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Research Article

COMPARISON OF PHYSICO-CHEMICAL ANALYSIS BETWEEN ESTUARY AND GROUNDWATER OF CHENNAI, TAMIL NADU, INDIA

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A B S T R A C T

The present study was carried out to determine the physico-chemical characteristics and heavy metals in Ennore - back water and Manali - CPCL (Chennai Petroleum Corporation Limited) for groundwater during six month (January 2017-June 2017). The water quality parameters were then compared with the quality standards. The water quality standards are vital for marine biota. Regular monitoring and assessment of these parameters will therefore maintain the dignity and social value of Ennore creek. The increased prominence of the petroleum industry in Manali has given rise to a concomitant upsurge of ecological disturbances together with groundwater pollution. Samples were collected monthly in the morning during low tide in Ennore and in the evening at CPCL to determine the important physico chemical parameters viz. turbidity, Electrical Conductivity (EC), Total Solids (TS), Total Dissolved Solids (TDS), salinity, pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), calcium, chloride, sodium, potassium and nutrients like nitrate, nitrite, silicate and phosphate. It is attributed due to the constricted outlet of the creek and large scale inflow of pollutants due to precipitation. Further the factor analysis indicates that the parameters responsible for water quality variations are mainly related to the influence of municipal sewage, agricultural effluents and industrial waste water in back water and in ground water as well.

INTRODUCTION

Water is an invaluable gift of nature. It evaporates from land and water bodies are also produced by all forms of life on earth. A lake is a low-lying part of the earth's surface. Almost half of the world's lakes are degraded, depleted and contaminated mainly by human activities. Life in an aquatic environment is largely governed by physico-chemical characteristics and their stability. Most of the forms exist only within narrow range of conditions. The changes in the water quality may be essential for the existence of some organisms while for others such changes may not be desirable (Diaz pardo *et al.*, 2006). Industrialization and urbanization of the coastal region often lead to decrease in coastal resource and destruction of natural defense structures (Zhao *et al.*, 2011). Ennore is located on the northeast coast of Chennai and Ennore coast consists of alluvial tracts, beach dunes, tidal flats and creek in the eastern part. Ennore comprises of lagoons, with salt marshes and backwaters, which are submerged under water during high tide and form an arm of the sea opening in to the Bay of Bengal (Kannan *et al.*, 2007). The progressing of large industries in nearby areas has become a threat to the health of estuarine and coastal water environment (Mukunda Kesari Khadanga *et al.*, 2012). High degree of industrialization and urbanization has led to a strong risk of heavy metal contamination in the coastal ecosystems in tropical and subtropical countries. It can also affect the function of heavy metal contaminants in soil and sediment. Evaluating the impacts of land use change is important to protect ecosystem resources (Charlesworth and Foster, 1999). In recent years, increasing industrialization, urbanization and developmental activities with the population explosion leads to generation of large amount of waste water from domestic, commercial, industrial and other sources. Industrial waste waters directly discharged in to river, lake, nallas, and khadi and created new pollution Problem (CEPI, 2010). Groundwater is one of earth's most vital renewable and widely distributed resources as well as an important source of water supply throughout the world. Its use in irrigation, industries and domestic usage continues to increase where perennial surface water sources are absent. The quality of groundwater is more significant as the case of quantity for all purposes (Mariappan *et al.*, 2005). The pollution of groundwater is of major concern, firstly because of increasing utilization for human needs and secondly because of the ill effects of the increased industrial activity (Jain *et al.*, 2006). Improper waste disposal and unscientific anthropogenic practices over the decades have adversely affected the surface and groundwater quality (Dash *et al.*, 2006). Industries

