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Seasonal Variations of Physicochemical Parameters in Coastal Waters of Visakhapatnam, East Coast of India

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Abstract: In this study, an attempt was made to investigate the physicochemical characteristics of coastal waters at four stations along the coast of Visakhapatnam, India from January to December 2012. Air and surface water temperatures varied from 27.3°C to 33.3°C and from 26.3°C to 32.3°C respectively. Salinity values varied from 23°/00 to 34°/00 and pH ranged from 6.0 to 8.1. Variation in dissolved oxygen content was from 7.4 to 8.2 ml/l. The range of inorganic nutrients viz., nitrates and phosphates were 4.0µg/l to 19.8µg/l and 20.5µg/l to 46.7µg/l respectively.

Key words: Temperature · Salinity · pH · Dissolved Oxygen · Physicochemical

INTRODUCTION

The hydrological study is a prerequisite in any aquatic system for the assessment of its potentialities and to understand the realities between its different trophic levels and food webs. Further, the environmental conditions such as topography, water movement, salinity, oxygen, temperature and nutrients characterizing particular water mass also determine the composition of its biota. Thus the nature and distribution of flora and fauna in an aquatic system are mainly controlled by the fluctuations in the physical and chemical parameters of the water body [1].

The marine environment, as a complex system is mainly influenced by various physical, chemical and biological processes. The open ocean is more stable compared to the near shore waters, where the interaction with the terrestrial zone is more effective in bringing about variations in different physicochemical parameters. Hence a thorough knowledge of hydrography is indispensible to estimate the quality of the environment and its influence on biological fertility [2].

Rapid industrialization along the coastal areas have brought considerable decline in the water quality. They are subjected to a variety of socio-economic drivers, producing increased pressures and impacts, which can lead to environmental stress or affect public health [3-5]. Such problems have been assigned mostly to an excess of nutrients, associated with industrial and municipal waste water [6]. The subsequent increase in nutrient loads produces an ecological impact over biological communities [7] associated mostly with eutrophication process [8]. Hence, it is imperative to know the inter relationships between the organisms and environmental parameters in order to evaluate the stability and function of the ecosystem.

Visakhapatnam coast is considered as one of the productive zones along the Bay of Bengal. The coast line is known for its rich marine life especially intertidal biota [9-10]. In recent years, due to increase in domestic sewage, industrial inputs and various anthropogenic activities, water quality has been a serious concern. These activities may result in decline of species abundance, diversity and change the biology of the species. This zone is very sensitive and fragile. Continuous monitoring and assessment of this zone is must. Present study therefore, has been aimed to study seasonal variations and correlation of hydrological parameters of surface waters at four stations along the coast of Visakhapatnam for a period of one year from January to December 2012.

MATERIALS AND METHODS

Study Area: Visakhapatnam lies between the latitudes 17^0 14'30" and 17° 45' N and the longitudes 83° 16'25" and 83° 21' 30" E on the east coast of India. For the present study four sampling sites were chosen [Fig. 1].

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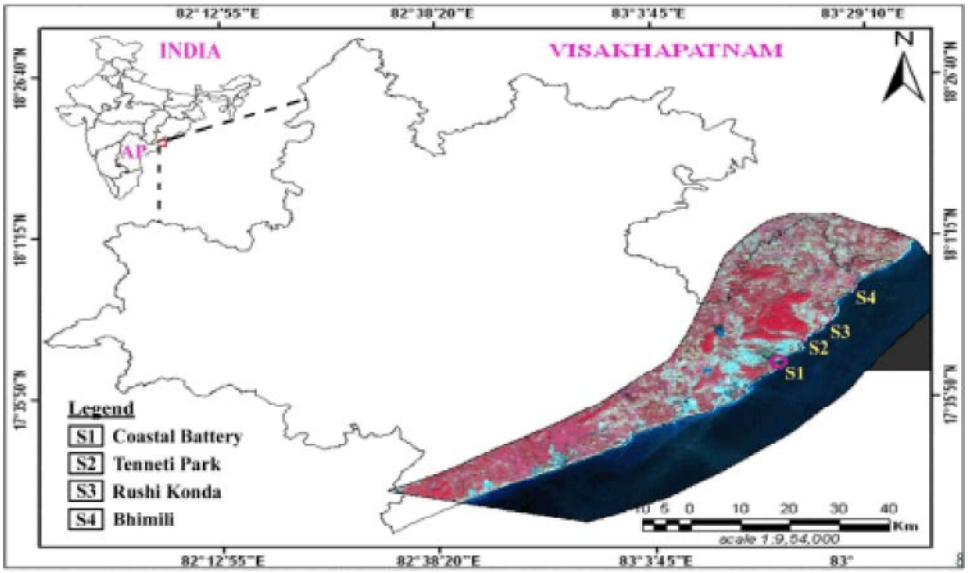

