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Seasonal Fluctuation of Hydrographical Parameters Along the Coastal Beaches of Mangaluru

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Abstract:- Coastal waters are considered to be the pillar and essential of Marine life. The study of Hydrographic properties of coastal environments is important, because the variations in the instantly influence on the floral and faunal production. The variations affect the species diversity, pattern of diversity, breeding, survival and other activities. To maintain optimum level of water quality parameters is better for the species survival and healthy ecosystem. The present study was carried out to determine the Hydrographic variations in coastal Waters of Someshwara, Panambur and Bengre beaches along the Mangaluru, south west coast of India. The sampling of coastal water was carried out from August 2016 to July 2017 over all three beaches at nine stations along the Mangaluru coast between 12° 47' 748" N to 12° 56' 449" N and 74° 50' 780" E to 74° 48' 207" E was studied. Spatial and temporal variations of the hydrographical parameters like temperature, salinity, pH, dissolved oxygen, ammonia, inorganic nitrite, nitrate, phosphate, silicate, and sediment organic carbon analyzed. The results showed decline in the quality of water during the non-monsoon season compared to that in the monsoon season. The dissolved oxygen and nutrients was found to be low in summer and high during monsoon season. Similarly temperature, pH and salinity were low during monsoon and high during summer season. The hydrographic properties have exhibited considerable seasonal and spatial variations.

Keywords:- *Hydrographical properties, Nutrients, South west monsoon, Coastal water, west coast of India.*

I. INTRODUCTION

Hydro-biological study is an important pre-requisite in coastal waters as it is very susceptible to natural and manmade influence. Pollution control is one of the prime objectives of coastal water management. The physical, chemical and biological properties of water affect the monitoring and assessment of coastal water quality (Clark, 1996). The measurement of physico-chemical parameters in the marine environment helps to understand the aquatic ecosystem (Sahu *et al*., 2012). The various physico-chemical parameters *viz* temperature, salinity, pH, dissolved oxygen and nutrients of the environment are the factors which mainly influence the production and successful propagation of organism's life in the coastal biotopes (Santhosh and Perumal, 2012). Several alterations in physico-chemical characteristics of water can leads to various ecological consequences like changes in species composition and distribution.

A. Environment

Mangaluru is located at 12.87°N and 74.88°E in the Dakshina Kannada district of Karnataka the present investigation was undertaken mainly to know the spatio-temporal variations of physico-chemical parameters of water from the beaches. The Someshwara beach is parallel to Netravathi River, which greatly receives fresh water inflow from the river, land nutrients, municipality, and domestic sewage, decayed plant and animal matter, pesticides from agriculture activities. Panambur beach is a part of Mangaluru port area located at one end which handles high sea traffic. And another end fertilizer and oil industries and domestic sewage from coastal side fisher folk this area is highly industrialized and also one of the famous touristic spot in Mangaluru. The Bengre is a small island in Mangalore city with few of the Mangalorean population staying there located near to old Mangalore port.This beach affects mainly inflow of waste water and domestic sewage from fish meal plants and small industries. Dredging activities are also going on this area.

Fig 1:- Map showing the locations of sampling station

II. MATERIALS AND METHODS

The study have been carried out for a period of one year from August 2016 to July 2017 along the selected beaches (Someshwara, Bengre and Panambur) of Mangalore, Karnataka (Fig.1). A total of nine stations designated as S1, S2, S3, P1, P2, P3, B1, B2 and B3 (Fig.1)The intertidal water samples were collected in a clean plastic bucket for the determination of various physical characteristics in the field and chemical parameters were determined in the laboratory. The sediment samples were collected by using scoop and placed in plastic cover for further analysis in the laboratory. The sampling stations were fixed by the global position system (GPS).The quantum of rainfall received in the study area was collected from Joint Director of Agriculture, Mangaluru was collected from 2016 August to July 2017.

Air temperature: The air temperature was recorded at each station in the beginning of the sampling at the shaded side of the station using a standard mercury centigrade thermometer and expressed in degree Celsius. Water temperature: Immediately after the collection of the intertidal water sample, the water temperature was recorded by using a standard mercury centigrade thermometer and expressed in degree Celsius.

Chemical parameters: The intertidal water samples were collected using a clean plastic bucket and stored in plastic bottles for analysis of pH, salinity, Nitrite-N, Nitrate-N and Silicate-Si. Samples for Dissolved oxygen, Ammonia-nitrogen (NH_3-N) and Phosphate-Phosphorous (PO_4-P) analysis were collected in acid washed glass bottles. Dissolved oxygen: The water samples were collected for the estimation of dissolved oxygen in a clean 125 ml stoppered glass bottles following all the precautions prescribed for determination of dissolved oxygen in the water sample and fixed using Winkler's reagents (Manganous sulfate and Alkaline iodide) (Strickland and Parsons, 1972). Ammonia-Nitrogen: (NH_3-N) The water samples were collected in clean 150 ml amber colored glass bottles and fixed following the phenol-hypochlorite method as described by Parsons *et al.* (1989). Phosphate-Phosphorus: (PO_4-P) For estimation of Phosphate-Phosphorus, water samples were collected in clean glass bottles and brought to the laboratory for further analysis by using ammonia molybdate method (Parsons *et al.*, 1989).

III. LABORATORY ANALYSIS

PH: The intertidal water pH was measured potentiometrically using digital pH meter (EUTECH instrument, pH/mV/°C/F meter). Salinity: The salinity of intertidal waters was analyzed in the laboratory by Mohr's method which was collected in polyethene bottles and expressed in PSU (Strickland and Parsons, 1972). Nutrients: The water sample collected from different sampling stations during the study period was brought to the laboratory and analyzed for the nutrients by employing standard methods (Parsons *et al.*, 1989). The nutrients such as Ammonia-nitrogen (NH_3-N by using phenol-hypochlorite method), Nitrite-nitrogen (NO_2-N by using sulphanilamide method), Nitrate-nitrogen (NO_3-N by using cadmium reduction method), Phosphate-phosphorus (PO_4-P by using ammonium molybdate method), and Silicate-silicon (Si by using Silico-molybdate method) were estimated. The absorbance for different parameters was measured using UV-VIS spectrophotometer.

- *Statistical analysis*: The simple correlation was determined between various physico-chemical parameters such as water temperature, pH, salinity, dissolved oxygen, nutrients and sediment fractions.

