Hydrochemistry study on Thengapattanam estuary, southwest coastal zone, Tamilnadu, India

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Abstract:

Estuaries are miraculous ecosystems making the complexity of the operating forces of both marine and fresh water. The physicochemical factors are constantly fluctuating in such ecosystem. It is important to assess the water quality parameters to determine the extent of pollution faced by a system. Estuaries are transition zones, where fresh water from river and marine water from sea mixes. Estuaries show the balance of forces between marine and fresh water, greatly influence the growth and distribution of living organism in this system. The present study has been undertaken to enlighten the influence of domestic sewage, agricultural runoff and coconut retting wastes on the Water samples were analysed for physico-chemical parameters including pH, turbidity, electrical conductivity, total hardness, dissolved oxygen , BOD and anions were analysed like Ca, Mg, NO_3^- , and Cl^- during the different seasons of monsoon period from June - April (2021-2022). surface water temperature varied from 26.2 to 29.4°C respectively. Salinity varied from 0.5 ‰ to 11‰. pH remained alkaline throughout the study period in all the stations with maximum value during summer and minimum during post monsoon. Higher dissolved oxygen concentration was observed during monsoon season might be due to the cumulative effect of higher wind energy coupled with heavy rainfall and river inflow. BOD was high during summer season and low during post monsoon season. Concentration of nutrients showed significant spatial and temporal variations and their levels in water increased during rainy season.

Keywords: Physicochemical factors, Estuaries, Salinity, turbidity.

Introduction:

Water is a precious substance, which plays a vital role in our daily life. Fresh water sources such as rivers, lakes, wells, ponds and streams are used for industrial and 27 developmental projects, agricultural, irrigation processes and human activities. Nowadays, surface water bodies are under threat due to contamination of organic as well as inorganic pollutants. Due to the lack of proper sewage drainage system, wastewater directly enters into surface water systems. There was no systematic way of disposal of solid garbage and domestic waste, which directly enters into local rivers. Rivers due to their role in carrying industrial, domestic waste and agrochemical waste in their vast drainage basins are among the vulnerable water bodies to pollution (Singh et al., 2005; Koklu et al., 2010).

Estuaries are effective ecosystem subject to changeable environmental conditions like tidal amplitudes and salinity. Industries and respositories for many effluents were the sites of estuaries. Land use and climate with geology are the ultimate determinants of water quality which become modify the ecosystem (Zolina et al., 2010). Estuarine and coastal areas are

complex and dynamic aquatic environment. When river water mixes with sea water, large numbers of physical and chemical processes take place which may influence water quality. River plays a major role in assimilation of municipal ,industrial waste water and agricultural lands. To establish the spatial and temporal variations in water quality, regular monitoring programs are required. Also the health status and biological diversity of Indian estuarine ecosystems are deteriorating day by day through man made activities such as dumping of domestic sewage and industrial effluents into estuaries which has resulted in a drastic reduction of shallow water fish population and disappearance of numerous flora and fauna The hydrobiological parameters were used to determine the composition of biological organisms. Many studies were made on the physical and chemical variations of Indian estuaries (Gadhia et al., 2012).

Estuaries are often contaminated with a range of organic and inorganic contaminants. Sources of environmental contaminants to the coastal system are numerous. They enter the estuarine system through different pathways mainly rivers. Contaminated sediments may be directly toxic to aquatic life or through bio accumulation. The biomagnification can cause long term chronic effects (Swartz et al., 1985).

The overall aim of the present study is to obtain a general assessment of the relative load and type of pollutants and their effects in the estuary by coconut husk retting effluents, domestic sewage and agriculture wastes.

