Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 6, Issue, 12, pp.11218-11225, December, 2014

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCHARTICLE

COMPARATIVE PHYSICO-CHEMICAL ANALYSIS OF UPPANAR ESTUARY AND KILLAI BACK WATER FROM TAMILNADU COAST WITH SPECIAL REFERENCE TO THEIR NUTRIENT STATUS

Jothivel, N. and *Paul, V.I.

Department of Zoology, Annamalai University, Tamilnadu, India -608002

ARTICLE INFO

Article History:
Received 10th September, 2014
Received in revised form
23rd October, 2014
Accepted 17th November, 2014
Published online 30th December, 2014

Key words:

Physico-chemical parameters,
Nutrients,
Uppanar estuary Killai back water

ABSTRACT

Seasonal variations of physico-chemical parameters such as rainfall, temperature, alkalinity, nitrite, nitrate, phosphate, sulphate and fluoride were studied from two different coastal water bodies of south east coast of India *viz*., Uppanar estuary, Cuddalore and Periyavaikal area of Killai region, Cuddalore District, Tamilnadu southeast coast of India for one calendar year. The results significantly increased levels of most of the parameters at Uppanar estuary than Killai backwaters throughout the year. There were significant variations among the parameters at various months / seasons within each of the study sites also. The spatio-temporal variations observed among the physicochemical parameters of the two study sites indicate the ecological degradation of Uppanar estuary.

INTRODUCTION

The dependence of biological processes on the physico-chemical properties of water makes it mandatory to investigate the hydro-geo- biological properties and interactions of aquatic ecosystems. Physico-chemical profiling of water could also give an idea about the pollution load of the water body and may help to identify pollutants of particular significance in that ecosystem. This may be useful for implementing measures to control the water pollution. As estuary is the area where river get emptied into the ocean it has hydrological characteristics different from sea and river and the hydro-geographical characters prevailing in the estuarine habitat support rich biodiversity under normal estuarine conditions (Croot and Hunter, 1998).[1]Recently, the surface water ecosystems such as estuaries are turning in to receptacles of wastes orginating from residential areas, industries, and other sources of pollutions. Elevated levels of organic as well as inorganic wastes from these sources often cause increased biochemical oxygen demand due to the increased presence of organic pollutants as well as nutrients. Due to their proximity to land based ecosystems estuarine and coastal waters are natuarally rich in nutrients and primary productivity (Bierman *et al*., 2009). However, as a result of anthropogenic activities many of the coastal environments throughout the world are getting affected by eutrophication of varying degrees, often as a result of increase in nutrients (Anderson *et al.,* 2002). Such unsdicited accumulation nutrients and other substances can have deleterious consequences for marine ecosystems as well as on the people dependent upon them (Hallegraeff, 1993; Smayda, 1997; Anderson *et al.*, 2002). Deteriorations in water quality have also been caused reportedly by increases in the concentrations of pollutants of industrial origin and contaminants like oil, heavy metals, organic compounds etc. (Shahidul Islam and Tanaka, 2007; Orpin *et al*., 2004; Sanchez *et al*., 2007). All these have negative implications on the well-being of marine ecosystems and those who depend upon them.

The optimal level of nutrients determines the potential fertility of the water masses and therefore it is important to gather information about their distribution and behavior in different coastal eco-systems. The distribution and behavior of nutrients in coastal environment particularly in the near shore waters and estuaries also exhibit considerable seasonal variations in relation to rainfall pattern and quantum of fresh water inflow (Sithik *et al*., 2009). Therefore hydrobiological studies are important criteria associated with the health status of marine and estuarine ecosystems. Maintenance of good coastal water quality is essential for the survival of the inhabitant aquatic communities as well as the terrestrial communities who depends the former in many ways (Padhi and Padhi, 1999; Sithik *et al*., 2009). In this context, attempts have been made in the present study to investigation the level of selected physicochemical parameters in the Uppanar estuary as well as Periyavaikal area of Killai coast for a period of one year.

Corresponding author: Dr. V.I Paul,

Department of Zoology, Annamalai University, Tamilnadu, India - 608002

The selected parameters include rainfall, water temperature, alkalinity, nitrite, nitrate, phosphate, sulphate and fluoride. The prevailing environmental situation in the study areas (Sundaramanickam *et al.,* 2008; Soundarapandian *et al.,* 2009; Santhi, 2012) also warrants the need of monitoring thephysico-chemical factors of these ecosystems.

MATERIALS AND METHODS

Study sites and sampling

The sites selected for the study were the Uppanar estuary (SIPCOT industrial area), Cuddalore (referred to as polluted site) and Periyavaikal area of Killai coast (referred to as reference site) of Cuddalore district, Tamilnadu, India. Water samplings were done on monthly basis from both the study sites for one calendar year (Jan 2012 – Dec 2012).

In order to have uniformity, water samples were collected from fixed locations on each of the study sites. Water samplings and preservations were carried out according to the methods prescribed by APHA *et al.* (1989) and Prakash (2004)

Parameters analysed

The physico chemical parameters analysed to assess the water quality in both the sites include, Rainfall (RF), Water temperature (WT), Alkalinity (A), Total Hardness (H), Nitrite (NO_2^-), Nitrate (NO_3^-), Phosphate (PO_43^-), Sulphate (SO_4^{2-}), Fluoride (F^-).

