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Physico Chemical and Microbial Characterization of Coastal Area of Kanyakumari, Tamil Nadu, India

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ABSTRACT

The physico-chemical condition and microbiological characterization of the coastal soil of Kanyakumari, Tamil Nadu was examined in the year of 2010. In the present study, the rainfall range varied from 13.8-405.0mm. The temperature varied from 23.4 – 32.7ºC. In the month of April high temperature was recorded. Maximum pH (9.0) was recorded in the month of April and minimum pH (7.8) was recorded in the month of November. The annual mean electrical conductivity was recorded as 0.80±0.314m mhos cm^{-1}. NPK content showed greater fluctuations. The accumulation of heavy metals such as ferrous, manganese, copper and zinc was found in moderate level. The bacterial, fungal and actinomycetes population were high in the month of May. The variation in physico-chemical parameters and microbial load mainly depends on monsoon rains. The fluctuations in physico-chemical parameter influence the natural activity and efficiency of microorganism.

Key words: *physico-chemical parameters, microbiological analysis, NPK content, heavy metals*

INTRODUCTION

The coastal zone, the meeting place of land, sea and air, is a dynamic area with many cyclic and random processes owing to a variety of resources and habitats. Among the total world population, nearly three quarters live near or on the coast. This was found to be true in India also, where there are still sprawling and growing coastal cities with about 7,500km of coast line. A variety of coastal habitats like coral reef, mangroves, seaweeds and sea grass bed, salt marshes, sand dunes, ports, fishing harbours and a number of coastal industries are endowed in Tamil Nadu coast which is nearly 950km long.

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Stress on coastal zone developed by the increasing population combined with other factors often leads to erosion of the coastal areas. The release of metals from solid to liquid phase caused by the changes in environmental conditions, such as temperature, pH, redox potential and organic ligand concentrations. These environmental changes sometimes cause contamination of surrounding waters in aquatic systems[1]. Problems like pollution, siltation, erosion, flooding, salt water intrusion, storm surges and ever expanding human settlements threaten and highly disturb the coastal ecosystem. Coastal regulation is thus a place of hectic human activity, followed by intense urbanization, resulting in human interference because of rapid development. This condition is urged to protect the coastal environment while ensuring its continued production and development. Many countries around the world developed the concept of coastal zone management to combat these problems and to preserve the coastal zone for the future generation. Hence, there arises a need to collect, analyze and assess the data for the effective monitoring and management of the coastal area. Therefore this study is focused to evaluate the above said parameters such as physical parameters, chemical and heavy metal parameters in the Kanyakumari coast, a famous tourist place in this district.

MATERIALS AND METHODS

Sample collection and processing

Collection of sample

Marine soil samples were collected from the coastal area of Kanyakumari, Tamilnadu, India. The sampling site is situated on Latitude 8°14'23.10" N, longitude 77°20'04.02"E and altitude 58.3m.

500g of soil was collected aseptically from 6-10cm depth of coast using a spatula. The soil samples were packed and labeled accordingly in sterile plastic bags which were previously autoclaved and treated with 70% ethanol and immediately transported to the laboratory.

Fig: Sampling station, Kanyakumari

Processing of sample

The samples were air dried aseptically for one week under laboratory conditions. The soil clods were powdered using a mortar and pestle. The entire quantity was passed through 2mm stainless steel sieves. The plant residues

were discarded. Gravels and other content retained on the sieve were measured and the percentage of the samples collected (W/W) were recorded. The soil samples were ground for specific analysis (e.g. organic carbon) and were further passed through 0.2 to 0.5mm sieves and mixed thoroughly before analysis.

Annual rain fall

Rainfall records for every month from January 2010 to December 2010 were collected from the Hydrology Division, Ministry of Agriculture and Water (MAW) and Meteorological Environment and Protection Agency (MEPA).

Analysis of physical parameters

Soil temperature, pH, and electrical conductivity (EC) were recorded for the twelve months from January 2010 to December 2010. The temperature was recorded using a thermometer, pH was measured using Systronics- digital pH meter and EC was recorded using a digital EC meter (systronics) and EC was represented as milli mhos cm^{-1}.

Analysis of NPK contents

The soil nitrogen was determined by the alkaline permanganate method as described by Subbiah and Asiza[2]. The amount of soil phosphorus was calculated as per Bray and Kurtz[3]. The concentration of soil potassium was measured using flame photometer at 766.5nm.

