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An Environmental Study of the need for Rehabilitation and Restoration of the Mangrove Ecosystems in Kannur District, Kerala

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Abstract: **Mangrove ecosystem is unique in nature due to the combination of Halophytic plants, animals, birds and aquatic organisms.Physico-chemical parameters play an important role in structuring the fish species and other aquatic organisms in mangrove swamp, estuaries and coastal areas. The world's mangrove ecosystems are being threatened by many factors. These include a variety of anthropogenic activities, which entail urgent need of research and education programs to create awareness in the society for their protection and conservation. The present study was conducted over the selected three mangrove regions, namely Payangadi, Ramapuram and Edat in Kannur district. The objectives of the study was to investigate the seasonal variations of physico-chemical parameters such as temperature, pH, transparency, primary productivity, hardness, ammonia, carbon dioxide, dissolved oxygen, Biological Oxygen Demand and Chemical Oxygen Demand.Surface water samples were collected once in every month from all the selected stations for a period during the year 2021-2022 from the study area and the physico-chemical parameters were analyzed with respect to the seasons following standard methods. The study indicates that there is a pronounced variation of most of the water quality parameters with variations in season. In the present study, hardness is highest in site Ramapuram which is comparatively polluted areas, where human activities fishing, boating occurs. Ammonia is comparatively higher in site Edat. The present study would be helpful in assessing the changes in water quality that might happen in long run due to port development, regular port activities, industries that are in operation in and around the port area, shrimp farming etc.**

Keywords**: Mangrove ecosystem, restoration, Dissolved Oxygen, BOD, COD**

I. INTRODUCTION

Water is essential for the survival of humans, animals and plants. Water is also a home to a very wide range of micro flora and micro fauna, creating a fascinating environment of extreme biological importance, but which attracts too little attention. The quality as well as the quantity of water is deteriorating globally as a result of rapid urbanization, population growth and industrialization. Water quality is a major economic and environmental issue in both developed and developing countries. Rapid industrialization, urbanization and development activities, which aim at coping with the population explosion, bring inevitable water crises.

Mangroves serves as a habitat for many species of flora and fauna, with high density. Mangroves are also important to humans for many reasons, including fisheries, agriculture, forestry, building material resources, protection against coastal erosion and hurricanes, the absorption of pollutants and to support coastal fisheries. Mangroves occur in diverse environmental settings of geophysical (i.e. climate, tides and sea level) and geomorphological (dynamic history of the land surface and contemporary processes and biological components). Mangroves and its associated ecosystems as biologically most productive, socio-economically important, and aesthetically attractive while providing food and shelter for many vital biotic species, some that are commercially important. A review of the literature revealed that studies pertaining to the mangroves confining the selected study areas of Kannur district is either fragmentary or outdated in nature.The comprehensive information on the mangroves provided here will help in the long term supervision of mangrove species in these sites and formulating species specific conservation strategies. The high productivity in mangrove ecosystems is often attributed to greater litter degradation rates and efficient recycling of nutrients, which are supplied by both autochthonous litter and allochthonous inputs from natural and anthropogenic sources. The stability of the

mangrove is influenced by salinity, soil type and chemistry, nutrient content and dynamics, physiological tolerance, predation and competition at local level. The present study deals with the assessment of fluctuations in the physico-chemical characteristics of three mangrove ecosystems in Kannur district. The regions selected for the study are;

1. Payangadi river side.
2. Ramapuram mangrooves.
3. Kannur kandal project, Edat.

II. Materials and Methods

The areas where mangrove and mangrove associated vegetation is existing around the three mangrove ecosystems in Kannur region was first identified and documented. Sampling stations were selected according to the topography and morphology of the area. First sampling station is situated in the Payangadi river side. The second and third sampling stations were fixed in the Ramapuram mangroves and Kannur kandal project, Edat. The study period (June to March) was divided into two different seasons, viz., south-west monsoon (June to August), monsoon transition period (September and October), north-east monsoon (November and December), post-monsoon/winter (January and February) and summer (March) based on the regional cyclic phenomena of meteorological events. In order to get the information required for the present study samples were collected monthly, uniformly during the year June 2021- June2022 from the study area using wide mouthed 1000ml polyethylene plastic bottles from three sampling points by direct immersion of bottles at water sampling points handled by rope while samples for oxygen had been taken in the Winkler bottles. In situ observations were done on temperature by an ordinary thermometer in degree Celsius. The containers must be capable of being tightly sealed either by stopper or cap. The collections were made once in a month at the time i.e., 7.00 to 8.30 am and from same sites throughout the period of study.Bottles were preserved using icebox and transported to the laboratory bottles.The dissolved oxygen of the sample was estimated by Winkler method (1988). The estimations were done in the laboratory after fixing the sample with Winkler A and Winkler B solutions at the collection sites itself. pH was determined by using digital pH meter.Transparency was measured using Secchi disc. Hardness was measured by titrating against EDTA using Eriochrome Black T as indicator.Ammonia was measured by titrating against HCl using methyl Orange as indicator.BOD was determined by following five day incubation method.COD was determined by titration against sodium thiosulphate. Carbondioxide was measured by titrating against sodium hydroxide using phenolphthalein as indicator. Thus, all physico-chemical parameters were analysed following standard methods of APHA (2005).