RESULTS

Rainfall (RF)

Reference as well as polluted sites recorded maximum ‘RF’ during the month of November (154.95±0.04 mm and 153.62±0.62 mm Fig1a). Similarly both the areas received no rainfall during the summer months of April, May and June. The significant correlations of RF with the other physicochemical factors are shown in (Tables 1, 2)

Water temperature (WT)

In both the study sites there was no significant differences between ‘WT’ on an annual basis (Table 3). The significant correlations of WT with other factors are shown in (Tables 1, 2)

Alkalinity

In both the sites, minimum alkalinity values were recorded during the summer (Fig 1c). While the reference site showed a minimum value of 62.67 ± 4.26 mg/l during May, the polluted site had a minimum alkalinity value of 64.33 ± 3.18 mg/l during May. In boththe cases, peak values were observed during monsoon. While the reference site had a monsoon peak of 244.00 ± 44.06 mg/l during November, the polluted site showed the maximum value of 372.33 ± 2.85 mg/l during the same period. The significant correlations as well as differences with the other investigated parameters are shown in Table 1, 2.

Nitrite (NO_2^-)

The polluted site contained comparatively higher quantity of NO_2^- than the reference site (Tables 3 and Fig 1d) throughout the year. In the case of the polluted site the values ranged from 2.05 ± 0.02 in April to 6.60 ± 0.05 mg/l in October and the reference site value sranged from 0.80± 0.04mg/l in May to 1.62 ± 0.04 mg/l in September. The significant correlations of NO_2^- with the other investigated factors given in Tables 1, 2.

Nitrate (NO_3^-)

In the case of the polluted site, the values ranged from 30.67 ± 2.33 mg/l in July to 72.67 ± 1.45 mg/l in November whereas in the case of the reference site the values ranged from 10.67 ± 2.33 mg/l in May to 28.00 ± 1.15 mg/l in December (Fig 2a). The NO_3^- contents in the polluted sites were significantly higher than those of reference site. The significant correlations expressed by NO_3^- are given in Tables 1, 2.

Phosphate (PO_4^{3-})

The PO_4^{3-} concentration of the reference site was considerably lower than (Fig. 2b) that of the polluted site. The minimum phosphate content observed in the case of the polluted site was 2.16 ± 0.03 mg/l in the month of April and the highest value observed was 14.26 ± 0.02 mg/l during November. In the case of the reference site, the minimum value observed during Aprilwas 0.63± 0.04 mg/l and the maximum (2.55 ± 0.05 mg/l) was observed during October. The significant correlations with other factors and differences between the sites are given in Tables 1, 2.

Sulphate (SO_4^{2-})

Al the polluted sites, the maximum sulphate content was recorded in November (1762.33±4.81m/l) and the minimum in May (758.33±7.26 mg/l) respectively (Fig 2c). On the other hand , in the case of reference area, maximum concentration recorded was 605.00±4.16mg/l in November and the minimum was registered in June (259.33±2.02 mg/l). The significant correlations with other factors and difference between the two sites are represented in Tables 1, 2.

Fluoride (F^-)

In the case of the reference site, minimum fluoride content was observed during July (0.05mg/l) and maximum in November (0.55mg/l). on the other hand, in the case of Uppanar estuary, a maximum of 1.60 mg/l F^- was recorded in the month of November and a minimum of 0.37 mg/l in the months of June.

The significant correlations of F^- with other factors and the significant differences between the two sites are shown in the Tables 1, 2.

Table 1. Correlation matrix between various physico-chemical indices ofUppanar estuary, Cuddalore

Parameters (Units)	RF (mm)	WT (°C)	A(mg/l)	NO_2^- (mg/l)	NO_3^- (mg/l)	PO_4^{3-} (mg/l)	SO_4^{2-}(mg/l)	F^- (mg/l)
RF(mm)	1							
WT (°C)	-.313	1						
A(mg/l)	.836**	-.532**	1					
NO_2^- (mg/l)	.637**	-.484**	.865**	1				
NO_3^- (mg/l)	.484**	-.774**	.745**	.771**	1			
PO_4^{3-} (mg/l)	.871**	-.478**	.836**	.734**	.649**	1		
SO_4^{2-}(mg/l)	.893**	-.473**	.931**	.769**	.671**	.769**	1	
F^-(mg/l)	.659**	-.562**	.701**	.674**	.734**	.738**	.757**	1

Note: **Correlation is significant at the 0.01 level (2-tailed); *Correlation is significant at the 0.05 level (2-tailed); RF = Rainfall; WT = Water temperature; A = Alkalinity, NO_2^- = Nitrite, NO_3^- = Nitrate, PO_4^{3-} = Phosphate; SO_4^{2-} = Sulphate; F^{--} = Fluoride

Table 2. Correlation matrix between various physico-chemical indices of Periyavaikal area, Killai back water

