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Influence of Dyeing and Bleaching Industries on Ground Water of Tirupur, Tamilnadu, India

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Ground water use for various purposes such as drinking, livestock and agriculture is constantly on the rise in areas where perennial surface water sources are scarce. In spite of ground water being crucial for human existence in such situations, it is getting polluted due to various human activities. Industrial activities such as sugar mills, dyeing, bleaching and allied units release effluents that may percolate down to the aquifer and foul it. Tirupur, famous for hosiery products, is an example of a township with meagre infra structure stumbling under hasty unorganised industrial boom. About 765 dyeing and bleaching industries operate in Tirupur (11° 7' N and 77° 15'E), located on the banks of the river Noyyal, a tributary of the river Cauvery. These units, using about 150 chemicals, discharge more than 7500 M^3 of effluent without treatment everyday into the river Noyyal and wetlands in the vicinity. As a result, the ground water quality of entire town has turned hazardous and unfit for use. However, no attempts to study the ground water contamination here was made so far. The present study was attempted to generate baseline data on the extent of ground water pollution in Tirupur and help delineate the area of contamination in predicting the possible risk to the population using ground water for domestic purposes and irrigation.

MATERIALS AND METHODS

Samples were collected from open wells close to the river Noyyal from areas where the dyeing and bleaching industries are many. Sampling sites (Figure 1) were located on either sides of the river. Ground water samples for analysis were taken from open wells in acid washed polythene bottles during May to December, 1997. Temperature of the water was recorded using centigrade thermometer, Turbidity was estimated by visual method in Jackson Turbidity units. pH was measured in the field by universal pH meter which was pre-calibrated. Total alkalinity was taken as the sum of the phenolphthalein and methyl orange alkalinity. Total hardness and calcium hardness (as $CaCO_3$) were estimated by EDTA titrimetric method (APHA 1992), and magnesium hardness (as $CaCO_3$) as the difference of calcium hardness and total hardness. Sodium, potassium, BOD and COD were analysed according to the methods of APHA (1992). Total solids (TS) were estimated by evaporation of

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the samples to dryness and total dissolved solids (TDS) by TDS meter. Total suspended solids (TSS) were calculated by deducting TDS from the TS. Chloride was estimated argentimetrically using silver nitrate. Nitrite was estimated using sulphanilamide and N-(1-naphthyl) ethylene diamine dihydrochloride (NEDA). Phosphate was estimated using stannous chloride and molybdenum blue (APHA 1992). Metal concentration (Cu, Zn, Cd and Cr) were estimated using the pre-concentration procedure of chelation and solvent extraction (Brooks *et al.* 1967) which involves the use of Ammonium pyrrolidine dithio carbomate (APDC) and Methy 1-Isobutyl Ketone (MIBK). Final quantification was made using an Atomic Absorption Spectrophotometer (Perkin Elmer model No. 3300). Using known standards, the pre-concentration procedure was found to recover 95% of metals.

RESULTS AND DISCUSSION

Mean values of the physico-chemical characters of the ground water samples are shown in Table 1. The pH in the present study ranged between 7.4 and 8.0, acceptable as per guidelines by WHO (1984). The lowest pH was observed in Chinnakarai area and highest at Kassipalayam and Mudalipalayam area (Figure 1).

Table 1. Mean values of physico-chemical parameters of the ground water samples (mg/L).

Parameters	Mangalam	Andipalayam	Chinnakarai	Veerapandi	Mudalipalayam	Kasipalayam	Angeripalayam	Kanjampalayam
pH	7.76	7.50	7.47	7.93	8.00	8.00	7.60	7.78
EC	11800	9600	21000	7000	1940	8800	6400	7400
TS	9563	7606	9727	5913	2144	6961	5800	6760
TDS	7900	6500	8000	4500	1510	6300	4275	5800
TSS	1663	1106	1727	413	634	661	1525	960
Total Hardness	4700	3200	1550	1140	390	1500	1250	1310
Alkalinity	250	575	625	350	400	500	575	650
BOD	110	120	80	140	130	110	98	120
COD	275	220	928	800	236	400	464	272
Ca	2800	1700	900	740	140	1000	750	410
Mg	1900	1500	650	400	250	500	500	900
Na	1090	1125	1880	1160	520	1110	550	1050
K	40	75	50	80	10	80	30	60
Cl	3545	2907	3332	2233	886	2765	2025	2446
NO_2	BDL	0.01	0.01	0.02	BDL	0.02	0.01	0.01
PO_4	0.21	0.01	0.43	0.76	0.31	3.94	0.17	0.21
SAR	22.5	13.8	67.5	48.6	37.3	40.5	45.0	41.0

