STUDIES ON THE PHYSICO-CHEMICAL PARAMETERS OF BORE AND LAKE WATERS IN SIPCOT TOWN AND POND AND WELL WATERS IN SERKKADU VILLAGE OF VELLORE DISTRICT, TAMILNADU

SIVACHANDRABOSE, K,
S.SAMUNDEESWARI, C.MAHALAKSHMI

Abstract: For the present study, water samples collected in Borewell and Lake waters from Sipcot town of Arcot Taluk and in pond and well waters from Serkkadu village of Katpadi Taluk of Vellore District were analyzed for physico-chemical parameters such as turbidity, EC, TDS, P^H , total alkalinity, total hardness, Ca, Mg, Fe, NH_3, NO_2, Cl, F, SO_4, and Tidy's test contents using standard methods as given in APHA (2000) and their results are depicted in table 1. The acceptable limit mentioned in the text represents the standard for drinking water quality according to WHO (1984). The result of the present study indicated that the levels of most of the physic-chemical parameters like TDS (1.19), pH (7.24), Alkalinity (232) Magnesium (36) and iron content showed within the permissible limit in lake water of Sipcot town and a slight hike values were noticed in turbidity (16), total hardness (670), calcium (208) and nitrate (52) in the same water. Sulphate content was very lower in lake water. It is concluded from the result of increase of turbidity and alkalinity contents and lower content of fluoride present in the water that the water body is under deteriorative condition. Among the result of four water bodies compared a hike values was noticed only in lake waters of Sipcot town and it may be due to the seepage by tannery, tannery effluent discharge from Sipcot tannery industries. It is recommended from the study that the release of tannery effluent discharge into the water body may be stopped to protect and sustaining the lake water more suitable for drinking purposes.

Introduction: India is a vast country, where a large number of people live in villages. A large number of villages and cities still do not have adequate and safe drinking water. In order to essential needs of the people, water comes at the second position of air. During the last decade, it has been realized that the time has come to pay more and more attention to the ground water resources and their adequate management by utilizing modern technique (Tiwari, 1999). India is a vast country, where a large number of people live in villages. A large number of villages and cities still do not have adequate and safe drinking water. In order to essential needs of the people, water comes at the second position of air. During the last decade, it has been realized that the time has come to pay more and more attention to the ground water resources and their adequate management by utilizing modern technique (Tiwari, 1999). Numerous anthropogenic activities, like disposal of sewage and industrial water, recreational activities, excessive usage of fertilizers to land and use pesticides have threatened environmental health of both surface and ground water. Water pollution has however, threatened to reduce the quantity available in ponds, lakes, rivers and reservoirs due to other human activities (Trivedy and Chandrasekar, 1999).

Roa, *et al*. (1999) reported that due to increasing industrialization, urbanization and other developmental activities most of our water bodies such as ponds, lakes, streams and rivers have become polluted. Environmental effects of chromium (Cr) have been extensively reviewed (NAS, 1974; Steven, *et al.,* 1976; Synder, *et al.,* 1977; Towill, *et al.,* 1978; Taylor and Parr, 1978; Langard and Norseth, 1979; Post and Campbell, 1980; Hatherill, 1981; Ecological Analysts, 1981). Tamil Nadu is situated at the South Eastern Extremity of the Indian peninsula and it is the southernmost state of mainland India. It is located between 8^{o}05 and 13^{o}34 at North Latitude, 76014' and 8021' at East Longitude, Andhra Pradesh in the north, Karnataka in the North-West, Kerala on the West, Bay of Bengal in the east. Vellore district has become not only the hub of educational institution and also for the tannery industry, chemical industry, sugar mills etc., Vellore water is in an alarming condition as it has been receiving domestic and industrial wastes. Hence, the present study is centered around the water quality assessment in well, bore, pond and lake waters of Arcot town and its surrounded area of Vellore District.

Materials and Methods: In the present work, water samples were collected from Sipcot area and Serkkadu village of Vellore District which is nearby to the Thiruvalluvar university (Figs.2-3). The Sipcot area of Ranipettai is located in 12.9283 latitude and 79.3325 longitude around 25km away from Vellore town and it is surrounded with 240 tannery industries. The aim of collecting lake and bore well waters from this area is to know the quality of water for drinking and irrigation purposes. Another sampling area of Serkkadu village is located 40 km away from Vellore town and it is also located in 13.2389 latitude and 80.1627 longitude nearby to the Thiruvalluvar University. The aim of collecting pond and well waters from this area is to know the water quality fit for drinking and irrigation purposes.

The methods followed for the physical parameters such as appearance, odour, turbidity NTU, Total Dissolved Solids and electrical conductivity and chemical parameters such as pH, alkalinity pH, alkalinity total, total hardness CaCo3, calcium, magnesium, sodium, potassium, iron total, manganese, free ammonia,, nitrite, nitrate chloride, fluoride, sulphate, tidy's test were done according to the procedures given in APHA (2000) and their units are represented as mg/l. The water samples were collected using 1 liter of polyethylene bottle from each month from January,2013 to March, 2013 for three months.

