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PHYSICO-CHEMICAL ANALYSIS OF WATER QUALITY OF KUNDAPURA MANGROVE FOREST, KARNATAKA, INDIA

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Abstract

Mangrove forest is a component of wetlands that has been recognized as one of the most productive ecosystem. Physico-chemical analysis of water quality of Kundapura mangrove forest, Karnataka, India, was studied at four different stations for a period of one year during April-2011 to March-2012. Atmospheric and surface water temperatures (°C) varied from 24°C to 31°C and 22°C to 29°C respectively. Seasonal variations of different parameters investigated were as follows: pH (6.65 to 8.42), dissolved oxygen (3.25 to 11.78mg/l), biological oxygen demand (0 to 3.65mg/l), carbon dioxide (0.55 to 2.3mg/l), electrical conductivity (0.36 to 29.1ms^{-1}), potassium (0.12 to 9.74mg/l), calcium (0.50 to 42.34 mg/l), magnesium (0.25 to 109.5mg/l), sodium (0.017 to 878.04mg/l), bicarbonate (1.40 to 6.23mg/l), carbonate (Nil), chloride (2.83 to 380.70mg/l), sodium absorption ratio (0.02 to 1300mg/l). A seasonal variation in these parameters was observed throughout the study period and monthly comparisons were made as monsoon, pre-monsoon and post-monsoon.

Keywords: Mangrove forest, physico-chemical analysis, monsoon, pre-monsoon, and post-monsoon.

FIG-1. JALADI MANGROVE FOREST:

Introduction

Mangroves are coastal wetland forests established at the intertidal zones of estuaries, backwaters, deltas, creeks, lagoons, marshes and mudflats of tropical and subtropical latitudes. Approximately one fourth of the world's coastline is dominated by mangroves that are distributed in 112 countries and territories comprising a total area of about 181,000 km^2 (*Saravanan, 2005*). The mangrove water was slightly alkaline and contained high amounts of pH, total hardness, calcium, magnesium, chloride, total inorganic and organic phosphate, ammonium, nitrite and nitrate (*V. Ramamurthy et al., 2012*). Mangroves forest grows well along the river bank, estuaries and coastal with the presence of brackish water or where saline and fresh water meets. Mangroves forest is a type of wetland and is considered as one of the most productive ecosystems in the tropic, high in value and has multiple roles and functions (*WWF, 2011; Karami et al., 2009*). Mangrove has unique features and special adaptations like breathing roots, buttresses and aboveground roots that allow and enable them to live and survive in the mud, anaerobic condition; and salty water (*Seca Gandaseca et al., 2011*).The study of mangrove regions is necessary as they are highly productive and play an important role as breeding and nursery grounds for many commercially important fishes especially shrimps (*Kathiresan and Bingham, 2001*). Distribution of nutrients determines the fertility potential of water mass (*Panda et al., 1989; Bragadeeswaran et al., 2007*). The regular and periodic changes in the climate synchronized with season are ultimately reflected in the environmental parameters also, which in turn have a direct or indirect influence over the planktonic population (*A. Saravanakumar et al., 2008).*When river water mixes with seawater, a large number of physical and chemical processes take place, which may influence of water quality (*Muduli Bipra Prasanna et al., 2010).*

Kundapura is located 445 kms west of Bangalore and 36 kms north to Udupi (13° 37' 24" N Latitude and 74° 41' 30" E Longitude and 58 ft. msl). The average annual rainfall is 4344 mm and actual of 4182 mm. The Haladi is the main river in this area. It descends from the Western Ghats to the Arabian Sea. It slows down as it reaches the coast and spreads out into wide estuaries, lagoons, and backwaters with extensive mudflat and small patches of mangrove forest. The mouth of the estuaries and creek are narrow and prominently open to the sea. Many fish and prawn farms are located in the vicinity of the mangrove areas. Mangrove forest is particularly well developed in this river near Gangolli. Much of the intervening coastline is sandy beach backed by coastal dunes, but there are some short stretches of rocky shore. Four

study sites were selected along the banks of river Haladi and Chakra; these are Herikudru, Uppinakudru, Jaladi and Hemmadi.