IV. RESULTS & DISCUSSION

Growth, production, survival and reproduction of aquatic organisms are influenced by physical, chemical and biological characteristics of water. Water quality provides information about the concentrations of various solutes dissolved in water at given place and time. Present study was designed to monitor temporal and spatial variations in water quality parameters to investigate limiting factors, which could adversely affect aquatic life in the intertidal ecosystem. And also intertidal area wave action and tidal amplitude could impose serious problems on water quality. The monthly rain fall data represented graphically in Fig. 2.The monthly variations of tidal amplitude of was recorded in the intertidal beaches of Mangaluru during August 2016 to July 2017. Monthly sampling was done during lowest low tide. It is one of the most important cyclic phenomena in tropical countries, as it bring profound changes in hydrographical characteristics of aquatic environment. The total annual rainfall recorded during the study period was 2495 mm. The patterns of rain fall along west coast of India revealed that the bulk of precipitation was received during south west monsoon in monsoon season followed by post-monsoon and pre-monsoon season the patterns of rain fall along west coast of India revealed that the bulk of precipitation was received during south west monsoon season followed by post-monsoon and pre-monsoon season.

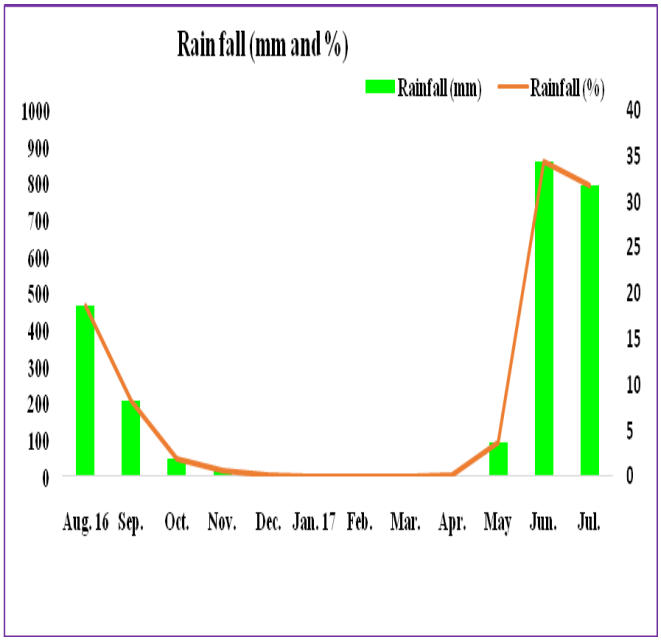

Fig 2:- Map showing the Rain fall (mm) and % during the study period

Similar rain fall patterns was reported in Mangaluru coast made by Chethan (2012), Swetha (2009), Madhavi (2014) and Shruthi (2015) the same study area.

A. Air Temperature

Stations \ Months		Monsoon				Post-monsoon				Pre-monsoon			
		June	Jul	Aug 16	Sept	Oct	Nov	Dec	Jan. 17	Feb	Mar	Apr	May
Someshwara beach	S1	27.4	26.5	24.4	27.3	27.6	24.4	24.0	24.2	26.7	26.5	30.6	27.4
	S2	27.5	27.4	24.5	27.8	28.4	25.4	24.2	24.8	27.7	26.9	30.8	27.5
	S3	27.8	27.6	24.5	27.5	28.3	25.9	25.3	25.2	28.4	27.3	30.8	27.7
Panambur beach	PI	28.3	28.0	24.8	25.4	28.3	30.2	30.4	28.2	32.0	28.8	32.5	29.4
	P2	28.5	28.1	24.8	25.9	28.6	30.2	30.0	28.8	32.4	29.6	32.3	29.1
	P3	28.8	28.0	24.9	26.5	28.7	30.4	30.2	29.3	33.0	29.9	32.5	29.6
Bengre beach	B1	28.3	27.8	26.2	26.9	28.9	30.5	30.0	29.8	33.2	30.2	32.6	30.6
	B2	27.4	28.1	26.2	25.7	29.0	30.5	30.4	30.1	33.3	30.4	32.6	30.8
	B3	27.1	28.0	26.5	25.4	29.4	30.8	30.6	30.5	33.5	31.0	32.8	30.7

Table 1. The variations of air temperature (^{0}C) at selected beaches of Mangaluru during August 2016 to July 2017

The air temperature was ranged between 24.0 and 33.5 ºC. The minimum was observed in the month of December (post-monsoon) at Someshwara beach (S1) while the maximum was observed in the month of February (pre-monsoon) at Bengre beach (B3).The fluctuation in the air temperature was closely related to the seasonal changes in the wind and precipitation, thus, highest temperatures were observed during pre-monsoon season (April) and lowest values during post monsoon (December) seasons. Temporally the maximum air temperature was recorded during pre-monsoon and minimum during monsoon season. Lowest temperature recorded during south west monsoon period may be attributed to the monsoon wind and precipitation and soon after monsoon the temperature increased gradually due to the increase in solar radiation and change in wind condition. Similar observations were made by, D'Souza (2001), Santhanagouda (2001), Tripathi (2002), Raveesha (2007), Chethan (2012), Ganapathi Naik (2012), Madhavi (2014) and Shruthi (2015) from the same study area.

V. WATER TEMPERATURE

It is well known that water temperature influences the intertidal organisms directly by effecting on their physiological parameters and indirectly through change in the physico-chemical properties of intertidal water. It influences the chemical processes such as dissolution-precipitation, adsorption-desorption, oxidation-reduction and physiology of biotic community in the intertidal habitat. Therefore, water temperature becomes an important factor in the environmental studies. A seasonal increasing trend in air temperature was observed for water temperature during the study period. The minimum water temperature was observed in the month of August (monsoon) at Someshwara beach station (S1), however all the stations recorded, maximum water temperature was observed during pre-monsoon season. The highest temperature was recorded in April has been influenced by the high intensity of solar radiation coupled with evaporation. Lowest surface water temperature recorded during post monsoon season could be due to the cloud over and reduction in solar radiation on the day of sampling therefore the recorded high monsoon and low post-monsoonal values can be ascribed to meteorological phenomenon *i.e*., high solar radiation and precipitation respectively. Shruthi and Rajashekhar (2013) opined that the surface water temperature ranged from 27.5 ºC to 31.5 ºC from the Netravathi estuary area. The recorded low temperature during monsoon could be due to overcast sky and strong sea breeze, which could be in accordance with the earlier reports Govindasamy *et al*., (2000), Tripathi (2002), Raveesha, (2007) and Chethan (2012), Shanthanagouda (2001), Swetha (2009) and Madhavi (2014) observed highest temperature during pre-monsoon and lowest temperature during the post-monsoon, in coastal waters of Mangaluru coast.

