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Nutrients assessment at Ennore backwater: reference to seasonal change.

Evaluación de nutrientes en el remanso de Ennore: referencia al cambio estacional.

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ABSTRACT

Nutrients play a major role in food cycle of aquatic ecosystem. Nutrients such as nitrite, phosphate, silicate and sulphate were analysed at Ennore creek for the period of one year in four station at 2021. Nitrite was varied from 0.005 to 0.12 µg/l. Phosphate was varied from 0.02 to 0.68 µg/l. Sulphate was varied from 1.03 to 38.4 µg/l. Silicate concentration was varied from 0.05 to 1.85 µg/l .All the nutrients were supplied by influx of fresh water during monsoon. Beyond, coal based waste water released from the thermal power stations contain all nutrients in a considerable amount which influence greater the nutrient content of study area.

Keywords: Nutrient assessment, Nitrite, Inorganic Phosphate, Silicate, Suplhate, Ennore backwaters.

RESUMEN

Los nutrientes juegan un papel importante en el ciclo alimentario del ecosistema acuático. Se analizaron nutrientes como nitrito, fosfato, silicato y sulfato en Ennore Creek durante un período de un año en cuatro estaciones en 2021. El nitrito varió de 0,005 a 0,12 µg/l. El fosfato se varió de 0,02 a 0,68 µg/l. El sulfato se varió de 1,03 a 38,4 µg/l. La concentración de silicato varió de 0,05 a 1,85 µg/l. Todos los nutrientes fueron suministrados por la afluencia de agua dulce durante el monzón. Más allá, las aguas residuales a base de carbón liberadas de las centrales térmicas contienen todos los nutrientes en una cantidad considerable que influye en mayor medida en el contenido de nutrientes del área de estudio.

Palabras clave: evaluación de nutrientes, nitrito, fosfato inorgánico, silicato, sulfato, remansos de Ennore.

INTRODUCTION

Urban and inland wastewaters contain high concentrations of nutrients. They discharge of nitrogen and phosphorus at various inorganic forms to coastal waters. They stimulate aquatic plant growth and phytoplankton. Estuaries could receive more nutrient inputs per unit surface area than any other type of ecosystem. More than

1,000-fold greater than those of heavily fertilized agricultural fields (Nixon et al. 1986). They result in increased production of phytoplankton (the microscopic algae floating in water), which in turn can lead to increased production of fish and shellfish (Nixon 1988, Hansson and Rudstam 1990, Rosenberg et al. 1990). However, excess nutrients can be leading to effects such as anoxia and hypoxia end up with eutrophication which in turn affect the seagrasses and corals, and reduced populations of fish and shellfish (Ryther 1954, 1989; Kirkman 1976; McComb et al. 1981; Kemp et al. 1983; Cambridge and McComb 1984; Gray and Paasche 1984; Officer et al. 1984; Larsson et al. 1985; Price et al. 1985; Rosenberg 1985; D'Elia 1987; Baden et al. 1990; Cederwall and Elmgren 1990; Hansson, and Rudstam. 1990.). Optimized nutrients are helpful to the ecosystem in a healthy status and normal function.

MATERIAL AND METHODS

Study area: Ennore estuary is a backwater located along the Coromandel Coast of the Bay of Bengal near Chennai, Tamilnadu. It is a peculiar geomorphological structure, formed as a brackish water lagoon which nearly 400 meter wide, extended parallel creek up to Pulicat Lake in Northeast–Southwest direction with the opening to the Bay of Bengal. The creek covers an area of 2.25 sq.km and the ecosystem spreads up to 8 sq.km. The creek area stretches its arm 3 km from the sea. The depth of the creek varies from 1 to 2 meter. Twenty three industries releases its discharges into creek water. The North Chennai Thermal Power Station and the Ennore Thermal Power Station are the important industries which release coolant water to the creek. As per the 1991 Coastal Regulation Zone notification, the entire creek water system is designated CRZ I. Still, the treated and untreated municipal and industrial wastewaters such as raw municipal sewage, industrial trade effluents, industrial cooling waters, oil from boat repairs, fish cleaning wastes etc., are discharged to the Ennore Creek and ultimately reached to the coastal waters. The present study was carried out four sampling stations which was identified (Study area Fig.1) by GPS for sampling and assessment of hydrobiological parameters. GPS values to the respective stations are given in the table 1.