Analysis of heavy metals

Determination of soil ferrous, manganese, copper and zinc (DTPA extractable method) were carried out according to the procedure of Lindsay and Norvell[4]. 10 gm of soil sample was mixed with 20 ml of the DTPA extract stirred for two hours on a mechanical shaker and filtered. Standard curve was plotted using AAS readings against the element concentrations and the concentration of ferrous, manganese, copper and zinc were determined by plotting the AAS values on the standard graph.

Quantitative analysis of Microorganisms

1gm of soil sample (dry weight equivalent) was suspended in 10ml of sterile water. 1 ml of the soil suspension was then diluted serially (ten-fold) with previously sterilized sea water and used in the estimation of heterotrophic bacterial, fungal and actinomycete populations by standard spread-plate dilution method described by Seeley and VanDemark[5], in triplicate. Nutrient agar containing 0.015% (w/v) nystatin (to inhibit fungi growth) was used for bacteria isolation and incubation was at 35ºC for two days. Potato dextrose agar to which 0.05% (w/v) chloramphenicol has been added (to inhibit bacteria growth) was used for fungal isolation, and incubation was at ambient temperature for seven days. Actinomycetes isolation agar supplemented with 1% glycerol was used for actinomycetes isolation and the incubation was done for seven days. The total viable count of bacteria, fungi and actinomycetes were calculated periodically and recorded.

RESULT AND DISCUSSION

Report on annual rain fall

Rainfall is the most important cyclic phenomenon in tropical countries as it brings significant changes in the hydrographical characteristics of the marine and estuarine environments[6]. In India two monsoons viz south west monsoon on the west coast, north and north eastern India and by, the north east monsoon on the south east coast plays a major role in bringing rainfall to exactly time[7]. The present data have shown that maximum rainfall was recorded in November (405.1mm). There was not any rainfall in the month of February and the month of March tinny rainfall of 13.8mm was recorded. Total rainfall obtained during different months was given in figure 1.

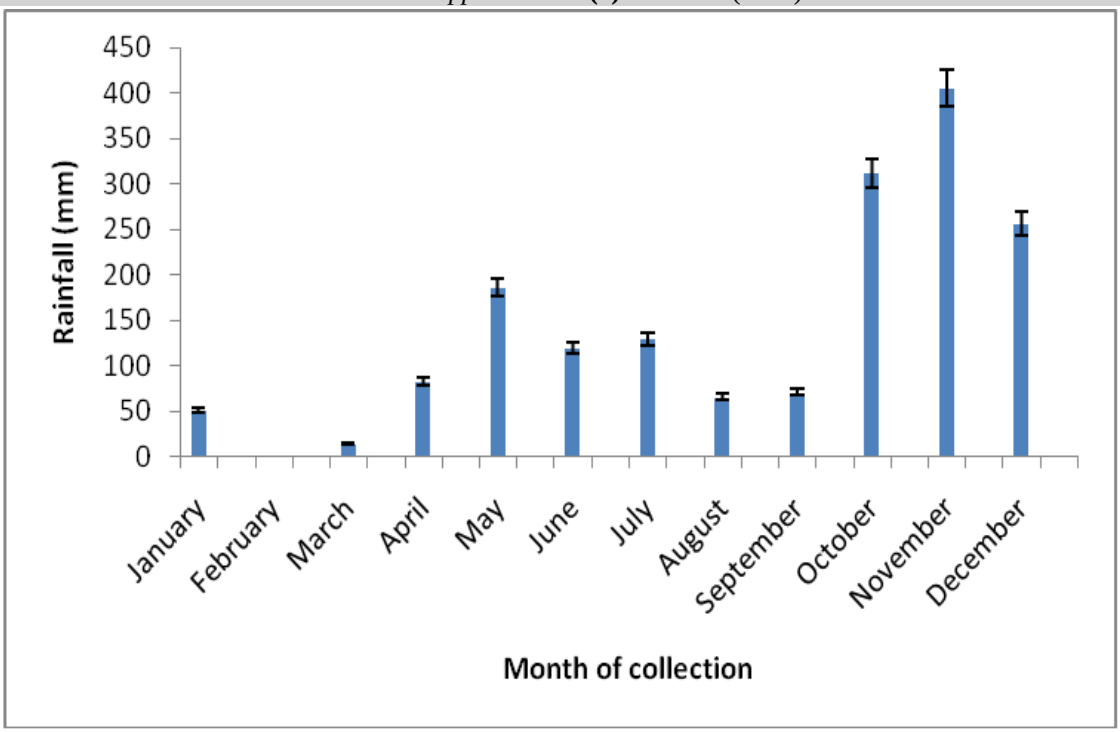

Fig. 1: Annual rainfall obtained during the study period of January 2010 to December 2010

