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Seasonal Variation in the Physico-Chemical Properties of the Coastal Waters at Kushalnagar Beach, Kasaragod, Kerala

KEYWORDS: Physico-chemical parameter, Nutrient, Coastal water, Monsoon

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ABSTRACT *Physico-chemical properties of the marine environment play an important role in determining the type of ecosystem. The analyses of the physico-chemical factors of the waters at Kushalnagar beach, Kasaragod, Kerala was carried out for a period of two years from June, 2012 to May, 2014. The variation in temperature, salinity, pH, and conductivity were high during the pre-monsoon period, whereas, dissolved oxygen was at minimum. Nutrients such as nitrate, nitrite, inorganic phosphate, and reactive silica were high during monsoon, while, sulphate levels were at a minimum. The results of the present study revealed that the physico-chemical parameters of Kushalnagar beach were significantly influenced by the freshwater influx during the south-west monsoon.*

Introduction

Marine environment is a complex system influenced by various physical, chemical and biological processes (Sushanth ***et al.***, 2011). Compared to open ocean, coastal area is more dynamic because of its interaction with the terrestrial zone, which brings about variation in its physico-chemical parameters (Bhadja and Kundu, 2012; Archana and Babu, 2013). Several alterations in these properties occur when the coastal region receives excess of nutrients by river inflow, sewage, and agriculture waste disposal, directly or indirectly. Such alterations can lead to various ecological consequences like changes in species composition, algal bloom, and decrease in oxygen concentrations (Sushanth ***et al.***, 2011).

The fluctuations in the physico-chemical parameters of a water body mainly control the nature and distribution of flora and fauna in that aquatic system (Damotharan ***et al.***, 2010). Thus the hydrological study of any aquatic system is a pre-requisite to assess its potentialities and to understand the relationship between its various trophic levels and food webs. The analysis of the physico-chemical properties of the coastal waters at Kushalnagar beach, Kasaragod, Kerala is being reported for the first time through this study.

Materials and Methods

Study area

Kushalnagar beach (12°18'11.63"N and 75°4'41.74"E) is a sandy beach situated in Kasaragod, Kerala, India.

According to the availability of rain the tropical region is characterized into three seasons, i.e., pre-monsoon (February-May), monsoon (June-September) and post-monsoon (October-January).

Collection of water samples

Water samples for the study were collected in screw capped plastic containers from the sampling station at a monthly interval for a period of two years from June 2012 to May 2014 and stored in a refrigerator prior to analysis.

Analyses of physico-chemical parameters

The rainfall data for the study period was obtained from the Kerala agricultural statistics, published by the Department of Economics and Statistics, Government of Kerala. Air and surface water temperatures were measured using mercury thermometer at the sampling site.

Salinity, pH and electrical conductivity were measured with the help of Systronics water analyzer 371 kit.

For the estimation of dissolved oxygen (DO), the water sample was fixed immediately with Winkler's reagent and estimated according to the methodology outlined in American public health association (APHA 1998).

Dissolved nutrients such as nitrate, nitrite, inorganic phosphate, reactive silica, and sulphate were estimated using standard protocols (Strickland and Parsons, 1972; APHA, 1998).

Results

The monthly rainfall 5.1 to 1400.0 mm for the years 2012-2013 and 2013-2014 has been represented in table 1. The average rainfall was 65.925, 684.825, and 43.125 mm for 2012-2013 and 64.7, 772.85, and 55.325 mm for 2013-2014; during pre-monsoon, monsoon, and post-monsoon periods respectively. The air and water temperature, salinity, pH and conductivity for each month of the study period have also been tabulated (Table 1) and DO is shown in figure 1.

The concentrations of nitrate varied from 0.1 to 0.7 mg/l, and 0.129 to 0.675 mg/l, while that of nitrite ranged from 0.06 to 0.1125 mg/l, and 0.06 to 0.109 mg/l, for the year, 2012-2013 and 2013-2014, respectively. Inorganic phosphate levels ranged from 0.045 to 0.1225 mg/l for 2012-2013 and 0.035 to 0.1225 mg/l for 2013-2014, while that of reactive silica varied from 0.9 to 4.15 mg/l, and 0.8 to 4.45 mg/l for the years 2012-2013 and 2013-2014, respectively. The level of sulphates in the water sample varied from 1550 to 2600 mg/l for 2012-2013 and 1500 to 2550 mg/l for 2013-2014.

Discussion

Higher air temperatures were observed during the pre-monsoon period mainly due to an increase in air temperature, high solar radiation and lack of sufficient rainfall (Puthiya ***et al.***, 2009). The lowest values for air and water

Volume : 6 | Issue : 7 | July 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 74.50

temperatures were observed during the monsoon season. Such temperatures could have resulted due to cloudy sky and heavy rainfall (Kannan and Kannan, 1996). During post-monsoon season the sampling was carried out in the evening low tide which might be the reason for the increase in air temperature during post-monsoon season.