Materials and Methodology

Monthly water samples were collected from 4 different sampling sites. The water samples were collected between 8.00 a.m. to 9.00 a.m. using wide mouth sterile transparent plastic jar of five liter capacity and usually from 10-15 cm depth from the water surface. For the analysis of dissolved oxygen and BOD, water samples were collected by BOD bottles of 300ml capacity. The manganous sulphate and the alkali iodide reagent were added immediately at the collection site to fix the samples for studying dissolved oxygen. The samples were analyzed in the laboratory. Samples for BOD were incubated in laboratory for five days at 20°C (*Trivedy and Goel, 1984*). The water temperature, air temperature and pH were measured at the place of sampling sites using standard mercury thermometer and microprocessor based pocket pH meter. Immediately after arrival into the laboratory the conductivity of the samples were measured with the help of a digital conductivity meter. For the study of potassium, sodium, carbonates, bicarbonates, chloride, calcium hardness, magnesium hardness and sodium absorption ratio, the samples were analyzed in the laboratory by following standard methods of American Public Health Association (*APHA 2005*). The results of analysis were expressed as mg/l except temperature and conductivity measured as ^{o}C and ms^{-1}respectively.

Statistical analysis: The data are obtained statistically analyzed mean ± standard deviation. All the data were analyzed statistically applying for all the studied parameters.

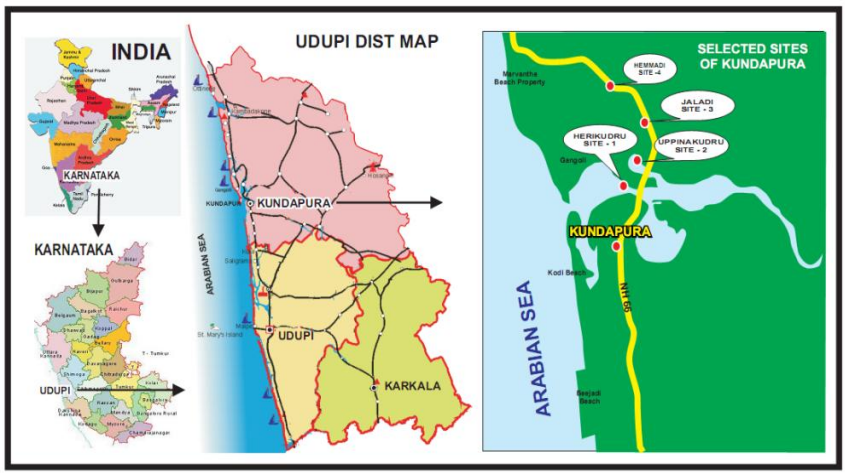


Fig-2 Map showing the geographical location of study sites:

Table-1Study sites:

Study sites	Latitude	Longitude	Elevation
Site-1. Herikudru	13°38'28"N	74°42'01"E	28'
Site-2. Uppinakudru	13°39'21"N	74°41'59"E	25'
Site-3. Jaladi	13°39'41"N	74°42'16"E	16'
Site-4. Hemmadi	13°40'46"N	74°41'20"E	32'

Results and Discussion

Table-2 Physico chemical characteristics of the water (Mean values and standard deviation) during (April-2011to March-2012)

Parameters	Site-1	Site-2	Site-3	Site-4
Air Temperature	27.59±1.59	27.31±1.76	27±1.73	27.59±1.59
Water Temperature	25.68±1.79	25.5±1.65	24.68±1.52	25.90±1.51
P^H	7.59±0.48	7.60±0.46	7.81±0.45	7.68±0.44
Electrical Conductivity	18.62±9.59	10.17±6.77	17.40±11.59	18.56±10.37
Dissolved Oxygen	6.48±1.50	7.78±1.76	5.28±1.58	6.60±1.99
Biological Oxygen Demand	0.79±0.51	0.92±0.66	1.06±0.73	1.25±0.96
Free CO_2	0.8±0.28	0.6±0.16	0.85±0.51	0.8±0.28
Potassium	6.61±3.53	4.29±2.83	6.12±3.56	6.90±3.52
Calcium	17.24±15.48	12.55±11.69	16.21±15.03	14.99±13.74
Magnesium	40.43±38.09	26.63±24.74	42.25±42.96	37.91±38.19
Sodium	297.85±278.83	108.73±100.00	273.87±278.98	248.38±268.11
Bicarbonate	3.78±1.29	3.23±1.25	3.65±1.28	3.66±1.07
Carbonate	00	00	00	00
Chloride	188.17±109.57	96.44±84.04	157.55±108.6	177.16±111.09
Sodium absorption ratio	173.42±398.09	118.35±326.35	247.23±433.34	214.98±372.72

Note: All the parameters are expressed in mg/l except air and water temperature (°C), electrical conductivity (ms^{-1}).

