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Study of Physiochemical Characteristics of waters of Bengre, Thannirbhavi and Chitrapur Off Mangalore Coast

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ABSTRACT

The study of various physiochemical parameters is of great importance in understanding the health status of an environment. The present investigation was carried out for the period of eight months along Bengre region having estuarine influences and receiving load of domestic sewage and Thannirbhavi receiving treated effluents from Fertilizer industry and Chitrapur receiving treated effluents Refinery Petroleum limited and Soda factory. The hydrographical parameters such as water temperature, pH, salinity and dissolved oxygen of surface and subsurface water were analyzed. Water temperature exhibited unimodal seasonal oscillation. Thermal stratification is more pronounced at Chitrapur followed by Thannirbhavi and Bengre. The pH value fluctuated from 7.4 to 8.51. The dissolved oxygen value ranged from 0 to 5mg/l with lowest in December. Industrial activity could also be one of reason for low dissolved oxygen content. Bengre coast registered lower value of salinity compared to Thannirbhavi and Chitrapur coast.

Key words: *Temperature, pH, Dissolved oxygen, Salinity mangalore coast, Industrial effluents.*

Introduction

The coastal zone is a region where land, ocean and atmosphere interact and hence it is dynamic in nature. The Mangalore coast which is situated at the western part of the Indian peninsula stretching to about 22 km of coastal district of Dakshina Kanada, Karnataka. Due industrializations and development activities as well as influence of land fresh water influx, cyclone severe wave action which makes the region most unstable. These factors will cause severe damage to benthic organisms by changing the water quality and substratum. The area selected for the study were Bengre coast having estuarine influences and having load of domestic sewage, Thannirbhavi region receives treated effluents from Mangalore Chemical Fertilizer MCF industry and Chitrapur receiving treated effluents from Mangalore Refinery Petroleum Limited MRPL and Baddish Analine Soada Factory BASF. The systematic and in-depth study of various hydrographic parameters is found to be most important and inevitable in assessing not only fishery potentialities of coastal and near shore water but also understanding the health status of the environment. The present study is aimed to understand the physico-chemical characteristics of surface and subsurface waters and influences of effluents on water quality of Bengre, Thannirbhavi and Chitrapur coast. A detailed study on the hydrography and circulation off the west coast of India during the south-west monsoon was studied by Shetty *et al*. (1990). Saravanan *et al*. (1997)

studied the environmental impact of thermal effluents in the vicinity of Madras Atomic Power station monitored the physiochemical parameters. Swami *et al*. (2000) observed hydrographical parameters like temperature, salinity and pH while studying water quality status of Mumbai harbour.

Materials and Methods

The present investigation was carried out in coastal waters of Arabian Sea off Bengre, Thannirbhavi and Chitrapur for the period of eight months from October 2006 to May 2007. The observations were made along three sections at 5 and 10 meters depth contour, first at 5 meter depth contour –B1,T1, and C1 and second at 10 meter depth contour-B2,T2, and C2(Figure1). From the selected stations observations on various hydrographical parameters were made at monthly intervals. Surface water sample and near bottom water samples from the selected stations were collected for the analysis of physical and chemical properties of water. Surface water samples were obtained using clean plastic bucket and near bottom water samples were obtained by employing Transparent Nansen's Reversing Water Bottle. Water temperature was recorded using a standard Mercury Thermometer immediately after the collection of samples. For the estimation of dissolved oxygen, water samples were fixed in the field by adding Winkler's Reagents. The dissolved oxygen content of fixed samples were estimated using Winkler's methods, (Strickland and Parsons, 1972). The water samples for the determination of pH and Salinity were collected in Clean Plastic Bottles. pH of the water was recorded in the laboratory using a digital pH meter (WTWPH320). As soon as the samples were brought to the laboratory the salinity of water samples were estimated using standard method (Strickland and Parsons, 1972).