Low rainfall and decreased freshwater inflow, rise in temperature and evaporation may also be the reason for an increase in salinity during pre-monsoon season (Kamalkanth ***et al.***, 2012; Sahu ***et al.***, 2012). On the other hand freshwater inflow from riverine sources and heavy rainfall may have caused decrease in salinity during monsoon season (Satpathy, 1996; Kamalkanth ***et al.***, 2012). The higher pH observed during pre-monsoon seasons might be due to the uptake of CO_2 by photosynthetic organisms and high biological activity (Balasubramanian and Kannan, 2005; Sridhar ***et al.***, 2006). The decrease in pH observed during monsoon season might have resulted due to the dilution of seawater by freshwater influx, low temperature, reduced salinity, low primary productivity, and organic matter decomposition (Rajasegar, 2003; Sushanth and Rajashekhar, 2014). The electrical conductivity of the water sample was observed to positively correlate with the temperature (Sushanth and Rajashekhar, 2012). Thus, the increase in conductivity observed during pre-monsoon may be due to increase in salinity and temperature (Singh, 2012) resulting from the increase in salts and other contaminants.

The higher level of DO during monsoon could be ascribed to the cumulative effect of high wind velocity along with heavy rainfall, which results in aeration of the water (Rajasegar, 2003; Anantharaj, 2013). In the present study, DO show an inverse relationship with temperature and salinity. An imbalance between the process of photosynthesis, degradation of organic matter, re-aeration (Granier ***et al.***, 2000) and physicochemical properties of water (Aston, 1980) can result in oxygenation of the aquatic systems (Satpathy, 2010). As per studies, the greater solubility of oxygen is attributed to low values of temperature and salinity (Table 1) (Satpathy, 1996; Puthiya ***et al.***, 2009).

Aquatic organisms depend on the surrounding water for their nutrients, including nitrate and phosphate which are essential nutrients required abundantly. Higher levels of nitrate, inorganic phosphate, and reactive silica observed during monsoon might be due to enrichment caused by freshwater inflow and terrestrial run off (Das ***et al.***, 1997; Karuppasamy and Perumal, 2000). The oxidation of ammonia from nitrogen to nitrite and subsequently to nitrate also adds the concentration of nitrate (Rajasegar, 2003; Kalaiarasi ***et al.***, 2012). Weathering of rocks (Sridhar ***et al.***, 2006) and fertilizers applied in agricultural fields could be the other sources of inorganic phosphates (Tiwari and Nair, 1993). The higher nitrite levels during monsoon season could also be due to the oxidation of ammonia and reduction of nitrate, increased phytoplankton activity, nitrogen recycling and bacterial decomposition of planktonic detritus present in the environment (Govindasamy ***et al.***, 2000; Asha and Diwakar, 2007).

The low nitrate, inorganic phosphate, and reactive silica levels observed during pre-monsoon season might be due to their utilization by phytoplankton (Das ***et al.***, 1997; Govindasamy ***et al.***, 2000) The decrease in freshwater inflow, higher salinity and adsorption to sediments also results in a drop in their concentrations (Rajasegar, 2003; Prabhu ***et al***, 2008). The sulphate levels were highest during pre-monsoon and lowest during the monsoon seasons. However, as sulphate is a major ion in seawater, a variation in its concentration due to biological processes is not significant (Sushanth and Rajashekhar, 2012).

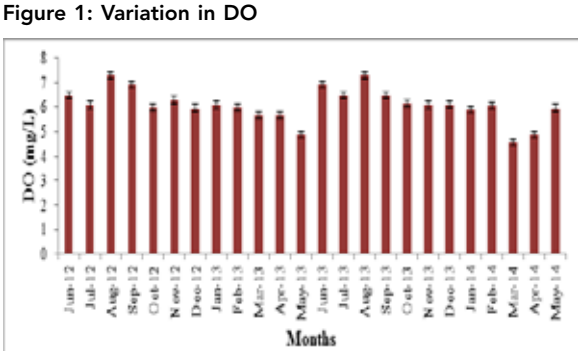
Table 1: Variation in rainfall, air temperature, water temperature, pH, electrical conductivity and salinity

Months	Rainfall (mm)	Air Temperature (°C)	Water Temperature (°C)	pH	Electrical conductivity (mS)	Salinity (ppt)
Jun 12	928.4	25.5	27.0	7.67	45.3	32.83
Jul 12	501.6	25.0	26.5	7.65	39.4	28.14
Aug 12	994.0	25.0	25.5	7.23	33.4	30.02
Sep 12	315.3	28.0	26.0	7.63	39.7	30.51
Oct 12	110.5	29.0	28.5	7.97	44.9	30.52
Nov 12	62.0	27.0	29.0	8.00	45.8	31.89
Dec 12	0.0	28.5	30.0	8.10	48.1	34.77
Jan 13	0.0	31.0	31.5	8.24	46.9	34.83
Feb 13	83.2	30.0	31.0	8.32	48.5	33.77
Mar 13	17.8	28.0	29.5	8.10	46.1	35.77
Apr 13	76.8	26.0	30.0	8.00	47.5	33.89
May 13	85.9	28.5	30.0	7.97	47.7	34.71
Jun 13	1400.0	27.5	26.5	7.70	31.2	27.45
Jul 13	1001.2	24.5	25.5	7.22	34.6	27.44
Aug 13	435.0	27.5	27.5	7.33	40.5	31.89
Sep 13	255.2	27.5	27.5	7.61	44.9	30.02
Oct 13	182.1	28.0	28.5	7.98	45.1	31.89
Nov 13	34.1	29.5	29.5	7.97	46.6	32.83
Dec 13	5.1	30.0	29.5	8.10	45.4	34.77
Jan 14	0.0	30.5	30.5	8.26	47.9	33.89
Feb 14	0.0	29.5	31.0	8.34	47.5	33.83
Mar 14	0.0	27.5	30.0	8.10	47.2	35.83
Apr 14	15.4	26.5	31.0	7.99	47.6	33.99
May 14	243.4	28.0	31.0	7.95	45.3	34.60