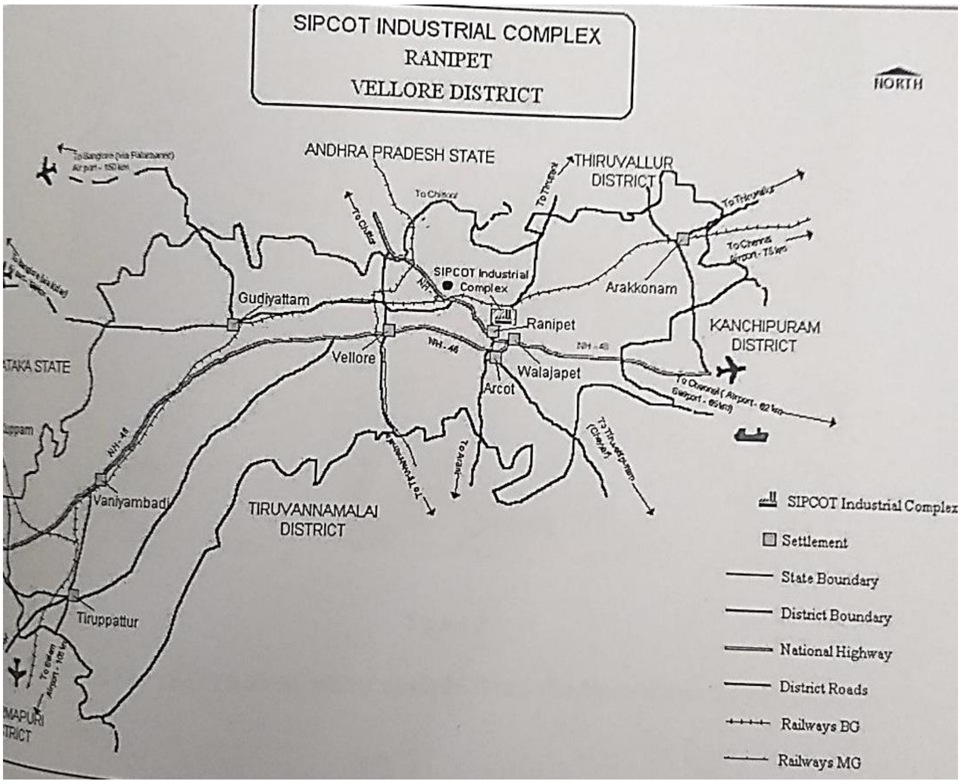

Fig 1. Denotes the Collection Spot of Water Samples from SIPCOT Area

Fig 1: Showing the Collection of Water Sample from the Pond water in Serakadu Village

Fig 3: Showing the Collection of Water Sample from the Lake of Sipcot Village

Results and Discussion: For the present study, water samples collected in Borewell and Lake waters from Sipcot town of Arcot Taluk and in pond and well waters from Serkkadu village of Katpadi Taluk of Vellore District were analyzed for physico-chemical parameters such as turbidity, EC, TDS, P^H , total alkalinity, total hardness, Ca, Mg, Fe, NH_3, NO_2, Cl, F, SO_4, and Tidy's test contents using standard methods as given in APHA (2000) and their results are depicted in table 1. The acceptable limit mentioned in the text represents the standard for drinking water quality according to WHO (1984).

Since the Sipcot town is a tannery industrial area and Serkkadu village is 15 km away from Sipcot area, there is a chance of getting the water polluted due to the possibility of mixing tannery effluent discharge in Sipcot and Serkkadu village water bodies. Hence, it is very essential to see the physico-chemical parameters of bore well and lake waters of Sipcot town and well and pond waters of Serkkadu village whether it is suitable for drinking and irrigation purposes. Appearance of lake and pond waters was seemed to be yellowish in colour and bore water and well water was seemed to be clear and colourless. Colourless appearance may result from the presence of natural metallic ions like Iron and Manganese, human and peat material, plankton, weeds and Industrial waste.

Table 1: Result of the Physico-Chemical Parameters of the lake and Bore Well Water Samples in Sipcot of Ranipet and Well Water and Pond Water Samples in Serkkadu Village of Vellore District

S. No.	Parameters	Acceptable Limit WHO (1984)		Sipcot (Lake water)	Sipcot (Bore well water)	Serkkadu (Well water)	Serkkadu (Pond water)
	PHYSICAL EXAMINATIONS						
1.	Appearance	*A*	*B*	Yellowish	C & C	C & C	Yellowish
2.	Odour	Unobjectionable		--	None	None	None
. 3.	Turbidity NTU	1	10	16±1.0	1±0.0	1 ±0.0	14±1.0
4.	Total Dissolved Solids mg/l	500	2000	1519±3.0	948±2.0	700±2.0	112±1.0
5.	Electrical Conductivity (Mic mho/cm)	-	-	2170±2.0	1354±3.0	1000±5.0	160±2.0
	CHEMICAL EXAMINATIONS						
6.	pH	6.5-8.5	6.5-8.5	7.24±0.10	7.03±0.01	7.01±0.02	7.32±0.02
7.	Alkalintiy pH as $CaCO_3$ mg/l	-	-	0	0	0	0
8.	Alkalintiy Total as $CaCO_3$ mg/l	200	600	232±1.0	244±3.5	208±3.0	28±2.0
9.	Total Hardness as $CaCO_3$ mg/l	200	600	670±2.0	420±3.0	230±2.0	50±0.09
10.	Calcium as Ca mg/l	75	200	208±2.0	128±1.00	62±1.00	9±0.0
11.	Magnesium as Mg mg/l	30	150	36±0.90	24±1.0	18±1.0	7±1.5
12.	Sodium as Na	-	-	-	-	-	-
13.	Potassium as K	-	-	-	-	-	-
14.	Manganese as Mn	0.05	0.5	0.00±00	0.00±00	0.00±00	1.13±0.09
15.	Iron Total as Fe mg/l	0.1	-	0.81±00	0.00±00	0.00±00	0.00±00
16.	Free ammonia as NH_3 mg/l	-	-	0.24±0.09	0.12±00	0.00±00	0.61±00
17.	Nitrite as NO_2 mg/l	-	-	0.04±00	0.02±00	0.00±00	0.09±00
18.	Nitrate as NO_3 mg/l	45	45	52±1.0	25±0.05	26±1.0	5±0.05
19.	Chloride as Cl mg/l	200	1000	495±3.0	224±3.0	141±1.00	24±1.00
20.	Fluoride as F mg/l	1.0	1.5	0.2±00	0.6±0.05	0.4±00	0.4±00
21.	Sulphate as SO_4 mg/l	200	400	194±1.0	157±2.0	113±2.0	21±0.07
22.	Phosphate as PO_4 mg/l	-	-	0.09±0.07	6.05±00	0.00±00	0.18±00
23.	Tidy's Test	-	-	0.3±0.02	0.3±0.02	0.1±00	0.6±00
24.	BACTERIOLOGICAL EXAMINATION (M.F Technique)			-	-	-	-
25	Fecal Coliform (100M)	0	0	--	-	-	-