Table. 1 Sampling stations and its GPS positions

Stations	Latitude	Longitude
Station 1	13^{o} 13’ 35.61”	80^{o} 19’ 14.28”
Station 2	13^{o} 14’ 14.07”	80^{o} 18’ 59.87’’
Station 3	13^{o} 15’ 45.38”	80^{0} 19’ 17.73’’
Station 4	13^{o} 16’ 10.3”	80^{0} 19’ 18.06”

Methodology: Water Samples were collected in four stations in Ennore creek on monthly basis for the period of one year from January to December 2021 at distinct stations. The samples were collected using clean plastic bottles and brought to the laboratory for further analysis. The following parameters were analysed

Table2. List of hydrobiological parameters assessed in Ennore Back waters

S. No	Parameters
1	Nitrite
2	Inorganic Phosphate
3	Sulphate
4	Silicate

Nutrients such as Nitrate and Nitrite were estimated by Wood *et al.,* (1967) where amalgamated cadmium filings column was used to reduce the nitrate to nitrite. Inorganic phosphate, reactive silicate and sulphate were determined using the method of Strickland and Parson, (1968).

Statistical analysis

Coefficient of correlation: Coefficient of correlation (r) was performed to understand the relationship between the various parameters by showing their positive, negative correlation. It was performed using Microsoft Excel (Version 2013, USA).

Principal component analysis: PCA is a powerful pattern recognition tool that attempts to explain the variance of a large dataset of intercorrelated variables with a smaller set of independent variables (Simeonov et al. 2003). PCA technique extracts the eigenvalues and eigenvectors from the covariance matrix of original variables. PCA is designed to transform the original variables into new, uncorrelated variables (axes), called the principal components, which are linear combinations of the original variables. The new axes lie along the directions of maximum variance (Shrestha and Kazama 2007). It reduces the dimensionality of the data set by explaining the correlation amongst a large number of variables in terms of a smaller number of underlying factors, without losing much information (Vega et al. 1998). The PCA can be expressed as

$$Z_{ij} = pc_{i1}x_{1j} + pc_{i2}x_{2j} + . . . : pc_{im}x_{mj}$$

Where z is the component score, pc is the component loading, x is the measured value of the variable, i is the component number, j is the sample number, and m is the total number of variables. PCA was analysed through PAST 3 statistics software.

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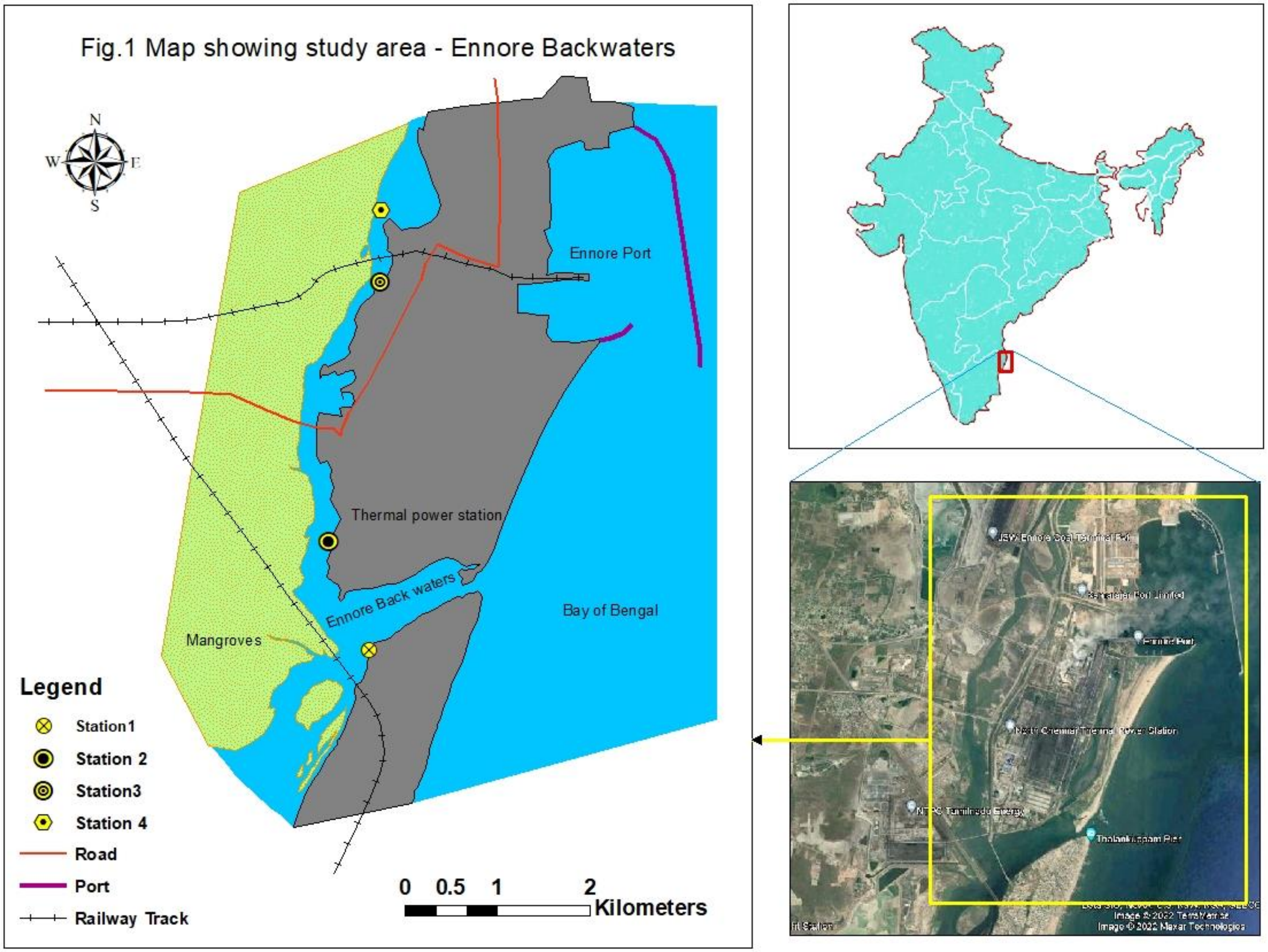