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consume large quantities of water, consequently depleting the available resources and at the same time produce wastewater containing organic chemicals and toxic heavy metals depending upon the various chemicals used in the industries (Vaishnav *et al.*, 2007). Tannery is an oldest and fastest growing industry in India. There are about 2161 tanneries which process 500,000 tons of hides and 314 kg of skins annually. These industries spread mostly across Tamilnadu, West Bengal, Uttar pradesh, Andhra pradesh, Karnataka, Maharashtra, Rajasthan, Punjab and Kanpur (Vijayanand and Hemapriya, 2014). In Tamilnadu alone there are about 1120 tanneries located in Vellore, Ranipet, Trichy, Dindugal, Erode and Chennai (Noorjahan, 2014). In Chennai, the Manali Refinery has a capacity of 9.5 MMTPA and is one of the most complex refineries in India with Fuel, Lube, Wax and Petrochemical feed stocks production facilities. Contamination of air, soils and groundwater by the release of fuels, oils and halogenated solvents has posed serious environmental problems in this region (Arul Antony *et al.*, 2008). To preserve the high quality of the environment new concept so called "*Cleaner Production*" for waste minimization is being introduced, technology designed to prevent waste emission at the source of generation itself (Uwadiae *et al* 2011). Hence Effluent Treatment Plants or ETPs are used by leading companies in the pharmaceutical and chemical industry to purify water and remove any toxic and non effluent-treatment-plant toxic materials or chemicals from it. These plants are used by all companies for environment protection (Kavitha *et al*., 2012).

MATERIALS AND METHODS

Study Area

Ennore back water (13°13'54.48" N, 80°19' 26.60" E) (Fig. 1) is located in the northeast coast of metropolitan Chennai city, India. The total area of the creek is 2.25 sq km and is nearly 400 m wide. Its channels connect it to the Pulicat Lake to the north and to the Kortalaiyar River in the south. Araniar and Kortalaiyar are the two seasonal rivers which transverse Ennore back water. The Kortalaiyar River drains into the back waters and ultimately reaches the Bay of Bengal through the ennore creek. They confluence in brackish water bodies, mangroves situated at the fringes of ennore creek and Buckingham canal.

Chennai Petroleum Corporation Limited (CPCL) **(Fig. 2)** is an Indian state-owned oil and gas corporation headquartered in Chennai, India. It was formed as a joint venture in 1965 between the Government of India (GOI), AMOCO and National Iranian Oil Company (NIOC), having a shareholding in the ratio 74%: 13%: 13% respectively. From the grassroots stage CPCL Refinery was set up with an installed capacity of 2.5 million tonnes per annum (MMTPA) in a record time of 27 months at a cost of Rs. 430 million without any time or cost overrun. The Manali Refinery in Chennai has a capacity of 10.5 MMTPA and is one of the most complex refineries in India with fuel, lube, wax and petrochemical feed stocks production facilities. CPCL plays the role of a mother industry supplying feed stocks to the neighbouring industries in Manali. CPCL's products are marketed through IOCL. CPCL's products are mostly consumed domestically except naphtha, fuel oil and lubes which are partly exported. It has also made pioneering efforts in the field of energy and water conservation by setting up a wind farm and sewage reclamation and sea water desalination plants. The production line has been affected multiple times due to nature's adversities in form of drought and excessive rains.