Note: 1. A CPHEEO Std – Desirable Limit: B.CPHEEO/BIS Std – Permissible limit in the absence of alternative source. 2. Results of Chemical Examination expressed in mg/l except pH 3. C & C – Clear & Colourless

The colour is usually the first contaminant to be recognized in waste waters that affects the aesthetics, water transparency and gas solubility of water bodies (Yuxing and Jian 1999). The odour of bore well, lake, pond and well waters was in none. Turbidity content was 16 in lake water and 1 in bore water of Sipcot town and the same parameter was 1 in well water and 14 in pond water of Serkkadu village. The result showed that the lake water (14) has exceeded than the value of permissible limit. Turbidity is a measure of the ability of water to absorb light and is caused by small particles. Turbidity in water is caused by suspended matter such as clay, silt, finely divided organic and inorganic matter, soluble coloured organic compounds, plankton and other microscopic organisms.

Due to increase of turbidity content in the water, lack of primary productivity, reduction of O_2 and increase of CO_2 and there by reduction of biomass including fish and other aquatic organism will occur (Akan, et al., 2009). Total dissolved solid content was in a range of 1519 and 948 in lake and bore well waters of Sipcot area and 700 and 112 in well and pond waters of Serkkadu village, respectively. Result indicated that there is no harmful effect due to the presence of total dissolved content ranged between 112-1519. Total dissolved solid (TDS) is one of the important measures of water quality. Water with high solid content are of inferior palatability and may induce an unfavourable physiological reaction in the transient consumer. The desirable limit of TDS is 500 (WHO 1984). Escalation level of TDS may cause harmful effect for the purpose of the agriculture and drinking once it is released into the land area with uncontrolled levels.

For most of the natural water the main contributors for total dissolved solids are calcium, Magnesium, Sodium, Potassium, Chloride, Sulphates and bicarbonates. TDS reflect the increasing extent of industrial and domestic discharge in aquatic habitats (Welcomme, 1985). High value of TDS was found to affect the survival and growth of fish (Dicketson and Vingard, 1999). High levels of TDS in the effluent renders it unsuitable for irrigation and drinking purpose. According to Manivasakam (1984) high amount of TDS recorded in tannery effluent could be attributed to processes like soaking, liming, dehairing, defleshing and deliming. Electrical conductivity content was found to be around 2170 in lake water and 1354 in bore water of Sipcot town and 1000 in well water and 160 in pond water of Serkkadu village. Electrical conductivity is a useful tool to evaluate the purity of water. It is the property of water caused by the presence of various ionic species. The acceptable limit of electrical conductivity is 600 (WHO, 1984). It is significantly noticed that the electrical conductivity content was likely to be increased only in the canal water carrying the sludge of tannery effluent discharge.

High level of conductivity may be due to the presence of inorganic substances and salts which show good conductivity (Robinson and Stokes, 1959). The Electrical conductivity is a useful parameter of water quality for indicating salinity hazards. Among the physico-chemical parameters of water compared in four different water bodies like lake and bore well waters of Sipcot town and well and pond waters of Serkkadu village, their levels were seemed to be within the desirable limit as prescribed by WHO (1984) and there by it is clearly indicated that there is no harmful effect due to presence of these parameters and it is also so healthy for drinking and irrigation purposes. It is suggested that the water bodies should be kept in a sustainable manner from free of intrusion of industrial waste into the water bodies by direct or indirect means.

It is suggested according to these parameters that the suspicious release of tannery effluent discharge into the lake by any other means may be stopped. Total dissolved solids analysis has great implications in the control of biological and physical waste water treatment processes. The desirable and acceptable limit of pH is 6.5 to 8.5 in accordance to CPHEEO / BIS STD. In the present study, the pH levels were found to be within the acceptable range of 7.24-7.32. pH of water samples collected from lake and bore well water of Sipcot town and pond and well waters of Serkkadu village was shown to be slightly acidic. The pH value of water is an important indication of its quality and it is dependent on the carbon dioxide, carbonate and bicarbonate equilibrium. The discharge of waste water into water bodies may cause a drop or increase their pH affecting size and activities of microbial populations therein other workers also reported acidic (Pathe, et al., 1995, Dikshit and Shukla, 1989; Mbuthia, et al., 1989; Saravanan, et al, 1999) and alkaline tannery waste waters (Shukla and Shukla, 1994; Kadam, 1990; Sastry, 1986; Sakthivel and Sampath, 1990). The factors like photosynthesis, exposure to air, disposal of industrial wastes and domestic sewage affect pH (Saxenea, 1987). WHO (1984) prescribed beyond pH 8.5, the water can affect the mucous membrane. According to Umavathi et al. (2007) pH is ranged 5 to 8.5 is best for plankton growth.