Analysis of physical parameters

The monthly variation in temperature, pH and electrical conductivity at the sampling station was tabulated in table 1.

In the present study, the temperature ranged between 23.4ºC (January) and 32.7ºC (April). The annual mean temperature values were 27.76 ± 0.25ºC. This temperature tends to be normal when comparing with the Gulf of Kachchh where the soil temperature ranged from 18.4ºC to 37ºC which was reported by Saravanakumar *et al*.[6]. According to Saravanakumar *et al*. [6], soil temperature decreased in June with the atmospheric temperature.

In the soil found in the part of Bay of Bengal the highest pH was recorded (8.3) during the summer and lower pH was observed (7.2) during the monsoon season[8]. This phenomenon is due to the removal of excess carbon dioxide owing to the growth of photosynthetic organisms. In the present study, minimum pH was observed in November (pH 7.8) and maximum pH that was found in the month of February and April (pH 9.0). The annual mean pH value was 8.61±0.366. The pH ranged as nearly neutral to alkaline and on most of the occasions higher pH may be caused by higher decomposition of organic matter. In contrast, the pH remained alkaline throughout the study period of Anitha and Sugirtha[9], and the pH varied from 7.2 to 7.96. Such a pH range indicates less contamination in that region.

Electrical conductivity clearly explains the salinity of the sample. In the present study electrical conductivity (EC) ranged from 0.32- 1.35 m mhos cm^{-1} in the month of May and February respectively. The annual mean electrical conductivity of the samples was recorded as 0.80±0.314 m mhos cm^{-1}. In the cultivated lands of Maybac of South Wello zone of North Ethiopia the EC ranged from 0.32 to 0.21 m mhos cm^{-1} , in grazing lands the highest EC value might be due to its highest exchangeable sodium ions, whereas the lowest EC value in the cultivable lands can be associated with the loss of base forming cations (Ca^{2+} and Mg^{2+}) after deforestation and intensive cultivation[10].

Table 1: Analysis of soil physical parameters (Temperature, pH and EC)

Month of collection	Temperature ^{0}C		pH	EC
	Minimum (^{o}C)	Maximum (^{o}C)		(m mhos cm^{-1})
January	23.4	30.9	8.8	0.92
February	23.8	31.6	9.0	1.35
March	25.1	32.1	8.9	1.04
April	26.2	32.7	9.0	1.11
May	26.2	32.5	8.8	0.32
June	24.6	30.6	8.7	0.62
July	24.0	30.4	8.6	0.84
August	23.9	30.4	8.5	0.34
September	24.3	30.6	8.8	1.04
October	24.3	30.5	8.1	0.53
November	24.0	30.2	7.8	0.70
December	23.8	30.2	8.4	0.83
Annual mean	27.76 ± 0.25		8.61±0.366	0.80±0.314

Analysis of NPK contents

NPK content of the marine soil from Kanyakumari coastal area during the study period of January to December 2010 was recorded in figure 2. Nitrogen concentration of marine soil sample showed a greater fluctuation. Minimum concentration of nitrogen was observed in December (06 ppm) and maximum nitrogen was observed in May (15 ppm). The annual mean value of nitrogen concentration was 9.66±2.83 ppm. Saravanakumar *et al*.[6] stated that the total nitrogen in sediment is generally high during winter and summer due to the oxidation of dead plant organic matter, which gets settled on the top layer. The lower value of total nitrogen will generally be during the monsoon due to low level of organic matter. Phosphorus is unique among the anions due to its minimal mobility and availability in soils. It is difficult to manage because it reacts so strongly with both the solution and solid phases of the soil[11]. In the present study, total inorganic phosphorus ranged between 0 and 2.8ppm. Elevated concentration of inorganic phosphate observed during monsoon season might be possibly due to intrusion of upwelling seawater into the creek, which increased the level of phosphate. The high value of phosphorous observed in the marine soil may be due to dead organic matter from the top layer and low values may be related to removal of the top layer of sediments by heavy floods or rain. The amount of total potassium in the present study was noticed to be between 11and 89 ppm. The annual mean value of potassium concentration was 34.75±20.43ppm. In the coastal plain soil of south east Nigeria the amount of potassium ranged between 5 and 17ppm[12].

