti river which flows on the Southern part of this town, Koaiyaru and Kottamangalam. The climate throughout the year is moderate. The maximum, temperature in Tiruchy is 37.7˚c. The rise in the temperature is due to its location i.e. it is located in the interior part of the district. Table (2.1) and Fig (2.3, 2.4).

Table 2.1. Temperature and Raifall in Trichirappalli Town – 2013

S.NO	MONTH	RAINFALL (MM)	TEMPERATURE IN (˚C)
1	January	-	31.7
2	February	033.8	32.7
3	March	022.02	36.6
4	April	175.2	37.4
5	May	106.7	38.6
6	June	001.5	36
7	July	067.6	35.6
8	August	105.6	36.4
9	September	188.1	36.1
10	October	227.5	32.1
11	November	083.3	29.4
12	December	018.3	29.7

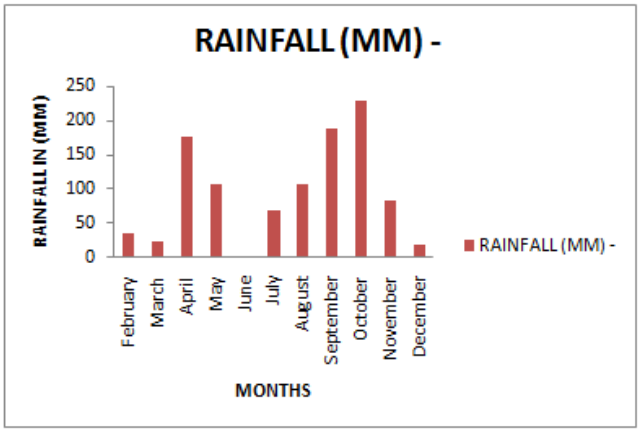


Fig. 2.3.

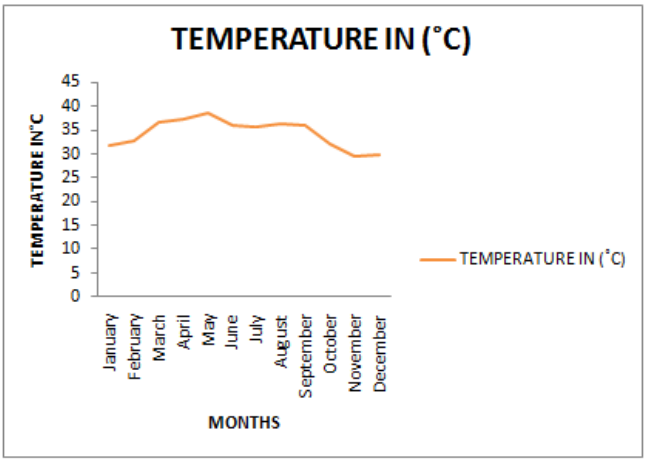


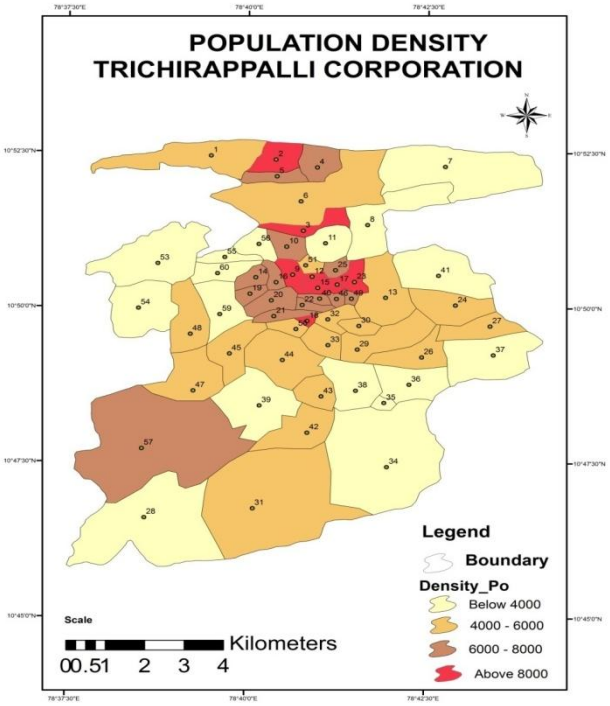
Fig. 2.4.