Alkalinity is a total measure of substances in water that they have acid neutralizing ability. Alkalinity is not a pollutant. The content of total alkalinity was 223 in lake water and 244 in bore well water of Sipcot town and 208 in well water and 28 in pond water of Serkkadu village. These levels were within the permissible limit of 200-600. Alkalinity is important for fish and aquatic life because, it protects or buffers against pH changes (Keeps the pH fairly constant) and makes water less vulnerable to acid rain. High alkalinity values are indicative of the eutrophic nature of the water body total alkalinity values of water are important in calculating the dose of alum and biocides in water (Trivedy and Goel, 1986).

The permissible limit of total hardness as $caco_3$ is between 200-600. Total hardness as caco3 content was 670 and 420 in lake and bore well waters of Sipcot town and 230 and 50 in well and pond waters of Serkkadu village, respectively. These levels were within the acceptable limit as prescribed by WHO (1984) except the lake water of Sipcot town as its value was in the range of 670. Among the values of four water bodies compared the pond water of Serkkadu village has the lowest value of total hardness up to 50. However, the result indicated that there is no much harmful effect due to its presence except the value recorded in lake water.

Hardness is advantageous in certain conditions. It prevents the corrosion in the pipes by forming a thin layer of scales and reduces the entry of heavy metals from the pipes to the water (Praharaj, et al., 2002). The harness of water is an important consideration in determining the suitability of water for domestic and industrial uses. Hard water will precipitate soap and leathering does not take place satisfactorily. Hujare (2008) reported total hardness was high during summer than rainy season and winter season. Calcium content was 208 and 128 in lake and bore waters of Sipcot town, respectively and these values were found to be within permissible limit except a slight hike value was noticed in Sipcot lake water. Calcium content was noticed to be 62 in well water and 9 in pond water of Serkkadu village and these values were seemed to be lower than the desirable limit. Among these two samples compared the pond water of Serkkadu showed its low value up to 9.

The presence of bicarbonates of calcium and magnesium indicate temporary hardness which can be removed by boiling. Hard water is generally believed to have no harmful effect on human being. Cardiovascular diseases were reported to continue more to the areas of soft waters than to those having hard water (Crawford, 1972). Maximum value of hardness is observed in winter and minimum in summer (Pandhe, et al., 1995). Vijayaram et al. (1989) found that the concentrations of total hardness, chlorides, calcium, magnesium and sulphates were 2 to 20 times higher in the ground water of Tiruchirappalli city, Tamil Nadu due to the presence of tanneries.

Calcium is most important cation in the study of water quality. Calcium is one of the nutrients required by the organism and at low concentration calcium has no hazardous effect on human health and calcium is an essential constituent of human being. The low content of calcium is drinking water may cause rickets and defective teeth; it is essential for nervous system, cardiac function and in coagulation of blood. Being an important contributor to hardness in water it reduces the utility of water for domestic use (Purohit and Saxena, 1990). Iron content was noticed to be 0.81 in lake water and a nil value in bore well water of Sipcot town. In Serkkadu village, iron content was noticed to be nil in well water and 1.13 in pond water. Among these four water bodies of Sipcot town and Serkkadu village compared, an optimum quantity of iron could be noticed only at lake water of Sipcot town and pond water of Serkkadu village. Whereas, bore well and well waters of Sipcot town and Serkkadu village could not contain the presence of iron.

These fluctuations may be due to presence of inorganic load in the water bodies at various levels. Generally, surface water contains < 1mg/l of Fe and some ground water contains much higher levels of Fe. The iron value > 2mg/l imparts bitter astringent taste of the water (Maiti, 2002) and concentration of Fe above the safe limit could lead to liver, lung, kidney, brain, heart, muscles and respiratory disorders (Lark et, al., 2002). Free ammonia content was noticed to be 0.24 in lake water and 0.12 in bore well water of Sipcot town. Free ammonia content was noticed to be nil in well water and 0.61 in pond water of Serkkadu village. Free ammonium contents were comparatively less in bore well water of Sipcot town and nil in well water of Serkkadu than lake water of Sipcot town (0.24) and pond water of Serkkadu village (0.61). Wetzel (1983) stated that ammonia is generated by heterotrophic microbes as a primary end product of decomposition of organic matter either directly from proteins or from the organic compounds.

Nitrite content was noticed to be 0.04 in lake water and 0.02 in bore well water of Sipcot town and these values were noticed to be nil in well water and 0.09 in pond waters of Serkkadu village. The result indicated that well water of Serkkadu village is so suitable for drinking purpose compared to other waters of Sipcot town and Serkkadu village. Nitrite poisoning causes fish mortality resulting in converting hemoglobin to form methemoglobin as indicated by Boyd (1990). Nitrate content was noticed to be 52 in lake water and 25 in bore well water of Sipcot town and 26 in well water and 5 in pond water of Serkkadu village. Among these four water bodies compared the pond water of Serkkadu registered with low value upto 5 and an optimum low value with a range of 25 in bore well water of Sipcot town and 26 in well water of Serkkadu village. Where as, a hike of nitrate content was noticed up to 52 in Sipcot lake water.

