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RESEARCH ARTICLE

Seasonal variations in seawater quality of two tourism affected shores off South Saurashtra Coastline, India

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Manuscript Info

Abstract

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The results of monthly observation on the physico-chemical parameters at anthropogenically influenced shore of Veraval and Diu at south Saurashtra coastline during the period November-2011 to April- 2012 were reported. The impact of coastal human activities and the inter-relation between various parameters was studied. It was observed that, Seawater temperature was changed accordance with season and atmospheric temperature. Due to same reason pH value showed less variation month wise as well as station wise. Similarly Conductivity, TS, TDS and turbidity values showed more or less varied over the months. Salinity value increased during pre-summer and summer months. It is reported that with increasing salinity, the DO level decreased. Because of this reason DO was found quite low in summer and maximum in winter season. The BOD and COD levels were very low. The result of sulphide and sulphate did not show much variation. The value of hardness, calcium and magnesium were within the range of value reported for typical Arabian Sea. Result of the present investigation indicate that there is no significant difference between two station and suggest a normal coastal condition for both the station which is indicative of not much influenced by its anthropogenic activities because, it is neutralized by the tremendous buffering activity of seawater and immense tidal activity of sea. The findings of the present communication thus, give the present-day status of the general water quality parameters for these coastal areas as a reference, if these places are becoming SEZ's in future.

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Introduction

The coastal ecosystem of India has been endangered by several kinds of anthropogenic causes such as over fishing, shipping, tourism, domestic sewage, industrial waste and pollution along the coast. More than half the world's population resides within 100 km of the coastline (National Oceanic and Atmospheric Administration 1998; Vitousek et al. 1997), with increases likely over the next two decades (Stegeman and Solow 2002). The coastal areas are under pressure since they have become an ultimate dumping place for all the treated and untreated wastes from surrounding areas. These kind of human impacts generally alter the structure and

function of marine aquatic ecosystem by changing the species compositions of community and also affecting nutrient cycle and ultimately threaten equilibrium of planet's biosphere (Ravan, 1988). It is globally recognized that phenomena taking place in the interface between terrestrial and marine systems are particularly important as it concern the transport of pollutants, although the majority of the systems studied hot spots due to coastal human activities having interesting physico-chemical characteristics, is also recognized, but less frequently studied (Mihopoulos P. et. al., 2000). Gujarat shares the lion portion of coastline covering 1650 km long shore, of that Saurashtra region, which is the northern part of Indian coast line occupies a total stretch of 865 km. Saurashtra coastline harbours one of the biggest

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industrial belts of the country with mega industries, along with large fishing stations except numerous small scale industries that has got establishment on the shore line itself.

The nature and distribution of the flora and fauna in the aquatic system are mainly controlled by the fluctuations in the physical and chemical characteristics of the water body (Sundaramanickamet al., 2008). The Arabian Sea is considered as one of the most productive zones in the world oceans (Qasim, 1977; De Sousa et al., 1996). Coastal regions between Okha and Bhavnagar is now a hot-spot for mega industries like Refineries, Cement, Chemicals, Soda Ash, Rayon, Power plant, Fertilizer and other supportive industries. This coastline is known for its rich marine life especially intertidal biota in its extended intertidal and subtidal areas (Shukla and Misra, 1977). Going through the literature it was revealed that water quality studies of this area were patchy and meager (Bhadja and Kundu, 2012). Present studies therefore, have been aimed to set up a seasonal database of standard water quality parameters of five shores along the South Saurashtra coastline which are favorite for setting up mega industries or SEZ's.