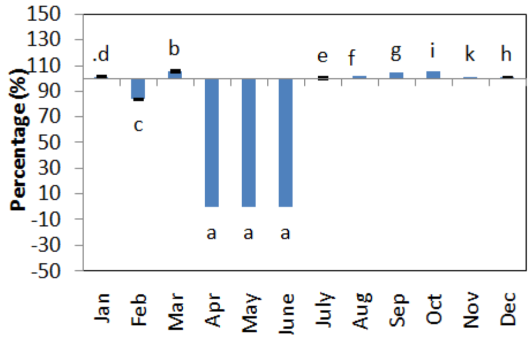
Parameters (Units)	RF (mm)	WT (°C)	A(mg/l)	NO_2^- (mg/l)	NO_3^- (mg/l)	PO_4^{3-} (mg/l)	SO_4^{2-}(mg/l)	F^- (mg/l)
RF(mm)	1							
WT (°C)	-.161	1						
A(mg/l)	.827**	-.451**	1					
NO_2^- (mg/l)	.613**	-.199	.561**	1				
NO_3^- (mg/l)	.686**	-.534**	.651**	.426**	1			
PO_4^{3-} (mg/l)	.907**	-.381*	.879**	.723**	.708**	1		
SO_4^{2-}(mg/l)	.804**	-.538**	.712**	.543**	.839**	.869**	1	
F^-(mg/l)	.453**	-.642**	.540**	.305	.586**	.627**	.630**	1

Note: **Correlation is significant at the 0.01 level (2-tailed); *Correlation is significant at the 0.05 level (2-tailed); RF = Rainfall; WT = Water temperature; A = Alkalinity, NO_2^- = Nitrite, NO_3^- = Nitrate, PO_4^{3-} = Phosphate; SO_4^{2-} = Sulphate; F^{--} = Fluoride

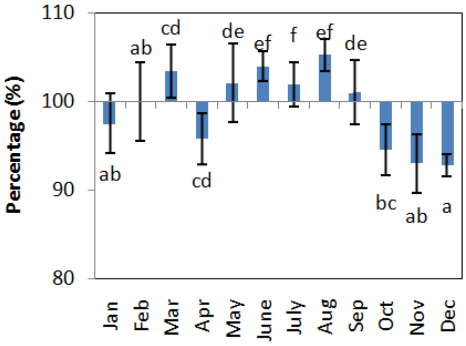
Table 3.Student's t- test showing significant differences between the physic-chemical parameters of Periyavaikal and Uppanar estuary on annual basis

Sites	RF (mm)	WT (°C)	A(mg/l)	NO_2^- (mg/l)	NO_3^- (mg/l)	PO_4^{3-} (mg/l)	SO_4^{3-}(mg/l)	F^-(mg/l)
Periyavaikal (Reference)	46.19 ± 7.84	32.17 ± 0.58	164.00 ± 9.86	1.13 ± 0.04	16.25 ± 1.07	1.33 ± 0.11	384.72 ± 20.77	0.36 ± 0.19
Uppanar Estuary (polluted)	47.04 ± 8.00*	32.31 ± 0.60^{NS}	213.03 ± 17.00***	3.43 ± 0.21***	53.06 ± 3.02***	5.07 ± 0.63***	1246.25 ± 66.04***	0.97 ± 0.47***

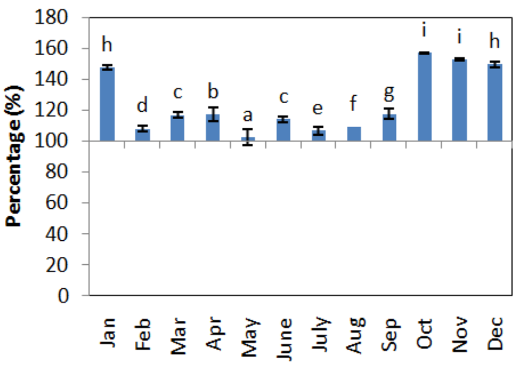
Note: $\overline{X}$ ± SE; RF = Rainfall; WT = Water temperature; A = Alkalinity, NO_2^- = Nitrite, NO_3^- = Nitrate, PO_4^{3-} = Phosphate; SO_4^{2-} = Sulphate; F^{--} = Fluoride; comparison is made between the annual averages of parameters of reference and polluted sites.



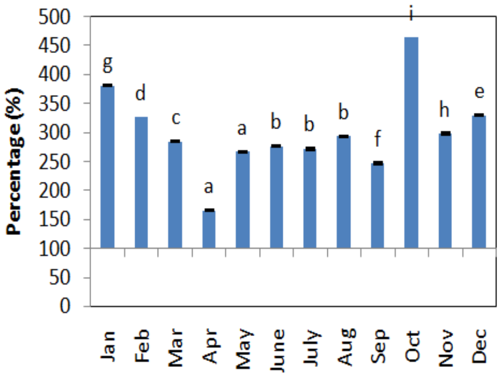
a. Rainfall (RF)



b. Water Temperature (WT)