Results are expressed as mean.

Pre-monsoon: February-May; Monsoon: June-September; Post-monsoon: October-January.

Figure 1: Variation in DO



Results are expressed as mean ± standard error. All values are calculated in triplicates.

Pre-monsoon: February-May; Monsoon: June-September; Post-monsoon: October-January.

Volume : 6 | Issue : 7 | July 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 74.50

Table 2: Variation in nitrate, nitrite, inorganic phosphate, reactive silica and sulphate.

Months	Nitrate (mg/l)	Nitrite (mg/l)	Inorganic phosphate (mg/l)	Reactive silica (mg/l)	Sulphate (mg/l)
Jun 12	0.100±0.04	0.1125±0.0000	0.0450±0.0000	1.35±0.21	2450±70.71
Jul 12	0.375±0.04	0.0925±0.0035	0.0450±0.0000	3.05±0.07	2250±00.00
Aug 12	0.700±0.07	0.0725±0.0035	0.1025±0.0035	4.15±0.07	2075±106.07
Sep 12	0.700±0.11	0.0675±0.0061	0.1225±0.0106	3.15±0.21	1550±0.00
Oct 12	0.475±0.04	0.0675±0.0035	0.0750±0.0071	1.55±0.21	1875±106.07
Nov 12	0.350±0.07	0.0975±0.0000	0.0675±0.0035	2.35±0.21	2175±35.36
Dec 12	0.250±0.00	0.0750±0.0000	0.0525±0.0035	1.55±0.00	2325±106.07
Jan 13	0.200±0.00	0.0945±0.0000	0.0550±0.0000	1.15±0.50	2225±106.07
Feb 13	0.375±0.07	0.0600±0.0035	0.0525±0.0035	1.40±0.28	2350±141.42
Mar 13	0.125±0.04	0.1050±0.0035	0.0575±0.0035	0.90±0.35	2425±35.36
Apr 13	0.225±0.07	0.0750±0.0035	0.0450±0.0000	1.25±0.57	2550±00.00
May 13	0.125±0.00	0.0875±0.0000	0.0750±0.0000	2.75±0.35	2600±70.71
Jun 13	0.400±0.07	0.0910±0.0071	0.0725±0.0106	4.45±0.21	2125±35.36
Jul 13	0.675±0.07	0.1050±0.0141	0.0825±0.0035	3.15±0.50	2100±00.00
Aug 13	0.429±0.07	0.0850±0.0071	0.1225±0.0248	2.20±0.28	2300±141.42
Sep 13	0.411±0.00	0.0650±0.0035	0.0475±0.0035	2.02±0.21	1500±70.71
Oct 13	0.442±0.00	0.0600±0.0071	0.0750±0.0000	3.25±0.07	1575±35.36
Nov 13	0.313±0.00	0.0910±0.0000	0.0700±0.0071	1.25±0.07	2275±106.07
Dec 13	0.285±0.04	0.0875±0.0035	0.0575±0.0035	1.15±0.00	2250±00.00
Jan 14	0.206±0.00	0.0950±0.0000	0.0450±0.0035	0.80±0.14	2300±70.71
Feb 14	0.199±0.00	0.0620±0.0035	0.0350±0.0071	0.90±0.14	2200±141.42
Mar 14	0.163±0.04	0.1090±0.0141	0.0550±0.0000	0.80±0.14	2375±70.71
Apr 14	0.129±0.04	0.0740±0.0035	0.0500±0.0035	1.50±0.00	2500±00.00
May 14	0.348±0.00	0.0825±0.0071	0.0750±0.0071	2.94±0.07	2550±35.36

Results are expressed as mean ± standard deviation. All values are calculated in triplicates.
Pre-monsoon: February-May; Monsoon: June-September; Post-monsoon: October-January.

Conclusion

From the above results it is evident that the concentrations of nutrients such as nitrate, nitrite, inorganic phosphate, reactive silica and dissolved oxygen were high during monsoon, whereas, temperature, salinity, pH, conductivity and sulphate were at their minimum level during the same period. Thus we can safely conclude that the physico-chemical parameters of the coastal waters are mainly influenced by the freshwater influx during the south-west monsoon.

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Volume : 6 | Issue : 7 | July 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 74.50

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