Stations \ Months		Monsoon				Post-monsoon				Pre-monsoon			
		June	July	Aug. 16	Sept	Oct	Nov	Dec.	Jan. 17	Feb.	Mar.	Apr.	May
Someshwara beach	S1	30.0	28.9	23.5	23.5	27.3	28.1	28.4	26.5	28.7	29.6	30.4	30.4
	S2	30.0	28.9	23.6	23.5	27.2	28.4	28.5	27.1	28.7	29.5	30.8	30.4
	S3	29.8	28.9	23.6	23.7	27.2	28.7	28.5	27.6	28.9	29.8	30.6	30.3
Panambur beach	PI	29.9	29.3	24.5	25.2	30.0	29.4	28.7	27.0	29.4	30.1	32.5	31.2
	P2	29.8	29.5	24.5	24.9	30.5	29.5	29.0	27.3	29.8	30.4	32.5	31.7
	P3	29.6	29.2	24.6	24.9	30.2	29.5	29.3	27.8	30.0	30.7	32.2	31.4
Bengre beach	B1	29.5	29.3	24.7	25.4	30.9	29.6	29.9	28.5	30.3	30.9	32.4	31.9
	B2	29.5	29.2	24.7	24.9	31.0	29.7	30.2	28.1	30.4	30.9	32.4	31.8
	B3	29.6	29.5	24.8	24.9	30.8	29.4	30.3	28.3	30.0	30.8	32.5	31.7

Table 2. The variations of water temperature (^{0}C) at selected beaches of Mangaluru during August 2016 to July 2017

Water temperature was ranged from 23.5 to 32.7 ^{o}C. The minimum was recorded in the month of August (monsoon) at Someshwara beach (S1) while maximum was observed in the month of April (pre-monsoon) at Panambur beach (P2). Spatially, there were not many variations between the stations of the selected beach. Seasonally the minimum water temperature was observed in monsoon followed by post and pre-monsoon season.

*pH :*The variation of hydrogen ion concentration (pH) in the present study is presented in the Table 3.

The pH is the only parameter which not only changes the chemical property of the interstitial habitat but also influences the intertidal benthic community structure. The variations in pH of the intertidal water also generally followed the changes observed in the overlying coastal waters. The minimum pH 7.4 of intertidal water was recorded in the monsoon season at Panambur beach station (P3). However, maximum pH was observed in all stations during pre-monsoon season. The observed pH maxima during pre-monsoon could be attributed to the high rate of evaporation under high temperature conditions. The observed post-monsoon minima can be ascribed to rainfall, resultant freshwater mixing.

Similar results were also observed by earlier workers Sushanth and Rajashekhar (2012) observed pH values ranging from 7.9 to 8.5 in coastal waters of Uttara Kannada district. Shruthi (2015) recorded pH 7.8 to 8.6 in Mangaluru coastal waters. Chethan (2012) recorded pH values from 7.10 to 8.30. However, previous studies indicated that coastal waters are well buffered with pH ranging from neutrality to slightly alkaline. Several investigators Shanthanagouda (2001), Tripathi (2002) and Swetha (2009) while working on the hydrography of Nethravati-Gurupur estuarine and coastal waters of Mangaluru, have reported lower values of pH during post-monsoon season. Tripathi *et al.* (2001) and Shruthi (2015) documented a pH range of 7.2 to 8.4 during their investigation in Mangaluru coast.

Stations \ Months		Monsoon				Post-monsoon				Pre-monsoon			
		June	July	Aug 16	Sept	Oct	Nov	Dec.	Jan. 17	Feb.	Mar.	Apr.	May
Somesh wara beach	S1	7.84	7.65	7.60	8.01	8.00	8.04	8.10	8.04	8.05	8.15	8.15	8.24
	S2	7.82	7.73	7.66	7.99	8.04	8.11	8.11	8.05	8.10	8.12	8.17	8.26
	S3	7.87	7.83	7.54	8.04	8.07	8.12	8.16	8.13	8.14	8.18	8.17	8.26
Panambu r beach	PI	7.86	7.80	7.56	8.03	8.04	8.12	8.11	8.04	8.10	8.13	8.18	8.27
	P2	7.69	7.68	7.65	8.04	8.11	8.16	8.15	8.04	8.12	8.15	8.20	8.29
	P3	7.61	7.40	7.43	8.02	8.07	8.16	8.16	8.11	8.08	8.13	8.18	8.27
Bengre beach	B1	7.80	7.76	7.57	8.07	8.17	8.10	8.15	8.12	8.15	8.13	8.19	8.26
	B2	7.87	7.79	7.79	8.08	8.16	8.19	8.16	8.08	8.18	8.19	8.18	8.28
	B3	7.70	7.61	7.88	7.98	8.12	8.11	8.14	8.13	8.11	8.17	8.22	8.21

Table 3. The variations of water pH at selected beaches of Mangaluru during August 2016 to July 2017

The intertidal water pH ranged from 7.40 to 8.29. The minimum pH was observed in the month of July (monsoon) at Panambur beach (P3) while the maximum was observed in the month of May (pre-monsoon) at Panambur beach (P2). There were no spatial variations between the stations. During the monsoon season water pH was lower compared to post and pre-monsoon season.

Salinity: The salinity (PSU) at selected stations during the study period is given in the Table 4.Salinity is a dynamic indicator of the nature of the exchange system. The salinity of water with in the coastal and estuarine area tells us how much freshwater has mixed with sea water. Salinity is one of the key factor in marine environment. In the present study, considering the seasonal trend, the maximum salinity (32.19 PSU) of water was observed in the month of May 2017 at Bengre beach (B3), whereas the minimum salinity (23.75 PSU) was observed in the month of July 2017 at Panambur station (P3). It is well known that salinity is determined by the factors like precipitation, run-off, evaporation and the degree of dilution caused by the mixing of sea and river water. In the present study also the salinity showed an increasing trend from monsoon to pre-monsoon the most crucial factor responsible for the death of intertidal fauna is salinity which decreased considerably during monsoon Datta *et al.* (2010).

Similar observations were also made by Sampathkumar and Kannan (1998), Sridhar *et al.* (2006), Muruganantham *et al.* (2012), Sushanth and Rajashekhar (2012). Madhavi (2014) observed maximum salinity during pre-monsoon season due to low amount of rainfall and higher rate of evaporation. Sridhar *et al.* (2006) reported salinity ranging from 26 to 34.5 PSU in South-east coast. Muruganantham *et al.* (2012) recorded salinity variation from 28 to 37 PSU in the South-east coast of India. Sushanth and Rajashekhar (2012) reported salinity ranging from 26.5 to 31.8 PSU in the coastal waters of Uttara Kannada district. Gopalakrishnan and Nair (1998) recorded salinity between 20 and 36 PSU in the coastal waters of Padukkotai and Thanjavur districts. Chethan (2012) documented decadal difference which exhibited a decrease of 1.6 PSU with average surface water salinity of 32.22 PSU from 1990 to 2000 and 31.56 PSU from 2001 to 2011 along the coastal waters of Mangalore. Madhavi (2014) recorded surface water salinity range from 9.12 to 34.36 PSU in the coastal waters of Mangaluru.Datta *et al.* (2010) observed the high Bray-Curtis similarity matrix values of salinity (74.54 and 78.26) with organisms/month and biomass/month in selected beaches of Mumbai and he reported that salinity is the most important factor that controls the distribution of organisms in the intertidal area.