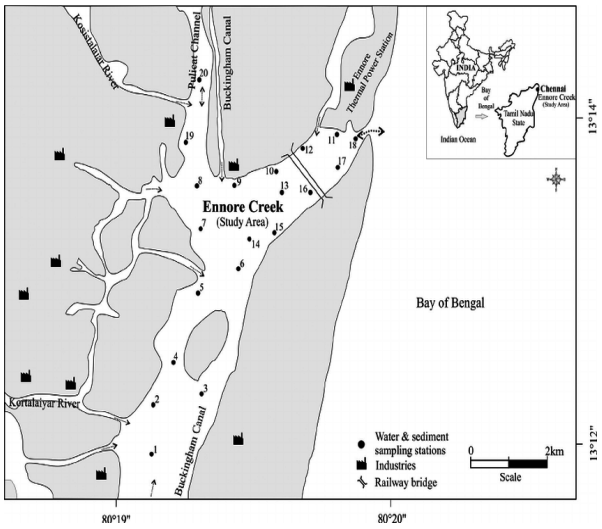

Figure 1 Ennore creek

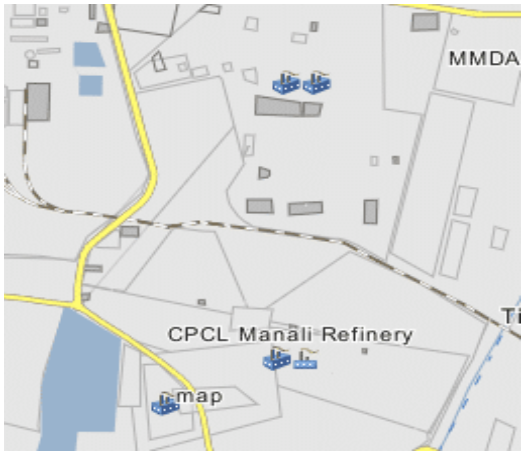

Figure 2 Manali CPCL

Sample collection

Water samples were collected in polyethylene bottles, closed bottle was dipped in the creek at a depth of 0.5 to 0.7 m, and then the bottle was opened inside and closed again to bring it out at the surface. Same procedure was followed for the ground water sample also. The water temperature and pH were noted immediately on the spot after collection, whereas the remaining parameters were analyzed in triplicate and was stored at 4ºC.

Determination of physico-chemical parameters

The effluent samples were analyzed for their physicochemical properties such as appearance, odour, turbidity, total solids, total suspended solids, total dissolved solids, electrical conductivity, pH, alkalinity pH, total hardness, calcium, magnesium, sodium, potassium, iron, manganese, free ammonia, nitrite, nitrate, chloride, fluoride, sulphate, phosphate, tidy's test (as O), silicate, chemical oxygen demand (COD) and biological oxygen demand (BOD) analyzed.

RESULTS

All through different monsoons has an influence on pH, salinity, total hardness and total alkalinity with respect to tidal

and riverine influences. In the present study, the temperature varied from a minimum of 26°C to a maximum of 28°C in both places recorded during the post monsoon season and minimum of 30°C to a maximum of 31.7°C in both places during summer. The temperature variation is one of the factors in the coastal and estuarine system, which may influence the physico-chemical characteristics and also the distribution and abundance of flora and fauna. Higher temperature values recorded in the summer months are expected since heat from sunlight. Similarly, the drop in water temperature in the rainy season months is attributable to heavy rainfall.

Physical parameters in creek and groundwater effluents

1. Appearance of water samples are colourless and clear in ennore creek during the post monsoon season and summer whereas turbid in ground water in manali and odourless in both seasons.
2. The turbidity range in creek was lower (3.8-6.81 NTU in post monsoon and 5-5.6 NTU in summer) and in groundwater was higher (26 NTU in post monsoon and 28 NTU in summer).
3. TSS (Total Suspended Solids) value was lower in creek (4 mg/l in post monsoon and 6 mg/l in summer) and higher in groundwater (14 mg/l in post monsoon and 84 mg/l in summer).
4. TDS (Total Dissolved Solids) values were higher in creek (25398 mg/l in post monsoon and 26266 mg/l in summer) and lower in groundwater (1946 mg/l in post monsoon and 1943 mg/l in summer).
5. TS (Total Solids) values were higher in creek (25402 mg/l in post monsoon and 26085 mg/l in summer) and lower in groundwater (2780 mg/l in post monsoon and 2749 mg/l in summer).
6. EC (Electrical Conductivity) values were higher in creek (36204 mg/l in post monsoon and 34729 mg/l in summer) and lower in groundwater (2780 mg/l in post monsoon and 2900 mg/l in summer) as showed in TABLE I.

