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Research Paper

SEASONAL VARIATIONS IN PHYSICO-CHEMICAL PARAMETERS OF UPPANAR RIVER WATER, CUDDALORE DISTRICT, TAMIL NADU, INDIA

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The present study was determination of physico-chemical variations of water in 11 stations along the Uppanar River, Cuddalore district of Tamil Nadu, India. Physico - chemical variable in water samples collected along Uppanar River during summer and winter is analyzed for Temperature (t), Electrical conductivity (Ec), pH, Calcium, Magnesium, Sodium, Potassium, Chloride, Sulphate and Nutrients like Nitrate, and Phosphates. The noted increase of temperature and Ec is found in summer, whereas other parameters are more during winter. The study infers that the effluent flow, sewage drainage, catchment runoff and the tides are having great influence on the changes in physico-chemical parameters and fluctuation macronutrient. The degradation of our river ecosystem and water quality of various rivers all over the country is evaluated to understand the present status of Uppanar River.

Keywords: Physico-chemical parameters, Uppanar River, Water, Cuddalore

INTRODUCTION

In recent times, more attention is being paid to estuarine geology owing to the significant role played by the estuaries in the coastal and marine sedimentary system. Whereas sediments brought by rivers are being transported to the sea and surrounding environment. The interactions of so many variables and differences in the physico-chemical, biological, meteorological and sedimentological conditions that exist in the different regions of our country make this problem more complicated. Hence, it is necessary to study each estuary individually. In recent year, several reports are published on the physicochemical features of Indian estuaries (Murugan and Ayyakkannu, 1991; Govindasamy *et al.,* 2000; Balasubramanian and Kannan, 2005; Paramasivam and Kannan, 2005; Rajaram *et al.,* 2005; Ajithkumar *et al.,* 2006; Sridhar *et al.*, 2006; Asha and Diwakar, 2007). Water is the most significant and abundant substance on earth's surface, which covers 75%. Water is necessary for metabolism and catabolism activity, and the importance of water cannot be over emphasized. It is difficult to understand the biological phenomenon clearly because the chemistry of water revels much about the metabolism of the ecosystem (Basavaraja Simpi *et al*., 2011). It also

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serves agricultural, industrial and the environmental conditions such as topography, water movement, stratification, oxygen, temperature and nutrients characterizing particular water mass in addition the composition of its biota (Karande, 1991). Distributions of nutrients are mainly based on the season, tidal conditions and freshwater flow from land source. The comprehensive ways in which man affect aquatic ecosystems is through altering nutrient dynamics (Boostman and Hecky, 1993). Water quality characteristic of aquatic environment arise from a multitude of physical, chemical and biological interactions (Deuzane, 1979; Dee, 1989). Through runoff nitrogen and phosphorus as nutrients for the growth of aquatic plants enter into lake water or estuary and also depends on the concentration limits of nitrogen and phosphorus elements. The use of rivers for various purposes has ended in with pollution, for net outcomes of pollution, water quality data is needed to integrate the chemical and biological information to evaluate the potential impacts to the freshwater ecosystem.