Tiruchirappalli town receives rainfall during North East Monsoon Season. Normally, it receivers around 400 mm during North East Monsoon and little rain in summer season. In the year 2011, actually the town has received 43.6 mm during North East, South West monsoon period. The soils available in the area can be broadly classified into two varieties namely, Alluvial and Regur. This lies on the Cauvery delta; it contains more of alluvial soil. The following table and figure clearly explain the land use pattern of the Tiruchirappalli Corporation. The total area coverage of the town is about 4,403 sqkm. Land under residential use are 775.39 hectares, 87.01 hectares of land are under commercial use 45.33 hectares of land are for industrial use. 470.66 hectares of land are under Public use. 190.21 hectares of land are under transport and communication use. 467 hectares of land are under agricultural use. 121.40 hectares of land are under water bodies. Among the land uses, the residential area occupies a major share.

Distribution and Density of Population

The spatial distribution of the population is evident from the density map. The total population of Tiruchirappalli Town is about 74, 18,366 (2011). The highest population density is found in the CBD areas. This is mainly because of historical factors and commercial importance of this town. The streets in these circles are crowded with houses. Medium density is

found in circles and adjacent to the core area. The low density is mainly found in the peripheral areas around the town (extension areas). The total population of Tiruchirappalli town in 1991 was 6, 46,480. In 2011 the population of the town was 74, 54,891. Tiruchirappalli town has been divided into 60 wards. The population is unevenly distributed in all the wards of the town.



Analysis

The city is located on the southern bank of river Cauvery. However most of the population depends on ground water for drinking, domestic, agriculture and industrial activities. For the present study the ground water quality was checked in and around the cluster of tanning industries situated at Sempattu. There are 11 tanneries' functioning in Sempattu. The selected villages namely Sempattu Tiruchirappalli, Kundur, Ayanpatti, Ayanputhoor and Mathur were situated around the cluster of tanneries. The chosen village for the present study were located at a distance of 0.5 km, 1.00km, 1.5km,2.0km,2.5km and 3.5km from the tanning industries respectively. The villages were selected to study the impact of tanning industries on ground water quality. Sempattu village 4 bore wells. Tiruvalachipatti village 3 bore wells, Kundur village 4 bore wells. Ayanpatti village 6 bore wells and Ayanputhoor village 8 bore wells and Mathur village 6 bore well samples were collected from all the sampling points (Table 3.1, 3.2). Sampling of ground water from these villages was carried out during 2009 (Dec to Feb). Water samples were collected in polythene cans from bore wells after running them for 15 minutes. All samples were refrigerated in laboratory at 4˚c. Back ground information regarding the location of the bore wells were recorded. The physico-chemical parameters such as P^H, total alkalinity, total hardness, chlorides, total dissolved solids, turbidity, dissolved oxygen, chemical oxygen demand and biochemical oxygen demand were analyzed the P^H of the water was measured using a digital P^H meter. The dissolved oxygen was recorded at the site of collection following Winkler's methods and the results were recorded at the site of collection following Winkler's methods and the results were expressed in mg/h. Turbility was estimated using nephelo Turbidity meter and the results were expressed in Nephelo Turbidity unit (NTU). Estimation of remaining parameters were made using the following methods, described in APHA and the results were expressed in mg/h.

Table 3.1. Details of sampling of ground water in and around Tanning industries of Tiruchirappalli

S.NO	SAMPLING AREA	BORE WELL NO
1	Sempattu	4
2	Tiruvalarchipatti	3
3	Kundur	4
4	Ayanpatti	6
5	Ayanputhur	8
6	Mathur	6
	Total sampling points	31