Study area

Kanyakumari is a small district with a geographical area of 1687 Sq.km. The district is situated to the north of the equator between 8.030 and 8.880 and between 77.050 and 77.360 east latitude . The district is named after the goddess “Kanyakumari”. The district constitutes the southernmost tip of India with Kerala on the Northwest, Tirunelveli district in the Northeast, Arabian Sea in the west, and Bay of Bengal in the east and Indian Ocean in the south. The elevation of the district from the sea level is 18.29 meters .The district receives good rainfall distributed throughout the year. It has three small rivers, the Thamaraparani, the Pazhayar and the Valliyar. All the rivers originate from the southern most hill ranges of the Western Ghats. The district has more than 3000 ponds, rain fed, irrigated and spring fed with an irrigation system which dates back from over thousands of years which make this district a fertile one. In Kanyakumari district nearly 1000 hectare of estuarine environment could be identified as potential for fisheries resources. There are three important riverine ecosystems, which confluence with Arabian Sea. They are, 1. Manakudy estuary 2. Rajakamangalam estuary and 3. Thengapattanam estuary

Thengapattanam estuary is located in the south west coast of India 10 km from Marthandam. It is one of the minor estuary in Kanyakumari district, Tamil Nadu formed by the confluence of Tampirabarani river (locally known as Kuzhithuraiar) with Arabian sea in between Thengapattanam and Eraiummanthurai (7°53' N latitude and 77°07' E longitude). (Sundresan Perumal et al 2016)

Station 1: was fixed at a distance of 3.5 km away from the sea towards the river Tamirabarani. The station was characterized by a 36 coconut tree, clayey sediments and boat repairing yard.

Station 2: located 1 km away from station I towards the sea and the station was characterized by sandy silt sediments, human activities of dumping the sewage and using the place as a public latrine.

Station 3: fixed 1 km away from station II, it was fixed the bar mouth region. The bar mouth with dynamic human activities of dumping of sewage, drying fish and direct discharge of municipal wastes.

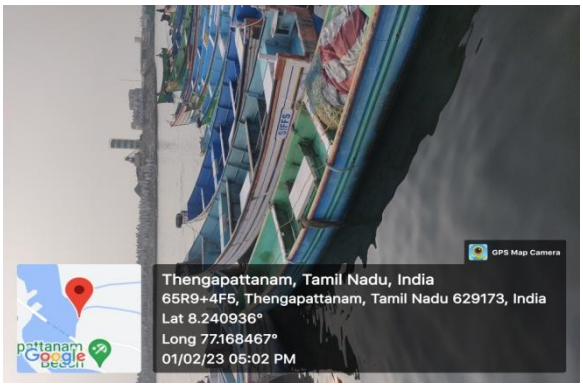
Station 4 and 5: The Station IV and V were fixed the sea area, the sampling stations were chosen at a distance of about half to one kilometer apart from each other.

Station 1

Station 2

Station 3

Station 4



Station 5

Sample collection

For the present study five different locations were selected and water was collected for a period of eleven months starting from June 2021 to April 2022 covering the monsoon (June-September), post-monsoon (October-January), and premonsoon (February-April) seasons. Samples were collected in pre cleaned two litre polythene cans every month. The cans were cleaned with concentrated HNO_3, washed thoroughly with tap water to remove acid content and rinsed with distilled water, finally rinsed with water samples.

For the estimation of dissolved oxygen, samples collected in separate bottles. Oxygen fixation done at the spot for the estimation of dissolved oxygen. Physicochemical characteristics such as atmospheric temperature, water temperature, turbidity, pH, electrical conductivity, TDS, Alkalinity, Total hardness, dissolved oxygen, BOD, nitrite, nitrate, ammonia, sulphate, phosphate, calcium, magnesium, sodium, potassium, chloride and fluoride were estimated for the collected samples.

Atmospheric temperature and water temperature were measured on the site using mercury thermometer. The samples were analysed for different parameters pH was measured using digital Elico pH meter. Salinity and EC were measured by Erma hand refractometer and digital conductivity meter. Dissolved oxygen was fixed immediately after collection and then determined by Winkler's method, Flame photometer was used for the determination of metal ions Na, K, Ca etc(APHA1998).Total hardness was calculated by complexometric titration using EDTA (Vogel 1978).Nitrite, nitrate, phosphate were measured according to the standard procedure(APHA 1998) . Turbidity was determined by using turbidity meter. Alkalinity of water