Material and Methods

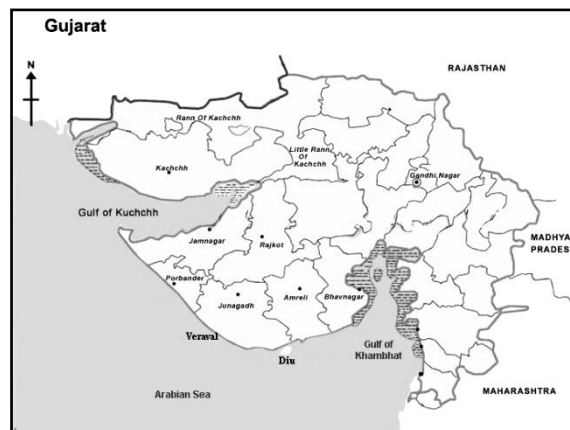
Study area

The investigation was carried out from November-2011 to April-2012 at two different stations Veraval ($20^{\circ} 53' N$, $70^{\circ} 26' E$) and Diu ($20^{\circ} 42' N$, $71^{\circ} 01' E$) along the South Saurashtra coastline of Arabian Sea (Figure 1). Veraval coast being, a part of the biggest commercial fishing centers in Asia, receives a huge amount of wastes, oil and effluents from the port. It also receives wastewater from domestic sewage system as well as from heavy industries and small scale fish processing plants of the city. On the other hand Diu, a small tourist town, is devoid of sorts of major industrial pollution and anthropogenic pressure. Each sampling stations were visited monthly and at least six samples of surface seawater were collected from different locations of the same coast. However, the locations for the collection of samples in a particular coast were fixed.

Sample Collection

Seawater samples were collected once in a month at uniform space from all the sampling sites for various water quality parameters. All the Parameters were determined following methods given in American Public Health Association (1995) and Trivedi and Goel (1986). Some of the parameters such as pH, Temperature, Conductivity measurement were carried out at site immediately after the collection of the water samples, while for other parameters, sample

Figure 1. Map showing the study locations along the South Saurashtra Coastline, Gujarat, India.



were collected and stored in the plastic bottles and samples for Dissolved Oxygen (DO) and Biological Oxygen Demand (BOD) were collected in BOD Bottles (300ml capacity) directly from the surface seawater.

Data Analysis

As the study area, stations were further divided into few sampling sites, water sample were taken into each sites, and thus data on all parameters were analyzed statistically using mean, standard deviation and student's t-test for the variations among the sampling stations. All statistical analyses were done as per Sokal and Rohlf (1969).

Results

The results of the different water quality parameters at each of the sampling stations can be seen in Figure. 2. The temperature fluctuation did not differ much between the two stations. Minimum temperature was measured in winter ($20.27^{\circ}C$); thereafter increased and maximum seawater temperature was observed during summer ($26.18^{\circ}C$) at both the stations. The pH values showed less variation between stations as well as months. As it appears the pH was increased during winter (8.57) and thereafter decreased during pre-summer (7.92). The overall Variation in conductivity, total solids, total dissolved solids and turbidity did change throughout the study period, more or less variations observed between two stations. The electrical conductivity values were in the range of 17.12 - 17.55 ms/cm. It has been observed in case of salinity, there was not any significant difference between two stations. The salinity value showed much variation over the months. However, the values range between 32- 35 ppt. Salinity values increased during pre-summer and summer season.