Fig.1 Map showing study area - Ennore Backwaters

RESULT AND DISCUSSION

Nutrients are essential to coastal ecosystems (Bricker and Stevenson, 1996) and its supplement and distribution based on freshwater flow, seasons and tidal conditions (Kamalkanth *et al.,* 2012). Nutrients such as nitrite, inorganic phosphate, silicate and sulphate were analysed in Ennore creek.

Nitrite was varied from 0.005 to 0.12 µg/l and the mean value of 0.031 µg/l (Fig.2). During the study, the peak values of nitrite noticed during the post monsoon could be attributed to the influence of seasonal flood, accumulation of nutrients through monsoonal inflow, oxidation of ammonia, reduction of nitrate and bacterial decomposition of detritus (Swami *et al.,* 1996; Kannan and Kannan, 1996; Govindasamy *et al.,* 2000; Ashok Prabhu *et al,* 2008 and Sundaramanickam, 2008). However, the prominent reason for the nitrite elevation at Ennore creek due to the supplement of nutrients by monsoonal inflow and prevalence of less saline condition. The less value of nitrite during summer could be due to less freshwater inflow, higher salinity which might have hindrance the process of nitrification (Mani and Krishnamurthy, 1989; Gadhia *et al.,* 2012) which is confirmed by correlation coefficient analysis stated that salinity (salt concentration) and nitrite are negatively correlated (r=-0.0489, Fig.6). Despite, the higher temperature during summer support the proliferation of nitrifying bacteria (Nitrosomonas, Nitrosospira, Nitrosococcus sp) (Water Environment Federation, 1998), salt concentration may prevent the bacterial growth and ultimate reduction of nitrite content in the water. It is confirmed through PCA analysis that surface water temperature and nitrite are single component and salinity fallen in other group. Similar pattern of nitrite variation were reported earlier by Sundaramanickam *et al.,* (2008) from Parangipettai and Cuddalore coast; Manikannan *et al.,* (2011) from Great Vedaranyam swamp, Point Calimere wildlife sanctuary. But, nitrite content in the present investigation is lesser than the other coastal areas. Station 3 noticed to be high content nitrite might be the reason of waste water released from the out let of thermal power station which have content of nitrogen compounds. Coal usually contains between 0.5 and 3 percent nitrogen on a dry weight basis.