Table 3.2. Details of ground water sampling stations

Sampling Area	Ground water source bore well	Distance from tanning industry (m)
Sempattu	BW1	500
	BW2	300
	BW3	350
	BW4	400
Tiruvalarchipatti	BW5	1000
	BW6	1000
	BW7	900
Kundur	BW8	700
	BW9	800
	BW10	750
	BW11	700
Ayanpatti	BW12	1600
	BW13	1600
	BW14	1200
	BW15	1100
	BW16	1150
	BW17	1500
Ayanputhur	BW18	1550
	BW19	1650
	BW20	1700
	BW21	1750
	BW22	1800
	BW23	1850
	BW24	1900
	BW25	1950
Mathur	BW26	2700
	BW27	2760
	BW28	2810
	BW29	3000
	BW30	3100
	BW31	3200

The ground water quality has been studied in Sempatti, Tiruvalarchipatti, Kundur, Ayanpatti, Ayanputhoor, and Mathur of Tiruchirappalli. Tiruchirappalli is the one of the active centers of Tanning industries and it occupies fifth rank in Tanning Industry, next only to Ambur, Vanimbadi, Erode and Dindigul in Tamil Nadu of the 13 tanning industries in Tiruchirappalli 11 are located in and around Sempattu as a small cluster. They fall under the category of small scale tannaries. The tanning capacity of each industry is about 2 tonnes of skins and hides. They produce semi finished skins and hides by following the methods of East Tanning or

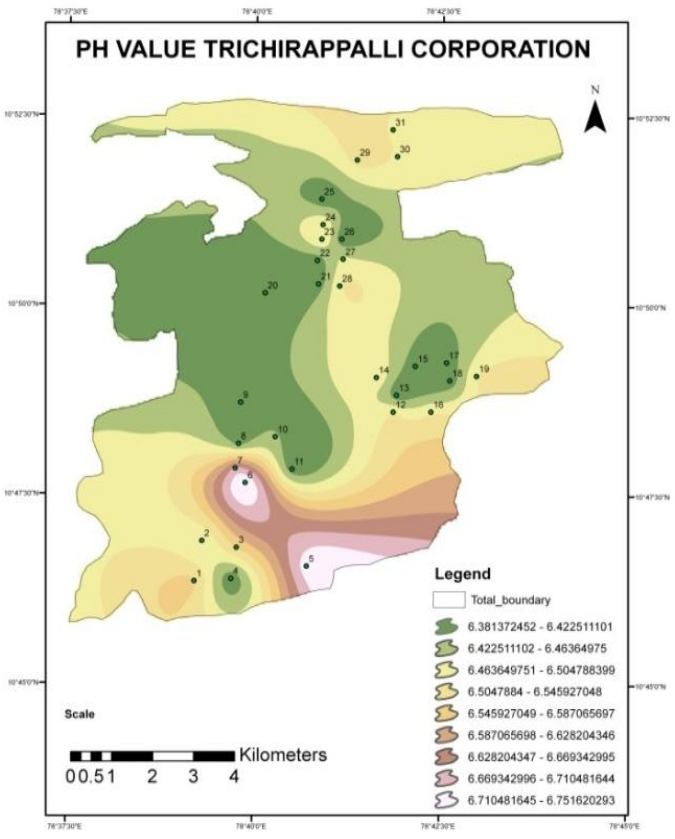
Table 3.3. Water quality parameters of ground water samples