Chemical parameters in creek and groundwater effluents

1. pH in creek was 7.75 in post monsoon and 7.7 in summer and in groundwater were 7.82 in post monsoon and 7.76 in summer which showed alkalinity nature.
2. TA (Total Alkalinity) was lower in creek (148 mg/l in post monsoon and 159.9 mg/l in summer) and higher in groundwater (456 mg/l in post monsoon and 516 in summer).
3. TH (Total Hardness) values were higher in creek (6400 mg/l in post monsoon and 4748.3 mg/l in summer) and lower values of TH were recorded in groundwater (590 mg/l in post monsoon and 1320 mg/l in summer).
4. Calcium (Ca) values in creek were higher (1520 mg/l in post monsoon and 1619.6 mg/l in summer) than in groundwater (156 mg/l in post monsoon and 259 mg/l in summer) were recorded.
5. Magnesium (Mg) values in creek were higher (624 mg/l in post monsoon and 856 mg/l in summer) than in groundwater (48 mg/l in post monsoon and 102 mg/l in summer) were recorded.
6. Sodium (Na) values in creek were higher (5700 mg/l in post monsoon and 4789 mg/l in summer) than in groundwater (340 mg/l in post monsoon and 1120 mg/l in summer) were recorded.
7. Potassium (K) values in creek were higher (400 mg/l in post monsoon and 515 mg/l in summer) than in groundwater (20 mg/l in post monsoon and 240 mg/l in summer) were recorded.
8. Iron (Fe) values in creek were higher (0.73 mg/l in post monsoon and 4.8 mg/l in summer) than in groundwater (0.52 mg/l in post monsoon and 10.5 mg/l in summer) were recorded.
9. Free Ammonia (NH_3) values in creek were higher (9.98 mg/l in post monsoon and 10.5 mg/l in summer) than in groundwater (6.98 mg/l in post monsoon and 35 mg/l in summer) were recorded.
10. Nitrate (NO_3) values in creek were lower (0.52 mg/l in post monsoon and 0.21 mg/l in summer) than in groundwater (zero value in post monsoon and 1.3 mg/l in summer) were recorded.
11. Nitrite (NO_2) values in creek were lower (4 mg/l in post monsoon and 4.9 mg/l in summer) than in groundwater (7 mg/l in post monsoon and 11 mg/l in summer) were recorded.
12. Chloride (Cl) values in creek were higher (11691 mg/l in post monsoon and 13515 mg/l in summer) than in groundwater (406 mg/l in post monsoon and 84 mg/l in summer) were recorded.
13. Fluoride (F) values in creek were lower (0.13 mg/l in post monsoon and 0.11 mg/l in summer) than in groundwater (0.49 mg/l in post monsoon and 0.3 mg/l in summer) were recorded.
14. Sulphate (SO_4) values in creek were higher (1613 mg/l in post monsoon and 1875 mg/l in summer) than in groundwater (298 mg/l in post monsoon and 1056 mg/l in summer) were recorded.
15. Phosphate (PO_4) values in creek were higher (0.12 mg/l in post monsoon and 1.42 mg/l in summer) than in groundwater (0.86 mg/l in post monsoon and 1.5 mg/l in summer) were recorded.

Table I Physical Parameters In Study Area - Ennore And Manali

S. No	Physical Examination	Ennore creek		Manali – CPCL	
		Post monsoon	Summer	Post monsoon	Summer
	Temperature (ºC)	26°C to 28°C	30°C to 31.7°C	26°C to 28°C	30°C to 31.7°C
1.	Appearance	Colourless & clear	Colourless & clear	Turbid	Turbid
2.	Odour	None	None	None	None
3.	Turbidity (NTU)	3.8-6.1	5-5.6	26	28
4.	Total Suspended Solids (TSS) mg/l	4	6	14	84
5.	Total Dissolved Solids (TDS) mg/l	25398	26266	1946	1943
6.	Total Solids (TS) mg/l	25402	26085	2780	2749
7.	Electrical Conductivity (EC) (micro mho/cm)	36203	34729	2780	2900
8.					