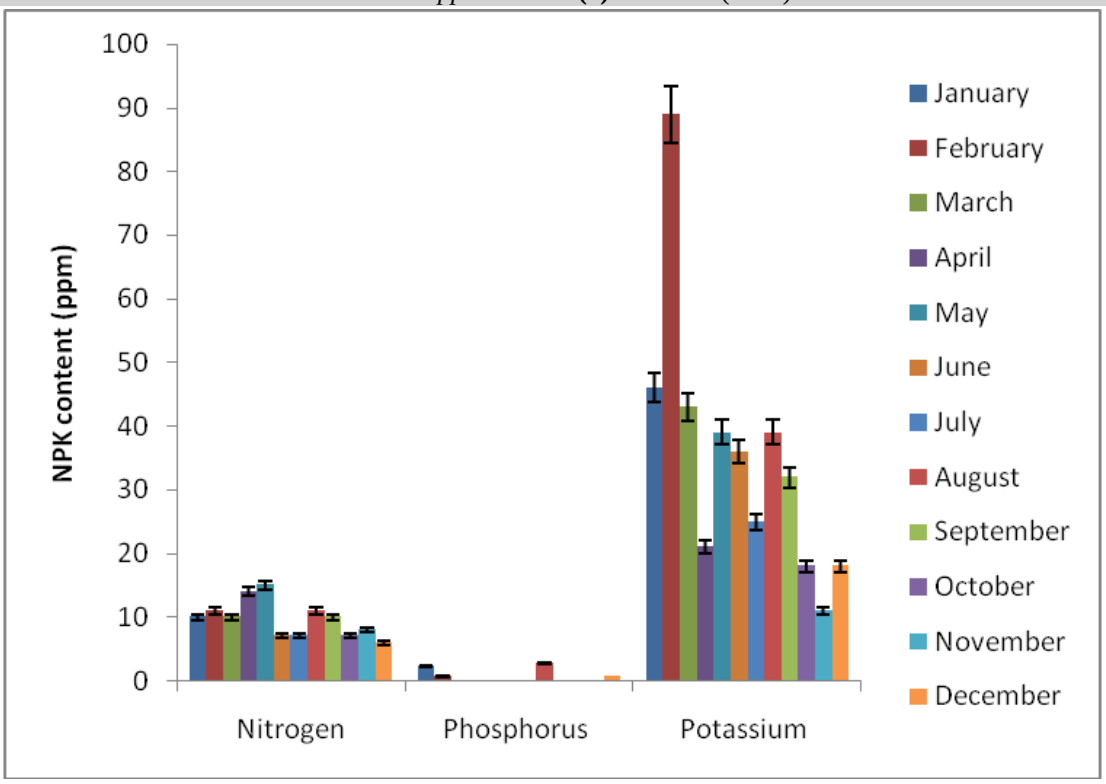

Fig. 2: Analysis of NPK (Nitrogen, phosphorus and potassium) content

Analysis of heavy metals

Heavy metals such as ferrous, manganese, copper and zinc were analyzed in the study period of January to December 2010 and the results were shown in figure 3. Ferrous is an essential metal in both plants and animals, especially in the cellular processes[13]. Ferrous concentration was noted to have a steady change in a year. Minimum ferrous ion concentration was recorded in the month of November (1.73ppm) and maximum ferrous ion was recorded in January (4.40ppm). The annual mean ferrous concentration was 2.96± 0.83ppm. The concentration of manganese showed remarkable variations from 1.07 and 3.28ppm. The annual mean manganese concentration was 2.20 ± 0.50 ppm. According to Lawson[14], the high manganese levels in the swamps of the Lagos lagoon may be due to methylcyclopentadienyl manganese tricarbonyl (MMT), an anti-knocking agent present in petroleum products which have manganese as an active component. The lower concentration of