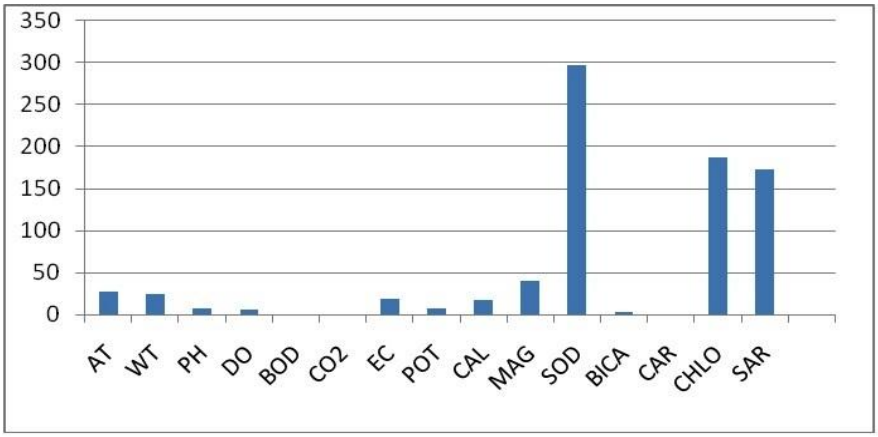


Fig -3.Graph showing the average values of physico-chemical characteristics of site-1

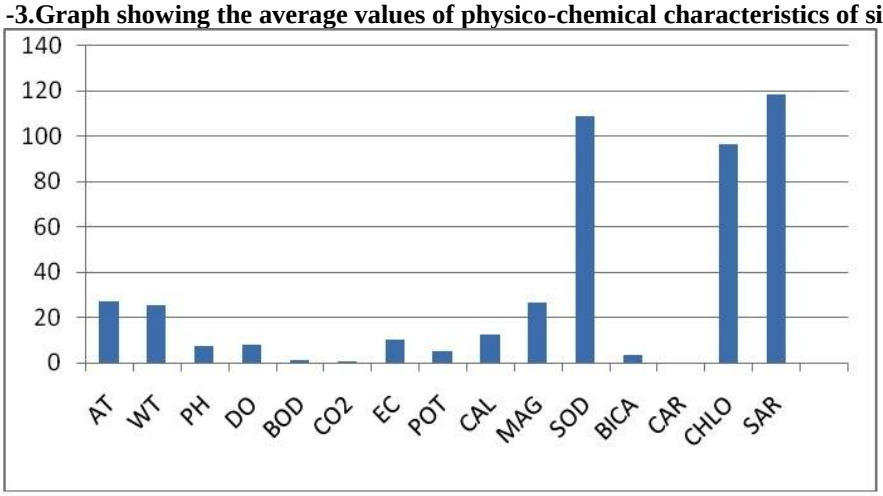


Fig4.Graph showing the average values of physico-chemical characteristics of site-2

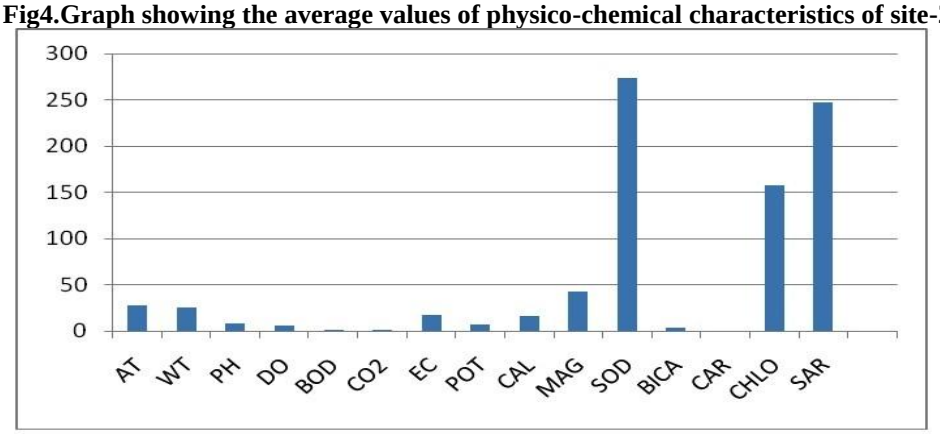


Fig5.Graph showing the average values of physico chemical characteristics of site-3