Study Area

The study area is located in Kannur district of Kerala. Kannur is one of the 14 districts along the west coast in the state of Kerala. It is located between 11°52′8.04 north latitude and 75°21′19.66 east longitude and has an area of 2,966 km². It is bordered by Kasaragod district to the north, Kozhikode district to the south and Wayanad district to the south-east. In Kerala only Kannur has good natural patches of mangroves than that in the other districts. The present study was conducted in the selected mangrove habitats of Kannur district such as Payangadi, Ramapuram and Edat

Site -1: Payangadi

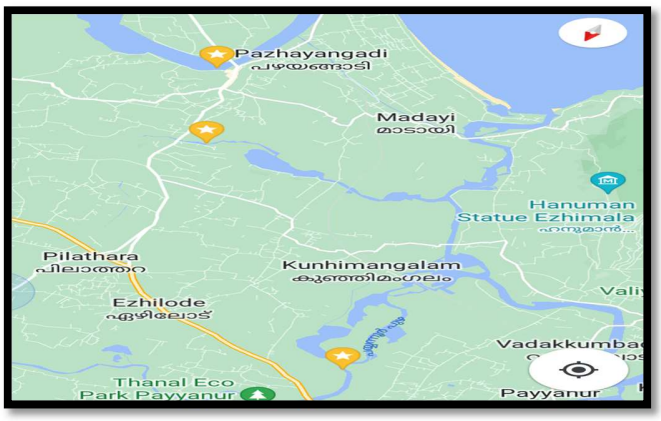
Payangadi (12˚01′33.7″N, 75˚16′07.5″E) is a small township, approximately 22km north of district headquarters Kannur, 14km south of Payyanur and 14km west of Taliparamba in the South Indian state of Kerala. The town is bounded by the Madayi hills on the west and by the Payangadi river on the South.Near to this, River view park is situated and it's a well-known tourism spot. The mangroves species in the study area predominantly includes *Avicennia officinalis*, *A. marina, Acanthus ilicifolius, Rhizophora mucronata and Bruguiera cylindrica*. Dragonflies, bees, grasshoppers and crabs made up the invertebrate fauna. The region provides a rich habitat for many vertebrate animals, especially fishes, frogs, reptiles and birds.

Site-2: Ramapuram

Ramapuram (12°02'47.0"N,75°16'07.5"E) is a small area, approximately 3 km away from Payangadi. Near to this, Vayalapra Floating Park is situated and it's a well-known tourism spot. The mangroves in these areas predominantly include the species of *Avicennia officinalis, A.marina, Rhizophora mucronata,* etc.

Site-3: Edat

Edat is situated near Kannur kandal project. It is located near Perumba river (12°05'58.8"N, 75°13'14.9"E). This area contains many species of mangroves and they are well protected. Kannur kandal project do great works for the protection of mangroves and gives awareness to people about the importance of mangroves. Nearly 90% of these forests – which support at least 10 species of mangroves (including the uncommon *Rhizophora apiculata*), 87 species of fish, 83 species of birds and 13 species of mammals – are under private ownership and are therefore highly threatened. There are many animals like crabs, prawns, fishes, birds, spiders, ants, amphibians, etc. This area is less polluted. (Radhakrishnan *et al.,*2006).



Map of the selected mangrove study sites

Site 1

Site 2

Site 3

Selected Study Sites

III. Results and Discussion

The study of physico-chemical parameters of selected three stations, station 1 (Payangadi), station 2 (Ramapuram), station 3 (Edat) of three seasons were analyzed and compared. The physico-chemical parameters of each stations exhibited variations in each period.

Temperature

Based on it, the temperature showed a minimum range of 30°C and exhibited maximum range of 32°C. All these stations showed an average temperature range from 30.33°C– 32.33°C. There was only a slight variation in temperature. A high range of temperature in pre monsoon season was observed in station 3 (32°C) and low range was showed in station 1(30°C). In monsoon period, the temperature ranges from 30°C to 31°C. The temperature of water samples in the post monsoon period ranges from 30°C 31°C (Table 1). The mean ± standard deviation ranged from 30.33 ± 0.57 to 31.33± 0.58.

pH

pH profile exhibited a neutral and alkaline nature. From the study, in pre-monsoon season the pH ranged from 6.5 to 8. A higher level of pH was observed in station 2(8) and lower pH level in station 1 (6.5). In monsoon season, lower pH was observed in station 3 (6) and higher pH in station 2 (8). The pH of water sample in post monsoon season ranged from 6.5 to 7.5. High range of pH was shown in the station 2(7.5) and lowest pH was observed in the station 3 (6.5). The average range of pH in all these season ranged from 7 to 7.33.(Table 1). In pre monsoon period mean± standard deviation was about 7.16± 0.76. 7 ± 1 range of mean ± standard deviation was observed in monsoon period. In post monsoon period mean ± standard deviation was about 7.33 ± 0.5.