manganese in the present study indicates less pollution in the sampling area. Copper ion concentration of marine soil sample during the year January 2010 to December 2010 varied between 0.04 and 0.11ppm. The minimum copper concentration was recorded in August, September, November and December (0.04ppm) and maximum copper concentration was recorded in March (0.11ppm). The annual mean value of copper concentration was 0.06 ± 0.2 ppm. The leaching experiment of Karathanasis[15] showed that zinc are easily mobile than copper. Copper and zinc may also be transported by humic acids, which adsorb metals by forming chelate complexes. According to Alloway[16] the stability constants of chelates with metals are higher for copper than for zinc. In the present study, minimum zinc concentration of 0.14ppm was observed in November and maximum zinc concentration was recorded in February (0.47ppm). The mean zinc concentration for the samples was calculated as 0.21 ± 0.25 ppm.

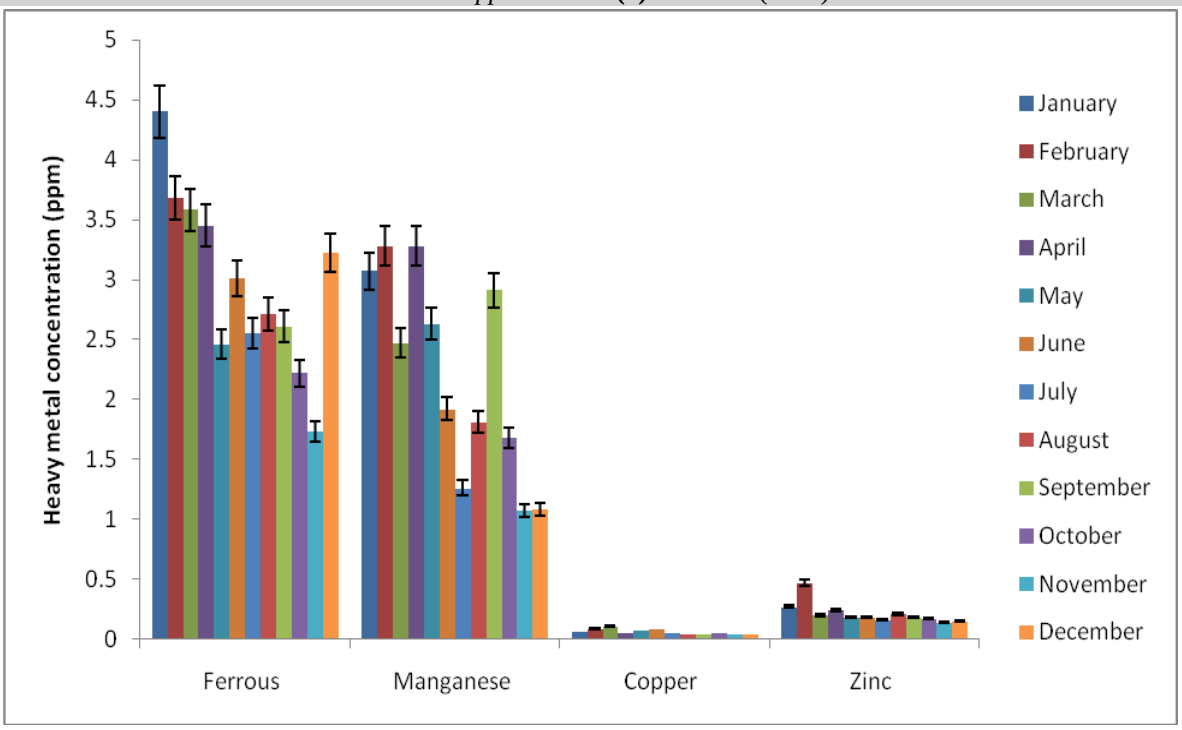

Table 1.4 Analysis of heavy metals (ferrous, manganese, copper and zinc)