16. Tidy's test (O) values in creek were higher (14.2 mg/l in post monsoon and 16 mg/l in summer) than in groundwater (8.6 mg/l in post monsoon and 15 mg/l in summer) were recorded.
17. Silicate (SiO_2) values in creek were higher (24.11 mg/l in post monsoon and 23 mg/l in summer) than in

groundwater (15.06 mg/l in post monsoon and 23.1 mg/l in summer) were recorded.

18. COD (Chemical Oxygen Demand) values were higher in creek (158 mg/l in post monsoon and 176 mg/l in summer) and lower values of COD were recorded in groundwater (90 mg/l in post monsoon and 170 mg/l in summer).
19. BOD (Biochemical Oxygen Demand) values were lower in creek (54 mg/l in post monsoon and 50 mg/l in summer) and lower values of BOD were recorded in groundwater (32 mg/l in post monsoon and 167 mg/l in summer) as mentioned in TABLE II.

Table II Chemical Parameters in Study Area- Ennore And Manali

S. No	Chemical Examination	Ennore creek		Manali – CPCL	
		Post monsoon	Summer	Post monsoon	Summer
1.	pH	7.75	7.7	7.82	7.76
2.	Total Alkalinity ($CaCO_3$)	148	160	456	516
3.	mg/l	6400	4748	590	1320
4.	Total Hardness ($CaCO_3$) mg/l	1520	1620	156	259
5.	Calcium (Ca) mg/l	624	856	48	102
6.	Magnesium (Mg) mg/l	5700	4789	340	1120
7.	Sodium (Na) mg/l	400	515	20	240
8.	Potassium (K) mg/l	0.73	1.5	0.52	4.8
9.	Iron (Fe) mg/l	0	0	0	0
10.	Manganese (Mn) mg/l	9.98	10.5	6.98	35
11.	Free Ammonia (NH_3) mg/l	0.52	0.21	0	1.3
12.	Nitrite (NO_2) mg/l	4	5	7	11
13.	Nitrate (NO_3) mg/l	11691	13515	406	842
14.	Chloride (Cl) mg/l	0.13	0.11	0.49	0.3
15.	Flouride (F) mg/l	1613	1875	298	1056
16.	Sulphate (SO_4) mg/l	0.12	1.42	0.86	1.5
17.	Phosphate (PO_4) mg/l	14.2	16	8.6	15
18.	Tidy's test (O) mg/l	24.11	23	15.06	23.1
19.	Silicate (SiO_2)	158	176	90	170
20.	COD mg/l	54	50	32	167
	BOD mg/l				

DISCUSSION

In the present investigation, the physicochemical parameters of the effluents were analyzed (TABLE I and II). The result of the study revealed that colour of the effluents were colourless and clear in ennore creek whereas turbid in ground water in manali. Similar results were reported by Noorjahan (2014) for the tannery effluent. A large number of pollutants can impart colour, taste and odour to the receiving water, thereby making them unaesthetic and unfit for domestic consumption (Jamal *et al.,* 2011). The colour of the effluent might be due to the presence of biodegradable and non-biodegradable high molecular weight organic compounds and high amount of inorganic chemicals like sodium and chromium used during the processing and the odour may be due to putrefaction of the organic residues from the processed skin and hides (Smrithi and Usha, 2012). The composition of solids present in tannery effluent mainly depends upon the nature and quality of hides and skins processed in the tannery (Islam *et al.,* 2014). High level of total suspended solids present in the tannery waste water could be ascribed to their accumulation during the processing of finished leather (Deepa *et al.,* 2011). Presence of Total Suspended Solids (TSS) in water leads to turbidity resulting in poor photosynthetic activity in the aquatic system (Goel, 2000). The turbidity of the effluent might be due to the discharge of high concentration of carbonates, bicarbonates and chlorides of calcium, magnesium and sodium (Chakrapani, 2005). Total Dissolved Solids (TDS) is the measure of total inorganic salts and other substances that are dissolved in water (Nasrullah *et al.* 2006). High levels of TDS are aesthetically unsatisfactory and may also produce distress in human and livestock (Patel *et al.,* 2009). Total dissolved solids are mainly due to carbonates, bicarbonates, chlorides, sulphates, phosphates, nitrates, nitrogen, calcium, sodium, potassium and iron (Kannan *et al.,* 2009). The presence of high level of TSS and TDS may be due to the insoluble organic and inorganic present in the effluent (Nagarajan *et al.,* 2005). The higher electrical conductivity alters the chelating properties of water bodies and creates an imbalance of free metal availability for flora and fauna (Akan *et al.,* 2008). It may be due to high concentration of acid base and salt in the effluent (Jamal *et al.,* 2011).