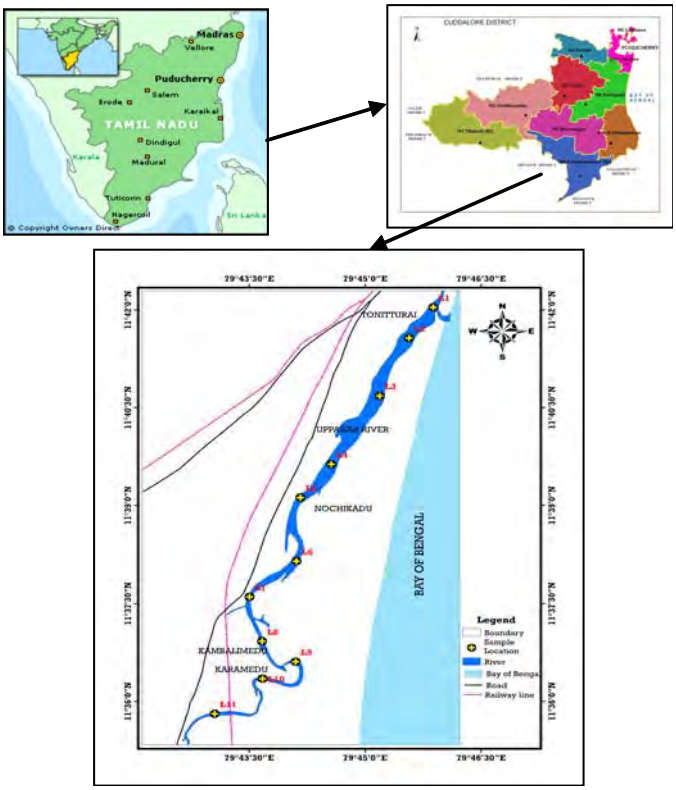
MATERIALS AND METHODS

The base map is prepared by using the SOI Toposheet 58/M of 1:50,000 scale and sampling work is done for further analytical work during summer and winter season. Eleven spots were identified, and surface water samples were collected. Water sample from each point is collected and stored in clean rinsed polyethylene bottles. The physical parameters like pH, EC and temperature of water samples are monitored during the field survey. A pre calibrated portable multi parameter kit PC TESTER 35 (Multi-parameter) was used for measuring pH, Electrical Conductivity (EC) and Temperature. Water samples were analyzed using standard procedures (APHA, 1998, Ramanathan, 1992; Ramesh and Anbu, 1996). Calcium, magnesium, and chloride were determined by a titrimetric method. Sodium and potassium were analysed through flame photometry (ELICO CL 378). Sulphate, phosphate, and Nitrate were determined by spectrophotometer (HACH DR6000).

STUDY AREA

The river flows parallel to the south coast of Cuddalore town and many streams of sewages and effluents of industries reach the coast through river. In this district, many small and large-scale productions are established in SIPCOT industrial estate on the western banks of Uppanar River (Figure 1). In the study area next to this coastal zone, industrial activities have started since from 1980's. The industries found in the study area are chemicals, beverage manufacturing, tanneries, soap, oil, paint production, glass pigments, PVC manufacturing, paper and metal processing plants. Other than the industrial development, Cuddalore harbours where mechanized fishing boats are operated in the coastal stretch are found in the estuarine part of Uppanar River. Another source of pollutants is from the nearby Thermal Power Plant, where Ash's water is discharged into the channel of Perumal Lake. The combined influence of pollutants disturbs the ecosystem, which is due to developmental and unplanned discharge of sewage and effluents from the industrial zone for decades that deteriorated since the quality of river and coastal water of Uppanar river of Cuddalore district.

Figure 1: Study Area Location Map



RESULTS AND DISCUSSION

The results obtained from the water samples of Uppanar River for physicochemical parameters such as Water Temperature (ºC), pH, Electrical conductivity (µS/cm), Calcium (mg/l), Magnesium (mg/L), Sodium (mg/L), Potassium (mg/L), Chloride (mg/L), Sulphate (mg/L), Nitrate (mg/L) and Phosphate (mg/L) are shown in Tables 1 and 2. The reported values refer the mean value of water samples collected during summer and winter seasons at different areas along the whole extends of Uppanar River.

TEMPERATURE

Temperature is one of the important physical factors as it regulates the rate of photosynthesis, which affects the chemical and biological reactions in water. The temperature difference may influence the physico-chemical characteristics, circulation and abundance of flora and fauna (Mullai *el al.,* 2013, Manikannan *et al.*, 2011; Soundarapandian *et al*., 2009). Temperature variation in the present study shows a fluctuation during summer and winter with 28.9 - 30.4°C and 28.9 - 30.1°C (Figure 2). Here the temperature variation is higher in summer season when comparing winter season, this dissimilarity is influenced by the intensity of solar radiation, evaporation, freshwater influx, cooling and mixing up with ebb and flow from adjoining neritic waters whereas the minimum temperature was due to sea breeze and precipitation (Govindasamy *et al.,* 2000; Damoharan *et al.*, 2010; Sankar *et al.*, 2010). This variation in water temperature might be because of an increase in rate of chemical reaction and nature of biological activities, since