The acceptable limit of NO_3 is 45-100. In excessive amounts it contributes to the illness of infant methemoglobinemia and to prevent this disorder a limit of 10mg dm^3 of nitrate nitrogen is imposed on drinking water (Agarwal, 2005). Nitrate represents the end product of oxidation of nitrogenous matter and its concentration is a presence of nitrification activities under progress in water (Singh, 2002). Nitrate is a prime plant nutrient and rising in its concentration might be expected to increase the eutrophication of waters

(Goher, 2002). Nitrate is one of the several inorganic pollutants contributed by nitrogenous fertilizers, human and animal wastes and industrial effluents through the biochemical activities of micro organisms (Agarwal, 2005). High concentration of nitrate in drinking water is toxic (Umavathi, et al., 2007).

Chloride content was in a range of 495 in lake water and 224 in bore well water of Sipcot town and 141 in well water and 24 in pond water of Serkkadu village. These values were found to be within the permissible limit in lake and bore well waters and very low in pond water of Serkkadu village (24) and moderately low in well water of Serkkadu village. Chloride level in water is a useful measure in water sample. High level is not known to be injurious to fresh water organism. The acceptable limit of chloride is 200-1000. Chloride becomes more toxic when they combined with other toxic substances such as cyanides, phenols and ammonia (Anonymous, 1976). The pollution from the industrial effluent will be a source of chloride concentration in the industrial area. High chlorides indicate organic pollution particularly from domestic sewage discharge of industrial effluents in surface water bodies, presence of sodium and calcium, chloride in natural water and higher salinity are responsible for higher concentration of chloride in the area. High concentration of chloride is association with increased level of pollution (Umavathi, et al., 2007).

Fluoride content was 0.2 in lake water and 0.6 in bore well water of Sipcot town and 0.4 in both the water of well and pond of Serkkadu village. It is generally noticed that fluoride content was found to be low in all the waters of Sipcot town and Serkkadu village. Among the waters analysed for fluoride content, very low values was noticed only in lake water of Sipcot town. Result of the present study indicated that the low level of fluoride content may cause dental fluorosis.

Fluoride is also an important chemical constituent of the water. It is generally present in small quantities. Its occurrence in higher amount in the order of 1mg/l is safe and effective in reducing the dental decay. These low levels of fluoride in the water samples may cause dental caries. The recommended permissible limit of fluoride is 1.0-1.5. The low concentration of fluoride below 0.5 mg/l cause dental caries. The low concentration of fluoride below 0.5 mg/l causes dental caries and when present in higher concentration it causes dental and skeletal fluorosis, mottling of teeth etc. (Agarwal, 2005; Prajapati and Raol, 2006). In the present study the fluoride content was very poor only at lake and bore well water of Sipcot town compared to the pond and well water of Serkkadu village as the fluoride content varies around 0.6 mg/l.

Gujarat is one of the most worst affected state amongst the 15 states of India reported as endemic for fluorosis (Jain, et al., 2000). Fluoride is often referred to as two-edged sward fluoride is very much essential for healthy growth of teeth. However, levels higher than 1.5 mg/l causes dental and skeletal fluorosis, decalcification, mineralization of tendencies, digestive and nervous disorders (Udhaya kumar, et al., 2006). Permissible limit of sulphate content is 200-400. Sulphate content was recorded to be 194 in lake water and 157 in bore well water of Sipcot town and 113 in well water and 21 in pond water of Serkkadu village. The results indicated that very low value was noticed only in pond water of Serkkadu area.

The presence of sulphate content in high salt water, sewage effluent, ceramic industry, etc., has been discussed in detail by many investigators (Saxena, 1987; Kaur, et al., 1996; Srinivas, et al., 2002). High concentrations of sulphate in the tanneries is also as a result of many auxiliary chemicals containing sodium sulphate as a byproduct of the manufacturer or chrome tanning powders containing high levels of sodium sulphate (Bosmic, et al., 2000). Phosphate content was noticed to be 0.09 in lake water and 0.05 in bore well water in Sipcot town and nil value and 0.18 in pond water in Serkkadu village. Generally, high content of PO_4 in the water may be attributed to the inlet of sewage from the drain of the city, which is rich in detergents and the detergents are the contribute factors for phosphates. The excessive phosphate concentration evokes an algal bloom in the water. Since, nitrate, nitrite and phosphate are nutrients for plankton growth, the water is rich in algal contents.

Tidy's content was noticed to be in a range of 0.3 in both the lake and bore well waters of Sipcot town and 0.1 in well water and 0.6 in pond water of Serkkadu village. Tidy's test is useful for testing organic pollution. The pollution may be due to sewage or industrial waste. When the organic load is high, the dissolved oxygen level in water decreased and affects the aquatic life. Sinha and Gaurav kumar Rastogi (2007) studied the physic-chemical characteristics of underground drinking water at Maradabad industrial area in India. This result indicated that the drinking water was found to be highly contaminated with reference to most of the parameters. Their study suggested that people dependent on this water are prone to health hazards of contaminated drinking water and some effective measures are urgently needed for water quality management.