Fig. 1: Map showing the study area

Temperature was measured using standard centigrade thermometer. Salinity was estimated with the help of a refractometer and pH was measured using digital pH meter. Dissolved oxygen was estimated by the standard method [11] and is expressed as ml/l. For the analysis of nutrients, surface water samples were immediately kept in ice box and transported to the laboratory. The water samples were filtered by using Millipore filtering system and analysed for dissolved inorganic nitrates and phosphates as described by [12] and expressed in µg/l. The obtained data was subjected to statistical analysis. Significance of spatial variations was compared by using single factor ANOVA. Correlation coefficient analysis was performed to find out relationship between various water quality parameters within a sampling site. All statistical analysis was carried out using SPSS software (Version, 16.0).

RESULTS

Monthly variations in physicochemical parameters viz., air and surface water temperature, salinity, pH, dissolved oxygen, nitrates and phosphates in waters were recorded for a period of one year from January to December 2012. The inter-relationship between various physicochemical parameters as indicated by correlation matrix is given in table 1.

Temperature: During the study period air temperature varied from 27.3°C to 33.3°C and the surface water temperature varied from 26.3°C to 32.3°C. Both air temperature and surface temperatures were recorded as minimum in winter season (December, 2012) at station 1 and maximum during summer season (May, 2012) at station 4. In general, all the four stations showed similar seasonal changes (Fig. 2 and Fig. 3).

Table 1: Correlation coefficient matrix of physicochemical parameters of coastal waters of Visakhapatnam (P<0.05) during Jan 2012 – Dec, 2012

Station 1							
	AT	ST	Salinity	pH	DO	Nitrates	Phosphates
AT	1.000						
ST	.991**	1.000					
Salinity	.884**	.889**	1.000				
pH	.538*	.544*	.581*	1.000			
DO	-.864**	-.880**	-.785**	-.693**	1.000		
Nitrates	.754**	.769**	.907**	.582*	-.832**	1.000	
Phosphate s	.281	.345	.368	.505*	-.384.	423	1.000

Table 1: Continued

Station 2							
	AT	ST	Salinity	pH	DO	Nitrates	Phosphates
AT	1.000						
ST	.993**	1.000					
Salinity	.845**	.862**	1.000				
pH	.670**	.701**	.818**	1.000			
DO	-.866**	-.893**	-.768**	-.662**	1.000		
Nitrates	-.041	.053	.314	.456	-.303	1.000	
Phosphates	.341	.409	.493	.821**	-.506*	.711**	1.000
Station 3							
	AT	ST	Salinity	pH	DO	Nitrates	Phosphates
AT	1.000						
ST	.996**	1.000					
Salinity	.727**	.749**	1.000				
pH	.577*	.595*	.909**	1.000			
DO	-.693**	-.683**	-.618*	-.578*	1.000		
Nitrates	.207	.246	.642*	.781**	-.410	1.000	
Phosphates	.336	.359	.765**	.833**	-.470	.929**	1.000
Station 4							
	AT	ST	Salinity	pH	DO	Nitrates	Phosphates
AT	1.000						
ST	.991**	1.000					
Salinity	.734**.	793**	1.000				
pH	.519*	.606*	.911**	1.000			
DO	-.777**	-.745**	-.450	-.280	1.000		
Nitrates	.441	.439	.048-	.087	-.401	1.000	
Phosphates	.208	.293	.748**	.802**	-.024	-.305	1.000

** Correlation is significant at the 0.01 level (1-tailed)

*Correlation is significant at the 0.05 level (1-tailed)

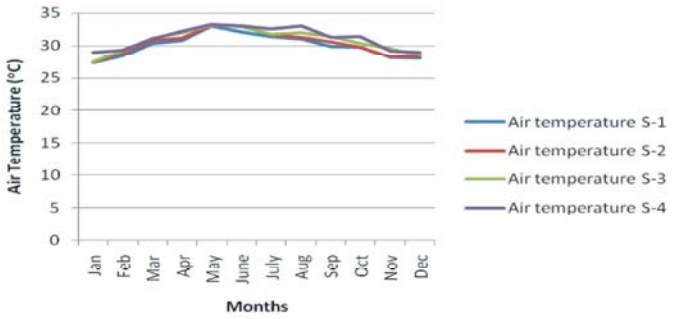

Fig. 2: Monthly variation in air temperature during Jan–Dec, 2012 at four stations