Transparency

Transparency range showed variations in all the seasons. Maximum transparency value was noticed about 69 cm in station 1 of monsoon season. The minimum range was 39 cm in station 2 of post monsoon season. The average range of transparency was 53.5 to 54.5 cm. In pre monsoon season the transparency of water range from 40.5 to 67.5 cm, high range of transparency was shown in station 1 (67.5cm) and lowest was obtained in station 2(40.5 cm). Transparency of water in monsoon season ranged from 42 to 69 cm. A high range of transparency was shown in station 1(69 cm) and lowest was observed in station 2 (42 cm). In post monsoon season the maximum range was observed in station 1 (67cm) and minimum range was observed in station 2(39cm)(Table 1). The mean ± standard deviation was about 53.5 ± 14.02 to 59.5 ± 38.95.

Ammonia

Ammonia of water sample in the pre-monsoon season ranged from 17 mg/l to 93.5 mg/l. Maximum range was observed in the station 3 (93.5 mg/l) and minimum range obtained in station 2 (17 mg/l). In monsoon season the maximum range was observed in station 2 (51mg/l) and minimum range obtained in station 1 (34 mg/l). Ammonia of water sample in the post monsoon season range from 25.5 mg/l to 76.5 mg/l. Maximum range was observed in station 3(76.5 mg/l) and minimum range was obtained in station 2 (25.5 mg/l). Maximum range of standard deviation was observed in pre monsoon season (38.95.) and minimum range in monsoon period (8.5) (Table 1).

In pre monsoon period the mean ± standard deviation was observed to be nearly 59.5 ± 38.95. 42.5 ± 8.5 in monsoon period. In post monsoon period the range of mean ± standard deviation was about 53.83 ± 14.02.

Hardness

Hardness of water sample in the pre-monsoon season ranged from 490 mg/l to 882 mg/l. Maximum range was observed in station 2 (882 mg/l) and minimum range was observed in station 1 (490 mg/l). Hardness of water sample in monsoon season was nearly 412 mg/l to 998 mg/l. Maximum range was observed in station 2 (998 mg/l) and minimum range observed in station 1 (412 mg/l).In post monsoon season maximum hardness was exhibited in station 2 (846 mg/l) and minimum range was observed in station 1 (504 mg/l) (Table 1). Maximum range of mean ± standard deviation was observed in pre monsoon period (666 ± 199.03) and minimum range was observed in post monsoon period (674 ± 171.01).

Chemical Oxygen Demand

Chemical Oxygen Demand of water sample in post monsoon season ranged from 3.2 mg/l to 11.2mg/l. Maximum ranges was obtained in station 2(11.2mg/l) and minimum was obtained in station 2 (17.7mg/l). In monsoon season the maximum range was observed in station 1 (51.9mg/l) and minimum range was observed in station 1 (3.2 mg/l). Chemical oxygen demand of water sample in pre monsoon season ranges from 4.8 mg/l to 12.8 mg/l. (Table 1).The mean ± standard deviation was range from 2.66± 1.84 to 9.06 ± 4.02.

Dissolved oxygen

Dissolved oxygen of water sample in the pre monsoon season, maximum range was obtained in station 1 (3.36 mg/l) and minimum range of dissolved oxygen was obtained in station 2 (2.08 mg/l).Dissolved oxygen of water sample in monsoon season range from 1.44 mg/l to 2.08 mg/l. Maximum range was observed in station 2 (2.08 mg/l) and minimum range in station 1 (1.44 mg/l). Dissolved oxygen of water sample in the post monsoon season showed maximum range in station 1(4.16 mg/l) and minimum range was observed in station 3 (1.92 mg/l) (Table 1).The range of mean ± standard deviation was about 1.76 ± 0.32 to 2.77± 1.21.

Biological Oxygen Demand

Biological oxygen demand of water sample were determined by the seeded dilution method.In the pre monsoon season ranged from 0.16 mg/l to 0.48 mg/l. Maximum range was observed in station 3 (0.48 mg/l) and minimum range was noticed in station 1(0.16 mg/l) .In monsoon season biological oxygen demand ranged from 0.16 mg/l to 0.64 mg/l. Maximum range was observed in station 3 (0.64 mg/l) and minimum range was observed in station 1 (0.16 mg/l). Biological oxygen demand of water sample in the post monsoon season ranged from0.8 mg/l to 0.64 mg/l. Maximum range was observed in station 2 (0.64 mg/l) and minimum range was observed in station 3(0.8 mg/l). Standard deviation of Biological oxygen demand in pre monsoon was 0.16 and in monsoon 0.24 (Table 1). The maximum range of mean ± standard deviation was observed in post monsoon period (0.64 ± 0.16) and minimum range was observed in pre monsoon period (0.32 ± 0.16).