Village name	Sampling station	PH	Total Alkalinity	Total Hardness	Chloride	TDS	NTU	DO	COD	BOD
Sempattu	BW1	6.55	392	414	430	770	2	3.6	8.8	4.6
	BW2	6.47	396	400	430	740	2.1	3.6	8.6	4.8
	BW3	6.55	392	414	410	770	2	3.2	8.4	4.2
	BW4	6.4	480	400	410	740	2.1	3.4	8.6	4.8
	BW5	6.73	446	450	450	810	2.2	2.4	12.4	5
	BW6	6.75	446	470	450	820	2	2.2	12.2	5.4
	BW7	6.69	440	476	460	810	2.1	2.6	12.8	5.6
	BW8	6.4	300	330	300	500	1.5	3.4	5.2	1.4
	BW9	6.42	310	310	310	510	1.8	3.6	5.4	1.6
	BW10	6.43	310	320	314	550	1.5	3.7	5.6	1.4
	BW11	6.4	320	316	320	520	1.7	3.5	5.2	1.6
	BW12	6.5	294	330	280	500	1.2	4.5	4.2	1.2
	BW13	6.4	296	310	290	505	1.5	4.2	4.8	1.4
	BW14	6.5	292	310	286	510	1.3	4.5	4.6	1
	BW15	6.4	296	320	294	510	1.4	4.1	4.2	1.2
	BW16	6.5	300	340	292	510	1.3	3.9	4.8	1.4
	BW17	6.4	310	320	284	500	1.6	4.5	4.2	1.2
	BW18	6.4	290	320	268	490	1.2	4	3.2	1.2
	BW19	6.5	300	312	264	496	1.7	4.2	3.4	1.4
	BW20	6.4	310	312	262	490	1.3	3.9	4.2	1.2
	BW21	6.4	314	330	264	490	1.4	4.1	3.8	1
	BW22	6.4	302	320	272	500	1.6	4.2	4.2	1.2
	BW23	6.5	312	320	272	500	1.7	4	4.8	1.4
	BW24	6.5	314	320	264	494	1.8	4.1	4.2	1.2
	BW25	6.4	396	324	268	490	1.5	4.2	4.6	1
	BW26	6.4	300	320	272	500	1.2	4	3.4	1
	BW27	6.47	314	324	268	498	1.1	4.2	3.8	1.2
	BW28	6.5	300	316	272	498	1.3	4.2	4.2	1.2
	BW29	6.52	298	320	266	496	1.13	4.3	4.6	1
	BW30	6.5	296	312	268	492	1.1	4.3	4.6	1.4
	BW31	6.5	310	324	266	492	1.1	4.5	4.2	1.4
		6.4-6.52	300+-7.24	319.5+-2.73	268.67+-2.73	4.96.33+-2.73	1.16+-0.08	4.25+-0.16	4.13+-047	1.20+-0.18

ALL THE VALUES ARE EXPRESSED IN MG/L EXCEPT PH

vegetable tanning. The tanning processes release huge volume of effluent which has a high oxygen demanding waste and dissolved solids. The present study is undertaken with the primary objectives of assessing the impact of tanning industry on the quality of ground water 31 sampling points at different bore wells were selected around the cluster of tanning industries. Their sampling points are located in 6 villages situated at varying distance from the sources of pollution 0.5 km-3.5km.

The physico-chemical parameters such as P^H, total alkalinity, Total hardness, Chlorides. Total dissolved solids Turbility, dissolved oxygen, chemical oxygen demand and biochemical oxygen demand were analyzed and its mean values of all 31 sampling points are given in the following table. Water quality parameters of the different sources of the same village did not show any significant variation. However distinct variations were observed with respect to various parameters among the different village samples. Table (3.3) The P^H value in the sampling source of bore wells in all the sampling points were in the range of 6.4 to 6.75. Total alkalinity in the sampling sources of bore wells of chosen villages around the cluster of tanneries varied from 297 to 445.5 mg/L, TH 307 TO 483 mg/L, CL 262to 460 mg/L, TDS 491 to 817 mg/L NTU 1.1 to 2.1 mg/L, DO 2.3 to 4.66 mg/L, COD 3.3 to 13.6 mg/L and BOD 1.2 TO 5.5 mg/L. The variations of water quality parameters like TA,TH,CL and TDS in hand pumps, open wells and bore wells of surrounding villages of tanning industries are given in table. Among the 6 villages, samples collected from Tiruvalarchipatti records higher levels of TA