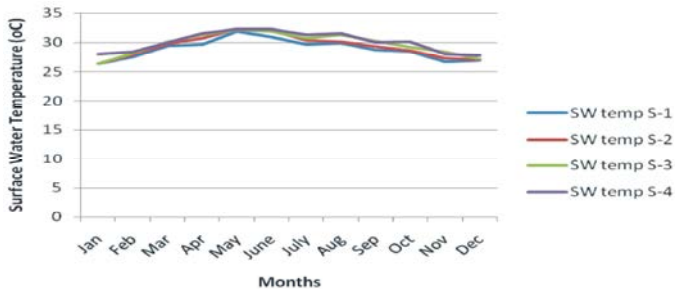

Fig. 3: Monthly variation in surface water temperature during Jan–Dec, 2012 at four stations

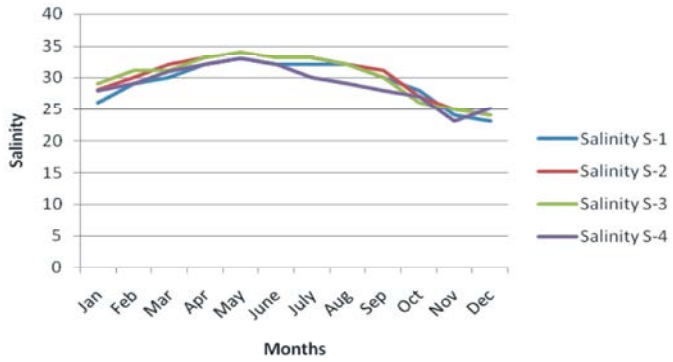

Fig. 4: Monthly variation in salinity during Jan–Dec, 2012 at four stations

Fig. 5: Monthly variation in pH during Jan–Dec, 2012 at four stations

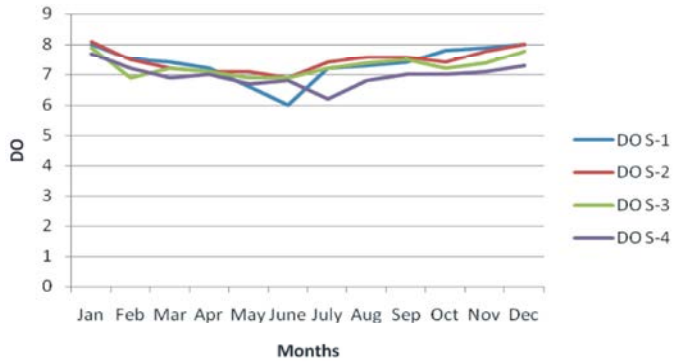

Fig. 6: Monthly variation in DO during Jan–Dec, 2012 at four stations

Fig. 7: Monthly variation in nitrate levels during Jan–Dec, 2012 at four stations

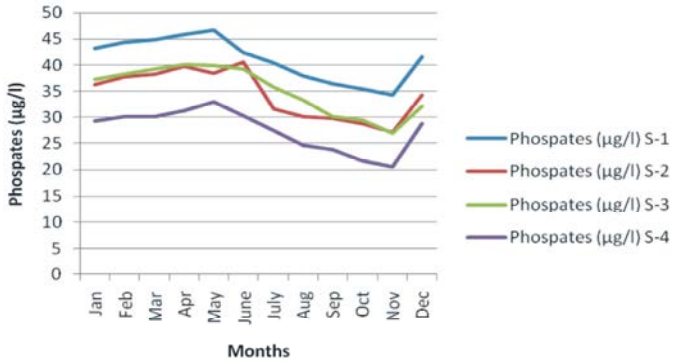

Fig. 8: Monthly variation in phosphate levels during Jan–Dec, 2012 at four stations

Salinity, pH and Dissolved Oxygen: Among the four stations, the salinity varied from 23°/$_{00}$ to 34°/$_{00}$ during the entire study period, recording maximum in May and minimum during December (Fig. 4). pH followed trend similar to that of salinity (Fig. 5). It ranged from 7.4 to 8.2. Dissolved oxygen varied from 6.0 ml/l to 8.1ml/l (Fig. 6). The maximum value recorded in the month of January and minimum during monsoon season (June, 2012).

Nitrates and Phosphates: The nitrate concentration varied from 4.0µg/l to 19.8µg/l in the entire study period. The maximum nitrate value was recorded in June at station1 and minimum was recorded in January at station 4 (Fig.7). Inorganic phosphate concentration varied from 20.5µg/l to 46.7µg/l. The maximum phosphate concentration was recorded in May in station 1 and minimum phosphate values in November at station 4 (Fig. 8).