Months / Stations		Monsoon				Post-monsoon				Pre-monsoon			
		June	July	Aug. 16	Sept	Oct.	Nov.	Dec.	Jan. 17	Feb.	Mar.	Apr.	May
Someshwara beach	S1	25.63	25.31	28.75	30.00	30.63	30.94	30.00	30.31	30.63	30.63	30.94	31.56
	S2	25.94	25.31	29.38	29.69	30.31	30.63	30.00	30.31	30.63	30.63	30.94	31.88
	S3	25.63	25.00	28.13	30.00	30.63	30.94	29.69	30.31	30.63	30.63	30.94	31.88
Panambur beach	PI	26.56	25.00	28.13	30.63	30.00	30.31	30.31	30.00	30.63	30.94	31.25	31.56
	P2	26.25	25.63	28.13	30.63	30.31	30.63	30.31	30.00	30.94	30.94	31.25	31.56
	P3	25.00	23.75	27.50	30.31	30.00	30.31	30.31	30.00	30.63	30.94	31.25	31.88
Bengre beach	B1	26.25	25.63	28.13	30.63	30.00	30.94	30.63	30.00	30.63	30.63	31.25	31.88
	B2	25.94	25.31	28.75	30.63	30.31	30.94	30.63	30.00	30.63	30.94	31.25	31.88
	B3	26.25	25.94	27.50	30.63	30.63	30.94	30.63	30.00	30.94	30.94	31.25	32.19

Table 4. The variations of salinity (psu) at selected beaches of Mangaluru during August 2016 to July 2017

The salinity of water varied from 23.75 to 32.19 PSU. The minimum salinity was recorded in the month of July (monsoon) at Panambur beach (P3) while the maximum value was observed in the month of May (pre-monsoon) at Bengre beach (B3). Monsoon season showed low saline condition, while high salinity was recorded in pre-monsoon period and spatially uniform values were recorded in all stations.

Dissolved Oxygen: The dissolved oxygen is an important characteristic of water and its concentration in water is an indicator of prevailing water quality and ability of water body to support a well-balanced aquatic life. The DO concentration also indicates the turbulence in the area which determines the dissolution of oxygen from the atmosphere. It also indicates the physico-chemical parameters of the water particularly the salinity and temperature on which the concentration of oxygen is inversely related. In the present study the dissolved oxygen concentration fluctuated between 5.71 and 8.15 mg/l irrespective of intertidal wave and tidal activities, with a variation of 2.44 mg/l. The highest concentration was recorded in the month of September and October and lowest in the month of April. The observed high values might be due to the effects of higher wind velocity, increased turbulence coupled with heavy rainfall. However, in intertidal waters the resultant freshwater mixing through run-off also might have resulted in high dissolved oxygen content. The observed low dissolved oxygen concentration could be attributed to high biological activity besides, low solubility of oxygen under high temperature and salinity conditions. The 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 (Vijayakumar *et al.*, 2000).The results obtained in the present study are almost similar to Tripathi (2002). He reported a variation in the dissolved oxygen content of surface water of Nethravati-Gurupur estuarine coastal waters from 2.56 to 8.53 mg/l, with an annual variation of 5.97 mg/l. Further, he has observed higher dissolved oxygen content in the surface waters during post-monsoon season, lower dissolved oxygen content during pre-monsoon season. The monthly variation in the dissolved oxygen concentration observed in the present study was almost similar to that of Rajeshwari (2009).

Stations \ Months		Monsoon				Post-monsoon				Pre-monsoon			
		June	July	Aug. 16	Sept	Oct.	Nov	Dec.	Jan. 17	Feb	Mar	Apr	May
Someshwara beach	S1	6.11	6.93	6.93	7.34	7.74	6.32	6.93	7.13	7.34	6.11	6.93	6.52
	S2	6.52	7.34	7.34	7.74	7.74	6.11	6.52	6.93	6.93	6.52	6.52	6.52
	S3	5.91	7.34	7.13	8.15	7.54	6.52	6.32	7.13	7.13	6.32	6.73	6.93
Panambur beach	PI	7.54	7.13	7.13	7.74	8.15	7.34	6.52	7.34	7.34	6.11	5.71	6.11
	P2	6.93	7.34	7.34	8.15	6.93	6.93	6.11	7.13	6.93	6.52	6.93	6.11
	P3	7.34	6.93	7.13	7.34	7.13	7.34	6.52	7.13	6.93	6.73	6.52	6.32
Bengre beach	B1	6.11	7.74	6.93	7.34	6.52	6.11	6.11	7.34	7.74	6.93	7.34	5.91
	B2	7.13	7.13	7.34	7.13	6.11	6.52	6.11	6.73	7.74	6.73	6.52	6.11
	B3	6.73	7.34	7.54	6.93	6.52	6.11	6.32	7.13	7.54	6.11	6.93	5.91

Table 5. The variations of dissolved oxygen (mg/L) at selected beaches of Mangaluru during August 2016 to July 2017

The dissolved oxygen concentration ranged from 5.71 to 8.15 mg/l. The lower concentration was recorded in the month of April (pre-monsoon) at Panambur beach (P1) while higher concentration was recorded in the month of September (monsoon) and October (post-monsoon) at Someshwara beach (S3) and Panambur beach (P1 and P2). There was a well oxygenated water condition observed during monsoon followed by post monsoon and pre monsoon season.

VI. AMMONIA-NITROGEN

Nitrogen being a major nutrient element plays an important role in determining the fertility status of an aquatic ecosystem. Aquatic plants require certain micronutrient elements for their healthy growth and multiplication. It bears a fundamental relationship to all protein synthesis and often played an important role in controlling primary production. As organic matter decomposes, nitrogen gets liberated as ammonia in the soil. Nitrifying bacteria converts ammonia to nitrate. The nitrate form is very soluble and is taken up by plants by absorption or used by microorganisms. The variation in Ammonia at selected stations during the study period is given in the Table 6 .Ammonium may be more readily bio-available for plant growth than nitrate. In the present investigation, the ammonia was ranged from a minimum of 7.52 µg-at./l in the month of November at Someshwara station (S1) to maximum of 24.55 µg-at./l in the month of July at Panambur beach station (P3), with a variation of 9.791 µg-at./l. The observed low ammonia-nitrogen values during the study period could be due to the uptake by phytoplankton, which might have influenced the dissociation of total ammonia, thereby resulting in its low level. The observed high values during post-monsoon might be due to influx of nutrient laden terrestrial and river run-off. According to Madhavi (2014), in estuarine waters, Ammonia-nitrogen ranged from 0.44 to 16.68 µg-at./l, with a variation of 16.24 µg-at./l. similar results were observed by Tripathi (2002), Rajeshwari (2009) and Amrutha (2010).