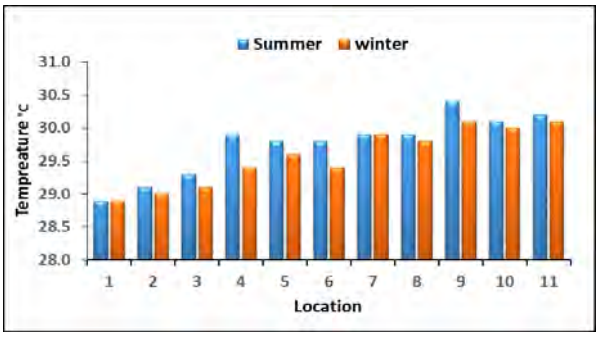
Table 1: Physico Chemical Parameters of Uppanar River in Summer

S.No.	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	So4 mg/l	NO3 mg/l	PO4 mg/l	pH	Temp °C	EC μmohs/cm
1	80	16.8	325.0	10.6	214.5	18.8	4.5	0.2	8.7	28.9	5016
2	56	20.2	294.8	9.1	218.0	23.3	2.0	0.2	8.4	29.1	4931
3	96	15.4	280.2	8.5	193.2	22.5	2.0	1.2	8.3	29.3	4772
4	56	17.3	318.1	9.5	177.3	9.8	3.0	0.2	8.1	29.9	4354
5	48	19.2	255.5	7.4	154.2	6.3	6.5	0.3	8.2	29.8	3694
6	48	15.8	295.8	8.5	131.2	12.3	5.5	0.8	8.3	29.8	3328
7	40	7.7	97.8	3.0	70.9	6.2	8.8	0.4	7.5	29.9	1746
8	40	8.6	122.2	3.8	79.8	27.0	8.6	1.0	7.5	29.9	2126
9	16	3.8	68.4	1.9	35.5	6.3	10.0	0.5	7.7	30.4	933
10	56	4.3	25.9	0.8	17.7	6.2	15.0	0.6	7.7	30.1	459
11	24	1.0	4.0	0.8	5.3	9.0	8.5	0.5	7.8	30.2	160
Min	16	1	4	0.8	5	6.2	2.0	0.2	7.5	28.9	160
Max	96	20.2	325	10.6	218	27.0	15.0	1.2	8.7	30.4	5016
Mean	52	11.6	185.9	5.7	117	13.9	7.0	0.6	8.0	29.7	2823

Table 2: Physico Chemical Parameters of Uppanar River in Winter

S.No.	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	So4 mg/l	NO3 mg/l	PO4 mg/l	pH	Temp °C	EC μmohs/cm
1	85	21.4	330.0	13.9	219.1	22.4	6.7	0.4	8.4	28.9	5000
2	63	24.8	299.8	12.4	222.7	26.9	4.2	0.4	8.1	29.0	4920
3	104	20.0	285.2	11.8	196.4	26.2	4.2	1.4	8.0	29.1	4760
4	62	21.9	323.1	12.8	181.9	13.4	5.2	0.3	7.8	29.4	4340
5	54	23.8	260.5	10.7	158.9	10.0	8.7	0.6	7.9	29.6	3680
6	53	20.5	300.8	13.2	135.8	16.0	7.7	1.2	8.0	29.4	3320
7	42	12.3	102.8	7.7	75.6	9.8	11.0	0.9	7.2	29.9	1730
8	48	13.3	125.7	6.2	84.4	30.7	10.8	1.5	7.2	29.8	2110
9	21	8.5	71.9	4.3	40.1	10.0	12.2	1.0	7.4	30.1	920
10	57	6.9	29.4	2.7	22.4	9.8	17.2	0.9	7.4	30.0	450
11	27	3.5	7.5	2.0	10.0	12.7	10.7	0.8	7.4	30.1	135
Min	21	3.5	7.5	2.0	10.0	9.8	4.2	0.3	7.2	28.9	135
Max	104	24.8	330.0	13.9	222.7	30.7	17.2	1.5	8.4	30.1	5000
Mean	57	15.8	190.3	8.7	121.5	17.6	9.2	0.8	7.7	29.6	2808

Figure 2: Temperature Variation During Summer and Winter

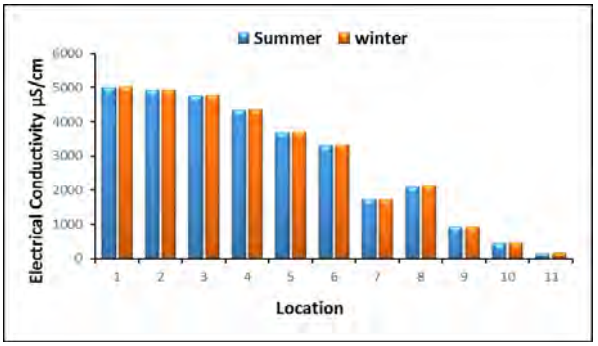


temperature governs the assimilative capacity of the ecosystems (Adefemi and Awokunmi, 2010; EPA, 1976).

