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Contamination of groundwater and soil samples by heavy metals in and around tanneries vicinity at Ambur -Vellore district, India.

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ABSTRACT

The study aims at getting more clear understanding about the contamination of the heavy metals in the water and soil samples which cause drinking water problems for habitants residing near the tannery zone .The research intents at reckoning the heavy metal contamination in 20 bore well water, 20 soil samples and 20 tannery workers taken from the zone in and around leather tanneries in Ambur -Vellore district. The samples were tested by various methods to estimate approximate value of heavy metals concentration including Cu, Al, Zn, Cr, and Ni. Besides; various physical characteristics of the water were also tested. The comparison against the permissible standard was made and the results showed excessive deposition of toxic metals in the samples.

KEYWORDS*:* Heavy metals, Ambur, soil, Tannery, Vellore district

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INTRODUCTION

The groundwater source assessment is of great significance in arid regions where groundwater is considered the only renewable water resource and therefore has critical social and economic importance. Environmental pollution is a major threat to humanity in view of increasing industrialization, urbanization and population growth[1].The situation becomes adverse when the communities are highly dependent upon groundwater resources for drinking and agricultural purposes. Tanning industry has become a serious environmental threat all over the world [2]. Groundwater is the main source for irrigation in Vellore district where deep wells extract water from the ground. Ground water quality mainly depends on the geological formation of underlying strata, the aquifers size and the sampling position. The groundwater quality in most regions of Vellore district does not have serious problems, but there are still water quality problems where the microbial and chemical contamination of groundwater is caused by mainly tanneries and other industries.

In groundwater the metal behaviours is complicated and is related to the source of water and the bio-geochemical process in elemental conditions[3]. The occurrence of metals in surface water, groundwater and soil may be due to the dissolution of minerals that contain metals in the water and soil or human activities such as tanneries and other industries and improper disposal of tannery wastes. Various chemicals with different properties are used in the process of tanning and discharged as effluent. The effluent liquid and solid wastes contain substantial quantities of chromium and other heavy toxic trace metals, organic matter, lime and sulfide [4, 5, 6].

Ambur is becoming more and more polluted every day due to increasing discharge of untreated wastewater effluents into water reservoirs and the rivers. The polluted water poses serious health hazards to residents. Besides the workers, farmers, children and fisherman are mainly affected as they work in the polluted water [7]. Tanneries in these areas play a major part in contamination.Tanneries use a large number of chemicals during the process, discharging toxic wastes effluents into the streams, which drain into ponds, thereby polluting the groundwater. Over the years, the groundwater in the areas where tanneries are located has become intolerably polluted[8]. The industry is highly water-intensive; each ton of hide/skin tanned requires over 40,000 liters of water. Hence even a small tannery with a capacity to process 3 to 4 tons a day uses over 100,000 liters of water a day which is the daily household requirement of at least 2,500 people. It is established that a single tannery can cause the pollution of groundwater around radius of 7-8 km[9]. Three categories of waste are emitted within the leather industry: wastewater (liquid), solid wastes (solids), and air emissions (gaseous). Data show that 50-150 liters of water is used for the conversion

of 1 kg of raw skin into leather. After completion of the process, the same quantity is also drained out [10].

Leather tanning involves several chemical processes. Generally, concentrations of heavy metals in environment occur due to continuous disposal of untreated effluents generated during operational phase of tanneries. The resultant tannery effluent is found to be highly concentrated with heavy metals[11]. When these tannery effluents percolate the ground water, its gets contaminated. Ground water is the major source of drinking and irrigation in these areas throughout the year. Heavy metals concentration in the ground water and surface water in these areas are compared to WHO permissible limit of heavy metals in drinking water. Tannery works in these towns are seriously affected from occupational diseases such as diabetes, asthma, chromium ulcers and skin diseases due to prolonged consumption of contaminated water [12 - 15]. The above literature indicates that industrial pollution especially tannery industrial pollution has negative impact on the health of the workers and the tenants. The present study used to investigate the effect of industrial pollution on metal by tannery activities in Ambur of Vellore district is undertaken.