Stations \ Months		Monsoon				Post-monsoon				Pre-monsoon			
		June	July	Aug 16	Sept	Oct	Nov	Dec.	Jan. 17	Feb.	Mar	Apr	May
Someshwara beach	S1	10.63	9.86	10.03	9.42	8.47	7.52	9.25	9.68	10.50	8.90	8.69	9.42
	S2	12.36	12.02	12.62	11.15	10.72	8.90	9.51	10.29	11.70	10.72	10.89	10.61
	S3	14.26	12.71	13.83	11.93	10.46	9.42	10.20	11.07	11.03	10.45	10.37	11.83
Panambur beach	PI	12.45	11.07	12.97	10.63	10.29	11.76	11.07	11.84	11.83	11.18	11.93	10.31
	P2	12.97	10.20	11.07	10.03	9.86	10.72	10.20	11.24	12.62	11.41	11.05	10.45
	P3	21.97	24.55	17.64	14.68	13.49	13.31	12.79	12.19	12.93	12.37	11.69	12.31
Bengre beach	B1	15.04	11.32	13.40	11.32	10.55	9.34	11.50	11.32	11.72	10.03	10.78	10.09
	B2	11.32	13.57	11.41	10.98	9.51	10.98	10.63	11.76	12.19	10.20	10.32	10.47
	B3	9.77	12.19	11.93	9.68	9.08	9.77	9.42	9.94	10.78	9.58	8.47	8.57

Table 6. The variations of Ammonia-Nitrogen (µg-at/L) content of water at selected beaches of Mangaluru during August 2016 to July 2017

The Ammonia content in water was ranged from 7.52 to 24.55 µg-at./l. The minimum concentration was reported in the month of November (post-monsoon) at Someshwara beach (S1) while maximum was reported in the month of July (monsoon) at Panambur beach (P3). Seasonally lower concentration recorded during post monsoon and pre-monsoon season.

Nitrite-Nitrogen: The Nitrite-nitrogen content in water at different stations selected during the study period is given in the Table 7. Among the three nitrogenous nutrients, Nitrite-Nitrogen is considered to be a very unstable component being an intermediary stage in the nitrogen cycle. Nitrite gets converted to either nitrate state by nitrification or changes to ammonia or ammonium form by de-nitrification processes.

During the present investigation, the Nitrite-Nitrogen content was ranged between 0.11 and 4.91 µg-at./l, with a variation of 4.8µg-at./l. The minimum values were observed in the month of January at Bengre beach station (B1) and maximum are observed in the month of July at Panambur beach station (P3).The higher values at Panambur beach station (P3) which also receive sewage during the post monsoon season, could be due to the oxidation of ammonia, reduction of nitrate and also due to the formation as intermediate compound during the decomposition of autochthonous and allochthonous organic matter (that entered into these waters through land run-off during monsoon season). The values obtained in the present study are slightly higher than that of previous works from the same study area. Amrutha (2010) observed nitrite-nitrogen in the range of 0.04 to 7.84 µg-at/l in Nethravati estuarine waters, whereas, Rajeshwari (2009) recorded an annual range from 0.042 to 5.58 µg-at/l in Mangaluru coastal waters. This increased level could be due to the variation in input of run-off over the past several years.

Stations \ Months		Monsoon				Post-monsoon				Pre-monsoon			
		June	July	Aug. 16	Sept.	Oct.	Nov.	Dec.	Jan. 17	Feb.	Mar.	Apr.	May
Someshwara beach	S1	1.81	1.95	0.17	0.23	0.40	0.67	0.13	0.13	0.78	0.29	0.27	0.46
	S2	1.56	1.85	0.13	0.40	0.90	0.80	0.13	0.19	1.66	1.30	0.32	0.57
	S3	2.21	1.55	0.21	0.50	0.44	1.11	0.53	0.27	0.90	0.55	0.23	0.55
Panambur beach	PI	1.49	1.37	0.95	0.46	0.61	0.92	0.25	0.13	0.92	0.40	1.34	0.38
	P2	1.87	1.34	0.46	0.46	0.42	0.84	0.25	0.15	0.57	0.63	1.59	0.17
	P3	4.28	4.91	2.56	3.07	0.57	1.24	0.82	0.21	1.93	0.71	0.44	0.32
Bengre beach	B1	2.29	2.90	0.38	0.29	0.36	0.92	0.44	0.11	0.40	0.65	0.86	0.48
	B2	2.14	3.38	0.17	0.13	0.34	0.50	0.36	0.40	1.76	0.95	0.25	0.34
	B3	1.91	3.05	0.15	0.32	0.32	0.90	0.44	0.36	0.88	0.46	1.81	0.53

Table 7. The variations of Nitrite-Nitrogen (µg-at/L) content of water at selected beaches of Mangaluru during August 2016 to July 2017

Nitrite-nitrogen varied in the range of 0.11 to 4.91 µg-at./l with the minimum values in the month of January (post-monsoon) at Bengre beach (B1) and maximum in the month of July (monsoon) at Panambur beach (P3). Seasonally higher concentration recorded monsoon and pre-monsoon.

Nitrate-Nitrogen: The Nitrate-nitrogen content in water at different stations selected during the study period is given in the Table 8. The data collected on the fluctuation of Nitrate-Nitrogen concentration in Nethravati estuary at selected stations during the study period shown that the concentration ranged between 0.62 and 21.41µg-at./l. The minimum value was observed in the month of January at Bengre beach station (B3) and maximum was observed in the month of June at Panambur beach station (P3). Relative values are higher than the corresponding values of Nitrite. High nitrate during monsoon season could be due to freshwater influx and increased organic matter input to the system (Santhanam and Perumal, 2003).