Results and Discussion

Water temperature

In the present investigation, the surface water temperature varied from minimum of 27.4 to maximum of 32.3 °C. Thus the water in this area experienced variation to the extent of 5.9 °C. The subsurface water experienced an annual range of 4.5 °C. Menon et al., (1977) observed an annual range of 6.3 °C, Reddy and Hariharan (1986) 2.9°, Mridula (1999) 5.4 °C, and Raghavendra (2004) 4.6 °C. The present observation was found to be similar to that of the observations made by Mridula (1999), and Raghavendra (2004) in the same area. However, the annual water temperature range was lower than

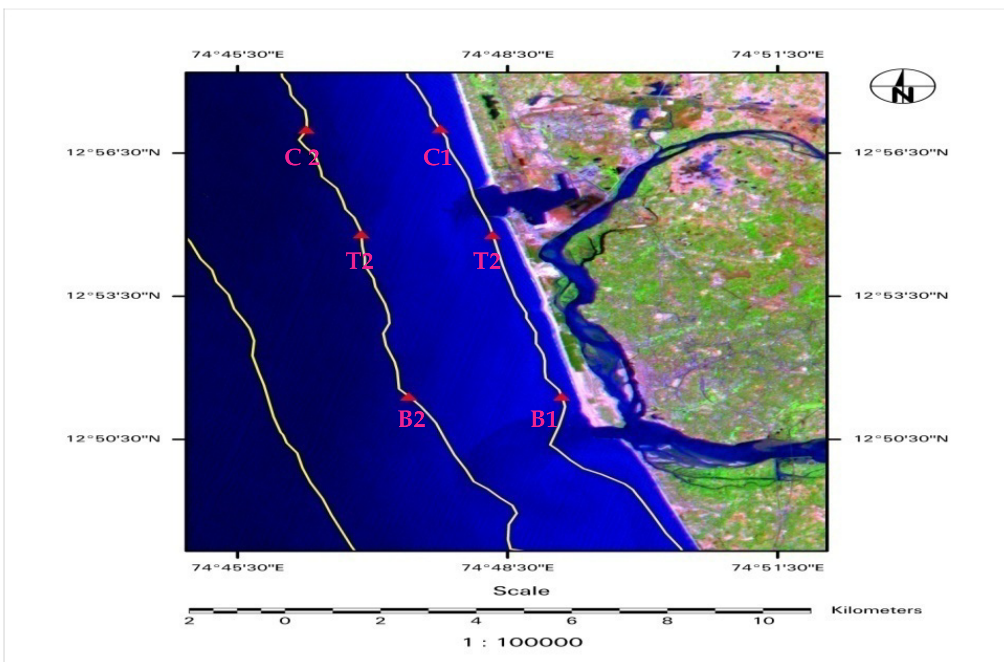

Fig. 1. Map showing location of sampling station

that of the observation made by Menon *et al.* (1977). From the Table 1, it is evident that the water temperature gradually reduces from October (except Station T2) and reached its minimum in December, thereafter the water temperature gradually increased and reached its Maximum in the month of April at all the stations. Therefore from the data gathered it becomes evident that, the water temperature exhibited unimodal seasonal oscillations at one minima and one maxima during December and April. Rajanna (1997) observed a unimodal seasonal fluctuation in the Dakshina Kannada area, from October to May Mridula (1999) observed trimodal seasonal oscillations. Raghavendra (2004) observed bimodal oscillations in the same area. Highest water temperature was recorded in the month of April / May is in agreement with the observations made by many authors in the same area. Gradual decrease in water temperature reaching its minimum in December during post monsoon season was found to be due to protruded south west monsoon season and in association with winter season, prevailing coastal water currents. However the post monsoon low water temperature was recorded in the month of January by Kumar (1984), Mridula (1999) and Raghavendra (2004) from the coastal waters of Dakshina Kannada. The highest temperature during April / May could be directly related to higher air temperatures during April / May. Subsurface water temperature was always found to be lesser than that of the surface waters at Thannirbhavi and Chitrapur. However at Bengre, the difference between surface and sub surface water was very narrow at 5 meters depth and slightly lower at 10 meters depth. Therefore from Table 1 it is clear that the thermal stratification is more pronounced at Chitrapur followed by Thannirbhavi and Bengre. Almost all the authors who have worked in coastal waters of the Dakshina Kannada made the similar observations. In the present study, water temperature along the coast of Thannirbhavi and Chitrapur could not exhibit much variation. However during the month of November waters along Thannirbhavi were slightly warmer than that of Chitrapur waters. It is interesting to note that while many observations made in the same area indicated sloping up trend in the water temperature during October, November and December, the present investigation revealed a gradual decrease in water temperature from October to December. Raghavendra (2004) has observed lowest water temperature in the month of January/ February, while in the present study the minima were observed in December. This could be due to change in/or the season and the general coastal water circulation.