The electrical conductivity of the ground water samples was between 1940 and 21000 µ mhos/cm. The maximum EC was recorded at Chinnakarai (21000 µ mhos/cm) and the minimum at Mudalipalayam (1940 µ mhos/cm). The high EC may be because of the effluent discharge into the land directly without any treatment, favouring

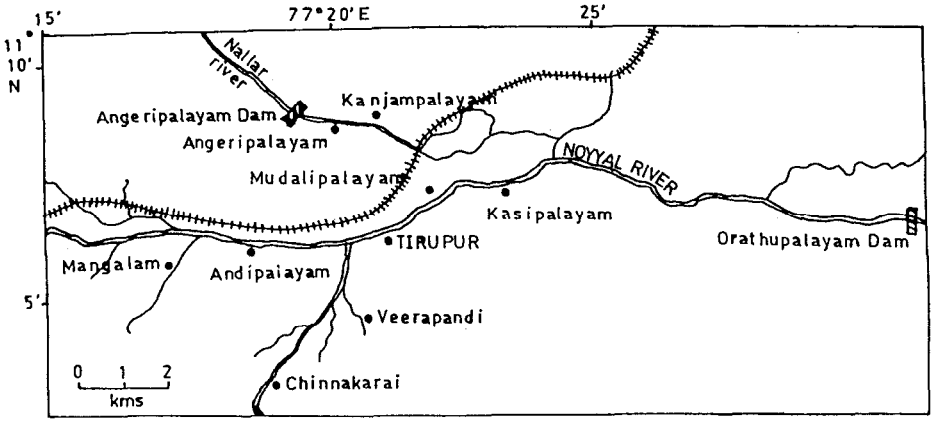

Figure 1. Map showing sampling areas

percolation to the aquifer. TS in the ground water rauged between 2144 (Mudalipalayam) and 9727 mg/L (Chinnakarai). The TDS aud TSS showed higher levels at Chinnakarai (8000 and 1727 mg/L) and lower levels at Mudalipalayam (1510 and 634 mg/L). The solids present in ground water, besides effecting the growth of the plants directly, also effect the soil structure, permeability and aeration, indirectly effecting the plant growth. The water from irrigation point of view classified according to the salt content and solubility (Jain *et* al. 1996) is show in Table 2. The TDS in ground water ranged from 1500 to 8000 mg/L. As per the classification (Table 2) all the sampling sites in and around Tirupur fall under very high salinity zone and the water is unfit for irrigatiou and other uses.

Table 2. Classification of ground water for irrigation.

Zone	TDS mg/L	Conductivity (μ mhos/cm)
Low salinity zone	< 200	< 250
Medium salinity zone	200 - 500	250 - 750
High salinity zone	500 - 1500	750 - 2250
Very high salinity zone	1500 - 3000	2250 - 5000

The total alkalinity values in the grouud water varied from 250 to 650 mg/L. It was observed that the locations having higher alkalinity also had higher industrial effluent discharges containing strong acids and bases. The maximum total hardness was recorded at Mangalam (4700 mg/L) and minimum at Mudalipalayam (390 mg/L) area. Similarly, calcium and magnesium level were also highest at Mangalam area (2800; 1900 mg/L) and lowest at Mudalipalayam (140; 250 mg/L) area. These values are above the prescribed ISI limits (ISI 1983). Sodium in the samples ranged from 520 (Mudalipalayam) to 1880 mg/L (Chinnakarai). In general, most of the values were well above the levels suitable for irrigation (Table 3).

Table 3. Classification of water for irrigation (after Willcox 195.5)

Classified water	Percentage sodium
Excellent	0 - 20
Good	20 - 40
Permissible	40 - 60
Doubtful	60 - 80

Sodium react with soil and reduce its permeability (Vijayakumar *et al.* 1996) by de-flocculation. Excess sodium in irrigation water may be toxic to sensitive crops. The condition is prompted by water of high sodium absorption ratio (SAR) and is reversed by water containing high proportion of calcium and magnesium (Richards 1954). SAR in the ground water of the study area varied between 13.75 and 67.50 (Table 1). The ground water was classified as per Table 4. In the study area, except at Angeripalayam the SAR are well above the acceptable levels and is not suitable for agriculture. The high level of SAR in the study area may be due to the seepage of polluted water. The low level of SAR in Angeripalayam is because of the comparatively low polluted surface water in the check dam on the river Nallar (Figure 1).