In a report of Government of Tamilnadu it is stated that a water system head-work has to be virtually abandoned due to the high pollution level by tannery effluents. The water quality in and around Vaniyambadi, Ambur, Walajapet and Dindugal leave much to be desired. The need for tackling the tannery effluents on a serious footing has been raised from time to time (Tamil Nadu Leather Corporation, 1986). According to Dhulasi Birundha and Saradha (1993), the sewage of a tannery discharged after treatment of one ton hide is equivalent to public sewage of little town inhabited with 5000 people. The effect that leather tanning industry has on the open water bodies is very greater often quite detrimental. The presence of sodium sulphate, chromium and some tanning agents remove oxygen from water, give it an unpleasant odour and completely stop the self purification process in water bodies by killing the biota.

The tanning industry is a potential polluting industry of considerable importance. It is realized that the untreated waste waters when allowed to stagnate as is being done in most cases now, give rise to odour nuisance unsightly appearance besides creating ground water and surface water pollution. Ramaswamy and Sridharan (1998) studied the groundwater quality of Tamil Nadu in the premises of tanneries and observed that the total hardness, chlorides, calcium and magnesium were 3 to 28 times higher than the drinking water permissible limit prescribed by WHO (1993). The tannery effluent contains high concentration of metallic ions like chromium, potassium, sodium and magnesium and organic pollutants like oil, grease, tannin and lignin (Manonmani, et al., 1991). Khwaja, et al. (2001) discussed about the influence of wasted on the physico-chemical characteristics of the Ganga water and sediments vis-a-ris tannery at Kanpur (India) and revealed that increase values of parameters such as BOD, COD, chlorine and total solids could be due to the domestic wastes just as much as to the tannery wastes. However, chromium is one parameter, which can primarily be identified to originate from the tanneries.

Sponza (2003) stated that the waste water (industrial effluents) causes soil and ground water pollution besides causing a number of adverse effect on agricultural produce, animals and health of people living in the neighboring areas, since it contains waste chemicals and toxic heavy metals. An enormous increase in pollution due to discharge of effluents from industrial units into rivers and lakes is a matter of great concern in developing countries and developed countries which have water pollution problem due to industrial proliferation and modernization of agricultural technologies, are now on the ways of combating the problems through improved waste water treatment technique. But, developing countries with lack of technical known how, weak implementation of environmental policies and with limited financial resources are still facing problems.

The result of the present study indicated that the levels of most of the physic-chemical parameters like TDS (1.19), pH (7.24), Alkalinity (232) Magnesium (36) and iron content showed within the permissible limit in lake water of Sipcot town and a slight hike values were noticed in turbidity (16), total hardness (670), calcium (208) and nitrate (52) in the same water. Sulphate content was very lower in lake water. It is concluded from the result of increase of turbidity and alkalinity contents and lower content of fluoride present in the water that the water body is under deteriorative condition. In bore well water of Sipcot town the contents of TDS (948), Ec (1354), pH (7.03), alkalinity (244), total hardness (420) and calcium (128) were within the permissible limit. Although lower values of nitrate (25), Fluoride (0.6) and sulphate (157) noticed in the same water, this water may however be recommended for drinking purpose.

In Serkkadu village well water, contents of TDS (700), EC (1000), pH (7.01), alkalinity (208) and Total hardness (230) were found to be within permissible limit for drinking purpose. Where as, contents of calcium (62), magnesium (18), nitrate (26), fluoride (0.4) and sulphate (113) were found to be lower than the desirable limit. However, the fluctuation of low values noticed in terms of the above mentioned parameters in the same water, it is recommended to be suitable for drinking purposes. In pond water of Serkkadu village, most of the physico-chemical parameters like TDS, alkalinity, total hardness, magnesium, nitrate, chloride, fluoride and sulphate were seemed to be below the desirable limit and thus this water may not be suitable for drinking purpose. Among the result of four water bodies compared a hike values was noticed only in lake waters of Sipcot town and it may be due to the seepage by tannery, tannery effluent discharge from Sipcot tannery industries. It is recommended from the study that the release of tannery effluent discharge into the water body may be stopped to protect and sustaining the lake water more suitable for drinking purposes.

Acknowledgement: Authors are thankful to the authority of the Thiruvalluvar university, Vellore for proving facilities to carry out this work.

References:

1. Agarwal, A.K., 2005. Water pollution. APH Publication, New Delhi. pp. 1-384.
2. Akan, J.C., F.I. Abdul Rahman, V.O. Ogubuaja and K.D. Reuben, 2009. Study of the physicochemical pollutants in Kano Industrial Areas, Kano State, Nigeria. *Journal of Applied Sciences in Environmental Sanitation,* 4(2):89-102.
3. Anonymous, 1976. Quality Criteria for water. *U.S. Environmental Protection Agency, 440-9-76-023.*
4. APHA, 2000. Standard methods for the examination of water and waste water. American Public Health Association, Washington DC.
5. Bosmic, M., J.Bujan and R.P.Daniels, 2000. Regional program for pollution control in tanning industry US/RAS/92/120 in Southeast Asia, pp1-4.