Water pH

During the present investigation pH value of surface water fluctuated from 7.40 to 8.50, and near bottom waters varied from 7.46 to 8.51. While working in

Table 1. Distribution of surface and sub surface water Temperature (^{o}C) at different sampling stations

Stations		2006			2007				
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
B1	Surface	29.5	29.6	27.8	28.1	28.6	30.8	31.8	31.9
	Sub Surface	29.4	29.6	27.8	27.8	28.6	30.6	31.7	31.8
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
B2	Surface	30	30.3	27.8	28	28.4	30.3	31.4	31.6
	Sub Surface	30	30	27.7	27.9	28.2	30	31	31.5
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
T1	Surface	30.5	30	27.8	28.2	28.9	30.1	31.9	32
	Sub Surface	29.5	29.9	27.7	28	28.2	29.7	30.9	31.5
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
T2	Surface	29.5	30.1	27.4	28.4	29	30.3	31.3	31.5
	Sub Surface	29.2	29.4	27.5	27.9	28.9	30	30.9	31.4
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
C1	Surface	30.3	29.6	27.7	28.1	29.2	31.2	32.3	31.3
	Sub Surface	30.2	29.4	27.5	27.8	29.2	30.5	31.8	31.2
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
C2	Surface	30.4	29.8	28.3	28.3	29.3	30.5	31.9	30.2
	Sub Surface	30.2	29.5	27.3	28	28.7	29.9	30.8	29.7

coastal waters of Dakshina Kannada, Kumar (1984) and Rajanna (1997) and Raghavendra (2004) recorded pH values, which range from 8.2 to 8.8, 8.1 to 8.4 and 7.81 to 8.26 respectively. In the present study, the minima and maxima of pH values are higher than that of the values recorded by above authors. However, the present range was in agreement with value recorded by Katti *et al*. (2003) in the coastal waters of Chitrapur. From the Table 2 it is evident that pH values were higher in the month of December, March and May and values were lower in the month of October, January, February and April(except at station C2 in the month of February). Therefore this parameter exhibited a trimodal seasonal oscillation three lows and three highs. Lower values in the month of October could be due to influence of Southwest monsoon season. The 2nd and 3rd low pH values could be attributed to biological activity coupled with discharge of industrial effluent especially Bengre and Chitrapur. Rajanna (1997) while working in the same area found that monsoon in one hand and anthropogenic impact on other hand was responsible for lower pH. The higher pH values during December, February, March and May could be due to meager influence of monsoon and maximum influence of biological status in the environment. The sub surface waters exhibited almost similar seasonal trend. But the difference between surface and sub surface varied between the stations. Rajanna (1997), Mohan Kumar (1999) also could not observe much difference between surface and sub surface pH. However, Raghavendra (2004) observed slightly higher pH value in the near water of coastal waters of Dakshina Kannada.

Dissolved Oxygen

In the present investigation, dissolved Oxygen content of surface water fluctuated from minimum of 0.28 to maximum of 5.00 recording an annual range of 5.00 ml/l. Noble (1968) documented an annual range of 2.5 ml/l along north coast, while Dakshina Kannada coast Kumar (1984), Reddy and Hariharan (1986), Lingdhal (1991), Rajanna (1997), Mridula (1999), Raghavendra (2004) observed an annual range of 1.83, 2.70, 3.6, 3.84, 1.86, 4.10, 1.47 and 2.0 ml/l and from the above observation it was clear that the surface waters of Bengre, Thannirbhavi and Chitrapur experienced an annual range of 4.72. This lower range was found to be mainly due to low oxygen content in the month of December. Tiwari and Nair (1993) Dharmatara creek at Bombay harbor , Padmavati and Goswami (1996) in the coastal waters of Goa and Neelam Ramaya *et al*. (1998), in the Bombay harbour – Thana basin creek estuaries complex observed an annual range of 2.70 and 6.6 mg/l respectively. The annual range of fluctuation in the near bottom waters varied from 0.28 to 4.70. Thus the near bottom water experienced almost similar annual range. From Table 3 it is clear that the dissolved oxygen was nil at many stations followed by the sub surface water. Very low dissolved oxygen content almost a level of zero was recorded by