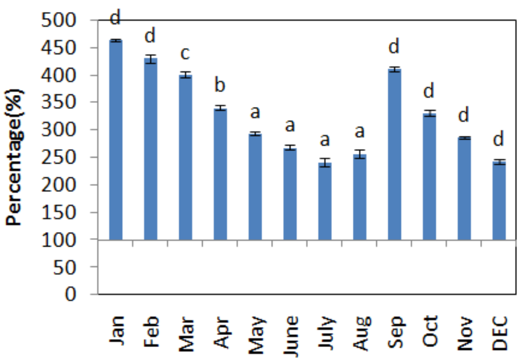


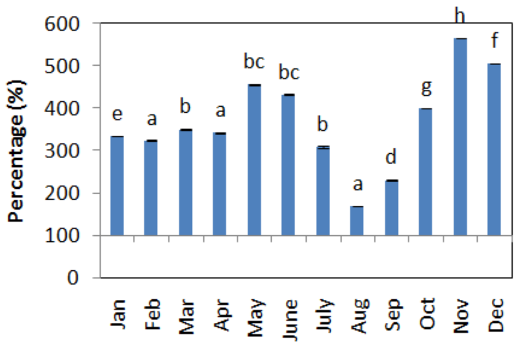
c. Alkalinity (A)



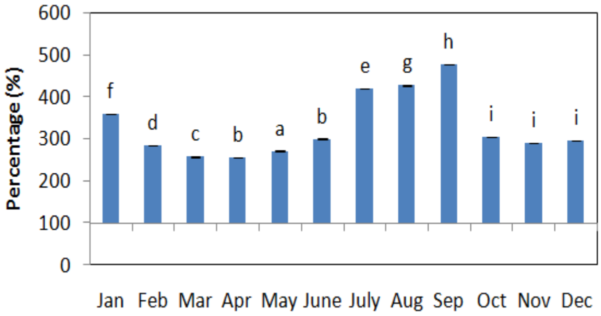
d. Nitrite(NO_2^-)

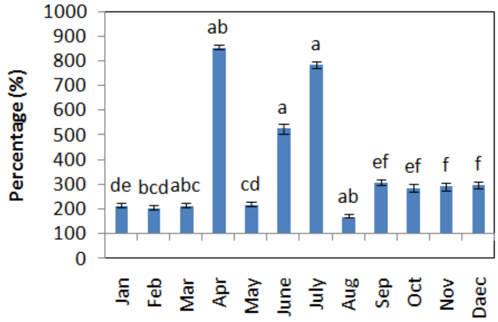
Fig 1. Variations in the rainfall (RF), atmospheric temperature (AT), alkalinity (A) andnitrite (NO_2^-) of Uppanar estuary from Periyavaikal (reference site).(Reference site values taken as 100%; based on ANOVA and DMRT; values with different superscripts are significantly different at P≤0.05)





a.Nitrate (NO_3^-)b.Phosphate (PO_4^{3-})





c. Sulphate (SO_4^{2-})d.Fluoride (Fl^-)

Fig 2. Variations in the nitrate (NO_3^-), Phosphate (PO_4^{3-}), Sulphate (SO_4^{2-})and Fluoride (F^-) of Uppanar estuary from Periyavaikal (reference site).).(Reference site values taken as 100%; based on ANOVA and DMRT; values with different superscripts are significantly different at P≤0.05)

DISCUSSION

The present study has clearly showed that RF causes important ecological changes especially among the various physic-chemical parameters of both the study sites as revealed by the correlation (Tables 1, 2). The monsoon run off brings in various contaminants in bulk amounts in to the estuarine as well as the back water areas in indicated by a sudden increase in most of the physicochemical parameters analyzed in the present study (Table 3). However, in general the rate of increase was much higher in the case of Cuddalore coast in comparison to Killai area. Such a differential increase could be attributed to the increased influx of industrial and urban effluents at the Uppanar estuary.

Temperature variations is an important factor in the coastal and estuarine ecosystems and influence the physico-chemical characters of coastal and estuarine waters to a greater extend along with other environmental factors and provide the environmental cues of spawning for marine organisms. If water temperature is consistently higher or lower than the average, organisms may be under chronic stress and may even have to relocate to the areas of desirable temperature range as the present study clearly indicates the influence of temperature on other ecological factors also (Table 3). While the maximum temperature recorded during the summer season could be attributed to high solar radiations due to clear sky, minimum values recorded during monsoon could also be ascribed to the cooling effect brought about by rainfall and strong winds from the land areas. Similar views have been expressed by other workers also (Sampathkumar and Kannan, 1998; Rajaram *et al*., 2005).

Alkalinity (A) of water is its acid neutralizing capacity and it is primarily a function of carbonate, bicarbonate and hydroxide content of water.It is taken as an indication of the concentration of these constituents in water. Alkalinity value reserve as an index of productive potential of water (Mariyappan *et al*., 2000).It is considered as a measure of the buffering capacity of the water (Train, 1978; Rao, 2001). It is commonly used as an index of potential sensitivity because it expresses, in part, the acid neutralizing capacity of water bodies. In other words 'A' stands for the relative tolerance of potential sensitivity to acidic inputs in to the water body. The biocarbonates, carbonates, chlorides, nitrates, phosphates and sulphates of Na, K, Mg, Ca and Fe are mainly responsible for the 'A' and hardness of water (Jameel, 1998; Singh **et al.,** 1999 a, b). Total 'A' is high during monsoon periods and it may be due to surface water runoff in to the estuary as well as due to the churning currents and mixing of benthic sediments in the sea. Increased 'A' due to commercial laundry wastes and agricultural wastes have been reported (Karunagaran, 1990). In case of Uppanar estuary, role of industerial effluents also cannot be ruled out. Hosetti *et al.* (1995) have also reported more alkalinity due to sewage dumping in river Tunga. Higher values of both total alkalinity and hardness were observed in by Iyyappan (2000) inParavanarRiver due to the combined effluents of coal-carbonization and fertilizer plants.