DISCUSSION

Temperature is a primary abiotic factor controlling key physiological, biochemical and life history processes of aquatic life [13]. From the results of the present study it is observed that the atmospheric temperature as expected is relatively higher than the surface water temperature. Seasonal variations are observed in atmosphere temperature and surface water temperature and all four stations showed similar pattern. The surface water temperature showed an increasing trend from January till June and is influenced by the intensity of solar radiation [14] and direction of water currents which bring warm waters from equatorial region. From July onwards decline in temperature is observed till December. Decline in temperature could be attributed to onset of cold weather and commencement of north-east winds [15]. There is no much variation in surface water temperature between the stations. Correlation matrix showed that in all the four stations atmospheric temperature showed positive correlation with surface water temperature, salinity and pH and negative correlation with dissolved oxygen. Surface water temperature also showed similar trend like air temperature in all stations.

Salinity is another important factor which influences the distribution of organisms. The salinity at any point will be dependent on the rainfall and extent of freshwater inflow [16]. Monthly variations of salinity followed a typical pattern of high values of salinity during summer and low values during December. The recorded low values could be attributed to strong southerly surface current that is known to bring large quantities of freshwater during south-west monsoon [15]. From December onwards there is steep rise in salinity and practically steady from March till July. High salinities were recorded during summer due to prevailing northerly current and reduction in the fresh water influx. The steady high salinity from March till July could be attributed to the upwelling of water [17-18]. Correlation matrix showed during the study period in all the four stations salinity has significant positive correlation with pH and highly significant negative correlation with dissolved oxygen. ANOVA indicated significant difference between the values among all the four stations as S1 and S2, $F_{8.85}$ = 22.92; S1 and S3, $F_{8.85}$ = 92.81; S2 and S3, $F_{8.85}$ = 23.18; S3 and S4, $F_{8.85}$ = 47.21; (p = 0.05).

Hydrogen ion concentration (pH) gets changed with time due to changes in temperature, salinity and biological activity. pH showed negative correlation with dissolved oxygen in all stations. ANOVA indicated no significant difference between the values in the four stations. High pH in summer is due to the influence of high biological activity and due to the occurrence of high photosynthetic activity. Statistical analysis showed that pH is negatively correlated with dissolved oxygen in all stations [19-20].

Dissolved oxygen is vital to aquatic life and is needed to keep organism alive. It is most significant parameter affecting the productivity of aquatic system. The two main sources of dissolved oxygen in seawater are diffusion of oxygen from atmosphere and photosynthetic activity of aquatic flora. Dissolved oxygen was higher during October to January and lower during February to May. From the present investigation it is apparent that oxygen concentration was influenced by temperature, salinity in association with physical and biological process in the coastal environment. Higher values were recorded in January when temperature and salinity were relatively low. Low values during April and May are due to upwelling. There is decrease in dissolved oxygen in June and July due south-east monsoons [21]. Relatively stagnant condition and biochemical demand due to organic load might have contributed to slightly low values of dissolved oxygen at station 1 compared to other stations. Dissolved oxygen showed significant negative correlation with nitrates and phosphates.

Nutrients are considered as one of the most important parameters in the coastal environment influencing growth, reproduction and metabolic activities of living beings [22-23]. Distribution of nutrients is based on the season and freshwater inflow from land resources [1]. The life supporting processes in the sea requires an array of inorganic substances but the role of nitrogen and phosphorus are considered vital in marine ecosystem [24]. Nitrates play role in the phytoplankton growth and proliferation. Relatively high concentration of nitrates was observed during the months of June and July during the study period in all the stations [25]. This could be due to the terrestrial run-off during south-east monsoon period. Low nitrate concentration was observed during November, could be attributed to their utilization by phytoplankton [26]. The recorded high concentration of phosphate during March and April is due to upwelling. Further, regeneration and release of total phosphorus from the bottom mud into the water column by turbulence and mixing is also attributed to recorded higher monsoon values [27]. In the present study, the concentration of nitrates and phosphates are higher at station 1 compared to other stations. Station 1, situated near harbour recorded more concentration of nitrates and inorganic phosphates due to discharge of industrial effluents and domestic wastes into harbour waters [28]. ANOVA showed significant difference only in nitrates between stations S1 and S3, $F_{19.40} = 67.97$; S2 and S3, F19.40 = 363.18 (p= 0.05).

CONCLUSION

The present study indicated that the physicochemical status of the coastal waters of Visakhapatnam is good in general. The anthropogenic activities influenced the study area minimally and all parameters are within the acceptable range.

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