ELECTRICAL CONDUCTIVITY

EC is a good indicator parameter of total dissolved ions in the aquatic ecosystem. Here the EC Value ranges were 160 – 5016 with an average of 2823 µmohs/cm in summer and 135 - 5000 µmohs/cm with an average of 2808 µmohs/cm in winter season. This is quite high in normal river water and reason due to salinity, industrial waste, anthropogenic activity and tidal influence (Figure 3). The proportion of EC is higher during summer than winter in downstream part of the area is by precipitation, mixing of saline water and similar findings were also reported by Manikannan *et al.* (2011).

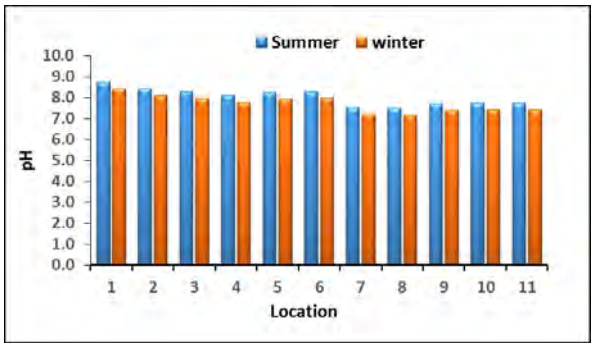
Figure 3: Change in Electrical Conductivity During Summer and Winter



pH

pH is a significant parameter in evaluating acidity or alkalinity of water. The pH is a calculation of the acid balance of a solution and is defined as the negative of the logarithm to the base 10 of the hydrogen ion concentration. The pH scale runs from 0 to 14 (i.e., very acidic to very alkaline), with pH 7 indicating a neutral condition (WHO, 2008). pH computation is to determine the intensity or alkalinity and measures the concentration of hydrogen ions. Thus pH is having primary importance in deciding the quality of water, here hydrogen ion concentration given the range of 7.5-8.7 with intermediate value of 8.0 during summer and during winter the values are 7.2-8.4 with medium value of 7.7 (Figure 4). The higher proportion of pH is by the influence of seawater and high biological activity and can also by the uptake of CO_2 by photosynthesizing organisms (Govindasamy *et al*., 2000). The low values of pH recorded during winter season may be influenced by the flooding and mixing up of fresh water (Prabha Devi, 1986).

Figure 4: Concentration of pH in Water Samples During Winter And Summer



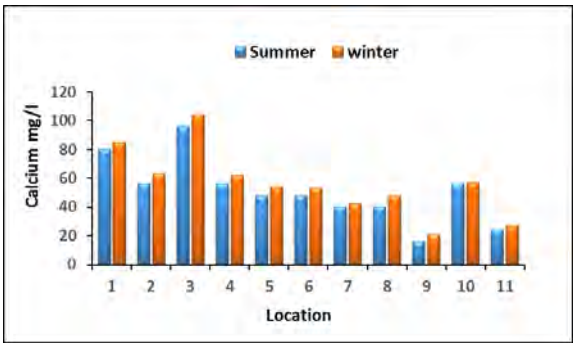
Similar trend in pH was observed by (Bijoy Nandan, 1991; Shibu, 1991; Reshmi, 2004; Radhika, 2005). The observed results exceeded the permissible limit of ICMR, 1975 (6.5 - 8.5) at some sampling stations. Similar trend in pH was

reported by Gasim *et al.* (2007) from Be- Bar River, Malaysia, Prabu *et al.* (2008) from Pichavaram mangroves, Damotharan *et al.* (2010) from Point Calimere coastal waters, Sundaramanickam *et al.* (2008) from Parangipettai and Cuddalore coast and Yadav and Srivastava (2011) from river Ganga. A change in water pH affects the freshwater life indirectly by modifying water chemistry, which in turn converts the dissolved oxygen level in the water, photosynthesis of aquatic plants, metabolic rates of aquatic organisms (Ahmed, 2012).