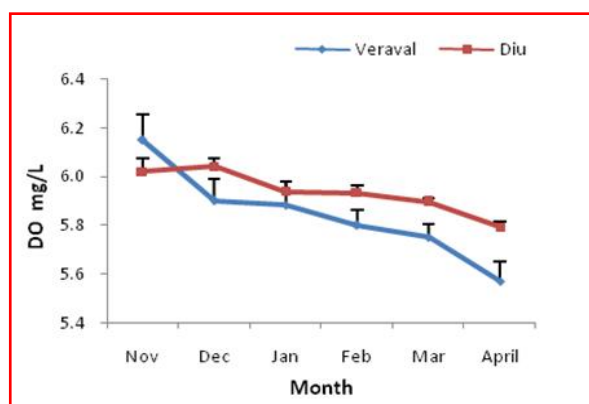
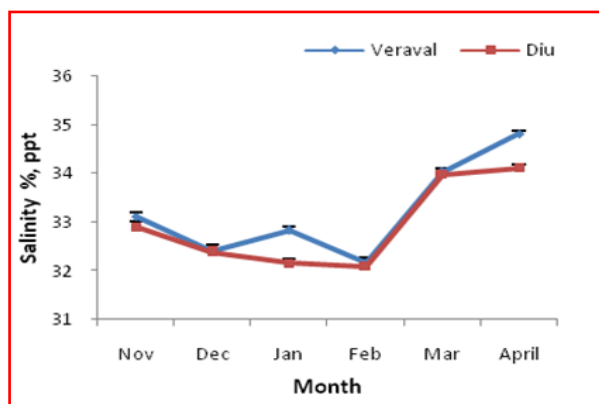
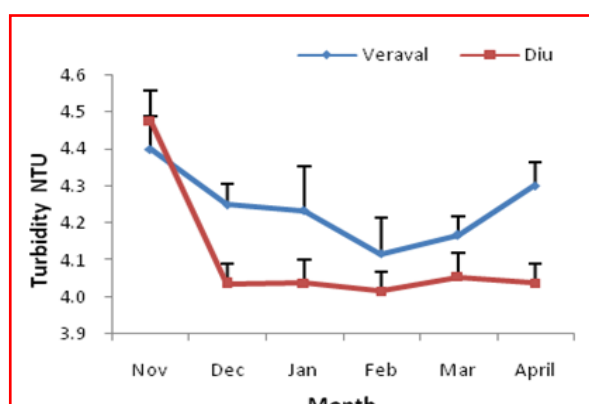
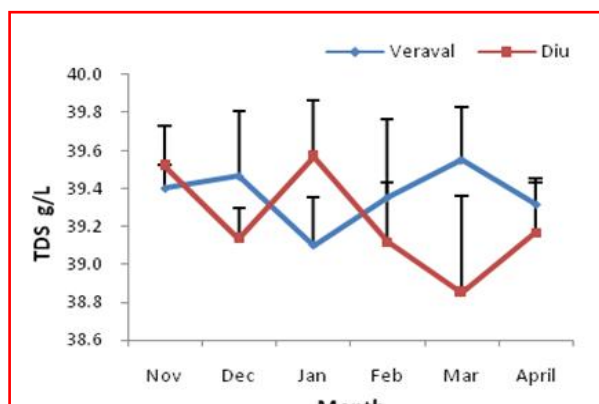
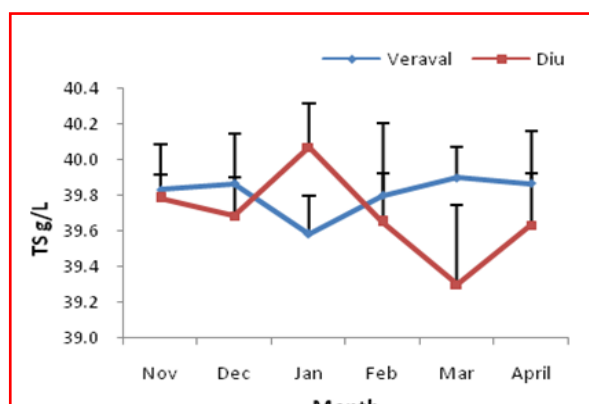
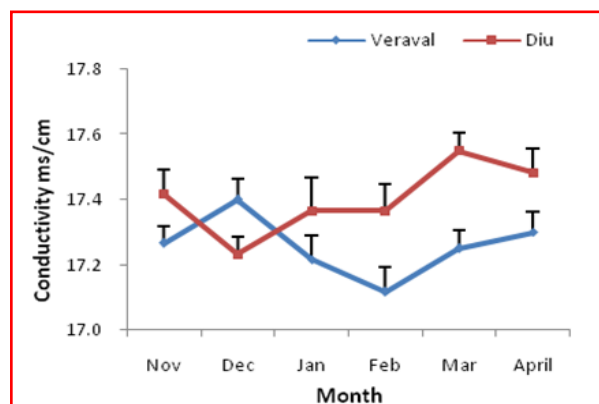
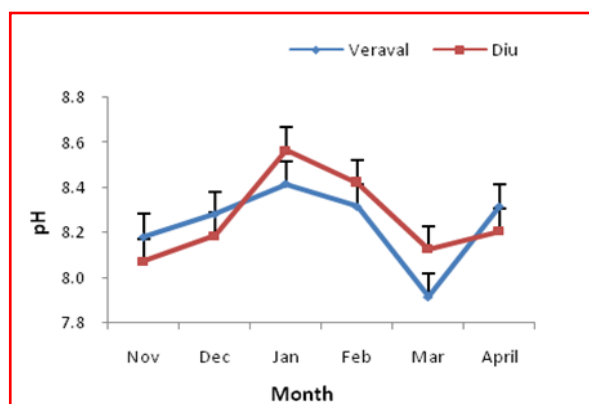
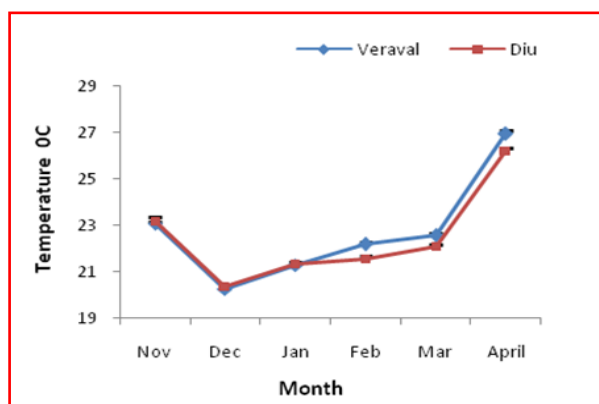
Table 1.Results of the t'-test of the mean value of seawater parameters between two stations. (Tabulated t- value at p=0.05 level is 2.0150).