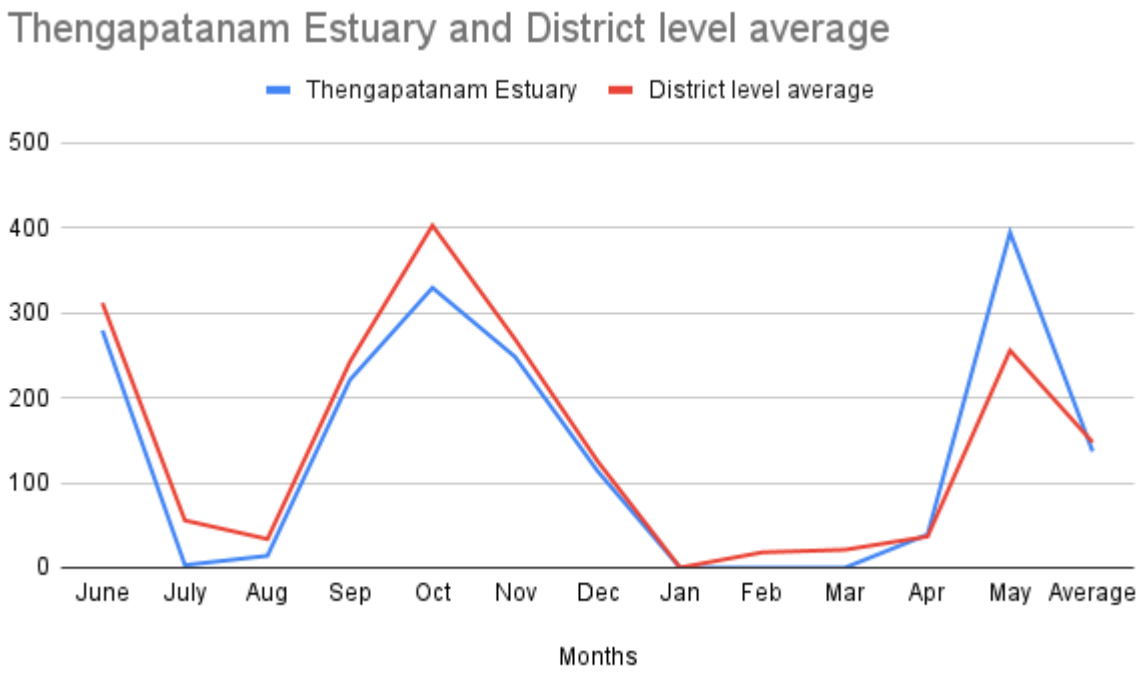
sample is determined by titration with standard acid and ammonia was determined by direct nesslerisation method.

Results and Discussion

The maximum rainfall (394.4mm) were recorded in the month of May and minimum rainfall (3.00 mm) was noted in June

Rainfall obtained in Thengapattanam estuary and district level average

Months	Thengapatanam Estuary	District level average
June	279.2	311.5
July	3	55.6
Aug	14	33.7
Sep	221	242.2
Oct	329.4	402.7
Nov	248.2	269
Dec	113.8	125.4
Jan	0	0.1
Feb	0	18.07
Mar	0	21.1
Apr	39	36.67
May	394.4	255.6
Average	136.83	147.64



Station wise monthly variation showed that at station I temperature ranges between 31.1^{o}C to 26^{o}C, at station II highest 28^{o}C, recorded in May and lowest 26.1^{o}C during monsoon season.

Station III recorded highest 28^{o}C and lowest26.3^{o}C. At station IV maximum temperature (28.1^{o}C) was recorded in May and minimum 26.5^{o}C in July. Highest water temperature 28.5^{o}C recorded in the month of May during pre monsoon season and lowest temperature (26.5^{o}C) in the month of July during monsoon season at station V. Lowest value of water temperature was recorded at station I in the post monsoon season and highest water temperature at station V in the pre-monsoon season.

The pH is the measure of hydrogen ion (H^{+}) concentration of a solution. It is the measure of the intensity of acidity or alkalinity of the sample. The pH of water samples ranges from 6.9 to 7.47. Due to the mixing of fresh water with sea water, the estuary station shows slightly alkaline pH.