MATERIALS AND METHODOLOGY

2.1. About Vellore district

Vellore district is one of the 32 districts in the Tamil Nadu state of India. Vellore city is the headquarters of this district and it has the blend of rich heritage and culture representing the ancient Dravidian civilization. The average maximum temperature experienced in the plains is 39.5 ° Celsius and the average minimum temperature experienced is 15.6°C. Ambur is the hub of much number of tanneries and chemical industries which are located around Vellore and its nearby towns with an estimated workers more than one lakh. Ambur is the top exporter of finished leather goods in the country.

Determination of Cr, Pb, Cu, Zn, Al and Ni concentration in Water and Soil samples were measured by using Flame Atomic Absorption Spectrometer –Model Varian Spectra A240, (Sample volume – 10 mL per min. Burner – Air/Acetylene, N_2O/Acetylene burner/ Gases hallow cathode – Acetylene and nitrous oxide).

The results obtained were tabulated and evaluated in accordance with the standards prescribed under ‘Indian standard drinking water specification IS 10500: 1992’ of Bureau of Indian Standards [16]

2.2. Soil sample collection and processing:

The sampling of soil was carried out from twenty places at Ambur of Vellore district, Tamilnadu. The samples collected in sterilized dry plastic bags and used for physic chemical examination. In the laboratory, the soil samples were spread on glass plates and then dried in an oven at 105 Celsius for six hours through 0-5 cm mesh sieve. The collected soil samples were analyzed for various parameters such as pH, electrical conductivity EC), Lead (Pb), Calcium (Ca), Chromium (Cr), Aluminium (Al), Nickel (Ni), Zinc (Zn), Copper (Cu), Total Organic Compound were determined. The results were compared with international standards methods.The study was carried out by systematic collection of soils samples near tannery industries areas Ambur of Vellore district. The samples were taken during the study period of 2017 to 20118. 20 soil samples and 20 water samples collected from the near vicinity of tannery industries. Soil samples were collected in fresh polythene bags and water samples in cleaned polythene bottles[17].

2.3. Digestion Procedures

A procedure recommended by Environmental Protection Agency (EPA, Method 3050B) was used as the conventional acid extraction method. 1 g of sample was placed in 250 ml flask for digestion. The first step was to heat the sample to 95 °C with 10 ml of 50% HNO_3 without boiling. After cooling the sample, it was refluxed with repeated additions of 65 % HNO_3 until no brown fumes were given off by the sample. Then the solution could evaporate until the volume was reduced to 5 ml. After cooling, 10 ml of 30% H_2O_2 was added slowly without allowing any losses. The mixture was refluxed with 10 ml of 37% HCl at 95 °C for 15 minutes. The digestate obtained was filtered through a 0.45 µm membrane paper, diluted to 100 ml with deionized water and stored at 4^0C for analyses[18-20]. All the digested soil samples were analyzed for concentration of chromium (VI), lead, copper, cadmium, iron, cobalt, magnesium, manganese, calcium, nickel, zinc, aluminum (Respective metal wave length calibration in nm) by using Atomic Absorption Spectrometer (VARIAN AA240, Austria).Table-1 Shows that analysis result of water sample and soil sample.

3.0. RESULTS AND DISCUSSION

Table 1. Heavy Metal Concentration in Bore well water and soil samples in the study areas.