Carbon dioxide

Carbon dioxide of water sample in pre-monsoon season showed the maximum range in station 3 (30.36 mg/l) and minimum range was observed in station 1 (9.68 mg/l). In monsoon season the carbon dioxide of water sample was observed maximum in station 3 (24.2 mg/l) and minimum range was observed in station 1 (5.28 mg/l).Carbon dioxide of water sample in post monsoon season range from 7.48 mg/l to 26.84 mg/l. Maximum range was observed in station 3 (26.84 mg/l) and minimum range observed in station 1 (7.48 mg/l) (Table 1). The maximum range of mean ± standard deviation was found in pre monsoon period (18.77 ±10.56) and minimum range was observed in monsoon period (15.98 ± 9.71).

Primary productivity

Primary productivity of water sample in three seasons varies.Net primary productivity (NPP)of water sample in the pre-monsoon season ranged from 0.3 mg/C/l/hr to 0.42 mg/C/l/hr. Maximum range was observed in station 2 (0.42 mg/C/l/hr.) and minimum range was observed in station 1 (0.3 mg/C/l/hr). NPP of water sample in monsoon ranges from 0.2 mg/C/l/hr to 0.18 mg/C/l/hr. Maximum range was observed station 2 (0.18 mg/C/l/hr) and minimum range was observed in station 1 (0.2mg/C/l/hr).NPP of water sample in post-monsoon ranges from 0.3 mg/C/l/hr to 0.36 mg/C/l/hr. Maximum range was observed in station 2 (0.36 mg/C/l/hr) and minimum range was observed in station 1 (0.3 mg/C/l/hr).

Gross primary productivity (GPP)of water sample in the pre-monsoon season ranged from 2.34 mg/C/l/hr to 3.02 mg/C/l/hr. Maximum range was observed in station 1 (3.02 mg/C/l/hr) and minimum range was observed in station 2(2.34 mg/C/l/hr). GPP of water sample in monsoon ranged from to 2.06 mg/C/l/hr to 2.34 mg/C/l/hr. Maximum range was observed station 1 (2.34mg/C/l/hr) and minimum range was observed in station 3 (2.06mg/C/l/hr).GPP of water sample in post-monsoon ranged from 2.42 mg/C/l/hr to 3.66 mg/C/l/hr. Maximum range was observed in station 1(3.66 mg/C/l/hr) and minimum range was observed in station 3(2.42 mg/C/l/hr).

TABLE 1
Seasonal Variations of Physico-chemical parameters

Parameters	Seasons	Station 1	Station 2	Station 3	MEAN ± SD
Temperature (ºC)	Pre monsoon	31	31	32	31.33 ± 0.58
	Monsoon	30	30	31	30.33 ± 0.57
	Post monsoon	30	31	31	30.66 ± 0.57
pH	Pre monsoon	6.5	8	7	7.16 ± 0.76
	Monsoon	7	8	6	7 ± 1
	Post monsoon	7	7.5	6.5	7.33 ± 0.5
Transparency (cm)	Pre monsoon	67.5	40.5	55	54.33 ± 13.51
	Monsoon	69	42	52.5	54.5 ± 13.61
	Post monsoon	67	39	54.5	53.5 ± 14.02
Ammonia (mg/l)	Pre monsoon	68	17	93.5	59.5 ± 38.95
	Monsoon	34	51	42.5	42.5 ± 8.5
	Post monsoon	59.5	25.5	76.5	53.83 ± 25.96
Hardness (mg/l)	Pre monsoon	490	882	626	666 ±199.03
	Monsoon	412	998	610	673.3 ±298.08
	Post monsoon	504	846	672	674 ± 171.01
COD (mg/l)	Pre monsoon	4.8	12.8	9.6	9.06 ± 4.02
	Monsoon	1.6	4.8	1.6	2.66±1.84
	Post monsoon	3.2	11.2	6.4	6.93±4.02
Dissolved Oxygen (mg/l)	Pre monsoon	3.36	2.08	2.72	2.72±0.64
	Monsoon	1.44	2.08	1.76	1.76±0.32
	Post monsoon	4.16	2.24	1.92	2.77±1.21
BOD (mg/l)	Pre monsoon	0.16	0.32	0.48	0.32±0.16
	Monsoon	0.16	0.48	0.64	0.42±0.24
	Post monsoon	0.48	0.64	0.8	0.64±0.16
CO_2 (mg/l)	Pre monsoon	9.68	16.28	30.36	18.77±10.56
	Monsoon	5.28	18.48	24.2	15.98±9.71
	Post monsoon	7.48	20.24	26.84	18.18±9.84
Net Primary Productivity (mg/C/l/hr)	Pre monsoon	0.3	0.42	0.18	0.3±0.12
	Monsoon	0.2	0.18	0.14	0.17±0.03
	Post monsoon	0.3	0.36	0.18	0.28±0.09
Gross Primary Productivity (mg/C/l/hr)	Pre monsoon	3.02	2.34	2.42	2.59±0.37
	Monsoon	2.34	2.26	2.06	2.22±0.14
	Post monsoon	3.36	3.08	2.42	3.05±0.48