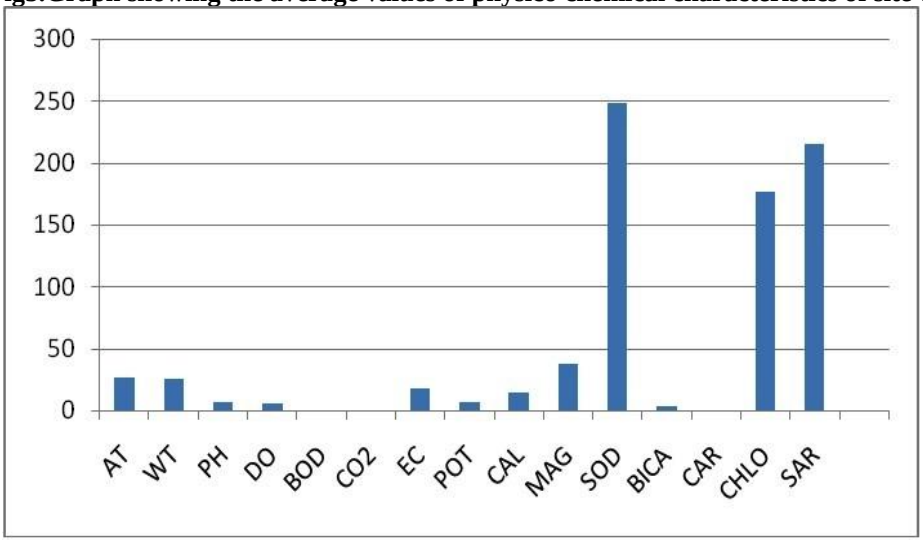


Fig6. Graph showing the average values of physico-chemical characteristics of site-4

The mangrove water was slightly alkaline and contained high amounts of pH, sodium, chloride, sodium absorption ratio and dissolved oxygen. Dissolved oxygen was high during monsoon and low during post monsoon and pre monsoon, Biological oxygen demand was low during monsoon and high during post monsoon and pre monsoon, free carbon dioxide is low during monsoon and slightly rises during pre monsoon; calcium, magnesium, potassium, bicarbonate were low during monsoon and high during post monsoon and pre monsoon. The electrical conductivity was maximum in the pre monsoon, and minimum in the monsoon. Carbonate was absent in all the sites during the study period. Most of the parameters tested were slightly higher in summer than the monsoon seasons. In general, the characteristics of water tested in all the seasons were varied. The physico chemical parameters showed variations in different seasons in the study region depending on the topography.

Temperature is an important biologically significant factor, which plays an important role in the metabolic activities of the organism (*J. Sirajudeen and M. M. Mohamed Mubashir, 2013*). Air temperature ranged from 24^{o}C (monsoon) to 31^{o}C (pre monsoon). Air temperature reaches its maximum during summer and minimum during monsoon and winter. The surface water temperature varied from 22^{o}C (monsoon) to 29^{o}C (pre monsoon). There was a steady increase in temperature from March to May, which peaked during May. All the stations showed similar trend with similar seasonal changes. Generally surface water temperature is influenced by the intensity of solar radiation, evaporation, isolation, freshwater influx and cooling and mix up with ebb and flow from adjoining neritic waters (*Govindasamy et al., 2000*). In the present study, summer peaks and monsoonal troughs in air and water temperature were noticed, as observed earlier in the west coast of India (*A. Saravanakumar et al*., *2008).*

The pH values were varied from 6.65 (in site-4 in the month of Oct) to 8.42 (in site-3 in the month of April) during post monsoon and summer season. P^{H} in surface waters remained alkaline and slightly acidic throughout the study period in all the stations with the maximum values occurring in the summer and minimum values occurring in the monsoon and post monsoon seasons. Generally, fluctuations in pH values during different seasons of the year is attributed to factors like removal of CO_2 by photosynthesis through bicarbonate degradation, dilution of seawater by freshwater influx, reduction of salinity and temperature and decomposition of organic matter (*Upadhyay, 1988 ; Rajasegar, 2003*). The recorded high pH values might be due to the influence of seawater penetration and high biological activity (*Balasubramanian and Kannan, 2005);* similar results were reported by *G. Velsamy et al., 2013.*

The electrical conductivity was found maximum in the month of May i.e. 29.1 (ms^{-1}) and minimum in the month of July i.e. 0.36 (ms^{-1}).The maximum and minimum values of electrical conductivity is due to fresh water influx and mix up with ebb and flow. The conductivity usually depends upon the dissolved nutrients and other dissolved ions have reported higher conductivity after the disposal of paper mill effluents in Krishna river (*Trivedy, R.K. 1988*) and (*Khatavkar, S.D. and Trivedi, R.K. 1992)* also reported higher conductivity value in natural freshwater after discharge of sugar factory effluents. Similar results were reported by *Prabhahar. C et al.,* 2011; Rita *Chauhan et al., 2008.*

The maximum value of dissolved oxygen concentration was observed in site- 2 in the month of July i.e. 11.78 mg/l (monsoon) where as the minimum value of dissolved oxygen was found in the site-3 in the month of May i.e.3.25mg/l (summer). Season-wise observation of dissolved oxygen showed an inverse trend against temperature and salinity. It is well known that temperature and salinity affect dissolution of oxygen in seawater (*Vijaya Kumar et al., 2000*). In the present investigation, higher values of dissolved oxygen were recorded during monsoon months in all the stations and relatively lower values found during summer could be mainly due to reduced agitation and turbulence of the coastal and estuarine waters. Higher dissolved oxygen concentration observed during the monsoon season might be due to the cumulative effect of higher wind velocity coupled with heavy rainfall and the resultant freshwater mixing. Similar results were reported by *and Saravanakumar et al., (2008*); *P. Satheeshkumar and B. Anisa Khan,2009.*