Stations \ Months		Monsoon				Post-monsoon				Pre-monsoon			
		June	July	Aug. 16	Sept	Oct.	Nov	Dec.	Jan. 17	Feb	Mar	Apr	May
Someshwara beach	S1	5.16	5.58	2.67	1.63	1.06	1.19	0.77	1.49	3.76	3.35	3.29	1.16
	S2	5.02	5.28	2.22	1.79	1.61	2.28	1.01	1.43	3.40	2.75	2.84	1.54
	S3	8.18	4.85	4.49	3.55	3.20	3.99	2.75	1.67	4.40	3.59	2.52	1.48
Panambur beach	PI	9.77	7.22	3.35	2.13	1.42	2.80	2.07	0.77	3.33	1.71	1.90	1.49
	P2	5.18	6.35	2.94	2.54	2.09	2.16	1.94	1.01	1.80	1.56	2.38	1.45
	P3	21.41	17.85	8.13	7.71	2.67	3.22	3.23	1.09	4.07	3.34	3.69	2.28
Bengre beach	B1	11.00	11.76	2.78	1.97	1.43	1.91	1.99	0.95	4.21	2.59	2.78	1.06
	B2	10.74	12.25	2.67	2.79	2.09	2.57	2.48	1.14	3.51	1.89	3.07	1.20
	B3	10.52	11.29	3.17	2.36	1.31	1.61	1.10	0.62	2.45	2.13	3.22	1.26

Table 8. The variations of Nitrate-Nitrogen (µg-at/L) content of water at selected beaches of Mangaluru during August 2016 to July 2017

Nitrate-Nitrogen values ranged between 0.62 and 21.41 µg-at./l with the minimum values in the month of January (post-monsoon) at Bengre beach (B3) while maximum in the month of June (monsoon) at Panambur beach (P3). Seasonally monsoon season recorded higher Nitrate-Nitrogen concentration than the post and pre-monsoon season.

Phosphate-Phosphorous: The Phosphate-phosphorous content in water at different stations selected during the study period is given in the Table 9.Phosphorus is an essential element in life processes including photosynthesis, metabolism, building of cell walls and energy transfer and intimately associated with organisms in aquatic systems (Karl, 2000)The concentration of Phosphate-Phosphorous in the present study area during the study period was ranged between 0.10 and 3.10µg-at./l with a variation of 7.270 µg-at./l. The minimum concentration of Phosphate-Phosphorous was observed at Someshwara station (S3) and Bengre station (B3) in the months of February and March, which could be attributed to increased suspended solids which adsorb the phosphorous. The weathering of rocks results in soluble alkali metal phosphates, which may be carried along with land run-off into these waters. Shaik (2015) in brackish water of Nethravati estuary recorded highest phosphate level as (4.82 µg-at./l). Shruthi and Rajashekhar (2013) reported the levels of phosphate ranged between 0.01 and 4.02 µg-at./l. Similar trend was observed by Senthilkumar *et al.* (2002), Ramalingam *et al*. (2001) in the East-coast of India and Sushanth and Rajashekhar (2012) and Madhavi (2014) in the West-coast of India. Sahu *et al.* (2012) observed phosphate concentration ranged between 0.14 and 0.82 µg-at/l in the Kalpakkam coastal waters. Muruganantham *et al*. (2012) recorded phosphate in the range of 1.44 to 5.50 µg-at/l. Lingadhal (1991) recorded the phosphate concentration of about 6.67 µg-at/l in the coastal waters of Thannirbhavi. Padmavathi and Goswami (1996) reported the phosphate range from 2.0 to 2.3 µg-at/l in the coastal waters of Goa. Rajashekar (2010) observed phosphate range from 0.2 to 3.1 µg-at/l in the south-east coast of India. Katti *et al.* (2002) observed phosphate ranging from 0.05 to 3 µg-at/l in coastal waters of Mangalore. Chethan (2012) recorded phosphate value from 0.39 to 4.81 µg-at/l in the same study area. Madhavi (2014) recorded phosphate value from 0.36 to 1.83 µg-at/l in the same study area. The present result showed a mean increase of about 0.97 µg-at/l in the concentrations of phosphate in the study area, compared earlier studies.

Months / Stations		Monsoon				Post-monsoon				Pre-monsoon			
		June	July	Aug. 16	Sept.	Oct.	Nov.	Dec.	Jan. 17	Feb.	Mar.	Apr.	May
Someshwara beach	S1	0.80	0.95	1.55	1.50	1.10	1.60	0.65	0.45	0.15	0.40	0.45	0.60
	S2	0.60	0.80	1.60	1.65	1.35	1.50	0.65	0.55	0.30	0.50	0.40	0.45
	S3	0.90	0.70	1.20	2.10	1.30	1.45	0.75	0.60	0.10	0.80	0.35	0.45
Panambur beach	PI	0.65	0.55	1.45	2.05	1.00	1.25	0.50	0.45	0.25	0.70	0.50	0.55
	P2	0.95	0.65	1.75	1.90	1.25	1.25	0.50	0.40	0.30	0.50	0.45	0.60
	P3	1.60	1.10	2.35	3.10	1.35	1.35	1.10	1.05	0.45	1.10	0.75	0.75
Bengre beach	B1	1.25	0.95	1.70	2.30	1.15	1.25	0.75	0.50	0.35	0.45	0.95	0.65
	B2	0.85	0.85	1.75	2.40	1.10	1.45	0.95	0.55	0.20	0.10	0.45	0.60
	B3	0.65	0.60	1.70	2.25	1.25	1.10	0.90	0.50	0.15	0.75	0.50	0.50

Table 9. The variations of Phosphate-Phosphorous (µg-at/L) content of water at selected beaches of Mangaluru during August 2016 to July 2017

The Phosphate-phosphorous content was ranged between 0.10 and 3.10 µg-at./l. The minimum value was observed in the month of February and March (pre-monsoon) at Someshwara beach (S3) and Bengre beach (B2) while maximum was observed in the month of September (post-monsoon) at Panambur beach (P3). Seasonally high concentration was recorded during monsoon and post monsoon than pre-monsoon.

Silicate-Silicon: The Silicate-silicon content in water at different stations selected during the study period is given in the Table 10.A seasonal fluctuation of this nutrient was observed during the study period. The present investigation revealed that the higher silicate concentration recorded in the month of June, while relatively lower concentration was recorded from December and September. The silicate content ranged between 3.39 46.46 µg-at./l with a variation of 43.07 µg-at./l. The minimum value was observed in the month of December at Panambur beach station (P1) and maximum was observed in the month of July at Panambur beach station (P3). Salinity plays an important role in the regeneration of biogenic silica. Hence, it has been revealed that the silicate values decreased as salinity increased and vice versa.

Similar observations were also made by Sridhar *et al.* (2006), Sampathkumar and Kanna (1998), Muruganantham *et al.* (2012) and Madhavi (2014). Muruganantham *et al.* (2012) recorded silicate range from 3.2 to 54.92 µg-at/l in

South-east coast of India. Sushanth and Rajashekhar (2012) recorded silicate in the ranged between 0.10 and 161.0 mg/l in the coastal waters of Uttara Kannada district. Damotharan *et al*. (2010) reported silicate range from 19.96 to 53.2 µg-at/l with a minimum during summer and maximum during post-monsoon in the coastal waters of Point Calimere. Katti *et al*. (2001) recorded a minimum silicate value of 0.97 to a maximum of 46.57 µg-at/l in the coastal waters off Dakshina Kannada district. Raveesha (2007) recorded its range from 8.6 to 32.3 µg-at/l in the coastal waters of Chitrapur, West coast of India. Chethan (2012) observed silicate value from 3.3 to 24.51 µg-at/l in the same study area. Madhavi (2014) recorded 21.67 to 165.00 µg-at/l in same study area.