CALCIUM

Calcium is an important constituent in natural water. The concentration of calcium in summer ranges from 16 to 96 mg/L with an average of 52 mg/L and in winter the range of value is 21 to 104 mg/L with an average of 57 mg/L (Figure 5). The amount of calcium was observed in winter season, and it is observed that the minimum concentration of calcium in Indian River water is reported as (30 mg/L) in summer and winter (Chandrasekaran, 2015). Here, the higher amount of calcium concentration was found in downstream of the study area due to the influence of tidal water. Hence when compared to the global average, it is suitable for aquatic systems (Sarin and Krishnaswamy, 1984).

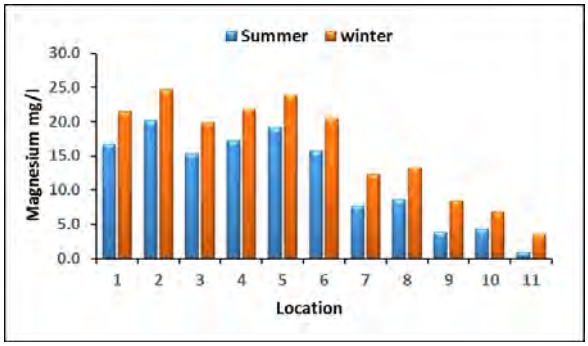
Figure 5: Calcium Dispersal in Water During Summer and Winter



MAGNESIUM

The surface water concentration of Mg in summer ranges between 1 - 20.2 mg/L with an average 11.6 mg/L and in winter ranges from 3.5 - 24.8 mg/L with an average 15.8 mg/L (Figure 6). The natural adsorption of magnesium in rivers is from 0.85 mg/L to 12.1 mg/L (Meybeck *et al.*, 1996, 1992). The varied concentration is noted downstream part of river. In general magnesium commonly present in natural waters as Mg^{2+} and along with calcium they contribute hardness to water (Puvaneswari,2015). The essential source of Magnesium is from the weathering of rocks containing Ferro magnesium minerals and from some carbonate rocks. Natural content of magnesium in fresh water are > 100 mg/L, based on the rock types within the catchment area. All though, magnesium is used in many industrial process this is moderately advanced in surface water. It is also reported that high magnesium values may be a result of soil erosion or to some extent by high density of phytoplankton (Maulood, 1989, Hassan, 2010).

Figure 6: Magnesium Concentration in Water Samples in Both Seasons

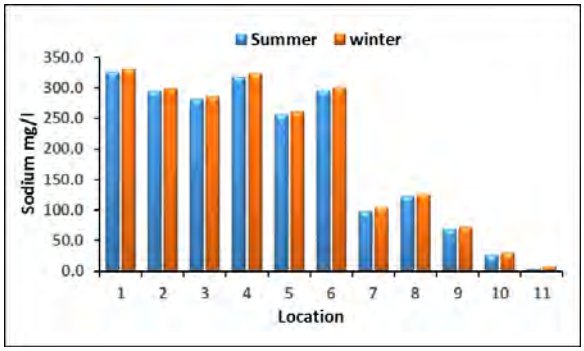


SODIUM

Natural range of dissolved sodium in river ranges from 8 to 25.3 mg/L (Meybeck *et al.*, 1996, 1992). However, in the study area sodium ranges

between 4 to 325 mg/L with an average of 185.9 mg/L in summer and 7.5 - 330 mg/L with an average of 190.3 mg/L in winter season (Figure 7). Sodium concentration was reported more winter than in summers, which clearly indicate that the atmospheric recycling is the main source for sodium, moreover less influenced by physical weathering (Subramanian *et al.*, 1987).