6. Boyd, C.E., 1990. Water Quality in Ponds for Aquaculture. Auburn University (Ala). Agriculture Experiment Station, Alabama pp: 482.40.
7. Crawford, M.D., 1972. Hardness of Drinking and Cardiovascular diseases. *Proc.Nat.Soci.,* 31:347-353.
8. Dhulasi Birundha,V and K.Saradha, 1993. Environmental implications of leather tanneries. Ashish Publishing House, New Delhi. pp. 37-38.
9. Dicketson, B.R and G.L. Vingard, 1999. Effects of high levels of total dissolved solids in Walker Lake, Nevade, on survival and growth of *Lahontan cut throat* trout. *Transactions of the American Fisheries Society,* 128:507-515.
10. Dilkshit, V.P. and N. P Shukla, 1989. Waste recycling and pollution control in Indian tanneries. *Indian Journal of Environmental protection*, 9(3): 182-186.
11. Ecological Analyst Inc., 1981. The sources, chemistry, fate and effects of chromium in aquatic environment. Available from American Petroleum Institute, 2101 L St., N.W., Washington, DC 20037, pp: 207.13
12. Goher, M.E., 2002. Chemical studies on the precipitation and dissolution of some chemical elements in Lake Qarum, Ph.D., Thesis, Faculty of Science, Al-Azhar University. Cairo, Egypt.
13. Hatherill, J.R., 1981. A review of the mutagenicity of Chromium. *Drug Chem. Toxicol.,* 4 : 185-195.
14. Hujare, M.S., 2008. Seasonal variation of physico-chemical parameters in the perennial tank of Talsande, Maharashtra. *Ecotoxicology and Environmental Monitoring*, 18(3): 233-242.
15. Jain, C.K., M.K. Sharma, K.K.S. Bhatia and S.M.Seth, 2000. Ground water pollution endemic of fluorosis. *Poll. Res*.,19(4): 505-509.
16. Kadam, R.V., 1990. Treatment of tannery wastes. Indian Journal of Environmental
17. Kaur,H., S. S.Dhiloon, K. S.Bath and G. Mandar, 1996. Analysis of element polluting river Ghaggar in the region of Punjab. *Journal of Environment and Pollution,*2:65-68.
18. Khwaja, A.R., R. Singh and S.N. Tandon, 2001. Monitoring of Ganga water and sediments vis-à-vis tannery pollution at Kanpur (Inda): A case study. *Environ Monit. Assess*., 68(1): 19-35.54.
19. Langard, S and T. Norseth, 1979. Handbook on the toxicology of metals-Chromium. Eds., Friberg, L, G.F. Nordberg and U.B.Vouk. *Elsevier / North Holland Biomedical Press*. pp. 383-397.
20. Lark, B.S., R.K. Maharajan and T. P. Swalia, 2002. Determination of metals of Toxicological significance in sewage irrigated vegetable by using atomic absorption spectrometry and anodic stripping voltammetry. *Indian J.Environ. Hlth*., 44(2): 164-167.

21. Maiti, S.K., 2002. Hand Book of methods in environmental studies vol.1 water and waste water Analysis. ABD publishers Jaipur, India.
22. Manivasakam, N., 1984. Physico-chemical examination of water, sewage and industrial effluents. Pragati Prakasham, Meerut.
23. Manonmani, K., J. Wakumari, S. Pongaliappan and K. Swaminathan, 1991. Effects of tannery effluents on the quality of an irrigation canal water. *J.Ind.Pollu.Contl.*,7(2):87-91.
24. Mbuthia, B.M., A.H.S.E. Busaidy and S.B. Jonnalagadda. 1989. Environmental protection-Treatment of tannery effluents. Indian Journal of Environmental Protection 9(6): 401-406. Ministry of Environment & Forest. 2002. General Standards for Discharge of Environment Pollutants: Effluent. Gazette Notification of MoEF, May 1993. http://www.mangalorecity.gov.inlforms/se zJMSEZ % 2ODraft% 2OEIAI/ Mangalore % 2OSEZ, % 20oct. % 202007/Annexures/Annexure-VI.DOC.
25. NAS,1974. Medical and biological effects of environmental pollutants chromium. Recommended Dairy Dietary Allowances. 8th (Edn.), Food and Nutrition Board, National Academy Science, Division Medical Science, National Research Council, Washington DC, pp:55.
26. Pandhe, G.M., A. J. Dhembarke and R. P. Patil, 1995. The physic-chemical characteristic and quality of water from the Pravarra area, Ahmednagar district, Maharashtra. *Journal Aqua. Biol.,* 10 (1) : 43-43.
27. Pathe, P.P., Nandy, T. and S.N. Kaul, 1995. Properties of chromium sludge from chrome tan wastewater. Indian Journal of Environmental Protection 15(2): 81-87. Reddy, P.M. and N. Subba Rao. 2001. Effects of industrial effluents on the groundwater regime in Vishakapatnam. *Pollution Research*, 20(3): 383 - 386.
28. Post, M.A and P. G. Campbell, 1980. Lead chromate pigments – a literature survey on environmental and toxic effects. *U.S. Dep. Comm. Nat. Bur. Stand. Rep*. NBSIR 809 – 1974. pp. 38.
29. Praharaj, A.K., B.K. Mohanfa and N.K. Nanda, 2002. Studies on ground water quality of Rourkela, Orissa. *Poll.Res.,* 23 (2) : 399-402.
30. Prajapati, J.R and B.V. Raol, 2006. Physico-Chemical and bacteriological characteristics of drinking water samples of various railway stations located on western railway line from Kalel to Abu road, Gujarat. *Ecol.Env.and Cons.,* 12(3): 543-546.
31. Purohit, S.S and M.M. Saxena, 1990. Water life and pollution in Physical, Chemical and Biological characteristics of water. Agro Botanical Publishers (India), New Delhi. pp.19-29.