The maximum value of B.O.D was observed in site- 4 in the month of October i.e. 3.65 mg/l where as the minimum value of B.O.D was found in the site-3 in the month of August i.e.0 mg/l. BOD is an indicator for the amount of the biodegradable organic substances. BOD also accounts the oxygen that is required in organic matter decomposition (*Amadi et al., 2010*). B.O.D depends on temperature, extent of biochemical activities, concentration of organic matter and such other related factors in monsoon period *(Muduli Bipra Prasanna et al., 2010)*. BOD value will rise when there is more organic matter such as leaves; wood, waste water or urban storm water runoff took place at the river water (*Seca Gandaseca et al., 2011).*

The value of free CO_2 ranges from 0.55 to 2.3mg/l. The maximum value (2.3 mg/l, in site-3) was recorded in the month of May and minimum value (0.55mg/l) in the month of June and July in all the selected sites. This may be depends upon alkalinity and hardness of water body. The value of CO_2 was high in pre monsoon .This could be related to the high rate of decomposition in the warmer months. Similar results were reported by *S. A. Manjare et al., 2010.*

The maximum calcium content was found in site-1 i.e.42.34 mg/l in the month of April and minimum value found in site-2 i.e.0.503 mg/l in the month of August. Calcium values are indicative of intense of chemical weathering in the Indian sub continent. Calcium concentration is highest in estuaries due to the influx of riverine source. Similar results were reported by *Rita Chauhan et al., 2008 and M. Gadhia et al., 2012.* Magnesium content varies among different sites. Maximum values of magnesium were observed during the month of March in site- 4 i.e. 109.5 and the minimum values were observed during the month of August in site- 3 i.e. 0.25mg/l. Similar results were reported by *V. Ramamurthy et al., 2012.*

The maximum potassium content observed during the month of December in site-1 i.e. 9.74 mg/l and minimum potassium content observed during the month of August in site-3 i.e.0.12 mg/l. The highest concentration appeared in the winter and the lowest concentration was observed in the rainy season. According to surface water standard, the K^{+} in fresh water should be 2.3 mg/l (*Garrels, R. M.; Mackenzie, F.T, 1971*). Seawater contains about 400 mg/l potassium. A study conducted by *Bergman, J., 2010* disclosed that seawater contains 392 mg/l of K. Rivers generally contain about 2-3 mg/l of potassium. This difference is mainly caused by a large potassium concentration in oceanic basalts. In the present

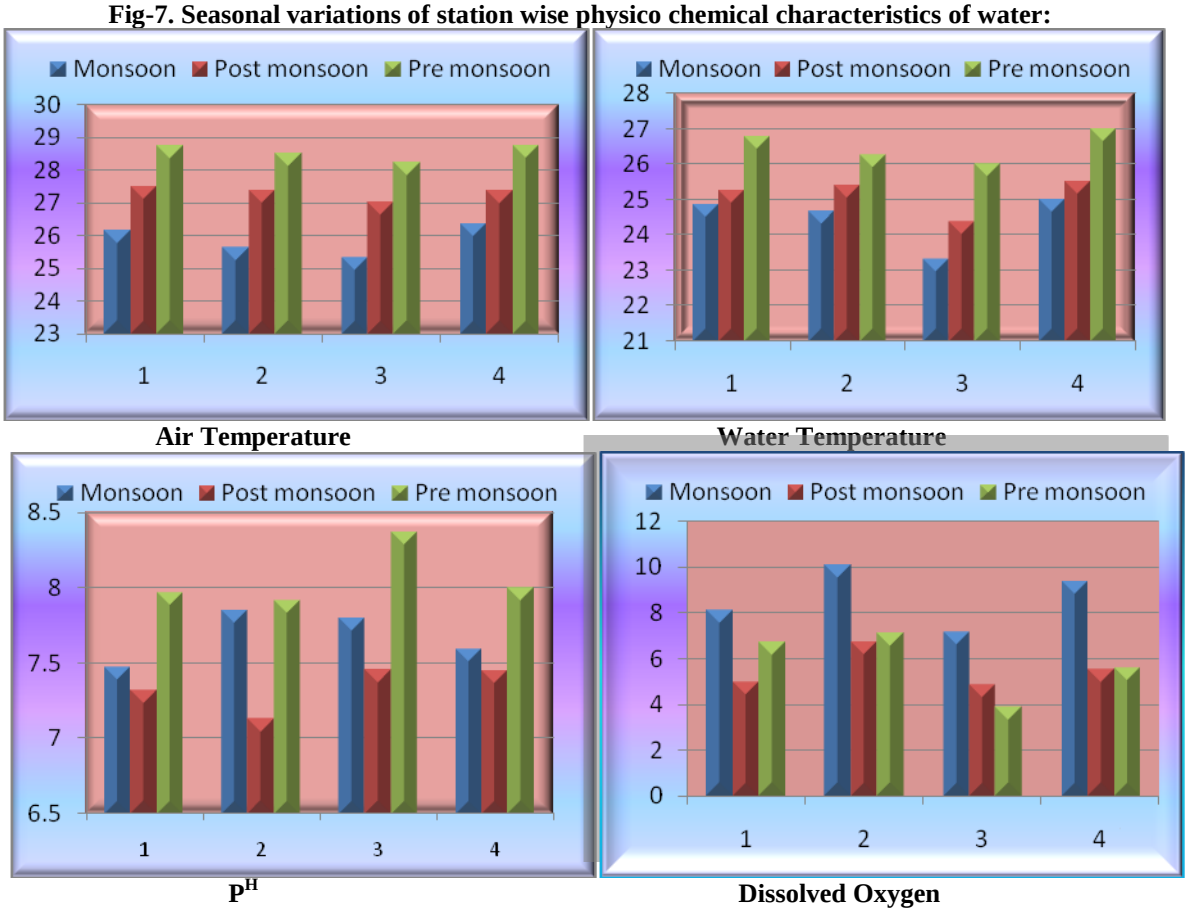
study, the potassium values in all stations and all seasons were slightly high. Similar results were reported *by Mohammad M. Rahman et al., 2013*.