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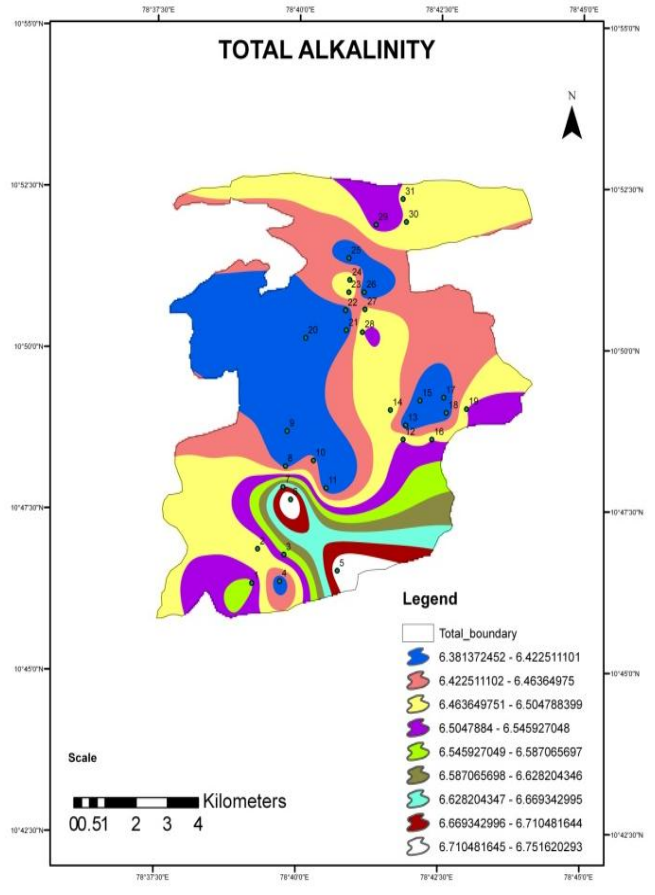

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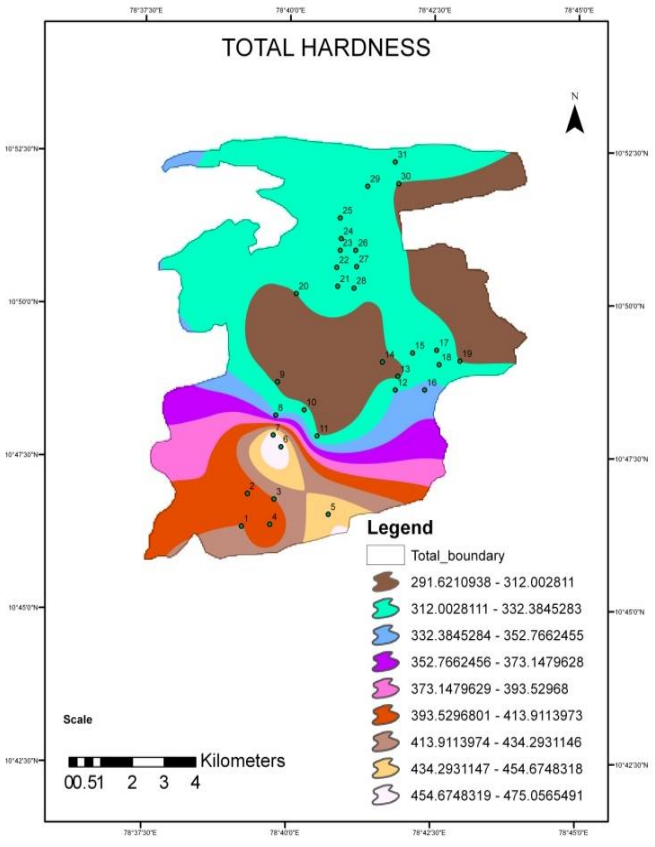