Microbiological analysis

The number of bacterial colonies was recognized with the dilution of 10^{-4} and the fungal and actinomycete colonies were observed in the dilution factor 10^3 and 10^2 respectively. The results were shown in figure 4. High bacterial load was recorded in the month of May, where 205.66 ±0.577 CFU/ml colonies were observed. In the month of April, minimum bacterial population (89.33±CFU/ml) was noted. The annual mean value of the bacterial population was 154.74±36.660 CFU/ml. The isolation of fungal colonies showed variation in each month and in the month of February there was no fungi have been isolated. Maximum number of fungal colonies was isolated in the month of May (5.66±0.577CFU/ml). The annual mean fungi population was found to be 1.914±1.575 CFU/ml. The number of actinomycetes in the marine soil sample in the year January-December 2010 varied notably. Minimum numbers of actinomycetes colonies (3.00+1.00 CFU/ml) were noted in the month of April and December. In the month of May, maximum numbers (6.66±1.154CFU/ml) of actinomycetes colonies were noted. The annual mean actinomycetes population was 4.33±1.278 CFU/ml. Saravanakumar *et al*.[6] stated that when the nitrogen content increases, the organic constituents also increase. These nitrogen content and organic constituents increase the habitat. Higher the nitrogen content in finer substrate results in an increase in microbial population. In the present study, the bacterial, fungal and actinomycetes population were high in the month of May, whereas the nitrogen concentration was also high in the same month.

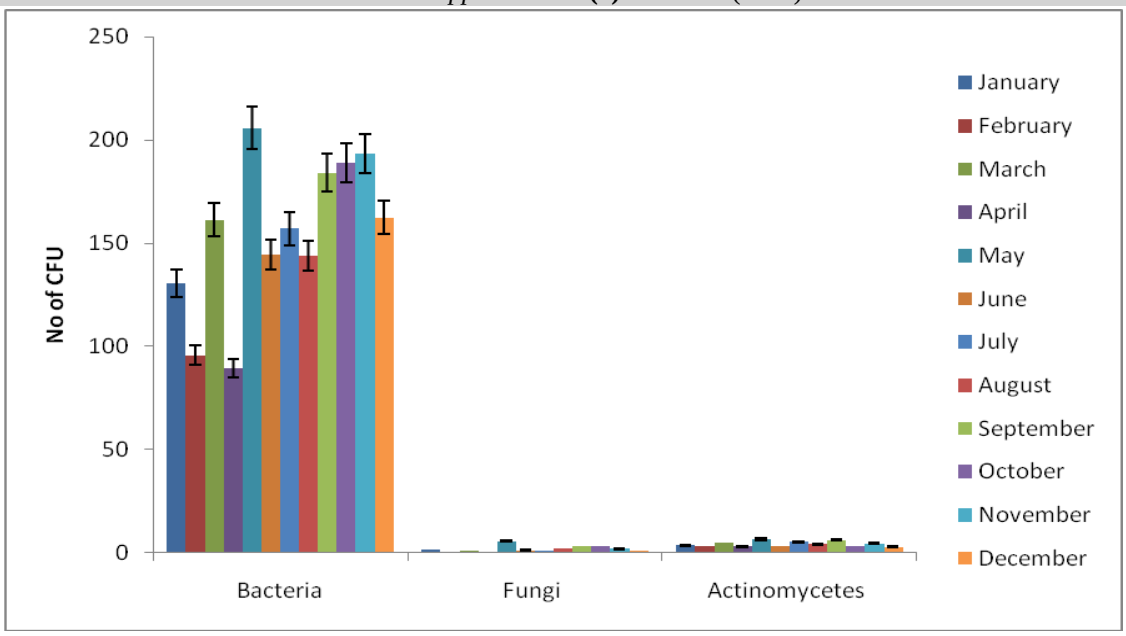

Fig. 4 Microbiological analyses (Bacteria, fungi and actinomycetes)

Studying the physical and chemical parameters of the marine soil is vital as it fetches a clear data on the type of habitat at that particular station[17]. Rani and Panneerselvam[18] reported that the diversity and distribution of different organisms in the marine environment are a function of physico-chemical properties of soil. Kanyakumari district receives rainfall both during the south west monsoon and north east monsoon. There are also summer showers during April. Rainfall greatly affects the dynamics of the environments, transports nutrients and all ochthonous materials and alters the visual, physical and chemical characteristics of marine water[14]. It also alters the heteroochthonous flora and fauna of the region.

CONCLUSION

The present work demonstrates that the changes in the physico-chemical properties and microbial loads of coastal area of Kanyakumari, Tamil Nadu are due to both monsoon and direct discharge of effluents from the surrounding environment.

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