Nitrite (NO_2^-) concentration was significantly higherin the Uppanar estuary than Killai back waters (Table 3) throughout the period of study. In both the sites higher nitrite content was recorded during the monsoon season than summer season. The peak values of nitrite observed during the monsoon season could be attributed to the influence of monsoonal floods. Another major reason for increase in nitrite concentration at cuddalore coast than killai region may be the increased presence of NO_2^- in the industrial effluents coming from the SIPCOT area. The higher concentration of nitrite and seasonal variation could also be attributed to the variation in phytoplankton excretion, oxidation of ammonia and reduction of nitrate (kannan and Kannan, 1996). Low values of NO_2^- observed during the summer seasons may be attributed to many factors such as lesser amount of fresh water inflow bringing in additional amount of NO_2^-as well as to higher salinity. The summer decrease may also be due to the increased primary production during summer due to deep penetration of light in to the estuarine water. Being a plant nutrient, along with nitrate and ammonia nitrite also may be assimilated by primary producers through the nitrification dentrification processes. Spatio temporal variations in the distribution of NO2- as observed in the present study were also recorded by Satpathy (1996) from coastal waters of Kalpakkam, Vijayalakshmi (1999) from Parangipettai and Cuddalore waters and Ashok prabu *et al.* (2008) from Uppanar estuary. High levels of nitrite in water are a potential factor triggering stress in aquatic organisms. Elevated environmental nitrite has been reported to induce methaemoglobin formation, which could cause hypoxia in tissue, and impair the respiratory metabolism (Chen *et al.,* 1991; Chen and Chen, 1992; Paul, 1995).

Nitrates (NO3-) are the most oxidized forms of nitrogen and the end product of the aerobic decomposition of organic nitrogenous matter. Natural waters in their unpolluted state contain only minute quantities of nitrates. Although a much needed plant nutrient, at higher concentrations, it leads to a lot of ecological issues. It's increased presence along with phosphate leads to the formation of plankton blooms, eutrophication and associated ecological disasters leading to reduced DO and increased BOD (Jayakumar, 2009). In the present study, the average NO_3^- content in the Uppanarestuary area is much higher than that of the reference area (Table) and its pattern of variation (Fig.2a) shows an increasing trend during the monsoon and winter seasons than the summer seasons in both the study sites. The highly increased presence of NO_3^- in the Uppanarestuary (Table 3) may be the result of the various factors such as decomposition of organic matter, influx of nitrogenous fertilizers from the surrounding agriculture fields and nitrogenous sewage from the township area together in the effluents coming from SIPCOT area. It may be noticed that the polluted site selected for the study acts as a receptacle for the effluents coming from SIPCOT industrial area.

Raman (1995) and Rajasegar (2003) have also reported increased $NO3^-$ content due to monsoon run off from agricultural field and oxidation of ammonia. Pillai (1994) and Karuppasamy and Perumal (2000) have also confirmed the possibility of increasing $NO3^-$ content due to land run off caused by monsoon. However in the case of Uppanar estuary, the industrial and sewage effluents might be the major players in increasing NO_3^- content.The presence of phosphate (PO_4^{3-}) in water is mainly due to detergents, used boiler waters, fertilizers and biological processes. It is essential for the growth of organisms and acts a nutrient that limits the primary productivity of the water body. Inorganic phosphorus plays a dynamic role in aquatic ecosystems. When it is present in low concentration, is one of the most important nutrients, but when in excess it along with nitrates and potassium causeseutrophication.

In the present study, both the study sites registered peak values of inorganic phosphate during the monsoon season and low levels during summer season (Fig. 2b). However the magnitude of increase was much significantly higher in the of Uppanar estuary (Table 3). Decreaseinphosphate content during summer season (Fig.2b) may be correlated to its utilization by the micro and macrophytobenthic communities of the area as well as due to the decreased land drainage and fertilizer disposal from the agricultural lands. High concentration of phosphate observed in the present study during monsoon season might have been due to heavy surface runoff, inputs of domestic sewage and agricultural runoff from the adjacent agricultural fields. Sampathkumar and Kannan (1998) and Karuppasamy (1999) have also expressed similar views. In the use of Uppanar estuary the industrial effluents coming from SIPCOT area might be theprime source of PO_4^{3-} when compared to killai backwaters because according various authors phosphate level at higher concentrations indicates pollution through industrial waste and sewage (NEERI, 1988; Kotaiah and Kumaraswamy, 1994; Kotaiah, 1994).

De Sousa *et al.* (1981) from their observations in Mondovi and Zuari estuaries have reported that phosphate might be originated from the exchange between mud-water interface and water exchange with sea. Some quantity might have also resulted from the regeneration of phosphate from the bottom mud and subsequent release of the same in to the water column by turbulence and mixing caused by heavy winds prevailing during monsoon season (Mahalakshmi, 1997). According to Pillai (1994) phosphate content in the intertidal water could also be resulted by microbial breakdown of organic matter and release of phosphate absorbed on the sediment particles. The high phosphate concentration is an important feature associated with sewage and industrial pollutionin the estuarine environment and hence PO_4^{3-} concentration could be taken as an index to identify the extent of pollution especially in the Uppanar estuarine environment, (Santhi, 2012).