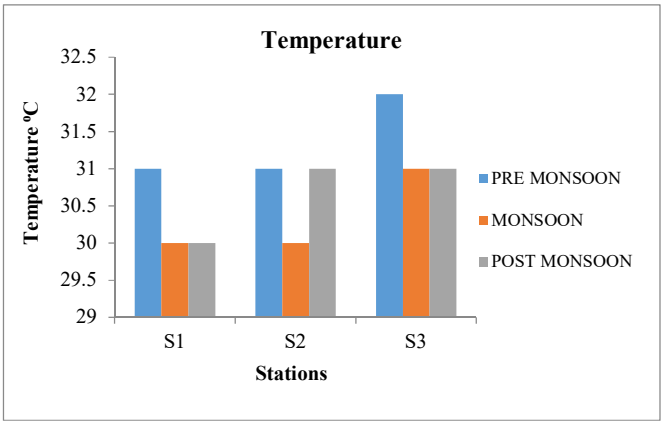


Fig 1: Seasonal variations of temperature

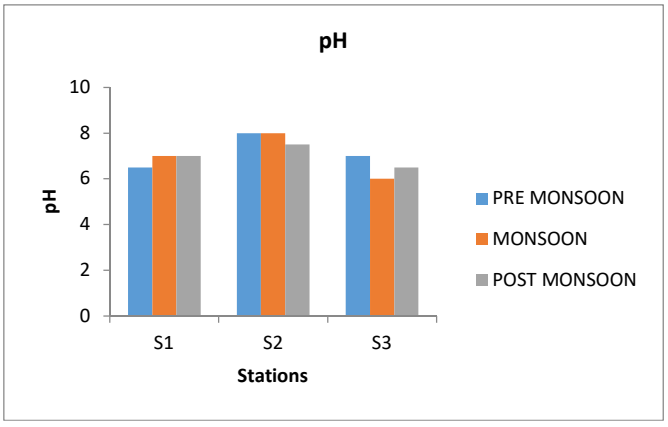


Fig 2: Seasonal variations of pH

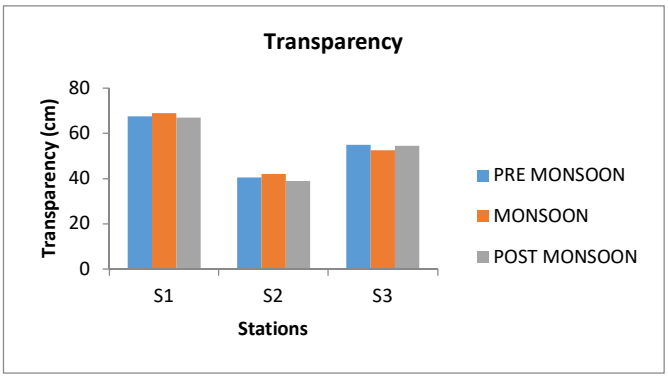


Fig 3: Seasonal variations of Transparency

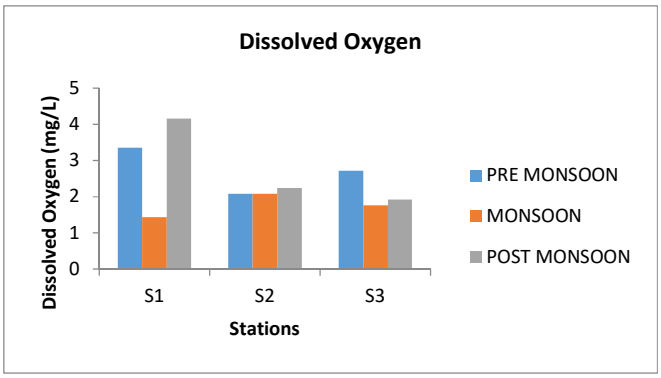


Fig 7: Seasonal variations of Dissolved Oxygen

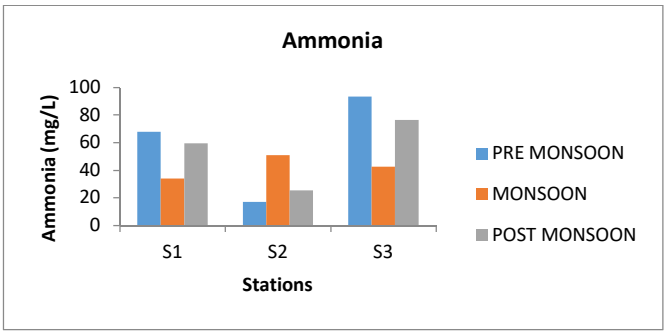


Fig 4: Seasonal variations of Ammonia

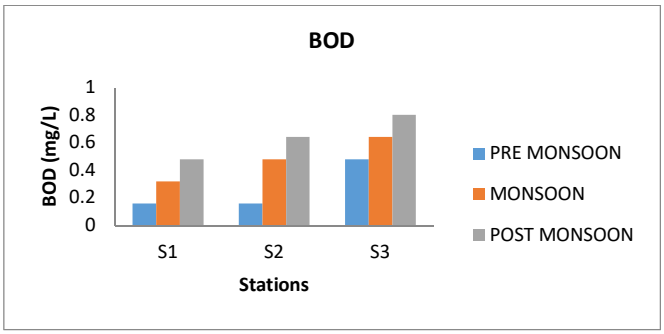


Fig 8: Seasonal variations of BOD

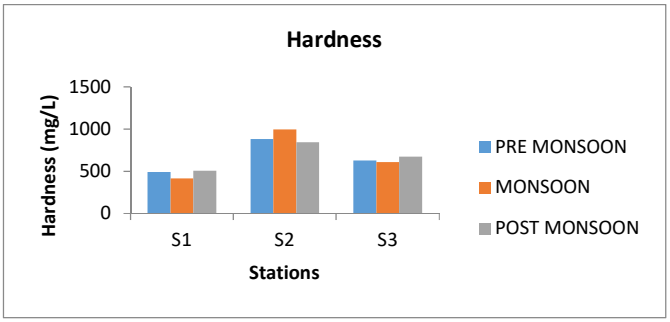


Fig. 5: Seasonal variations of Hardness

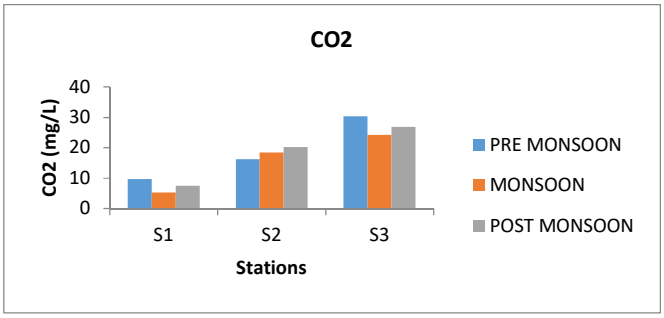


Fig 9: Seasonal variations of CO_2

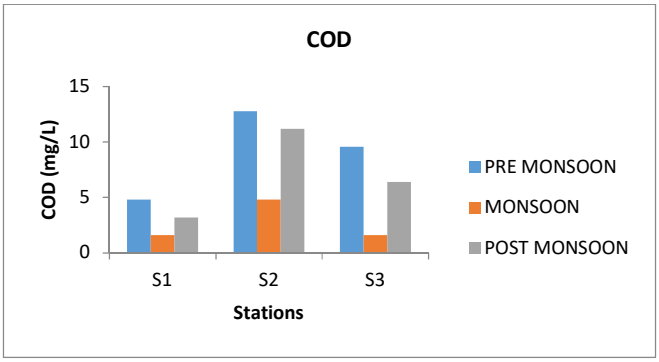


Fig 6: Seasonal variations of COD

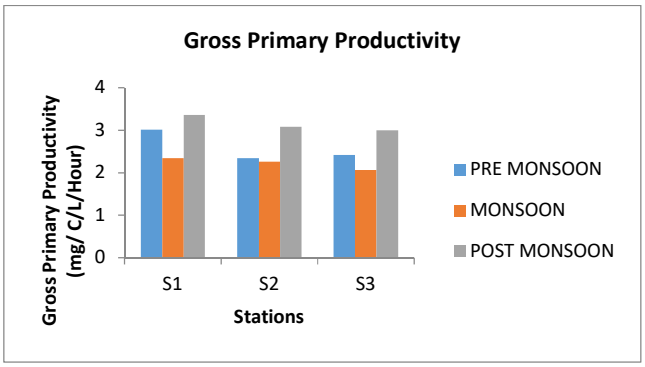


Fig 10: Seasonal variations of Gross Primary Productivity

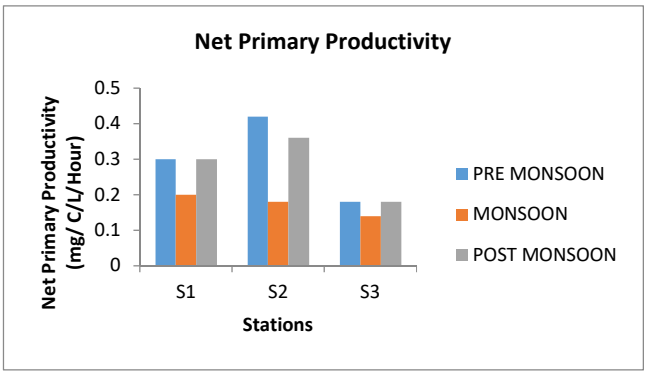


Fig 11: Seasonal variations of Net Primary Productivity

The study was focused on the analysis of physico-chemical parameters of three mangrove regions. Mangroves provide food, breeding grounds and nursery sites for a variety of terrestrial and marine organisms.Mangroves play also a key role in human sustainability and livelihoods, and offer protection from catastrophic events. Major parameters like water temperature, pH, Transparency, Ammonia, Hardness, Carbon dioxide, Dissolved oxygen, Biochemical oxygen demand, Chemical oxygen demand, Primary productivity were analyzed during the study.Temperature has an important role in the physical, chemical, and biological properties of water. The major impacts on Mangrove are likely to be caused by increasing temperature, changing hydrologic regimes such as rainfall, evapotranspiration, runoff and salinity and rising relative sea level, due to a combination of factors. Water temperature is of enormous significance as it regulates the biological activities and governs the solubility of gases in water. Generally, surface water temperature is influenced by the intensity of solar radiation, evaporation, freshwater influx and cooling and mix up with the ebb and flow from adjoining neritic waters. Temperature has direct influence on aquatic biota. The water