The maximum sodium content observed during the month of January in site-1 i.e. 878.04c mg/l and minimum sodium content observed during the month of August in site-2 i.e. 0.017 mg/l. Higher value of sodium (mg/l) during post monsoon season due to high salinity and low value during monsoon season due to rain and flow of river water *(M. Gadhia et al., 2012*. The high sodium values are largely due to the proximity of sea. The present data also reveals the potassium was lower than the sodium. This may be due to preferential absorption and incorporation into silicate minerals. Similar results were reported by *Rita Chauhan et al., 2008.*

The maximum bicarbonate content observed during the month of May i.e. 6.29 mg/l in site-4 and minimum bicarbonate content observed during the months of July i.e. 1.40 mg/l in site-3. The high value in summer is due to the mixing of sea water and low value during rainy season is due to inflow of fresh water. The presence of high amount of bicarbonate indicates very hard water which is very hazardous for ecosystems (*Mohammad M. Rahman et al., 2013)*. The carbonate content was absent in all the sites and in all the season.

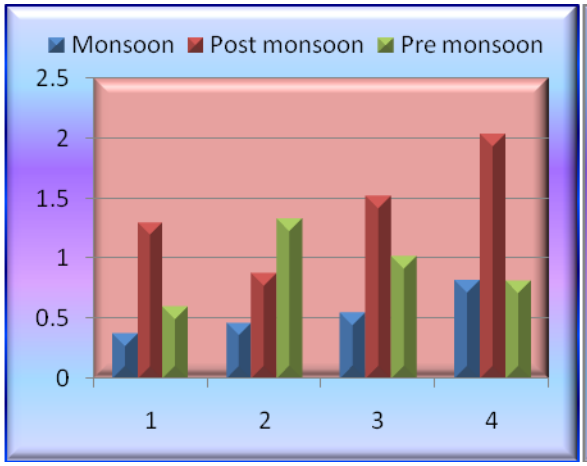
The values of chlorides range from 2.83 mg/l to 380.70 mg/l. The maximum value (380.7 mg/l) was recorded in the month of April in site-1 (summer) and minimum value (2.83 mg/l) in the month of August in site-2 (monsoon). Chloride contents tend to vary inversely to the rate of flow of water (*Amita Sarkar and Bhavna Upadhyay, 2013*). The chlorides, in high concentration, indicate presence of organic matter (*Dhanpakiam et al., 1999*). The value of chloride was higher during pre monsoon which might be due to high salinity, tidal flow and less fresh water mixing. Low value was during monsoon season due to rain and more mixing of fresh water from river *(M. Gadhia et al., 2012)*. In the present study maximum value of chloride reaches in summer. Similar results were reported by *Swaranlatha and Narsing rao, 1998*. The maximum sodium absorption ratio was observed during the month of January i.e.1300.9 mg/l in site-1 and minimum sodium absorption ratio was observed during the month of August i.e. 0.02 mg/l in site-2.