Samples Areas	Heavy metals in Water sample (mg/l)						Heavy metals in Soil sample (mg/Kg)					
	Cr	Pb	Cu	Al	Ni	Zn	Cr	Pb	Cu	Ni	Al	Zn
Loc-1	19.85	1.60	0.08	0.90	0.70	0.60	65.80	6.60	4.37	2.50	1.30	3.09
Loc-2	20.25	2.60	1.00	0.08	0.40	0.80	74.56	7.30	3.29	1.50	1.60	4.68
Loc-3	10.20	1.50	1.20	0.20	1.20	1.20	44.84	4.60	9.70	2.90	1.09	9.00
Loc-4	15.30	2.20	2.20	1.00	0.09	1.40	65.40	6.80	17.90	1.20	6.50	6.40
Loc-5	16.24	2.30	3.20	0.80	1.00	2.00	38.95	5.80	18.24	2.10	8.70	10.3
Loc-6	8.50	1.20	1.50	1.40	0.90	4.50	65.24	3.80	19.84	2.20	7.30	6.30
Loc-7	6.50	2.10	2.50	0.80	2.10	2.50	58.36	7.30	18.70	2.60	5.30	8.30
Loc-8	5.25	2.10	3.60	1.20	1.80	2.60	32.52	4.80	25.20	3.10	2.40	9.70
Loc-9	15.24	2.50	2.10	1.80	1.40	2.20	52.40	6.90	7.90	1.90	8.50	8.30
Loc-10	18.60	3.20	0.90	1.20	2.20	1.30	64.50	8.30	6.30	3.50	4.90	4.30
Loc-11	10.90	2.20	1.40	0.50	0.90	2.00	48.20	5.20	4.70	1.90	3.60	2.50
Loc-12	12.50	2.90	2.80	0.80	1.30	1.80	65.20	6.30	8.30	3.00	2.70	8.90
Loc-13	3.80	0.80	2.10	1.80	0.80	2.40	22.80	5.80	4.30	1.50	7.40	7.40
Loc-14	12.22	1.20	2.10	0.40	0.60	3.20	55.20	2.90	6.30	2.10	3.10	4.50
Loc-15	14.54	1.50	1.80	2.20	2.30	1.20	84.10	6.70	6.98	3.40	8.50	4.80
Loc-16	10.60	2.00	1.80	1.80	2.20	0.08	38.50	6.30	7.27	3.50	4.80	6.20
Loc-17	16.22	2.20	1.20	0.30	1.20	1.80	56.40	9.60	4.37	1.50	1.30	6.80
Loc-18	14.50	1.50	0.90	0.30	0.88	2.50	50.20	7.30	3.29	2.60	1.60	8.10
Loc-19	10.42	1.20	1.80	0.09	1.60	3.40	54.00	4.60	9.70	3.20	1.09	8.00
Loc-20	13.10	1.20	1.20	2.50	0.50	0.50	44.20	6.80	7.89	1.20	9.80	2.80
Range	Water						Soil					
	Cr	Pb	Cu	Al	Ni	Zn	Cr	Pb	Cu	Ni	Al	Zn
Low	3.80	0.80	0.08	0.09	0.40	0.50	22.80	2.90	3.29	1.20	1.09	2.80
High	20.25	3.20	3.60	2.50	2.30	4.50	75.56	8.30	25.20	3.50	9.80	10.3
Mean	12.74	1.90	1.77	1.00	1.20	1.90	54.07	6.19	9.73	2.37	4.57	6.52
SD	4.46	0.62	0.83	0.70	0.17	1.05	14.35	1.52	6.33	0.19	2.91	2.30

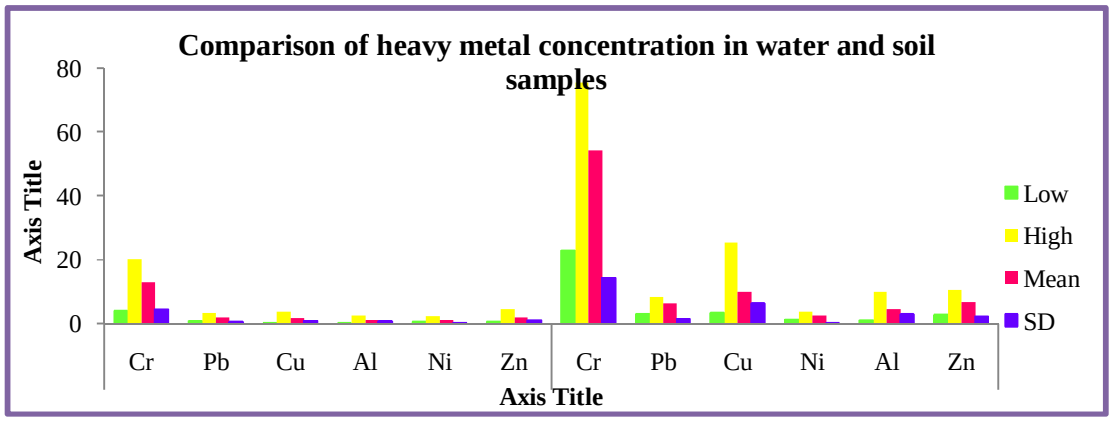

Fig 1. Comparison of heavy metal concentration in water and soil samples at Ambur