Conductivity measurement gives an idea about the ionic concentration of water samples. In the present study the highest value of electrical conductivity was observed in samples from station (I) in pre-monsoon season. Station I shows higher values in all seasons compared to other stations. Lowest value was observed in station V in the monsoon season. Higher conductivity values obtained for estuary station may be due evaporation, high salinity or variation in the discharge of river water. Number of studies explained the higher values of electrical conductivity in estuaries

Turbidity is due to the scattering of light on particles that dissolved or suspended in water. Maximum turbidity (56NTU) noticed at station II in the month of August during monsoon season and minimum (2NTU) recorded at station Iin March during pre-monsoon season.

TDS is the presence of dissolved minerals in water samples. The present study indicates higher values of TDS in the station I in the pre-monsoon season. The lowest value was seen in station V in the monsoon season. There are number of studies which indicate higher values of TDS in estuaries during pre-monsoon season.

Lowest value of alkalinity was recorded at station V in monsoon season and the highest value of alkalinity was recorded at station I in the pre-monsoon season. Alkalinity observed for different station at the three seasons shows that all the values are under acceptable limit.
Hardness is due to the presence of bicarbonate, chloride and sulphate of calcium and magnesium ion.

The highest value of total hardness is found in station (I) in pre-monsoon season and lowest value of hardness was seen at station V during monsoon season. Estuary station shows higher values in all three seasons.

Certain concentration of dissolved oxygen is required for the support of aquatic life. Comparatively higher value (6.93 mg/l) of Dissolved Oxygen was observed in post- monsoon season in station (V) and lowest value (5mg/l) was found in station I in the monsoon season. Low value of dissolved oxygen may be due to the addition of high organic content leading to oxygen depletion.

Biochemical oxygen demand is the amount of free oxygen required by bacteria for the biological oxidation of organic matter in water. station I in the month of March during pre-monsoon season and minimum value (2mg/l) of BOD was recorded at station IV in the month of October during post- monsoon season.

Nitrite is naturally present in the soil by the addition of nitrogen containing fertilizers. During heavy rainy season nitrite leached into surface water. Highest amount of nitrite (0.92mg/l) recorded at station II in the month of September during monsoon season and lowest value was recorded (0.03mg/l) at station I in the month of April during pre-monsoon season.

Magnesium concentration in river water is usually low but higher concentration may be due to the drainage from agricultural land or from weathering of rocks. Maximum value (110mg/l) of magnesium was measured at station I in the month of April during pre-monsoon season and minimum magnesium value (1mg/l) was recorded at station IV in the month of August during monsoon season and some station in February during pre-monsoon season.

Regarding K minimum was recorded during the monsoon and maximum during the summer season. Regarding station wise variation, station 5 having maximum values due to the mixing of sea water when the sand bar opens during northeast monsoon season

Regarding ammonia nitrogen maximum was observe in the monsoon and post monsoon seasons due to rainfall and the river run off carrying large amount of detritus (Indirani et al 2010).

The seasonal variation shows higher values in station (I) in pre-monsoon season and lowest value of sodium was seen at station V during monsoon season. Station I shows higher values in all seasons compared to other stations.

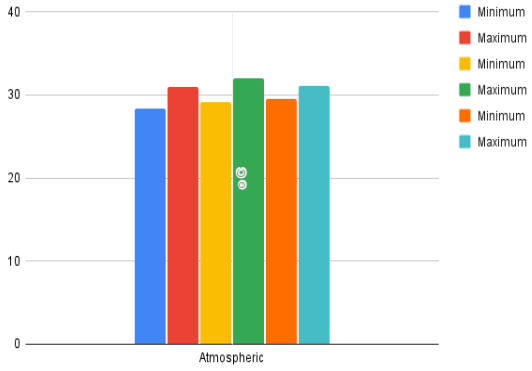
Chloride was found maximum (1816 mg/l) in station I in pre-monsoon season. Lowest value of chlorine (28.5 mg/l) was observed in station V in monsoon seasons. There is an increased concentration of chloride in all seasons in station I. This may be due to the mixing of sea water with river water. In all other stations, the seasonal variations of chloride concentrations are under