Sulphate (SO_4^{2-}) concentrations in water are the results of natural weathering of minerals, atmospheric deposition, and industrial discharges along with agricultural run-off and sewage. (Davies 2007). The burning of fossil fuels, particularly high-sulphur coal and diesel, is also a major source of sulphur to the atmosphere which and precipitation could serve as a source of sulphate content of aquatic ecosystem. In the present study the increased sulphate content in the Uppanar estuary could be related mainly to the industrial emissions and effluents as well as urban runoff. The increased presence of SO_4^{2-} in the reference site especially during rainy season may be mainly agricultural rather than industrial inorigin. Sulphate reacts with other elements to produce a variety of salts with a range of chemical characteristics. Sodium, potassium, and magnesium sulphates are all readily soluble in water, whereas calcium, barium, and heavy metal sulphates are not (Lide 2009). The soluble sulphate impacts hardness of water along with other cations. The most important form is sodium sulphate which is used in a variety of industrial products. Dissolved sulphate may be reduced to sulphide, volatilized to the air as hydrogen sulphide, precipitated as insoluble salt, or incorporated into living organisms (i.e. organic sulphur) (Meays and Nordin, 2012). Sulphates are of concern because the unpleasant odour it gives to the waste water and corrosion problem due to the reduction of sulphates to hydrogen sulphide under anaerobic conditions. Intrusion of salt water into the ground water table is a big issue in Cuddalore district. The result of the present study clearly indicates the fair possibility of the intrusion of the sulphate rich sea water into the ground water table and one of the probable reasons for the unpleasant odour and taste of bore wells in this region. In the present study, sulphate also shows significant positive correlations with most of the parameters analysed (Table 1,2).

Because of the great reactivity, it is difficult to find fluorine in its elemental state and exists either as inorganic fluorides or as organic fluoride compounds (e.g., freons) (Greenwood and Earnshaw, 1984; Gillespie *et al.,* 1989). In the global environment, inorganic fluorides are much more abundant than organic fluoride compounds. The major natural sources of inorganic fluorides are weathering of fluoride minerals and volcanic eruptions (CEPA, 1994). However, the increased presence of Fl^- in the Uppanar estuary than the reference site might be the result of anthropogenic activities including the industrial and urban runoff especially due to its proximity to the industrial complex. Many workers have reported that activities involving aluminium smeltering, discharge of fluoridated municipal waters, manufacturing of brick, ceramics, glass and fluoride chemicals, may cause significant increases in the fluoride concentration of surface waters (Camargo *et al.,* 1992a;Karunagaran and Subramanian, 1992; Warrington, 1992; CEPA, 1994; Skjelk_avle, 1994; Camargo, 1996a; Ruy *et al.,* 2000).

Even though the actual mechanism at molecular level by which inorganic fluoride inhibits enzyme activity and interrupts metabolic processes is not yet clearly known, the toxic action of fluoride on the health of aquatic as well as terrestrial animals resides in the fact that fluoride ions act as enzymatic poisons, inhibiting a varieties of enzyme activities (e.g., phosphatases, hexokinase, enolase, succinic dehydrogenase, pyruvic oxidase) and, ultimately, interrupting metabolic processes such as glycolysis and synthesis of proteins (Kessabi, 1984). A possible mechanism of action may be replacement by/ combination of fluoride ion with calcium and magnesium ions (that act as cofactors of different enzymes). It is reported that aquatic organisms living in soft waters with low ionic content may be more adversely affected by fluoride pollution than those living in hard or seawaters because the bioavailability of fluoride ions is reduced with increasing content of calcium and chloride (Pimentel and Bulkley, 1983; Smith *et al.,* 1985; Camargo, 2002). Seasonal variations in the physico-geo-chemical parameters of Uppanar estuary as well as influence of meteorological factors, anthropogenic inputs and geography of the area indetermining the pollution level of the water bodies. The highly increased presence of various nutrients ions and unfavourably increased other water quality parameters in the Uppanar estuary clearly reflect the environmentally degraded nature of the Uppanar estuary incomparisions to the Killai backwaters. Results of the present study also indicate a partial recovery of the degraded water body on an annual basis as most the parameters are at their peak during monsoon, which is followed by a gradual decrease in the post monsoon months and reaching the minimum level at summer months.

It is probable that the degraded water body could be recovered from the threat of pollution if appropriate steps are taken for its restoration. This may be accomplished especially by blocking the entry of untreated or partially treated industrial effluents and other contaminants such as ruraland urban runoff from entering the water body. It is also very important to completely process and remove the polluting substances if any from the effluents of adjoining industrial area.

Conclusion

Among the entire parameters investigated, exhibited significant variations between Uppanar estuary and Killai back waters. While the Uppanar estuary showed significant increase in rainfall, water temperature, alkalinity, nitrite, nitrate, phosphate, sulphate and fluoride on seasonal as well as annual basis, While most of the physico-chemical parameters of the Killai backwater lie within the permissible limits, those of the Uppanar estuary cross the safe limits on many occasions indicating the contaminated nature of the water body.