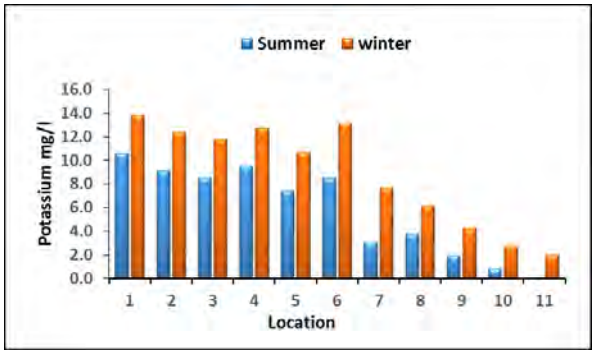
Figure 7: Concentration Variation of Sodium in Both Seasons



POTASSIUM

The concentrations of potassium in natural water are usually less than 10 mg/L, but the concentration of potassium in this study displays a range of 0.8 to 10.6 mg/L with an average of 5.7 mg/L in summer and 2 to 13.9 mg/L with an average of 8.7 mg/L in winter season (Figure 8). The proportion of potassium is moderately stronger when compared to winter season. The

Figure 8: Dispersal of Potassium in water of Both Seasons

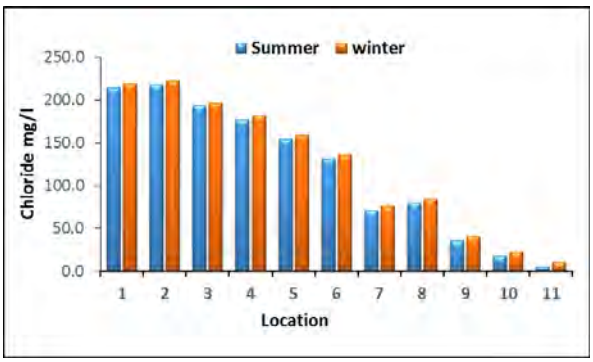


increase in level in winter is by the effluent discharge from industries since potassium salts are commonly used in industry and in fertilizers for agriculture (Meybeck *et al*., 1996, 1992)

CHLORIDE

Natural distribution of dissolved chloride in rivers is 0.62 - 25 mg/L (Meybeck *et al.,* 1996, 1992). In the study area the determined chloride ranges from 5 - 218 mg/L with an average of 117 mg/L in summer and 10 - 222.7 with an average of 121.5 mg/L in winter season (Figure 9). The higher concentration of chloride content was found during the monsoon season may be attributed by the increasing organic waste of human origin with runoff water (Puvaneswari, 2015). Chlorides occur naturally in all types of waters. In natural freshwaters, however, its concentration remains quite low and is generally less than that of sulphates and bicarbonates. Therefore, the chloride concentration serves as an indicator of pollution. The sewage water and industrial effluent are rich in Cl- and hence the discharge of these wastes result in high chloride level in fresh water (Hasalam, 1991; Puvaneswari, 2015).

Figure 9: Chloride Concentration in Water Samples in Summer and Winter

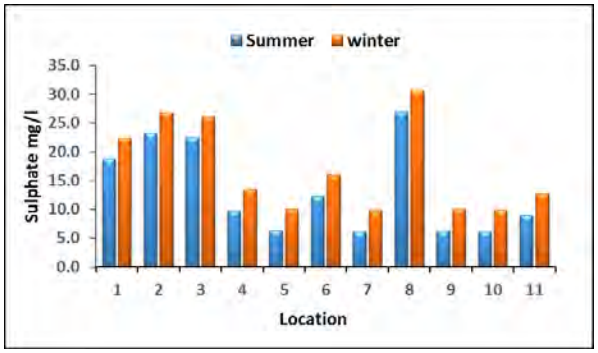


SULPHATE

Sulphate proportion ranges from 6.2 to 27 mg/L with an intermediate 13.9 mg/L in summer and

9.8 to 30.7 mg/L with an average 17.6 mg/L in winter season. The elevated values of sulphate were observed during winter and lowest during summer (Figure 10). Sulphate is a naturally occurring substance that contains sulphur and oxygen, which is present in various mineral salts in soil. Sulphate may be leached from the soil, fertilizers, decaying plant and animal matter commonly released into water (Ibbok *et al.*, 2010). Biological oxidation increases the sulphate concentration; discharge of industrial wastes and domestic sewage waters tends to increase its concentration. The increased concentration of sulphate observed during the winter season may be influenced by rain water runoff, sewage waste, soil, fertilizers, decaying plant and animal matter and decomposition of sulphate rich effluents from the husk retting grounds.