Parameters	**Units**	**Post monsoon**		**Pre monsoon**		**Monsoon**	
		Minimum	**Maximum**	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Atmospheric Temperature	^{o}C	28.3	30.9	29.1	32	29.5	31.1
Surface Water Temperature	^{o}C	26.2	29.1	27.6	29.8	27.7	29.8
Turbidity	NTU	29	38	3	19	4	18
Salinity	‰	0.5	6.5	1	7	2	4.5
pH		7.2	7..95	7.2	8	7.3	7..9
DO	mg/L	4.42	7.46	4.1	6.3	4.5	5.3
BOD	mg/L	1.2	3	1.4	3..2	2	3
Total Alkalinity	mg/L	30	56	32	64	36	53

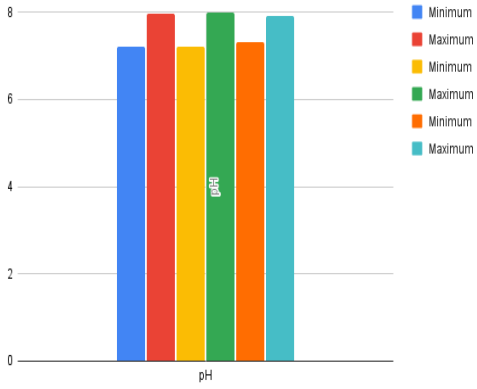
Total hardness	mg/L	300	1660	500	2500	710	1990
Total dissolved solids	mg/L	60	980	78	8200	55	1099
Conductivity	mg/L	110	1452	111	9500	150	3500
Nitrite	mg/L	0.05	0.2	0.07	0.1	0.1	0.5
Magnesium	mg/L	76	1100	74	7896	66	2567
Potassium	mg/L	23	320	42	1180	340	450
Ammonia	mg/L	0.07	1.05	0.3	1.2	0.3	0.9
Sodium	mg/L	270	1000	320	1100	290	450
Chloride	mg/L	23	450	14	2245	18	1678

The result of variation in physical and chemical parameters were presented in the Fig (1-15).

Temperature (fig1)

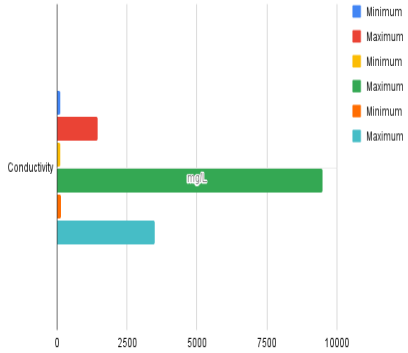


pH (fig2)

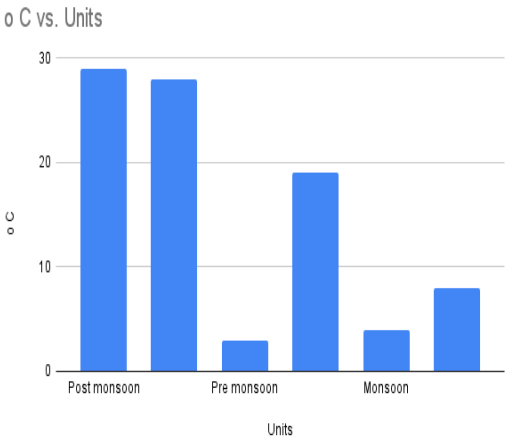


Conductivity (fig 3)

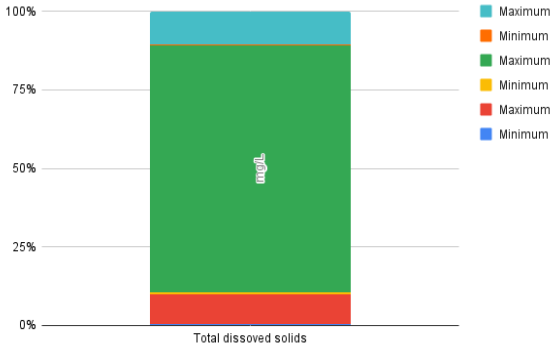
Turbidity (fig 4)