Table 4. Ground water classification for irrigation according to SAR levels.

SAR	Class
<10	Excellent
10 - 18	Good
18-26	Fair
>26	Poor

Potassium was high at Veerapandi (80 mg/L) and low at Mudalipalayam (10 mg/L) area. BOD and COD showed higher values in all the samples. BOD in ground water ranged from 80 (Chinnakarai) to 140 mg/L (Veerapandi). The COD ranged from 220 to 928 mg/L in Andipalayam and Chinnakarai area. High value of BOD and COD in ground water is an indication of high percolation of surface water pollution (Rana and Palria 1988).

Chloride, an index of surface pollution level was found high in many wells. The value ranged from 886 (Mudalipalayam) to 3545 mg/L (Mangalam). The acceptable value as per IS1 is 200 mg/L (Table 2). This may be because of the percolation of effluents containing high content of common salt used in textile processing. The high salt concentration in ground water leads to formation of a saline soil and is a serious hazard to agriculture. The phosphate content in the ground water was low ranging between 0.31 and 3.94 mg/L. Phosphate concentration, above 2 mg/L, can be an indication of pollution. In the present study, except in Kasipalayam area phosphate levels are acceptable. Nitrite is known to be the etiologic agent of methaemoglobinaemia (Sharma and Mathus 1995). The nitrites level were low and mostly below detectable levels (BDL). The maximum recorded value was 0.02 mg/L.

Heavy metal are considered a major contamination in natural waters (Senthilnathan and Balasubramanian 1996). Heavy metals have received considerable attention because of their inherent toxicity to living organisms. Being non-degradable they reach the aquatic environment, remain suspended or partially dissolved in the water column and accumulate in the organisms. The mean concentration of dissolved fraction of heavy metal (Cu, Zn, Cr and Cd) in ground water samples is presented in Table 5.

Table 5. Heavy metal concentration (µg/L) in ground water samples

Metals	Mangalam	Andipalayam	Chinnakarai	Veerapandi	Mudalipalayam	Kasipalayam	Angeripalayam	Kanjampalayam
Copper	1.04± 0.01	1.32± 0.08	7.24± 0.08	3.72± 0.02	1.20± 0.09	2.45± 0.06	2.84± 0.12	4.56± 0.05
Zinc	14.92± 0.10	9.06± 0.25	8.92± 0.05	44.04± 0.19	23.88± 0.24	12.08± 0.11	10.12± 0.14	27.08± 0.12
Chromium	2.12± 0.12	1.52± 0.19	2.12± 0.04	2.24± 0.13	1.84± 0.11	2.04± 0.04	1.84± 0.12	2.68± 0.23
Cadmium	0.08± 0.03	BDL	BDL	0.06± 0.02	0.84± 0.11	BDL	BDL	0.60± 0.05

The dissolved fraction of copper in the ground water ranged from 1.04 ± 0.01 (Mangalam) to 7.24 ± 0.08 µg/L (Chinnakarai). The dissolved chromium in ground water samples was between 1.52 ± 0.19 and 2.68 ± 0.23 µg/L. Chromium, concentrations was highest at Kanjampalayam area and lowest at Andipalayam area. However, the difference between the stations were not much wide (Table 5). The dissolved cadmium concentration in ground water ranges between BDL and 0.60 ± 0.05 µg/L. In ground water cadmium concentration is very low and below detectable limit and was found not to vary notably between the stations (Table 5). Among the metals the level of zinc was highest, ranging between 8.92 ± 0.05 (Chinnakarai) and 44.04 ± 0.19 µg/L (Veerapandi). The heavy metal concentration in ground water are in the order of Zn > Cr > Cu > Cd.

From the data collected in the present study, it is evident that quality of most of the ground water sources are highly polluted to an extent that they are not suitable for drinking and agricultural purpose as per IS1 standards (IS1 1983). It is apparent that this is mainly due to the discharge of untreated effluent from dyeing and bleaching industries, which are located in an unorganised manner.

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