Inorganic phosphate acts a limiting nutrient in the coastal ecosystem. Phosphate was varied from 0.02 to 0.68 µg/l (Fig. 3) with the mean value of 0.224 µg/l . During the study, inorganic phosphate was lower in summer and higher in monsoon. The high content of inorganic phosphate is noticed during monsoon season might possibly be the weathering of rocks, soluble alkali metal phosphates, carried by the water runoff to the creek. It is confirmed in correlation coefficient analysis stated that phosphate is positively correlated with sulphate and silicate (r=0.6455, 0.5618, Fig. 6) which are together supplied through allochthonous freshwater inflow. True to this, PCA grouped phosphate, silicate and monsoon seasons as single component (Fig.7). Sometimes, upwelling seawater into the Ennore creek, which increased the level of phosphate in a minimum gradient (Nair *et al.,* 1984; Ashok Prabhu *et al.,* 2008) when the Bay of Bengal peturbated at East wind drift. Further, regeneration and release of available residual phosphorus from bottom mud into the water column by turbulence and mixing could led increased content in the Ennore creek by strong water current (Chandran, 1982; Saravanakumar *et al.,* 2008 and Prabhahar *et al.,* 2011) during monsoon. Low content of phosphate during summer could be attributed to the limited flow of freshwater, less leaching of bottom sediments and utilization of available phosphate nutrients by the planktonic communities (Senthilkumar *et al.,* 2002 and Gadhia *et al.,* 2012) and also lacking of sources based contribution. Summer with low concentration of phosphate was recorded by other workers by a similar reasons *by* Kathiravan, (2013), Gadhia *et al.,* 2012 from Tapi estuary in Hazaria region.

Sulphate is the important component of coal which release as residual waste and fly ash from thermal power station and Ennore creek is the dumping backwaters which drain into coastal waters. Sulphate was varied from 1.03 to 38.4 µg/l (Fig.4) and it was high during monsoon and low in summer. Sulphate increases where *p*H can be neutral or acidic. Temperature, salinity inversely correlated with sulphate distribution. Hence, elevated sulphate content during monsoon season attributed to the release of coal based waste to Ennore creek where tidal water and influx of fresh water augment the dissolvation and distribution in a greater level resulting high concentration of sulphate and reversed condition prevailed in summer led to low level of sulphate (Anitha and Sugirtha Kumar, 2013).

Silicate is another important nutrient to the coastal ecosystem. Silicate concentration was varied from 0.05 to 1.85 µg/l (Fig.5). Silicate content was high in monsoon and low in pre monsoon. High content of silicate in monsoon was contributed by allochthonous sources of monsoonal land drainage carrying silicate which leached out from rocks and other sources along with phosphate. It is confirmed by PCA and correlation coefficient analysis (r=0.5617, Table 3; Fig. 6) (Ashok Prabhu *et al.,* 2008, Fanning and Pilson, 1973). Furthermore silicate available at the bottom sediments as a residual deposits might dissolved into the overlaying waters when the bottom is agitated by strong water current (Rajasegar, 2003 and Sundaramanickam *et al.,* 2008, Govindasamy and Kannan, 1996; Stephens and Oppenheimer, 1972; Choudhury and Panigrahy, 1991 and Chandran and Ramamoorthi, 1984). This process might be prevalent during monsoon season. Low concentration during pre-monsoon season could be the reason of ceasing the allochthonous sources and the up taking silicates by phytoplankton for their biological activity (Sujatha Mishra *et al*., 1993; and Prabhahar *et al.,* 2011). Similar distributional study carried out by Ashok Prabhu *et al.,* (2008) from Pichavaram mangroves; Prabhahar *et al.,* 2011 from Kadalur coastal zone, and Damodharan *et al.,* 2010 in Point Calimere coastal water.

Table 3. Correlation coefficient matrix between hydrobiological parameters at Ennore backwaters

	Phosphate	Nitrite	Sulphate	Silicate
Phosphate	1			
Nitrite	-0.00898282	1		
Sulphate	0.6454836	-0.185142418	1	
Silicate	0.56178701	0.246517253	0.295336	1