quality may depend on the changes in temperature (Sanalkumar, 2012). All living organisms have an optimum temperature for their better survival. The temperature ranged between 30°C-32°C. The maximum temperature was recorded on pre monsoon period and minimum was observed during the monsoon. Observed low water temperature during monsoon might be due to shorter photoperiod, decreased atmospheric temperature. Mangrove cannot tolerate temperature less than 20°C for a continuous period and therefore the mangrove formations are only found in the tropical and subtropical coasts of the world (Untawale, 1987). Considering the three stations, high temperature was observed in station 3 (32°C) during the pre-monsoon season. Presence of rich vegetation will reduce the temperature. Water temperature controls the rate of all chemical reaction; affect the fish growth, reproduction and immunity (Verma & Agarwal, 2012).The distribution of fish molluscs and crustaceans would adjust rapidly to any temperature increase caused by climatic change with in mangroves, soft bodied animals and bivalves would be highly sensitive to temperature rise, where as many species of mangrove crabs and gastropod snails could possibly accommodate a hotter environment provided they had access to water to replenish water lost by evaporation, respiration and feeding.

pH is one of the physical properties of water. All the aquatic organisms have an optimum pH known as minimum pH. A slight variation in the pH can change the acidity or basicity of water.High organic content will tend to decrease the pH. Mangrove ecosystem in general exhibits a lower pH concentration when compared to other tropical backwater ecosystem. The lower pH is attributed to a group of factors such as photosynthesis, litterfall, influx of rainwater, tidal influence and species diversification and most metals will become soluble in acidic pH which negatively affects the health of the organisms (Sujitha et al., 2012). The maximum pH was recorded in station 2 during the pre-monsoon and monsoon period.