Table 2. Distribution of surface and sub surface water pH at different sampling stations

Stations		2006			2007				
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
B1	Surface	7.5	8.43	8.44	7.86	7.84	8.48	7.2	8
	Subsurface	7.5	8.4	8.48	7.91	7.97	8.49	7.46	8
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
B2	Surface	8	8.2	8.5	7.96	8.04	8.43	7.83	8.1
	Subsurface	8	8.16	8.5	7.99	8.12	8.37	8.19	8.19
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
T1	Surface	7.99	8.38	8.5	7.93	7.97	8.43	7.84	8
	Subsurface	8	8.39	8.51	7.83	7.88	8.26	7.64	8.07
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
T2	Surface	8	8.34	8.48	7.93	8.27	8.37	8.07	8.07
	Subsurface	7.85	8.5	8.5	8.06	8.1	8.27	8.16	8.1
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
C1	Surface	7.85	8.09	8.4	8.23	8.29	8.13	8.01	8.46
	Subsurface	7.75	8.13	8	7.89	8.39	8.32	7.5	8.51
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
C2	Surface	7.9	8.09	8.46	8.2	8.39	7.84	8	8.49
	Subsurface	7.8	8	8.28	8.21	8.56	8.02	7.99	8.55

Reddy *et al*. (2005) in some areas and authors have attributed to the after effects of Tsunami-2004. It is well known that factors like exchange of gases across the sea surface, oceanic circulation and biological activities gain importance in shallow coastal waters since the area under investigation is influenced by industrial activity. Therefore in addition to the above factors, the impact due to industrial activity could also be one of the reasons for low dissolved oxygen content. The seasonal distribution of surface dissolved oxygen revealed gradual decrease from October and reaches its minimum value in December. Thereafter the values gradually increased and reached first maxima in the month of February/ March and further the oxygen content dropped gradually from February / March and attained the second low in the month of May. Considering the higher values of dissolved oxygen in October as first maxima, it could be stated from that this parameter exhibited by and large bimodal oscillation with two high (October and February / March) and two lows (December and May). Dissolved oxygen at subsurface waters was always lower than that of surface waters and exhibited similar seasonal trend. Mridula (1999) and Raghavendra (2004) could not observe any clear cut seasonal variations of this parameter in the same area whereas Rajanna (1997) and Ronald (2001) observed bimodal seasonal oscillation in the coastal waters of Mangalore. The higher dissolved oxygen in the month of October could be due to existing influence of South west monsoon season, while secondary peak, i.e. February / March could be due to intense photosynthetic activity. Similar opinion was expressed by the authors who have worked in the same area. From the data gathered, it was evident that there were not many variations between the stations.

Salinity

Surface water salinity in the present study ranged from minimum of 28.00 to 35.01 x 10^{-3} and subsurface values varied from minimum 28.00 to 35.10 × 10^{-3}. Thus experiencing an annual (non monsoon) range of 7.01 and 7.10 respectively. Ramesh (1989) documented a range of 4.01, Rajanna (1997) observed a range of 2.3X10^{-3} Mridula (1999) documented a range of 5.87 along the coastal waters of Mangalore. Goswami and Padmavati (1996) recorded a annual range of 1.7 X10^{-3} in coastal waters of Goa. Except Tiwari (1993) range of salinity observed in the present study was higher than the values documented by authors who work along coastal waters of Dhakshina Kannada. Seasonal variation of surface salinity exhibited by and large a gradual increasing trend from October to January, with the small drop in February. The values gradually increased and reached its peak in May. Thus from Table 4 it is evident that the surface water salinity of this area in present study did exhibit much variation between pre and post monsoon. The lower values in

Table 3. Distribution of surface and sub surface water dissolved oxygen (ml/l) at different sampling stations