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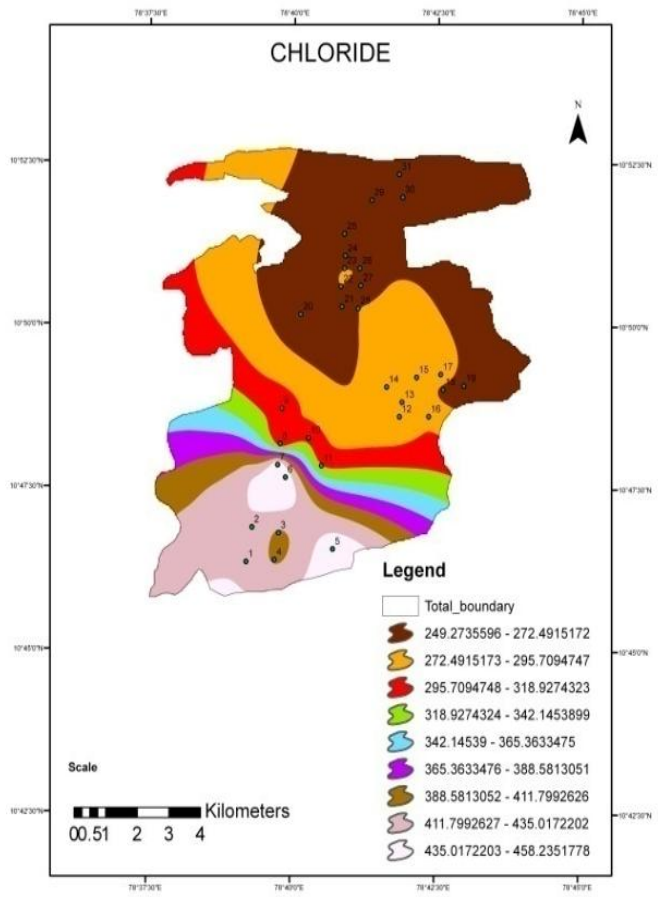

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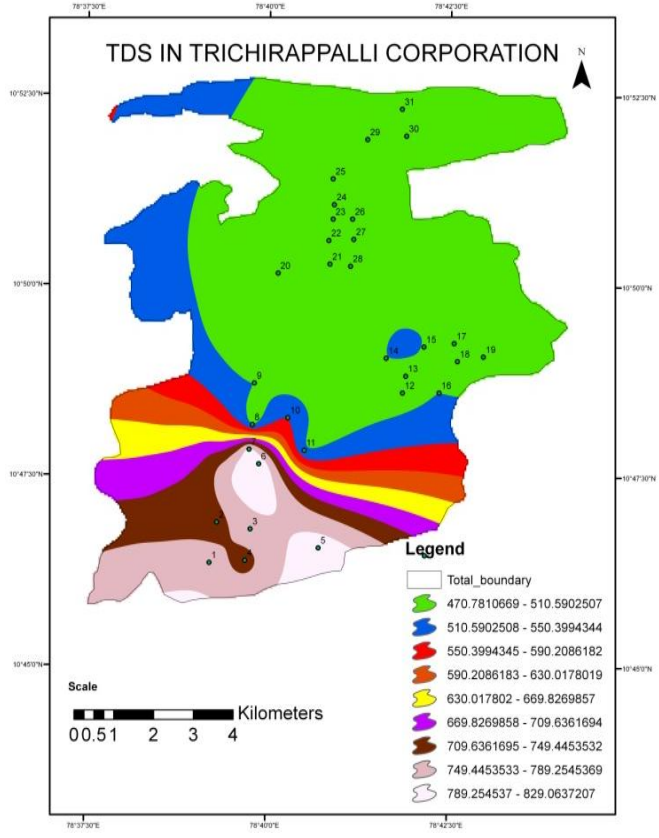

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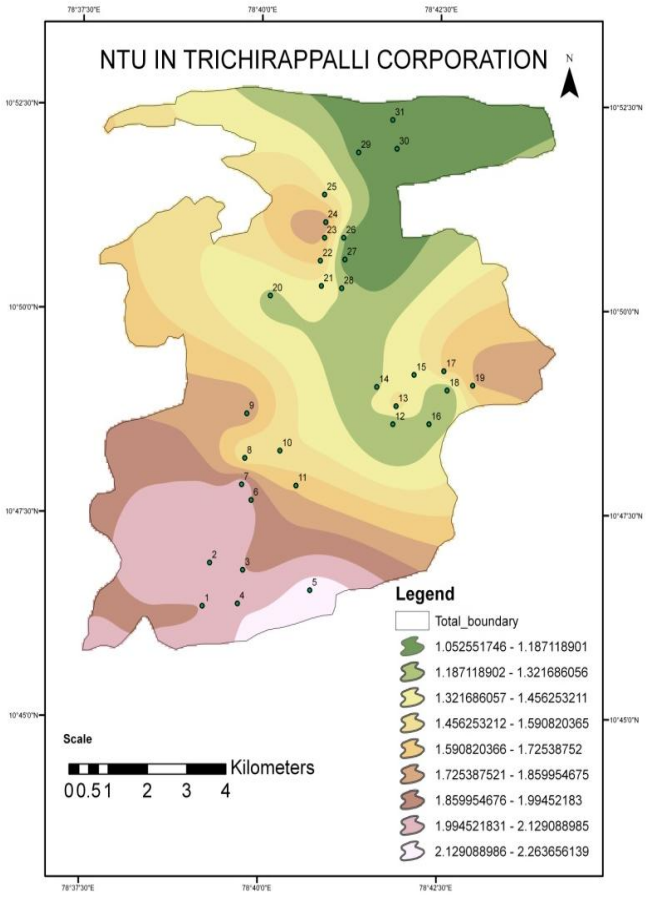