Hemamalini and Sneha (2014) reported that the Discharge of effluent with alkaline pH into ponds, rivers, etc. for irrigation may be detrimental to aquatic biota such as zooplankton and fishes. The alkalinity of natural water is due to the salt of carbonates, bicarbonates, borates, silicates and phosphates along with hydroxyl ions in the free state (Islam *et al.,* 2014). In the study conducted by Napit (2014), the level of O by Tidy s test was reported within the permissible limit. Dissolved silica exists as monosilicic acid at low concentrations. As silica concentration increases, polysilicic acid begins to form. Once formed, it will grow to spherical colloidal silica particles or to large polymerized silica networks depending on pH, temperature, silica concentration and TDS (Bergna and Roberts, 2006). Chloride is introduced into tannery effluents as sodium chloride usually on account of the large quantities of common salt used in hide and skin preservation or the pickling process. Being highly soluble and stable, they are unaffected by effluent treatment and nature, thus remaining as a burden on the environment. Chloride inhibits the growth of plants, bacteria and fish in surface waters; high levels can lead to breakdown in cell structure. If the water is used for irrigation purposes, surface salinity increases through evaporation and crop yields fall. When flushed from the soil by rain, chlorides re enter the ecosystem and may ultimately end up in the ground water (Bosnic *et al.,* 2000). Calcium, magnesium, carbonates, bicarbonates, sulphates, chlorides, nitrates, organic matter together associate and form hardness of water (Salim *et al.,* 2013). Determination of Biological Oxygen Demand (BOD) is one of the important parameters used in water pollution to evaluate the impact of waste waters on receiving water bodies (Arasappan Sugasini and Kalyanaraman Rajagopal, 2015). Increase in BOD which is a reflection of microbial oxygen demand leads to depletion of Dissolved Oxygen (DO) which may cause hypoxia conditions with consequent adverse effects on aquatic biota (Jerin, 2011). Chemical Oxygen Demand (COD) test is the best method for organic matter estimation and rapid test for the determination of total oxygen demand by organic matter present in the sample (Arasappan Sugasini and Kalyanaraman Rajagopal, 2015). Increased amount of COD may be due to high amount of organic compounds which are not affected by the bacterial decomposition (Nagarajan and Ramachandramoorthy, 2002). Sharma and Malaviya (2013) also reported alkaline pH, high colour intensity, and high values of physicochemical parameters such as COD, TDS, TSS, chloride, sodium and nitrate of waste water. Several components in effluent contain nitrogen as part of their chemical structure. The most common chemicals are ammonia (from deliming materials) and the