Fig-7. Seasonal variations of station wise physico chemical characteristics of water:

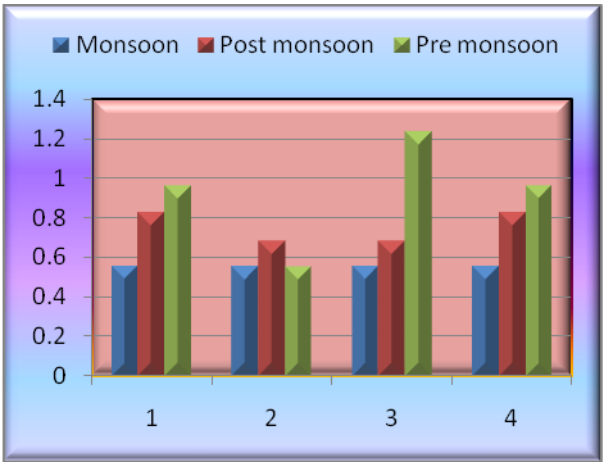


Air Temperature **Water Temperature**

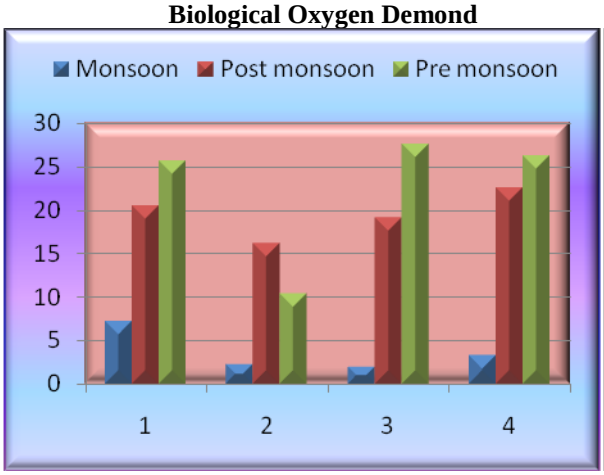
P^H **Dissolved Oxygen**



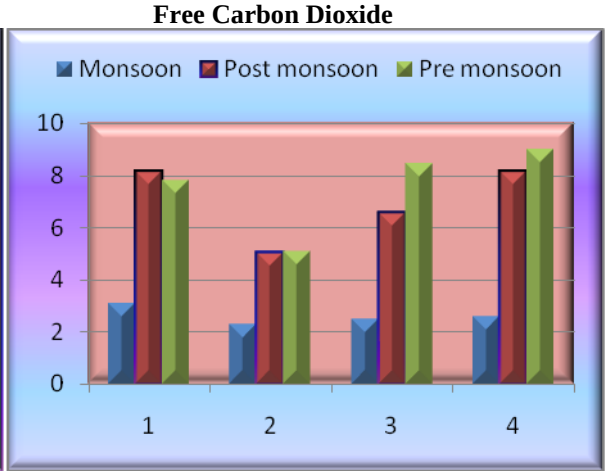
Biological Oxygen Demond



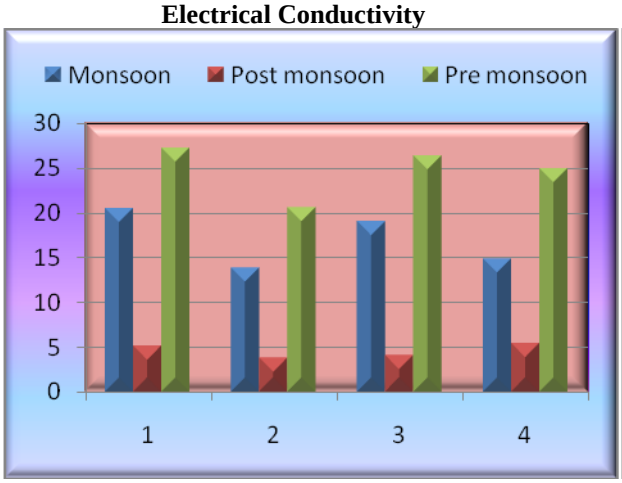
Free Carbon Dioxide



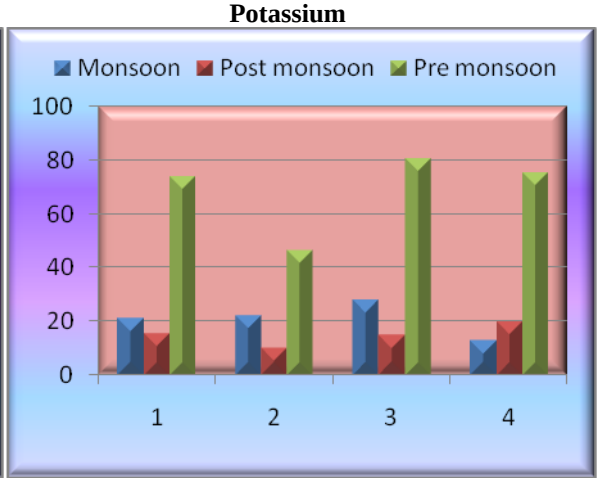
Electrical Conductivity



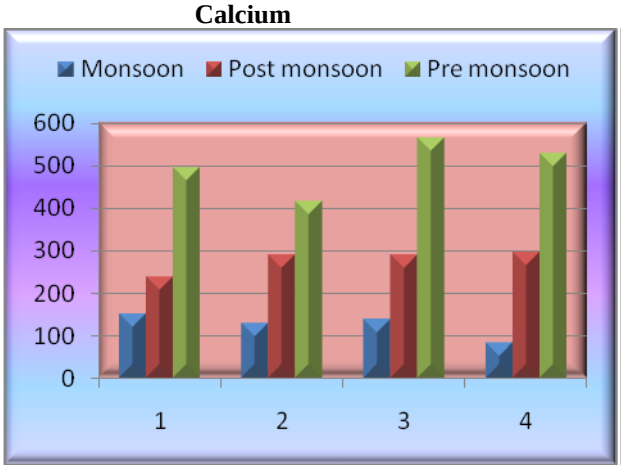
Potassium



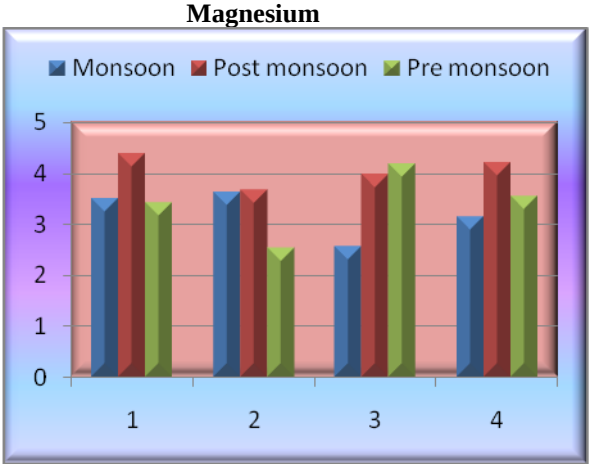
Calcium



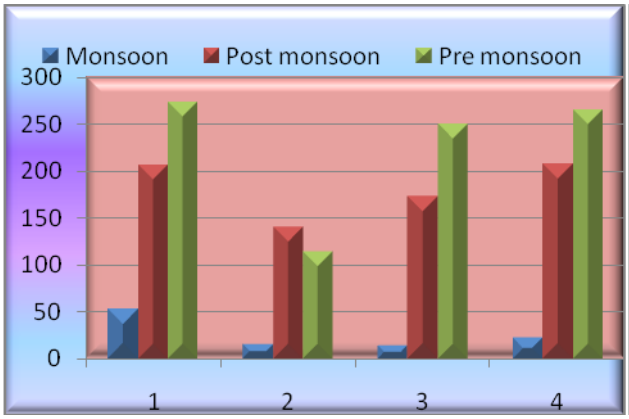
Magnesium



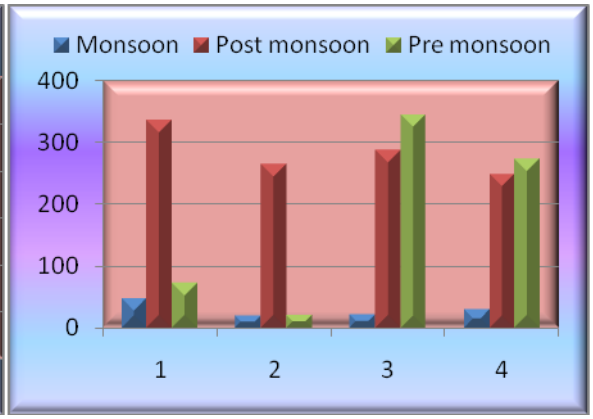
Sodium



Bicarbonate



Chloride



Sodium Absorption Ratio

Conclusion

As the season changes there is a fluctuation in the physicochemical characters of the water, this will be due to ebb and flow, flushing of rain water, change in the temperature and salinity as season changes. In addition, intense pollution from both agricultural inputs and shrimp culture ponds deteriorate the water quality of mangrove ecosystem. The present information of the physico-chemical characteristics of water would form a useful tool for further ecological assessment and monitoring of these coastal ecosystems.

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