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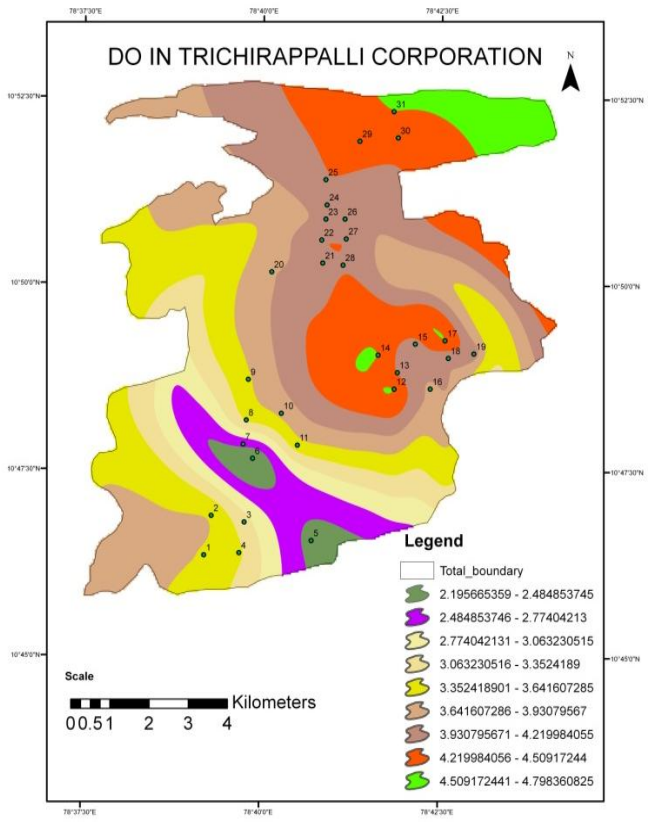

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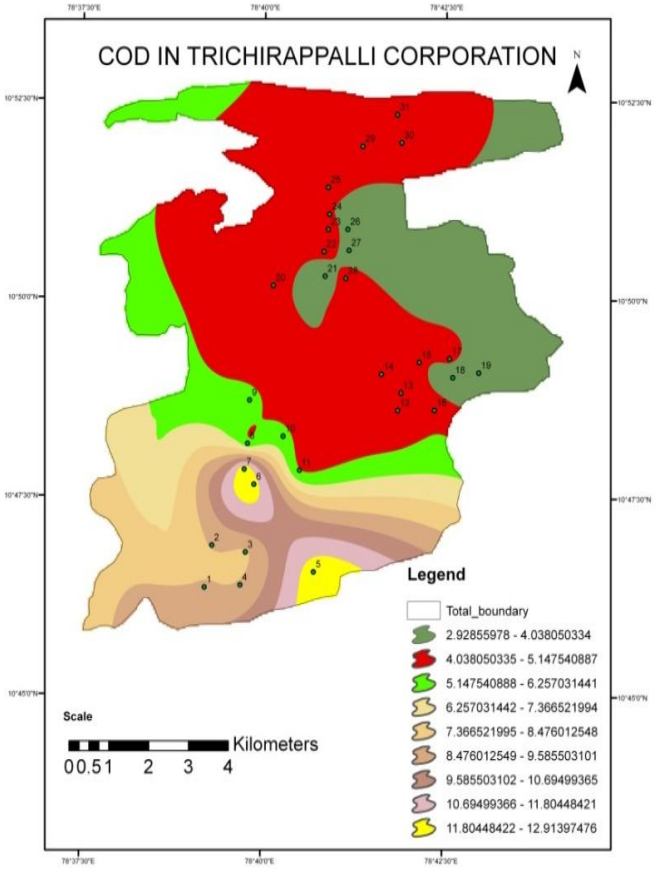

Fig. 3.8.