Fig. 2 Distribution Nitrite in the study area

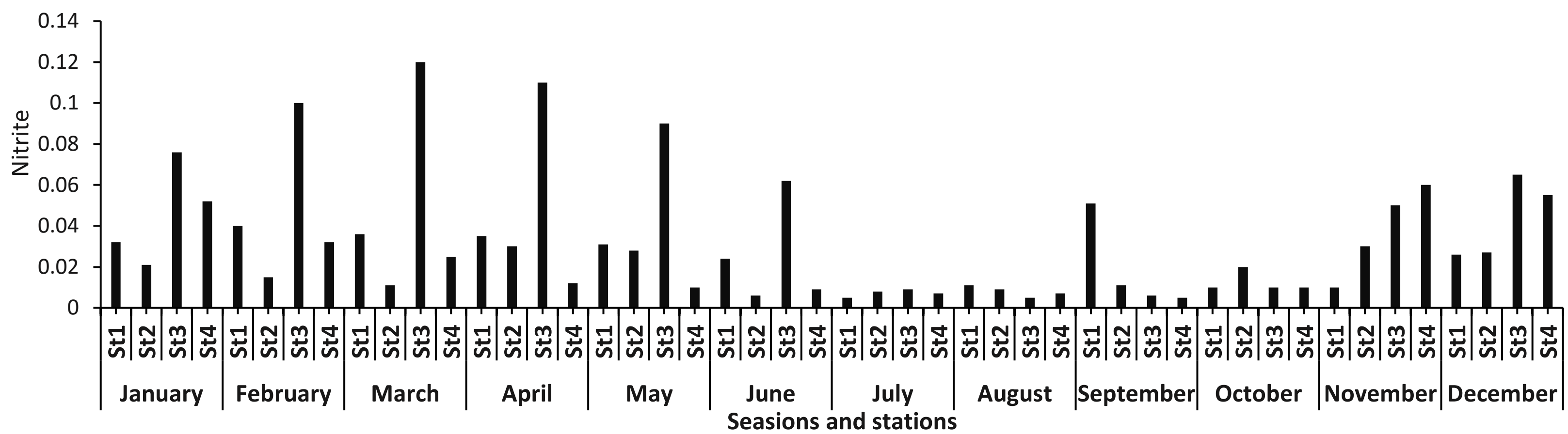

Fig. 3 Distribution Inorganic Phoshate in the study area

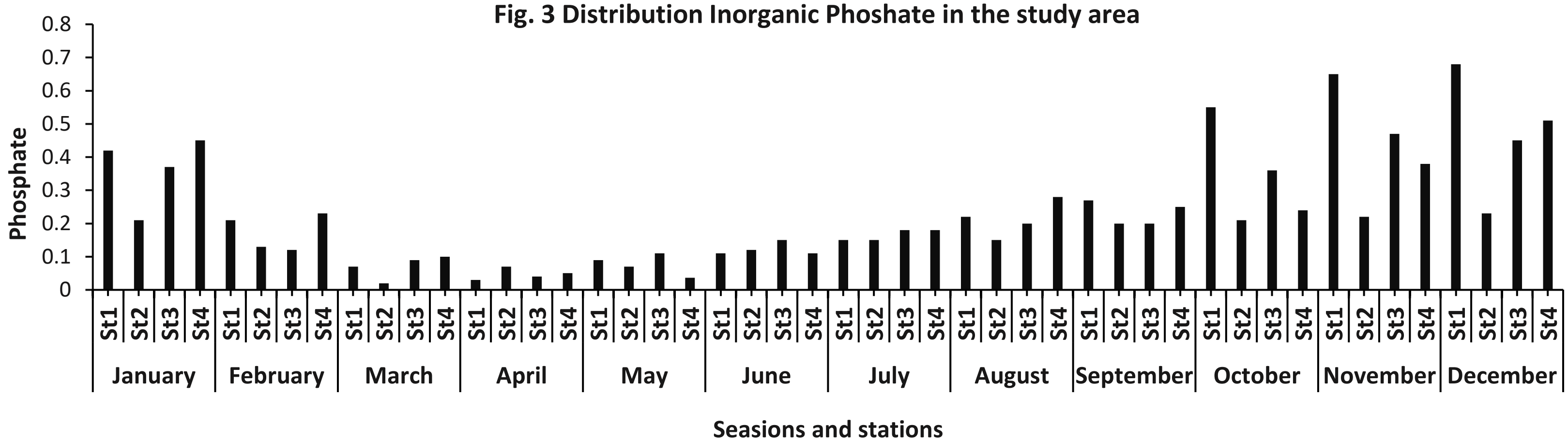

Fig. 4 Distribution Sulphate in the study area

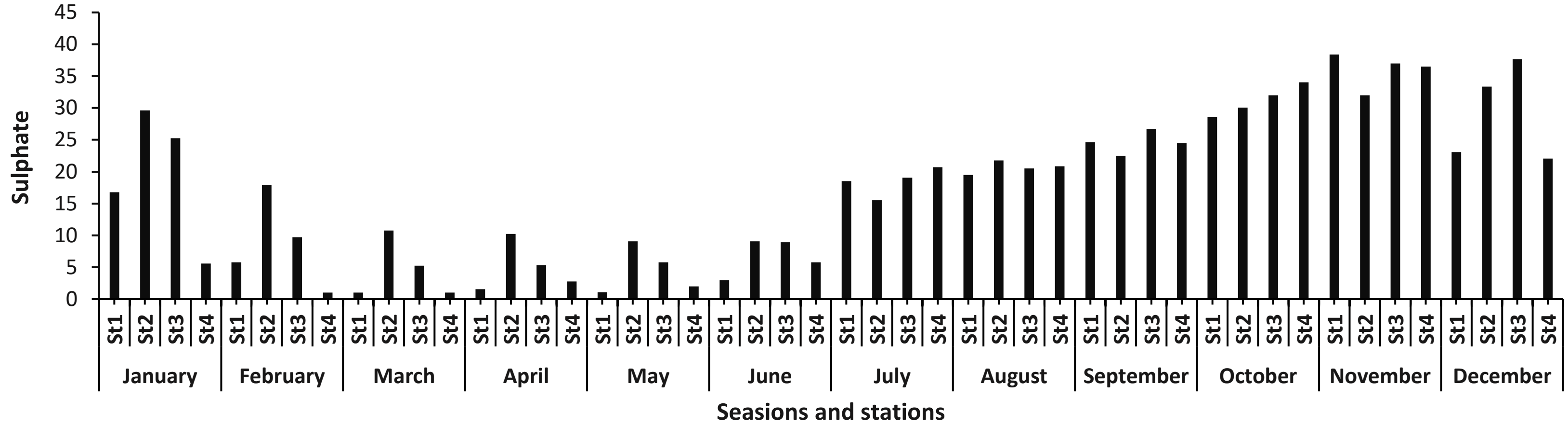

Fig. 5 Distribution of Silicate in the study area