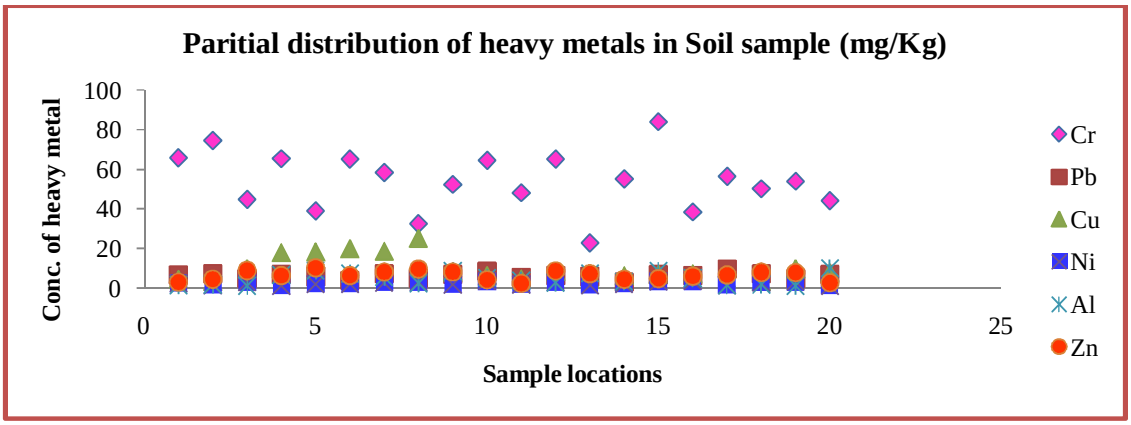

Fig 2.Partial contamination of.Heavy metal contamination in soil at Ambur

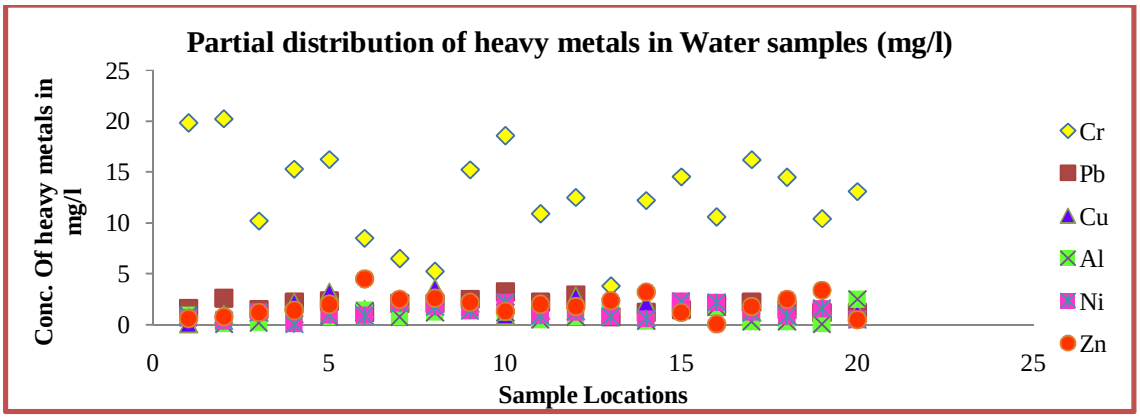

Fig 3. Partial contamination of.heavy metal contamination in water at Ambur

The accumulation of heavy metals in water samples and soil samples have a negative effects on physiological activities of plants (Photosynthesis and nutrient absorption), and may reduce the water quality and soil quality. The total metal concentration in soil samples and water samples followed the order:Cr<Cu<Zn<Pb<Al<Ni.

4. CONCLUSION

From the above results, the ground water and a soil from most parts of study area have quality problems like, high heavy metal content and organic pollutants. So, from this research study, it can be concluded that water and soil of the study areas in some locations are not suitable for drinking and agriculture purposes. People have to be advised to use surface water especially river water sources as far as possible. Serious attempts are needed to develop community based removal systems as a permanent solution to this problem. So it is recommended that a periodic assessment of the groundwater in Ambur taluk area be achieved regularly and this will help in preserving a valuable water resource for sustainable development.

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