Parameters	Estimated 't' - value
Temperature (°C)	0.0840
pH	0.3434
Conductivity (mS/cm)	0.0414
Total Solids (g/L)	0.2165
Total Dissolved Solids (g/L)	0.2161
Turbidity (NTU)	0.0204
Salinity (‰ , ppt)	0.0365
Dissolved Oxygen (mg/L)	0.0582
BOD (mg/L)	0.3781
COD (mg/L)	0.0253
Sulphide (mg/L)	0.0546
Sulphate (mg/L)	0.0004
Hardness (g/L)	0.2965
Calcium (g/L)	0.0006
Magnesium (g/L)	0.3991

The dissolved oxygen value varied between 5.57 - 6.15 mg/l at both the stations. The value was higher at Diu than veraval most of the time. High value of dissolved oxygen was observed in November month, thereafter decreased throughout the study period. Similarly the Biological Oxygen Demand (BOD) values showed variation in both stations. In the sample from Diu the BOD value were high in November and December months thereafter decreased. This trend was not observed in case of samples from veraval. Maximum BOD value was obtained (0.91 mg/l) at Diu during winter and (0.85 mg/l) at veraval during summer. The values of chemical oxygen demand did not show any variations Monthwise as well as station wise. Slightly elevated values were observed in November and December in both the sampling stations, but the values of COD were higher in veraval than Diu. The result of Sulphide values did not show much variation. The value of Sulphide was high in March but most of time it was more or less stable. The distribution of sulphate showed irregular pattern over the month. There were no meaningful variations observed between both the stations. Similarly trend was observed in case of hardness and magnesium at both the stations but calcium did not show variations over the month. At the both stations, Hardness, calcium and Magnesium values were higher in the sample of Diu. The statistical analysis showed there was not significant difference between stations.

Discussion

The present study indicated that both the stations are not much influenced by the anthropogenic activities as the water quality parameters are within the normal range for an open sea coastline (Bhadja and Kundu, 2012). The result showed decreasing trend in the seawater temperature as the winter was slowly started to set in. Seawater temperature was high in summer months as this time normally the blowing hot summer in this region. The atmospheric and water temperature rises in the day time with high velocity wind and dust. Due to the same reason the pH value was found to be little high in winter months. Electrical conductivity is the ability of the substance to conduct the electric current (EMECS, 2007). The pH and conductivity values were found to be in their usual range (Naik et al., 1991). In other physical parameters like TS, TDS and turbidity values were observed more or less variations may be due to the tidal activity. The values observed for these parameters were within the range of normal coastal seawater of an open sea (Bhadja and Kundu, 2012; Vaghela et al., 2012). There is no spatial and temporal variations what show ever may be as suggested by statistical analysis. The physical parameters in the coastal area depend normally on the weather conditions and up to certain extents, the local activities. The range of salinity observed between 32-35 ppt. Low salinity observed during post monsoon season because of owing rainfall and freshwater inflow into the open sea and due to low temperature. It is reported that with increasing salinity, the DO level decreased (Pillai et al., 1979). The dissolving capacity of oxygen is inversely proportional to the salinity and temperature. DO of water is the important parameter, which support the aquatic life (Paul and Mukherjee, 2006). DO level were found to be in range 5.57-6.15 mg/l at both the selected stations. It is a known fact that in the open marine environment where the DO level is normally high, the BOD and COD levels should be very low. This hypothesis was checked and found positive in the present study. The BOD and COD levels in the coastal water are generally low to naught due to the constant tidal activity and mixing of the water (EMECS, 2007). In the present study Sulphate showed irregular trend over the months. It is an important constituent of hardness with calcium and magnesium. Trace amount of sulphide are present in surface water due to reduction of sulphate. The values of hardness, calcium and magnesium were within the range of values reported for typical Arabian Sea. The present study revealed that there is no statistical significant variation between two stations.