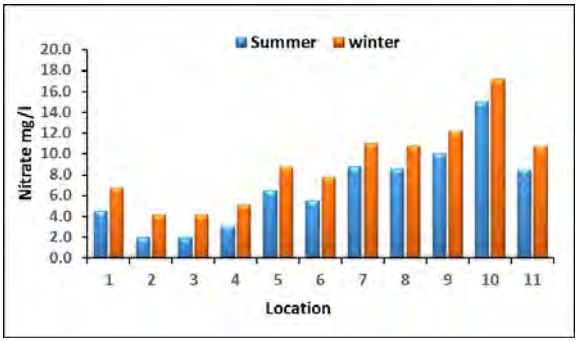
Figure 10: Distribution of Sulphate in Water Samples of Both Seasons



NITRATE

Nitrate in a form of nitrogen and a vital nutrient for growth, reproduction, and the survival of organisms. This nitrate observed in the study area from 2 - 15 mg/L with an average 7 mg/L in summer and 4.2 - 17.2 mg/L with an average 9.2 mg/L in winter season (Figure 11). The highest nitrate concentrations were recorded during winter season and minimum during the summer season. The higher absorption of nitrate in upstream area the recorded highest nitrate value could be mainly due to the organic materials received from the catchment area during ebb tide (Ashok Prabu *et al*., 2008). Another possible way of nitrate input could be through oxidation of ammonia form of nitrogen to nitrite formation (Rajasegar, 2003).

Figure 11: Concentration of Nitrate in Water of Both Seasons



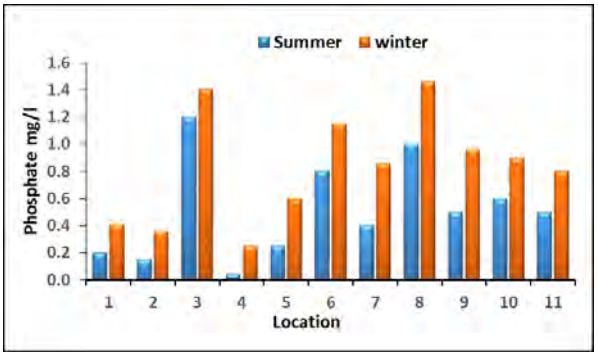
The utmost nitrite absorption during winter season could be due to the increased phytoplankton excretion, oxidation of ammonia, reduction of nitrate, and the recycling of nitrogen and bacterial decomposition of planktonic detritus (Govindasamy *et al*., 2000; Asha and Diwakar, 2007), and also due to denitrification and air-sea interaction exchange of chemicals and also by the organic materials received from the catchment area during rainfall, fresh water inflow and litter fall decomposition (Joseph and Jacob, 2010; Mahananda *et al*., 2010; Manikannan *et al.*, 2011, Rajasegar, 2003; Ashok Prabu *et al.*, 2008). The low nitrite concentration may be due to high salinity, phytoplankton as evidenced by high photosynthetic activity (Saravanakumar *et al.*, 2008, Sithik *et al*., 2009; Sankar *et al*., 2010; Umamaheswari *et al*., 2009).

PHOSPHATE

Phosphate in the present investigation fluctuated from 0.2 to 1.2 mg/L in summer with an average

0.6 mg/L in upstream side and 0.3 to 1.5 m/L with an average 0.8 mg/L in winter season in downstream part of the study area (Fig.ure 12). The flexible proportion of phosphate in the study area during both monsoons may be due to irregular season. Phosphate is the significant in regulating nutrient for plants in freshwater also causing eutrophication leading to extensive algal growth (Stickney, 2005). The increase in concentration of phosphate during monsoon season is the results of incoming water from the catchment area of human settlements, industrial and domestic sewage discharge. According to Ajithkumar *et al*. (2006) utilization of fertilisers from agricultural is also the source for phosphates in the ecosystem.

Figure 12: Phosphate Concentration in Water Samples During Summer and Winter



CONCLUSION

The seasonal variation pattern of surface water samples which highlights the diverse parameters were found to be influenced in two seasons. All the parameters values give a fluctuated proportion in winter season than summer season. The irregularity in monsoon precipitation and low water flow influences variability in some parameters. The concentration variation in physico-chemical variables in the present study areas is subjected to wide spatial and temporal variations. It is concluded that other the discharge of industrial effluents and domestic sewages, rainfall is also a criteria for the significant cyclic phenomenon in Tropical countries that brings almost essential changes in the physical and chemical characteristics of the estuarine and coastal environments.

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