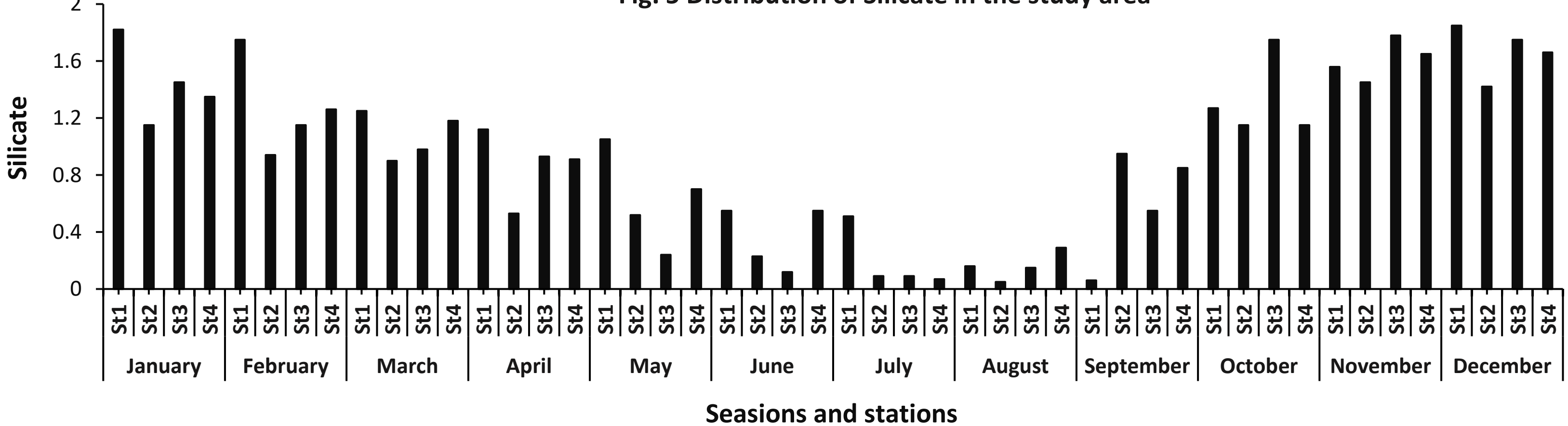

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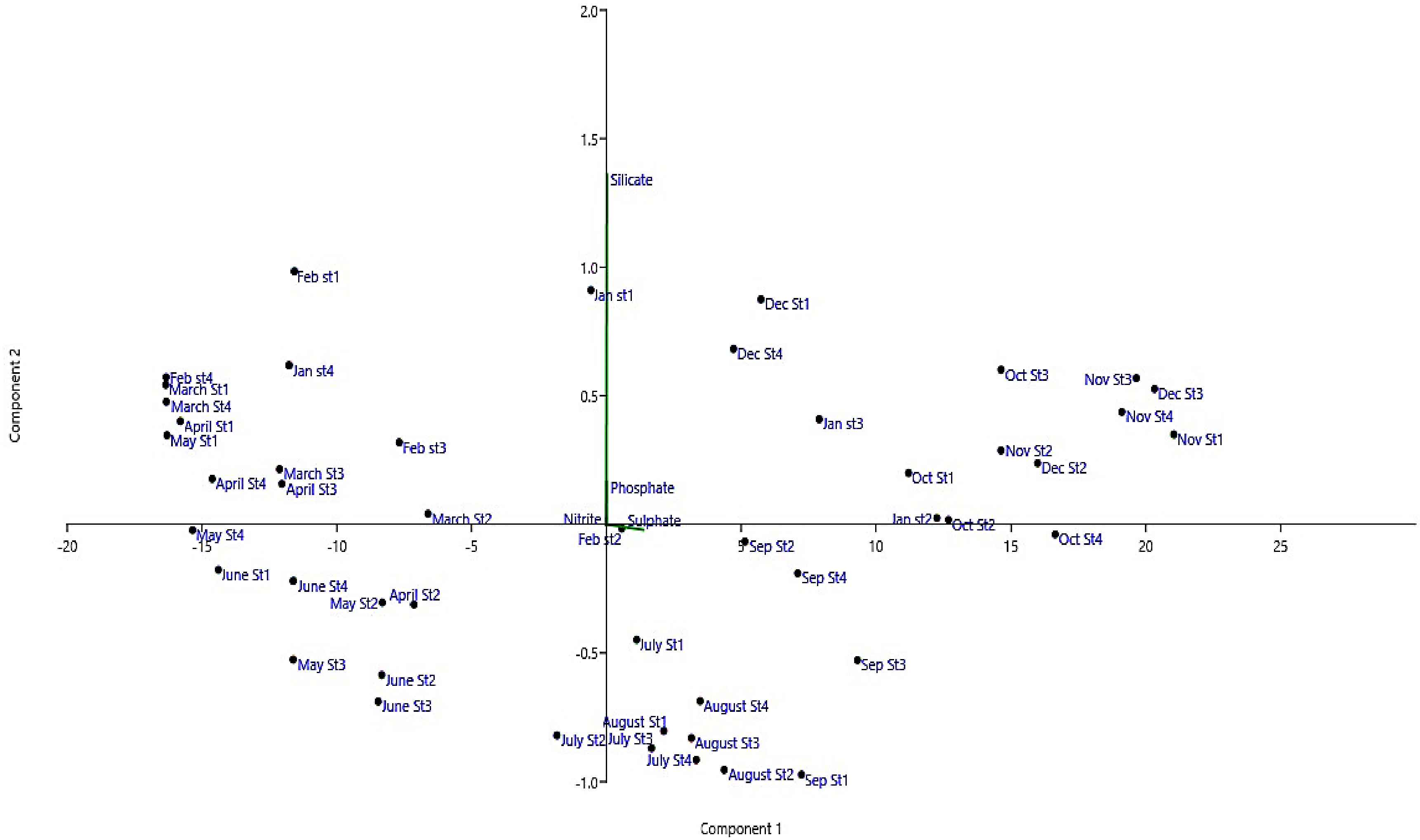
Fig 6. Principal component analysis between stations, seasons and nutrients parameters



As conclusion, nutrients such as nitrite, phosphate, silicate and sulphate were analysed at Ennore creek. All the nutrients were supplied by influx of fresh water during monsoon. Beyond, coal based waste water released from the thermal power stations contain all nutrients in a considerable amount which influence greater the nutrient content of study area. More nutrients led to eutrophication which could found in Ennore backwaters .

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