Transparency is the measurement of light penetration in the water body. Due to the presence of suspended solids like silts, clays, industrial waste, sewage will cause the transparency in water. Light penetration in to the bottom of the water surface will prevented by the transparent condition of the water which affect the benthic organisms and primary productivity (Gopalkrushna, 2011).The maximum range of transparency was recorded in station 1(69 cm) during the commencement of monsoon period and minimum range was recorded in station 2 (39 cm) during the post monsoon period. It is a general practice of observing the light penetration by using Secchi disc, to assess the phytoplankton and suspended soil particles, thereby general turbidity. In the Station-1 a highest transparency was observed, which was probably due to the low algal count towards the ending of summer season.

Ammonia is released in to the water by organic decomposition and also by the metabolic waste of aquatic organisms. The conversion of organic nitrogen in to inorganic ammonia is called ammonification or mineralization and is brought about by heterotrophic bacteria, actinomycetes and fungi. (Varunprasath, and Nicholas, 2010). The maximum range of ammonia was observed in station 3 (93.5mg/l) during pre-monsoon period. In monsoon season the maximum range was observed in station 2 (51 mg/l) and minimum range obtained in station 1 (34 mg/l). Ammonia occurs in two forms, which are un-ionized ammonia (NH_3) and ammonium ion (NH_4^+) in a pH and temperature dependent equilibrium (Boyd, 1992). As pH rises, un-ionized ammonia increases relatively to ammonium ion. Water temperature also causes an increase in the proportion of un-ionized ammonia, but the effect of temperature is less than that of pH, which confirms the genuine fact that the present study area also acquired a linear relationship between ammonia concentration and water pH of water.

Water hardness is the capacity of water to precipitate the soap. Presence of sulphates and chlorides of calcium and magnesium may cause hardness in water. Hardness is mainly two types. Due to the presence of sulphates and chlorides of Iron, Manganese and Aluminium cause permanent hardness. (Firoz &Sanalkumar, 2013).Maximum range of hardness was observed in station 2 (998 mg/l) during the monsoon season.