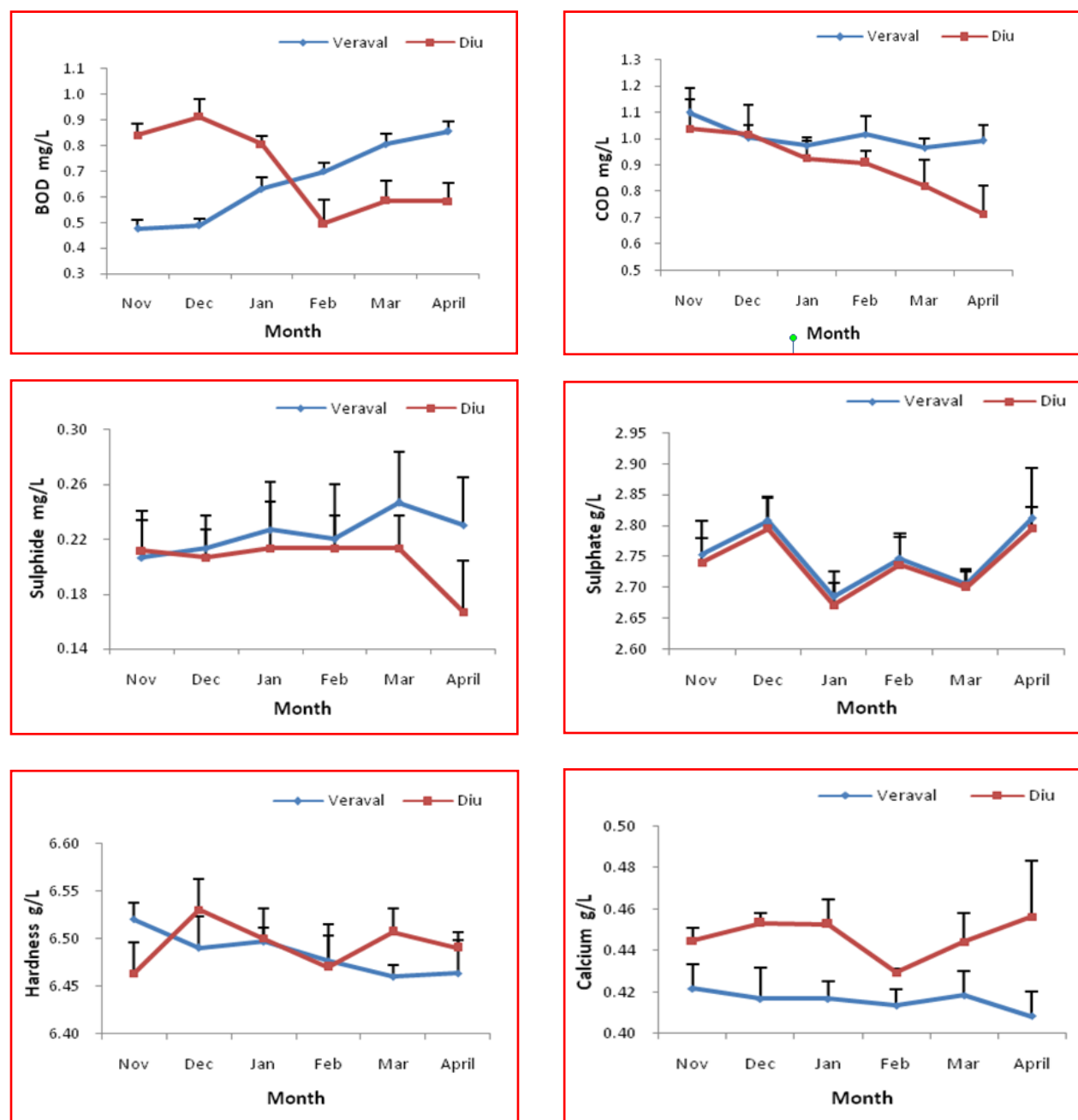


Figure 2. Monthly variations in mean (\pm SD) values of different Seawater quality parameters.

Conclusion

The present study reports that there were no any significant variations between two stations. The present study revealed that there is no statistical significant variation between two stations. It was also showed that there are not much influenced by the tourism and anthropogenic activities as the water quality parameters are within the normal range for an open sea coastline.

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