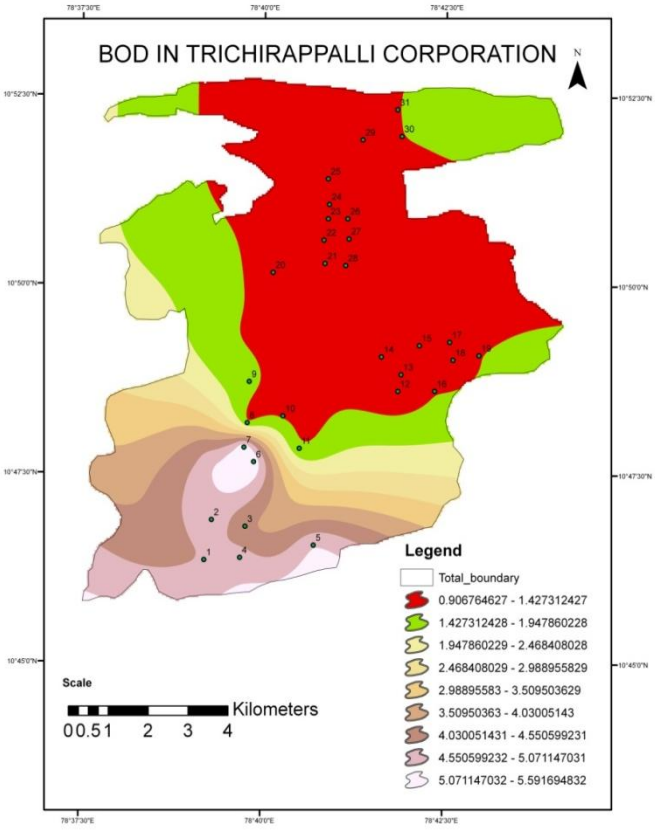

Fig. 3.9.

(445.4 mg/L), TH (483mg/L), and CL (460 mg/L), TDS (817 mg/L) NTU (2.1), DO (2.5 mg/L), COD (13.6 mg/L) and BOD (5.5 mg/L), CL (267 mg/L) TDS (9496 mg/L), NTU (1.4), DO (4.6 mg/L), COD (13.6 mg/L) and BOD (5.5mg/L). Samples collected from Mathur records lowest levels of TA (303 mg/L), TH (319.5 mg/L), CL (267 mg/L), TDS (496 mg/L), NTU 91.4) DO (94.6 mg/L), COD 94.1 mg/L) and BOD (1.3 mg/L) Figure (3.1,2,3,4,5,6,7,8,9). In the present study the pollution status of chosen villages are in the following decreasing order. Tiruvalachipatt > Sempattu > Kundur > Ayanpatti> Ayanputhoor >Mathur. However, ground water quality of Tiruvalarchipatti has been severely affected. Among the parameters tested the levels of TA, TH, CL, TDS, are highly varying. The quality of ground water in the study area is not suitable for drinking purpose. From the generated data, it can be concluded that Tiruvalarchipatti village is more affected than Sempattu eventhrough most of waste water were generated only in Sempattu. The ground water pollution in Tiruvalarchipatti may be attributed to 2 factors. One is closeness to pollution source and another is geological gradient towards East. It is quite natural that water will always flow east of Sempattu and hence Tiruvalarchipatti recorded a steep decline in ground water quality as compared to other villages.

Conclusion

The ground water quality of 6 villages showed a decline in quality when compared to safe drinking water standard. However, the impact of tanning industries has further deteriorated the ground water quality in Sempattu, Tiruvalarchipatti and Kundur, Sempattu village has already got municipal drinking water supply. Hence it is recommended that municipal drinking water supply should be provided to remaining villages also.

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