Chemical Oxygen Demand of water sample in post monsoon season ranged from 3.2 mg/l to 11.2mg/l. Maximum range was obtained in station 2 (11.2mg/l) and minimum was obtained in station 1 (3.2 mg/l). In monsoon season the maximum range was observed in station 2(4.8 mg/l). Chemical oxygen demand of water sample in post monsoon season ranges from 3.2.mg/l to 11.2 mg/l.

Dissolved oxygen is an important characteristic of water and its concentration in water is an indicator of prevailing water quality, trophic status and the ability of water to support a well-balanced aquatic life. It is essential for the respiratory metabolism of the entire aerobic aquatic life in the mangrove ecosystem. Dissolved oxygen is one of the prime factors deciding the diversification and distribution of all aquatic organisms. Photosynthetic activity, diffusion rate from atmosphere and decomposition rate of organic matter are the major factors determining the DO level in the aquatic system where as the other supplement factors such as rainfall, temperature, salinity, tidal flux and humidity are also likely to affect directly or indirectly the DO concentration in the natural systems. Oxygen is mainly consumed on the muddy bottom surface due to the biological and chemical actions. For indicating the water quality and organic pollution dissolved oxygen is an important parameter. Large fish population depend the minimum amount of dissolved oxygen. Dissolved oxygen level below 3 mg/l leads to the death of fishes and affects the reproduction and spawning. Low level of dissolved oxygen directly affects the fish community (Deepa et al., 2014). The present study indicates that the monsoon season showed high pollution. House hold wastes are the main source of the pollution. The maximum range DO was recorded on post monsoon period (4.16 mg/l). The minimum range of dissolved oxygen was observed in monsoon period (1.44 mg/l).

BOD is the measure of the extent of organic pollution in the water body; its value provides information regarding the quality of water and helps in deciding the suitability of water for different purposes. During pre-monsoon season, Biological oxygen demand was found to be 0.48 mg/l in station 2, 0.48 mg/l in station 1, 0.16.mg/l in station 1 and 0.64 mg/l in station 3. Maximum Biological oxygen demand was observed in station 3. In monsoon season the maximum Biological oxygen demand was recorded in station 3 and minimum in station 1. Higher BOD values were observed during monsoon/post-monsoon seasons due to microbial demand for oxygen in the decomposition of suspended organic matter (Murugan and Ayyakkannu, 1991) accumulated mangrove leaf litter. The decaying organic matter abundant in the mangroves which increase the organic load resulting in very high BOD. In post monsoon season, the maximum range of Biological oxygen demand was found in station 3 and the minimum range was found in station 1. Biological oxygen demand is an indicator of organic pollution in the water and also that affect the availability of Dissolved oxygen and pH values. (Kumar Manoj & Pratap Kumar, 2015).

Carbon dioxide is essential for the photosynthetic activity and aquatic vegetation. It is also required for the phytoplankton. By the process of decomposition and respiration carbon dioxide is formed. Carbon dioxide depletion will affect the aquatic ecosystem. Fish diversity and aquatic biota are adversely affected. (Firoz & Sanalkumar, 2013). The maximum carbon dioxide range was recorded in station 3 (26.84 mg/l) of the post monsoon period and the minimum range was 7.48 mg/l. Carbon dioxide will affect the aquatic pH. It will result in the formation of carbonic acid and cause changes in water equilibrium (Sanalkumar et al; 2014). A high primary productivity rate in the ecosystems is obtained when the physical factors (for instance: water, nutrients and climate) are favorable. The presence of some form of secondary energy can also help to increase the primary productivity rate. Here, net primary productivity and gross primary productivity varies. Maximum range of net primary productivity was found in station 2 in pre monsoon season. Whereas maximum range of Gross primary productivity was found in station 1 in post monsoon period.

IV. CONCLUSION

The study indicates that there is a pronounced variation of most of the water quality parameters with variation in season. Many human activities and their by-product have the potential to pollute water. Pollutants from such activities may enter surface or ground water directly, may move slowly within the ground water to emerge eventually in surface water, may run off the land or may be deposited from the atmosphere. In recent days water pollution is due to the alteration in physical, chemical and biological characteristics which may lead to harmful effect on human and aquatic biota. There are numerous causes including increasing number of industries and various other anthropogenic activities in the neighboring regions, global climatic changes that lead to the degradation of the quality of water for the pollution. Physicochemical parameters influence the species diversity, pattern of diversity, spawning, breeding and metabolic activities. The temperature, pH, salinity, dissolved oxygen are the major master factors of mangrove ecosystem. These parameters are occurring optimum level for the survival of species and poor water quality can influence the species activities and patterns of behavior. However, the base line physico- chemical data is toward the further study of ecological and conservation of economically and they are living species diversity patterns.The study will help to remind the need for conservation of mangroves as well as water bodies. In conclusion, this study will provide baseline information on these parameters of the selected Mangrove regions in Kannur district.

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