nitrogen contained in proteinaceous materials (from liming/unhairing operations). High level of N2 in aquatic system leads to eutrophication (Bosnic *et al.*, 2000). Estuaries, the important contributors of fisheries in India, suffer from severe loss of fish production due to increased industrialization and urbanization along the coastal zone by continuous discharge of industrial effluents (Padmini *et al.*, 2007). Temperature is an important limiting factor, which regulates the biogeochemical activities in the aquatic environment. Generally water temperature correspond with air temperature indicating that the samples collected from shallow zones has a direct relevance with air temperature, shallow water reacts quickly with changes in atmospheric temperature (Rajkumar *et al.*, 2011). Temperature controls behavioral characteristics of organisms, solubility of gases and salts in water (Vincy *et.al.*, 2012). pH of water is an important environmental factor, the fluctuation of pH is linked with chemical changes, species composition and life processes. It is generally considered as an index for suitability of the environment (Rani *et al.*, 2012). Highest EC was recorded in high may be due to the Industrial Effluent because it contained many chemicals, salts and dissolved solids (Mishra and Saksena, 1993). Higher EC indicates the presence of high amount of dissolved inorganic substances in ionized form (Murhekar, 2011). The alkalinity of water is its capacity to neutralize acids. Alkalinity of water is a measure of weak acid present in it and of the cations balanced against them (Singh *et al.*, 2010). Total alkalinity depends on the concentration of the substance which would raise the pH of the water. High levels of alkalinity indicate the presence of strongly alkaline industrial waste water and sewage in the estuary (Safari *et al.*, 2012). High values of hardness are probably due to the regular addition of large quantities of detergents used by the nearby residential localities into lakes that drain into estuaries (Krishna *et al*., 2017).

Variation in dissolved oxygen content showed that that the temperature and salinity affect the dissolution of oxygen (Vijayakumar *et al.*, 2000). High BOD might be due to the decomposition of organic matter and decay of vegetation in river which mixed with sea water during rainy season and the chemical oxygen demand (COD) was higher in the rainy season than the dry season. Since COD has a direct relationship with BOD, the reasons adduced for BOD being higher in the rainy season are also responsible for COD. The COD values of the industrial effluents were observed to be high and therefore contributing to the pollution of the river and calcium value was found higher during post monsoon and lower value during monsoon season. The value of chloride was found higher which might be due to high salinity, tidal flow and low fresh water mixing and low value was found during monsoon season due to rain and more mixing of fresh water from river. Fluctuation in chloride is not related to pyrite oxidation, but due to the tidal and seasonal changes in the river. Higher value of sodium due to high salinity and low value due to rain and flow of river water (Gadhia *et al*., 2012). The higher concentration of nitrate could be attributed due to the variation in phytoplankton, excretion, and oxidation of ammonia and reduction of nitrate and by recycling of nitrogen and also due to bacterial decomposition of planktonic detritus present in the environment The recorded low nitrite values during summer season may be due to less freshwater inflow and high salinity (Govindasamy *et al.*, 2000 and Kannan *et al*., 1996). Further, the increased nitrates level was due to freshwater inflow, mangrove leaves (litterfall) decomposition and terrestrial runoff (Karuppasamy *et al*., 2000 and Santhanam *et al*., 2003). The recorded high concentration of phosphates during monsoon season might possibly be due to the intrusion of upwelling seawater into the creek, which in turn increased the level of phosphate (Nair *et al*., 1984). Low summer values could be attributed to the limited flow of freshwater, high salinity and utilization of phosphate by phytoplankton (Senthilkumar *et al*., 2002). The phosphate content during winter month was higher and lower in summer months (Krishna *et al*., 2011). Ammonia is present in terrestrial and aquatic environments. Plants and animals excrete ammonia; it is produced by the decomposition of organisms and by the activity of microorganisms (Prosser *et al*., 2002). Silicate is associated with land-based resources with concentration higher in rainy season than in dry season (Wu *et al*., 2007). The physicochemical properties and heavy metals concentration of the effluent varies depending on the process of tanning adopted in various industries (Vidya and Usha, 2007). The crops and vegetables, which when consumed cause serious health hazards to the consumer (Mohanta *et al.*, 2010).

CONCLUSION

The analysis of physicochemical parameters of effluent for the period of January to June 2017 confirms that the waste water released from the industry has higher concentration of EC, BOD, COD, TSS, TDS etc. From the result of physicochemical analysis of effluents, it has been concluded that EC, TDS, chlorides, sulphates, BOD, COD, Sodium and Calcium etc. are very high in concentration. Heavy metal concentration also shows great variability. The effluents without proper treatment should not be discharged into the nearby water body or soil which leads to environmental problems and affect the flora and fauna of that particular habitat.

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