Months / Stations		Monsoon				Post-monsoon				Pre-monsoon			
		June	July	Aug. 16	Sept.	Oct.	Nov.	Dec.	Jan. 17	Feb.	Mar.	Apr.	May
Someshwara beach	S1	32.67	33.88	31.46	43.56	20.57	9.68	3.75	5.93	10.53	14.28	15.44	13.79
	S2	34.56	37.27	32.67	42.35	20.33	8.95	5.20	6.41	15.97	16.82	20.45	17.55
	S3	36.60	38.60	32.31	44.17	20.57	11.01	12.58	10.41	15.61	19.84	19.97	19.72
Panambur beach	PI	31.10	37.03	33.28	33.64	14.04	6.29	3.39	6.78	9.44	10.29	21.30	16.21
	P2	27.59	37.39	32.19	34.24	14.76	5.45	3.63	6.90	11.25	9.08	20.81	15.85
	P3	43.00	46.46	34.00	34.49	14.52	5.57	3.75	6.29	11.98	8.83	19.97	15.37
Bengre beach	B1	32.19	40.05	31.58	45.38	19.84	11.13	7.14	5.57	8.23	12.46	17.91	16.82
	B2	30.61	38.72	31.22	43.08	19.97	11.01	8.83	8.95	12.22	10.41	17.91	16.94
	B3	30.73	40.78	30.86	41.02	20.45	11.62	9.56	10.16	17.67	13.55	14.88	19.60

Table 10. The variations of Silicate-Silicon (µg-at/L) content of water at selected beaches of Mangaluru during August 2016 to July 2017

The Silicate content had ranged from 3.39 to 46.46 µg-at./l. The minimum value was observed in the month of December (post-monsoon) at Panambur beach (P1) while maximum was observed in the month of July (monsoon) at Panambur beach (P3). Seasonally the silicate-silicon was observed high in monsoon and pre-monsoon than post monsoon.

Sediment: Tropical intertidal areas are highly dynamic owing to variation in the tidal forces and energy of waves at the confluence result in a complicated sedimentary environment. Hopkison *et al*. (1999) contented that sediments play an important role in organic matter degradation and nutrient recycling in aquatic ecosystems.

VII. SEDIMENT TEMPERATURE

The sediment temperature is one of the important environmental factors measured as a relative parameter during the studies of various nutrient analysis and it also influences the distribution and availability of benthic organisms. The data on sediment temperature in the present study indicated a close similarity with the water temperature. The values fluctuated from a minimum of 26.2 C to maximum of 33.4ºC with a variation of 7.2ºC. The minimum values of temperature observed at Someshwara beach (S1) during the month of January could be due to the winter season. With the reduction in rainfall and reduced freshwater inputs from the catchment areas, an increasing trend in temperature of water and sediment was evident from January onwards. The maximum values were observed in the month of May at Panambur station (P3). These higher sediment temperature values in pre-monsoon season could be due to the higher penetration of solar radiation has caused for increase in temperature of the water and sediments which are in contact with the water. The sediment temperature values indicated a similar trend with water temperature with minor variation in its values. These fluctuations could be due to several factors such as temperature of water that influence air and water temperature, incoming radiation, time of sampling and turbidity conditions of water. Similar results were recorded by Ramachandra (1981), Reddy Gopala (1982), Shivakumar (2005) and Swetha (2009) in Mulki estuary.Madukumari (2007) and Rajeshwari (2009) studied the coastal waters of Mangaluru, Dakshina Kannada.

Stations \ Months		Monsoon				Post-monsoon				Pre-monsoon			
		June	July	Aug. 16	Sept.	Oct.	Nov.	Dec.	Jan. 17	Feb.	Mar	Apr.	May
Someshwara beach	S1	29.1	28.6	26.9	27.5	28.0	27.6	28.8	26.2	27.8	28.5	30.2	29.3
	S2	29.0	28.7	27.2	27.4	27.7	27.8	28.6	26.5	27.5	28.8	30.2	29.8
	S3	29.3	28.8	27.8	27.5	27.6	27.9	28.5	26.5	27.8	28.4	30.5	30.3
Panambur beach	PI	30.1	31.1	28.1	30.5	31.2	28.8	28.4	27.4	28.9	30.4	32.7	30.1
	P2	30.2	31.3	28.9	30.8	31.3	28.9	29.9	27.3	29.0	30.6	32.8	30.2
	P3	30.4	31.4	29.6	30.9	31.5	30.1	29.9	28.2	29.7	31.2	32.8	30.7
Bengre beach	B1	30.5	32.1	29.9	30.4	32.5	30.3	32.3	29.0	31.9	31.2	33.2	31.0
	B2	30.1	32.4	30.0	30.3	32.6	30.1	31.3	29.5	31.8	31.4	33.2	31.1
	B3	29.6	32.5	30.1	30.6	32.9	30.1	31.7	29.9	31.8	31.8	33.4	31.7

Table 11. The variations of Sediment temperature (°C) at selected beaches of Mangaluru during August 2016 to July 2017

Sediment temperature was ranged from 26.2 to 33.4ºC. The minimum was observed in the month of January (post-monsoon) at Someshwara beach (S1) while maximum was observed in the month of April (pre-monsoon) at Bengre beach (B3).The sediment temperature showed a similar trend with water temperature.Seasonally the minimum sediment temperature was observed in monsoon than post and pre-monsoon season.

Sediment organic carbon: The sediment organic carbon percentage had ranged from 0.01 to 0.24%. The minimum value was observed in the month of December and September at Someshwara (S1) while maximum was observed in the month of June at Panambur (P3). Spatially

high values recorded at Panambur beach. Spatially higher values were recorded in Panambur beach reason could be the high percent of fine sand which was strongly correlated with organic carbon%. Amrutha (2010) and Prashanth (2010) reported 0.45% to 3.28% in Nethravathi-gurupura estuarine system. Similar observations were recorded by Manjappa *et al*. (2003) in the brackish water impoundments at Nethravati estuary. Reddy Gopala (1982), Sahu (1985), Prabhu (1992) and Mohan (1999) observed in the coastal waters of Dakshina Kannada. Slight increase in sediment organic carbon % in monsoon to post-monsoon season to water temperature