Stations		2006			2007				
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
B1	Surface	4.5	5	0.28	2.8	4.35	3.93	3.37	3.25
	Sub Surface	4.81	4.21	Nil	2.8	4.21	3.37	3.08	3
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
B2	Surface	4.9	4.21	1.96	2.52	4.35	3.93	3.93	3.5
	Sub Surface	4.5	3.37	1.4	2.24	3.93	3.93	3.93	3.5
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
T1	Surface	4.5	4.21	0.56	3.37	4.21	3.65	3.65	3.75
	Sub Surface	4.25	3.37	0.56	2.8	4.21	3.65	3.65	3.5
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
T2	Surface	5	4.77	0.84	3.08	3.65	4.21	3.93	3.4
	Sub Surface	4.5	3.65	Nil	3.37	3.7	3.93	3.93	3.4
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
C1	Surface	5	3.93	1.68	1.68	4.35	3.93	3.93	3.37
	Sub Surface	4.7	3.37	Nil	2.24	3.93	3.37	3.65	2.8
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
C2	Surface	4.7	4.49	0.28	2.52	3.93	4.49	3.93	3.08
	Sub Surface	4.49	3.65	0.28	2.24	3.98	4.21	3.37	2.8

Table 4. Distribution of surface and sub surface water salinity (ppt) at different sampling stations

Stations		2006			2007				
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
B1	Surface	28	30.5	31.55	32.06	31.75	32.75	32.85	33.5
	SubSurface	28	30.8	31.85	32.5	32.58	32.9	33.04	33.68
B2		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
	Surface	28.5	31.05	31.75	32.85	32.75	33	33.35	33.75
	SubSurface	28.85	31.52	31.95	32.85	32.95	33.08	33.5	34.05
T1		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
	Surface	30.5	32.49	33.2	34.1	31.67	32.8	33.19	34.28
	SubSurface	31.08	31.78	33.12	32.06	31.05	32.8	32	35.1
T2		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
	Surface	31.43	31.89	32.05	32.53	32.28	32.75	32	35.01
	SubSurface	31.9	32.85	33.15	34.62	32.28	32.78	34.04	35.1
C1		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
	Surface	29.89	31.87	32.6	32.17	31.85	32.78	32.16	34.41
	SubSurface	31.1	31.87	31.15	34.15	32.36	33.3	34.3	35
C2		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
	Surface	31.89	32.13	32.85	32.05	31.64	33.28	33.43	33.89
	SubSurface	30.99	32.29	32.95	32.76	31.89	33.28	33.75	34.5

the month of October could be related to fresh water discharge through Netravathi Gurupur Rivers. The highest values in the month of May could be directly related to higher solar radiation resulting in greater evaporation. However small drop in the month of February could be related to North east monsoon coupled with existing coastal water current. Madikeri (1981), Mridula (1999) recorded bimodal oscillation in seasonal fluctuation of salinity in the coastal waters of Dhakshina Kannada. Spatial distribution revealed during post monsoon season station located along Bengre coast registered by and large lower values of salinity when compare to Thannirbhavi and Chitrapur. Near bottom water salinity values were slightly higher than that of surface water and exhibited similar seasonal fluctuations.

Conclusion

The present investigation was carried out in the three distinct section of the coastal waters of Dakshina Kannada, namely Bengre, Thannirbhavi and Chitrapur for eight months from October 2006 to May 2007. Along each section two station, one at 5m and another at 10m depth contour comprising a total of six stations were fixed. Regular monthly collection of water from surface and subsurface was collected for analysis of of physiochemical characteristics. The highest temperature was observed in the month of April along Chitrapur section and lowest temperature was recorded along Thannirbhavi section in the month of December. The water temperature exhibited a unimodal seasonal oscillation. During the period of investigation the water pH fluctuated from minimum of 7.40 to 8.51. The pH values exhibited trimodal seasonal oscillation, lower values recorded in the month of October, January and February whereas the higher values were recorded in the months of December, March and May. In the present study period the dissolved oxygen values ranged from 0 to 5 mg/l with lowest in the month of December and by and large exhibited bimodal oscillation. The salinity values fluctuated between minimum of 28×10^{-3} and maximum 35.10×10^{-3}. Seasonal variation of salinity exhibited increasing trend from October to May and could not exhibit much variation between pre and post monsoon season.

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Conflict of Interest- None

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