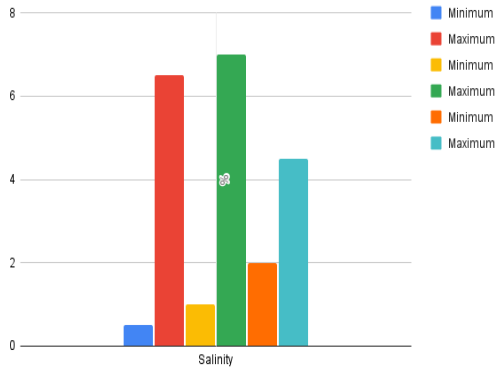
Total dissolved solids (fig 5)



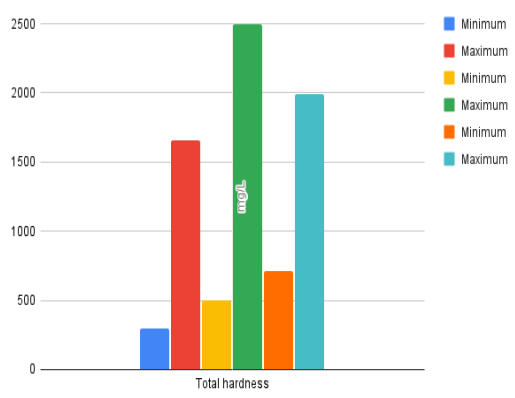
Salinity (fig 6)



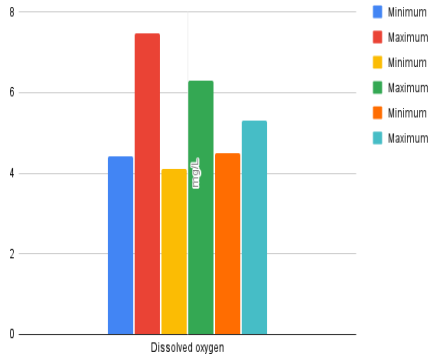
Total Hardness (fig 7)



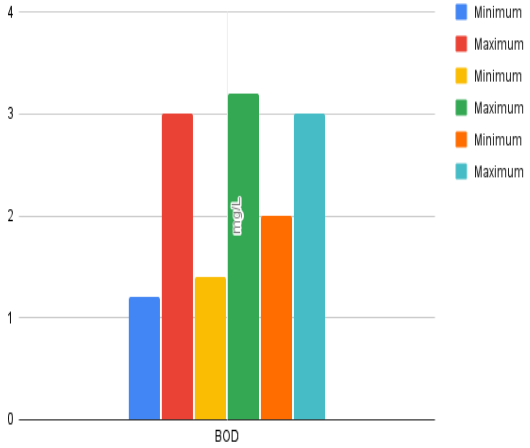
Dissolved Oxygen (fig 8)

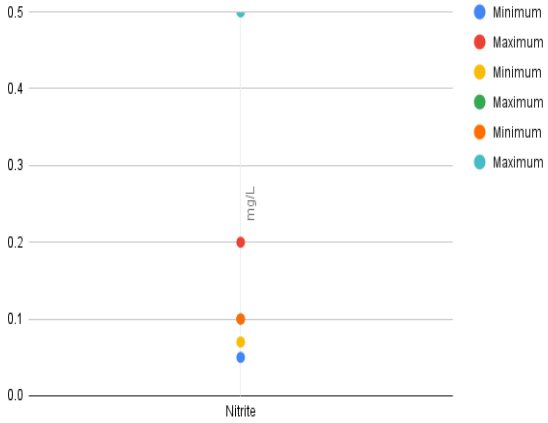


Biological Oxygen demand (fig 9)



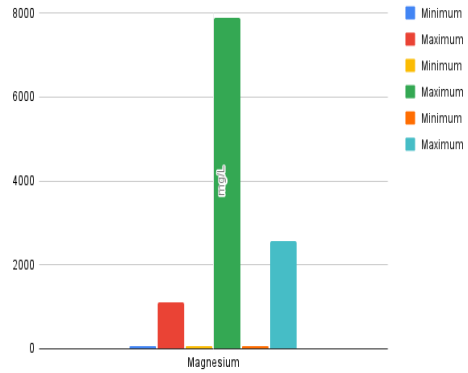
Nitrite (fig 10)