Stations \ Months		Monsoon				Post-monsoon				Pre-monsoon			
		June	July	Aug. 16	Sept.	Oct.	Nov.	Dec.	Jan. 17	Feb.	Mar.	Apr.	May
Someshwara beach	S1	0.14	0.08	0.08	0.01	0.08	0.05	0.01	0.07	0.06	0.06	0.06	0.11
	S2	0.17	0.10	0.07	0.03	0.09	0.07	0.02	0.07	0.09	0.08	0.07	0.11
	S3	0.19	0.11	0.08	0.04	0.10	0.11	0.02	0.08	0.07	0.05	0.08	0.09
Panambur beach	PI	0.17	0.10	0.03	0.03	0.10	0.06	0.03	0.12	0.09	0.07	0.10	0.08
	P2	0.20	0.14	0.05	0.04	0.11	0.07	0.06	0.11	0.10	0.09	0.07	0.09
	P3	0.24	0.16	0.09	0.07	0.08	0.08	0.08	0.09	0.08	0.04	0.09	0.10
Bengre beach	B1	0.17	0.08	0.07	0.02	0.08	0.05	0.02	0.11	0.06	0.06	0.07	0.09
	B2	0.17	0.08	0.04	0.03	0.10	0.07	0.04	0.09	0.02	0.06	0.08	0.07
	B3	0.18	0.07	0.03	0.03	0.07	0.04	0.02	0.06	0.03	0.04	0.06	0.10

Table 12. The variations of Sediment organic carbon (%) at selected beaches of Mangaluru during August 2016 to July 2017

The sediment organic carbon percentage had ranged from 0.01 to 0.24%. The minimum value was observed in the month of December and September at Someshwara (S1) while maximum was observed in the month of June at Panambur (P3). Spatially high values recorded at Panambur beach.

Parameters	Monsoon			Post-monsoon			Pre-monsoon		
	Someshwara	Panambur	Bengre	Someshwara	Panambur	Bengre	Someshwara	Panambur	Bengre
Air temperature	26.68±0.25	26.83±0.21	26.96±0.29	25.64±0.56	29.44±0.19	30.04±0.26	28.19±0.38	30.92±0.29	31.80±0.18
Water temperature	26.49±0.01	27.15±0.08	27.16±0.08	27.79±0.21	29.01±0.22	29.72 ±0.03	29.84±0.06	31.0±0.18	31.33±0.07
Sediment temperature	28.15±0.18	30.27±0.31	30.70±0.01	27.64±0.01	29.40±0.49	31.01±0.14	29.08±0.15	30.75±0.30	31.95±0.19
pH	7.79±0.02	7.73±0.10	7.82±0.05	8.08±0.04	8.10±0.03	8.13±0.01	8.2±0.02	8.175±0.01	8.18±0.02
Salinity	27.39±0.20	27.29±0.57	27.63±0.05	30.39±0.08	30.20±0.09	30.46±0.08	30.98±0.05	31.14±0.05	31.19±0.12
Silicate-Silicon	36.67±1.26	35.36±3.60	36.35±0.82	11.28±2.05	7.61±0.08	12.01±1.02	16.66±2.79	14.19±0.14	14.88±1.36
Phosphate-Phosphorous	1.19±0.03	1.5±0.46	1.43±0.13	1.00±0.04	0.95±0.23	0.95±0.05	0.41±0.01	0.575±0.16	0.47±0.13
Dissolved Oxygen	7.065±0.21	7.33±0.13	7.11±0.08	6.91±0.11	7.04±0.28	6.47±0.09	6.71±0.08	6.52±0.18	6.79±0.18
Ammonium-Nitrogen	11.73±1.62	14.18±4.8	11.82±0.94	9.62±0.80	11.56±1.25	10.31±0.66	10.42±0.91	11.67±0.57	10.26±0.80
Nitrite-Nitrogen	1.047±0.07	1.93±1.53	1.42±0.06	0.47±0.13	0.53±0.15	0.45±0.05	0.65±0.27	0.78±0.06	0.78±0.16
Nitrate-Nitrogen	4.20±0.93	7.88±5.15	6.94±0.15	1.87±0.92	2.03±0.45	1.6±0.46	2.84±0.19	2.41±0.82	2.44±0.20
Total Organic carbon	0.09±0.01	0.11±0.03	0.08±0.00	0.06±0.01	0.08±0.00	0.06±0.01	0.07±0.01	0.08±0.01	0.06±0.01

Table 13. Seasonal variations (Mean ± SD) in physico-chemical parameters of intertidal waters at selected beaches of Mangaluru.

Statistical Analysis: Simple Correlation (Pearson's) was carried out for different physico-chemical parameters of water and sediment fractions to understand their interrelationships, which finally governs the productivity of the intertidal ecosystem. There was a significant positive correlation between air, water and sediment temperature at all three beaches and the statistical relationship indicated that the strong relationship between ammonia and nitrate, whereas the organic carbon abundance negatively correlating with silicate and phosphorus.

Parameters	A.Temp	W. Temp	S. Temp	pH	Salinity	Silicate-Si	Phosphate-P	DO	Ammonia-N	Nitrite-N	Nitrate-Ni	O. carbon
A. temp.	1.000											
W. temp.	.992**	1.000										
S. temp	.987**	.995**	1.000									
pH	0.328	0.370	0.399	1.000								
Salinity	0.259	0.334	0.341	.691*	1.000							
Silicate	.992**	.999**	.993**	0.371	0.345	1.000						
Phosphate	0.413	0.371	0.392	-0.411	-0.651	0.352	1.000					
DO	-0.220	-0.287	-0.353	-0.482	-0.644	-0.274	0.088	1.000				
Ammonia	0.342	0.265	0.265	-0.363	-.774*	0.257	.876**	0.460	1.000			
Nitrite	0.420	0.351	0.369	-0.448	-0.649	0.341	.946**	0.128	.888**	1.000		
Nitrate	0.431	0.367	0.392	-0.286	-.672*	0.349	.947**	0.109	.891**	.942**	1.000	
O. carbon	-0.019	-0.084	-0.116	-0.546	-.779*	-0.075	0.553	.776*	.788*	0.573	0.500	1.000

Table 14. Correlation coefficient (significant at 99% and 95%) between physico-chemical parameters, of the selected beaches of Mangaluru.

VIII. CONCLUSION

The present study indicates that the physico chemical status of the coastal waters of Mangaluru exhibited distinct variations by different seasons. Occurrence of high concentrations of nutrients in the study areas can be reasonably due to the land runoff and anthropogenic input. The fluctuation of Temperature, pH, salinity, and Dissolved Oxygen are seen in the Monsoon and Non-Monsoon seasons. Salinity was found to be low along the monsoon season, it is due to the large amount of fresh water input along the coast during the northeast monsoon. The knowledge of nutrients, related to their sources, availability and the utilization levels gives us the information about the productivity potential and health of the marine ecosystem. The present baseline information is useful for the further ecological monitoring and assessment along the coastal beaches.

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