Acknowledgement

Authors are thankful to Annamalai university authorities for providing the necessary facilities for this study.

REFERENCES

Anderson, D. M., Gliberrt, P.M. and Burkholder, J.M. 2002. Harmful algal blooms and eutrophication: nutrient sources, composition and consequences. *Estuaries,* 25(4b):704-726

APHA, (American Public Health Association), AWWA (American Water Works Association) and WPCF (Water Pollution Control Federation) (1989): Standard methods for the examination of water and wastewater 17thedn. American Public Health Association, Washington, D.C. 20005.

Ashok Prabu, V., P. Perumal and M. Rajkumar, 2008. Diversity of microzooplankton in Parangipettai coastal waters, southeast coast of India. *J. Mar. Biol. Ass. India*, 47: 14-19.

Bierman, P., Megan, l., Ostendorf, B and Tanner, J. 2009. Arevive of methods for analyzing spatial and temporal patterns in coastal water quality. *Ecological Indicators*, 1-12.

Camargo, J.A. 1996. Estimating safe concentrations of fluoride for three species of neararctic freshwater invertebrates: 56:643–648.

Camargo, J.A. 2002. Fluoride toxicity to aquatic organisms: a review. *Chemosphere,* 2002 50(3):251-64

Camargo, J.A., J.V. Ward, and K.L. Martin, 1992.The relative sensitivity of competing hydropsychid species to fluoride toxicity in the Cache la Poudre River (Colorado).*Arch. Environ. Contam.Toxicol.*, 22:107–113.

Chen, J.C. and Chen, S.F. 1992.Accumulation of nitrite in the haemolymph of *Penaeusmonodon*exposed to ambient ammonia. *Comp. Biochem. Physiol.,* 103(3):477-481.

Croot, P.L. and Keith, A. Hunter, 1998. Trace metal distribution across the continental shely near Otango Peninsula, New Zealand. *Mar. Chem.,* 62: 185-201.

Davies, T. D. 2007. Sulphate toxicity to the aquatic moss, *Fontinalisantipyretica*. *Chemosphere,* 66: 444-451.

Hallegraeff, G. M. 1993.A review of harmful algal blooms and their apparent global increase. *Phycologia.,* 32 (2), 79-99.

Hosetti, B.B., Nataraj, S., Chandrasekhar, A.S., Kamalakar, S.B. and Patil, S.R. 1995. Ecological studies on river Tunga at Shimoga with special reference to water pollution and land use. *J. Nat. Cons.,* **7**(2): 111-117.

Iyyappan, K. 2000. Studies on the impact of coal-carbonisation and fertilizer plant combined effluent in relation to biotic components of a riverine ecosystem. Ph.D. Thesis, Annamalai University, India, 1-20.

Jameel, A. 1998. Physico-chemical studies in Uyyakondan channel water of river Cauvery. *Poll. Res.,* 17(2): 111-114.

Jayakumar, P. 2009. Ecotoxicological studies on the freshwater mussel Lamellidensmarginalis (Lamarck) from two lakes of Tamilnadu. Ph.D. Thesis, Annamalai University, India, 1-37.

Kannan, R. and Kannan, L. 1996. Physico-chemical characteristics of sea weed beds of the Palk Bay south east coast of India. *J. Mar. Sci.,* 25: 358-362.

Karunagaran, V.M. 1990. Impact of wastewater from SIPCOT industrial complex on the water qualityofUppanar estuary (Lat. 11°43′N : Long 79°49′E) with special reference to fluoride contamination. *M.Phil. Thesis,* Annamalai University, India, 35-42.

Karuppasamy, R. 1999. The effect of Phenyl Mercuric Acetate (PMA) on the physiology, biochemistry and histology of selected organs in a freshwater fish, *Channapunctatus* (Bloch). *Ph.D. Thesis,* Annamalai University, India, 1-181.

Kotaiah, B. and Kumaraswamy, N. 1994. Environmental engineering laboratory manual. Charotar Publishing House, Anand, India, 1-230.

Kotaiah, C.R. 1994. *Research Methodology methods and techniques,* 2nd Ed., Vishwaprakashan Publishers, New Delhi, 20-24.

Lide, D.R. 2009. CRC Handbook of Chemistry and Physics.90th Edition ISBN 978-1-4200-9084-0.2804 p.

Mariappan, P., V. Yegnaraman and T. Vasudevan, 2000. Ground water fluctuation with water table level in Thiruppathur block of Sivagangai (T.N.). *Pollution Research,* 19(2): 225-229.

Meays, C. and Nordin, R. 2012. Ambient Water Quality Guidelines For Sulphate Water Protection & Sustainability Branch Environmental Sustainability and Strategic Policy Division BC Ministry of Environment 1-55

Nagpur, Maharastra (India), 100-106.

Orpin, A.R., Ridd, P.V., Thomos, S., Anthonnny, K.R.N., Marshall, P. and Oliver, J. 2004. Natural turbidity variability and weather forecasts in risk management of anthropogenic sediment discharge near sensitive environments. *Marine Pollution Bulletine.,* 49 (7-8), 602-612

Padhi, M. and Padhi, 1999. Phytoplanktonic community of Gopalpur estuary. Seaweed Research and Utilisation Association, 21 (1&2):95-97

Paul, V.I. 1995.Histopathological analysis of the toxicity induced by the inorganic fertilizer ammonium sulphate in the skinand accessory respiratory organ of the air breathing catfish *Heteropneustesfossilis*. *Ph.D. Thesis,* Banaras Hindu University, Varanasi, India, 1-75.