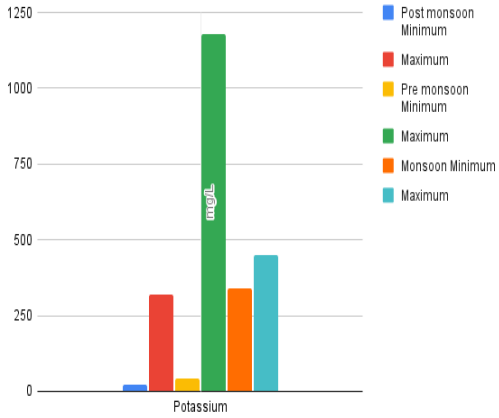




Magnesium (fig 11)

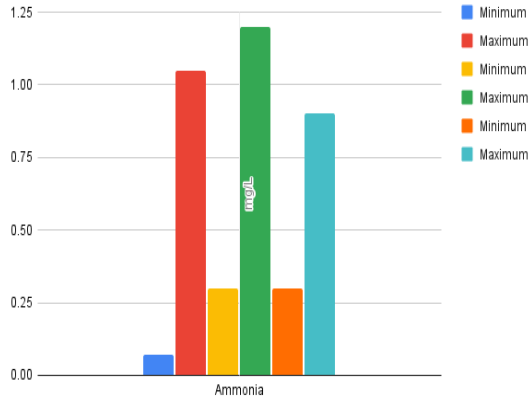
Potassium (fig 12)

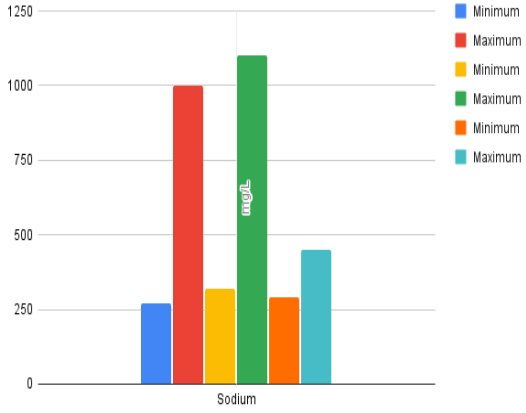




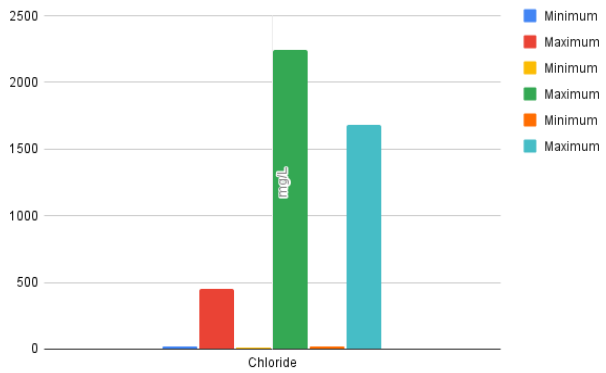
Ammonia (fig 13)

Sodium (fig 14)





Chloride (fig 15)



5. CONCLUSION

The present study investigating climate variation of physicochemical characteristic of Thengapatanam estuary, five different stations were selected and samples were collected. The result obtained indicates that station I shows higher values of electrical conductivity, TDS, Total hardness, Sodium, and chloride, in all seasons throughout the study period compared to other stations. Since it is an estuary station, the variations may be due to over mixing of sea water with fresh water. Water quality parameters vary due to different environmental conditions; geological location, modern agricultural practice and land run off during monsoon seasons. The estuarine region gets more polluted compared to other stations. Higher values obtained for Electrical conductivity, TDS, hardness, chloride and sodium in estuary station may be due natural weathering of rocks, and water pollution due to the discharge of industrial waste , use of agrochemical fertilizers and anthropogenic activities. High concentration of chloride leads to corrosion. Sewage should be properly treated before discharge in to water bodies, otherwise it will leads to serious environmental and health problems.

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