32. Ramaswamy, S and S. Sridharan, 1998. Physico-chemical characteristics of surface and ground waters in the tannery belt of Vaniyambadi and Ambur, North Arcot District, Tamil Nadu. *Poll.Res.,* 17 (2) : 141-147.
33. Rao, S.A., P. Rama Mohana, A. Rao and S. N. Rao, 1999. Study on degradation of water quality of Kolleru lake. Indian Journal of Environmental Health, 41(4): 300-311.
34. Robinson, R.A and R.H. Stokes, 1959. Electrolyte Solutions. 2nd Edition. Academic Press, New York, pp.466.
35. Sakthivel, M. and K. Sampath. 1990. Respiration, blood cells and food conversion efficiency in *Cyprinus carpio* exposed to sublethal concentrations of tannery effluents. In: P.B. Deshmukh, AT. Mathai, R.C. Dalela and K.S. Pillai (Eds.), *Environment and Experimental toxicology*, Jai Research Foundation, Valvada, pp. 139-150.
36. Saravanan, P., A. Saravanan, N. Elangovan and P.T. Kalaichelvan, 1999. Decolourization of tannery effluent by Flavobacterium sp. EK 1. *Indian Journal of Environmental Protection*, 19(1): 19- 24.
37. Shukla, A and N. P. Shukla, 1994. Tannery and electroplating effluent treatment- Precipitation of Chromium and Nickel. *Indian Journal of Environmental Protection*, 14 (6): 457-461.
38. Singh, A.K., 2002. Quality Assessment of surface and subsurface water of Damodar River Basin. *Indian J Environ. Hlth*., 44(1): 41-49.42.
39. Sinha, D.K and Gaurav Kumar Rastogi, 2007. Physico-chemical characteristics of underground drinking water at Moradabad. *Poll.Res.,* 26(3):345-349.
40. Sponza, D.T., 2003. Application of toxicity tests into discharges of the pulp-paper-industry in Turkey. *Ecotoxicology and Environmental Safety,* 54: 74-86.
41. Steven, J.D., L.J.Davies, E.K.Stanley, R. A.Abbott, M.Thnad, L.Bidstrup and J. J. Jaworski, 1976. Effects of Chromium in the Canadian environment. *Nat.Res. Coun,* Canada, NRCC No. 15017. pp. 168. Avail from publication, NRCC/CNRC, Ottowa, Canada, KIAORb.
42. Synder, A.D., D.G.DeAngelis, E.C.Eimutus, D.M.Haile, J.C.Ochsner, R.B.Reznik and H.D.Troy, 1977. Environmental monitoring near industrial sites chromium plus Appendices U.S. *Environ. Protection Agency Rep.,* 560/6–77 – 016, 56. pp.
43. Tamil Nadu Leather Corporation,1986. Common effluent treatment projects for tanneries in Tamil Nadu, pp.3-4
44. Taylor, F.G and P.D.Parr, 1978. Distribution of Chromium in vegetation and small mammals adjacent to cooling towers. *J.Tenn. Acad. Sci.,* 53 : 87-91.

45. Tiwari. D.R., 1999. Some thoughtfor water resource management for Cihhatarpur city, India. *Ecol.Env. and Cons*., 5(3): 289-291.
46. Towill, L.E., C.R.Shriner, J.S.Drury, A.S.Hammons and J.W.Holleman, 1978. Reviews of the environmental effects of pollutants : III Chromium. U.S. *Environ.Protection Agency Rep.*, 600/1-78-023. pp. 287.
47. Trivedy, R.K and T.R. Chandrasekar, 1999. Sediment characteristics of fresh water bodies of Mangalore, Karnatak. *N.Ecol. Biol*., 11(1): 59-64.
48. Trivedy, R.K and P.K. Goel, 1988. An Introduction to Air Pollution, *Techno. Science Publ*., Jaipur. pp. 216.
49. Udhayakumar, J., D. Natarajan, K.Srinivasan, C. Mohanasundari and M. Balasubramani, 2006. Correlations among water quality parameters for ground waters in Chidambaram town, *Ind.J.Environ.Prot.,* 18 (10) : 734-738.
50. Umavathi, S., Longakumar, K and Subhashini, 2007. Studies on the nutrient content of Sulur pond in Coimbatore, Tamil Nadu, *Journal of ecology and environmental conservation*, 13(5), pp 501-504. 32.
51. Vijayaram, K., L.James, P. Geraldine, T.S. Varadarajan, K. Periaswamy and Loganathan, 1989. Pollution studies of ground water in Sempattu, Tiruchirappalli., *India.J.Env.Prot.,* 9(10): 746-750.
52. Welcomme, R.L., 1985. River fisheries. FAO Fisheries Technical Paper, (262): 330.
53. Wetzel, R.G., 1983. Limnology. 2nd edition, ICMR Saunders college publication, U.S.A, 767.
54. WHO (World Health Organization), 1984. Guidelines for drinking water quality. World Health Organizations, Geneva.
55. WHO, 1993. Guidelines for drinking water quality. World Health Organization, Geneva.
56. Yuxing, W. and Y. Jian, 1999. Decolorization of synthetic dyes and wastewater from textile. Water Research, 33(16): 3512 - 3520.

***

Sivachandrabose, K/S.Samundeeswari/C.Mahalakshmi
Department of Zoology/Thiruvalluvar
University/Serkkadu/Vellore/Tamilnadu