Pillai, M. 1994. Hydrobiological investigation on the intertidal diatoms of the CuddaloreUppanar estuary (India). Ph.D. Thesis, Annamalai University, India, 1-159.

Pimentel, R., and R.V. Bulkley, 1983. Influence of water hardness on fluoride toxicity to rainbow trout. *Environ. Toxicol. Chem.,* 2:381–386.

Prakash, N.J. 2004. Studies on groundwater quality of Magaditaluk, Bangalore rural district, Karnataka. Ph.D. Thesis, Kuvempu University, India, 35-48.

Rajaram, R., M. Srinivasan and M. Rajasegar, 2005. Seasonal distribution of physic-chemical parameters. In effluent discharge area of Uppanar estuary, Cuddalore, South-east coast of India. *J. Environ. Biol*., 26: 291-297.

Rajasegar, M. 2003. Physico-chemical characteristics of the Vellar estuary in relation to shrimp farming. *J. Environ. Biol.,* 24: 95-101.

Raman, A.V. 1995. Pollution effects in Visakhapatnam harbour, India: An overview of 23 years of investigations and monitoring. *Helgolander Meeresuntler Suchungen,* 49: 633-645.

Rui A. S. Lapa*, José L. F. C. Lima and Ivone V. O. S. Pinto 2000. Sequential injection analysis determination of sulphate in wastewaters by ultraviolet-spectrophotometry,*J. Braz. Chem.Soc.,* 1- 11

Sampathkumar, P. and Kannan, L. 1998.Seasonal variations in physico-chemical characteristics in the Tranquebar, Nagapattinam region, south east coast of India. *J. Fisher.,* 45(3): 321-329.

Sanchez, E., Colmenarejo, M.F., Vicente, J., Rubio, A., Garcia, M.G., Travieso, L. and Borja, R. 2007.Use of the water quality index and dissolved oxygen deficit as simple indicators of watersheds pollution. *Ecological Indicators* 7 (2), 315-328.

Santhi, K. 2012. Comparative ecotoxicological profiling of Uppanar estuary, Cuddalore and Killai backwater with special reference to the green mussel Perna (=Mytilus) viridis. M.phil thesis, Annamalai University, 1-2.

Satpathy, K.K. 1996. Seasonal distribution of nutrients dissolved trace metals in the coastal waters off western Bay of Bengal. *Indian J. Mar. Sci.,* 19: 206-211.

Shahidul Islam, M. and Tanaka, M. 2007. Impacts of pollution on coastal and marine ecosystems including coastal and marine fisheries and approach for management: a revieve and synthesis. *Marine pollution Bulletin,* 48 (7-8), 624-649.

Singh, H.P., Mishra, J.P. and Mahaver, L.R. 1999 a. Observation on biochemical and chemical oxygen demands of certain polluted stretch of river Ganga. *J. Environ. Biol.*, 20(2): 111-114.

Singh, N.K., Kumar, B. and Singh, S.K. 1999 b. Impact of industrial and sewage wastes on water qualities in middle stretch of river Ganga from Kanpur to Varanasi.*J. Environ. Biol.,* 20(3): 279-285.

Sithik, M.A., Thirumaran, G., Arumugam, R., Ragupathi Raja Kannan, R.R. and Anantharaman, P. 2009. Physico-chemical parameters of Holy places Agnitheertham and Kothandaramar Temple; Southeast Coast of India. *American – Eurasion J. Sci. Res.,* 4(2): 108-116

Skjelkvåle, B.L. 1994. Factors influencing fluoride concentrations in Norwegian lakes.*Water Air Soil Pollut.,* 77(1–2):151–167.

Smayda, T.J. 1997. Harmful algal blooms: their ecophysiology and general relevance to phytoplankton blooms in the sea. *Limnology and Oceanography,* 42 (5, part 2), 1137-1153.

Smith, L.R., T.M. Hailstone, N.C. Bay, R.M. Block, and A.B. De Leon. 1985. Studies on the acute toxicity of fluoride ion to stickleback, fathead minnow, and rainbow trout. *Chemosphere*, 14:1383–1389.

Soundarapandian, Premkumar and Dinakaran, 2009. Studies on the physic- chemical characteristic and nutrients in the Uppanar estuary of Cuddalore, south east coast of India, *Current Research Journal of Biological Science*, 1(3):102-105.

Sundaramanickam, A., Sivakumar, T., Kumaran, R., Ammaiappan, V. and Velappan, R. 2008.A comparative study of physic-chemical Investigation along Parangipettai and Cuddalore Coast. *J of Environmental Science and Technology*, 1(1):1-10.

Train, A. 1978. Quality criteria for water.U.S.EPA, Washington D.C., Castle. House Publications Ltd., 1-256.

Warrington, P.D. 1990. Ambient water quality criteria for fluoride. Technical Appendix. British Columbia Ministry of the Environment, Victoria, B.C.

****