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Physico chemical properties of water collected from Dhamra estuary

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ABSTRACT

The temporal and spatial distribution of salinity, DO, BOD, turbidity, pH, hardness and dissolved nutrients of surface water collected from different points of Dhamra estuary were measured during February-2007 to January-2008. The pH of water was alkaline throughout the year. The salinity, conductance, hardness increased towards the river mouth as compared to inland stations. The DO level was found to be ~ 8 mg/l while BOD remained < 3 mg/l in all cases. Nutrients (NO_3, PO_4, and NH_3) in general exhibited decreasing trend from riverine to estuarine region. TDS values were high in the riverine and TSS values were high during monsoon period due to higher amount of floating particles. The concentration of NO_3^- was higher than NH_3 and PO_4 although the values were well within tolerance limits.

Key Words: Estuary, DO, BOD, Nutrients and Salinity

1. Introduction

Estuarine and coastal areas are complex and dynamic aquatic environment (Morris, e.t. 1995). When river water mixes with seawater, a large number of physical and chemical processes take place, which may influence of water quality. The quality of surface water is a very sensitive issue. The natural processes, such as precipitation inputs, erosion, weathering of crustal materials, as well as the anthropogenic influences, viz, urban, industrial and agricultural activities, calling for increasing exploitation of water resources, together determine the quality of surface water in a region. Rivers play a major role in assimilation or carrying off of municipal and industrial wastewater and run-off from agricultural land, the former constitutes the constant polluting source whereas the later is a seasonal phenomenon. To establish the spatial and temporal variations in water quality, regular monitoring programs are required.

2. Material and Methods

Water samples were collected every month during February-2007 to January-2008. Surface water samples were collected with a clean plastic bucket. Preservation and transportation of the water samples to the laboratory were as per standard methods (APHA, 1998). Water temperature was measured on the site using mercury thermometer.

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The samples were analyzed for 12 different parameters. pH was measured using a pH analyzer(WTW model Multi 340),while conductance and salinity were analyzed by Mohr-Kundsen $AgNO_3$ titration method (APHA, 1998). Dissolved oxygen was fixed immediately after collection and then determined by Winkler's method. Nutrients (NH_4^+, NO_3^-, PO_4^{3-}) were determined by standard photometric method (Grasshoff, e.t. 1999). using Varian 50 Bio U.V-visible spectrophotometer. Samples for BOD were incubated in laboratory for five days at 20^0 C (Trivedy and Goel, 1984). Turbidity was measured by Nephelometer using 0.02 NTU standards. Total hardness was estimated by the complexmetric titration with standard EDTA solution using Eriochrome Black-T as indicator. Whatman 541 filter papers were used for the determination of TSS and TDS. The light and dark bottles method was used for the estimation of primary organic production (Strickland and Parson, 1972). in the surface water. The average, maximum and minimum values for each season have been considered. The stations selected were fishing jetty (0489097E, 2298837N) at station-6, DRDO (0495720E, 2298057N) at station-5, Turningcircle (0497549E, 2303710N) at station-4, station-3 (0498692E, 2305084N), station-2 (0503676E, 2308734N), station-.1 (0509862E, 2312874N) The present study reports the seasonal pattern of the physico-chemical parameters at these six different stations.

3. Results and discussions

3.1 pH, conductance, salinity and turbidity

The pH of surface water was alkaline and fluctuated between 7.5 and 8.0. It was well within the limits (ICMR Standard; 7-8.5). Salinity of surface water showed an increasing trend from riverine to estuarine region during the study period. Conductivity of surface water varied in the range 3.97-46.03 mS/cm. The average conductivity was 29.54 mS/cm during the study period. The conductance value also increased from Station-1 to Station-6 with increasing salinity. Highest salinity (30.54 ppt) was recorded in the pre-monsoon period at Station-2 and the lowest at Station-6 during monsoon due to a wide variation in the discharge of river water. Comparatively higher salinity during pre-monsoon season was recorded and the salinity level increased from station-6 to Station-1.Turbidity is mainly due to the dispersion of suspended particles. Abnormal values of turbidity are usually due to discharge of water due to floating sediments carried by the river from catchment areas. Turbidity values varied from 1.89-112.75NTU, the maximum being at Station-1 in monsoon period and the minimum at Station-5 in the pre-monsoon period.

Total Hardness ranged from 969.68-5655.24mg/l, the highest and lowest recorded were at Station-1 and Station-6, respectively. It might be due to the dissolution of land derived carbonates and bicarbonates in the water.

$MCO_3 + CO_2 + H_2O = M(HCO_3)_2$, Where 'M' is Ca, Mg ions ---------- 1

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3.2 DO, BOD, TDS and TSS

Dissolved Oxygen (DO) levels varied from 6.0-7.36 mg/L, which is correlated to temperature and salinity of surface water. The average concentration of DO was higher in post-monsoon due to winter cooling and higher photosynthetic activity. The maximum value of DO was at Station–2 in post-monsoon period and the lowest value was at Station-6 in monsoon period. The lower values of DO were obtained at Station-6 due to the addition of high organic contents in the fishing jetty leading to oxygen depletion. Biochemical Oxygen Demand (BOD) depends on temperature, extent of biochemical activities, concentration of organic matter and such other related factors. During the study period, BOD was observed to be in the range 1.26-2.81mg/L. Maximum value of BOD was recorded at Station-3 in pre-monsoon period and the minimum was observed at Station-5 in monsoon period. In post-monsoon period due to low temperature prevailing in winter and low bacterial activity, higher levels of DO were encountered. This indicates a fall in BOD levels. So the observed BOD value was < 3mg/L, which is within the permissible limit. Maximum value of BOD was observed in pre-monsoon period due to the maximum biological affinity at elevated temperature and low in winter (Ghavzan, e.t. 2006). and reduced flow of riverine water.

Total Dissolved Solids (TDS) of surface water varied from 12.55 to 63.85g/L, which is within the permissible limits. The TDS value was maximum at Station-1 in pre-monsoon period and minimum was observed at Station-4 in post-monsoon period. TDS value is higher in summer than the rainy and winter seasons and increased from Station-6 to Station-1. Total Suspended Solids (TSS) varied from 0.38 to 1.48g/L. The maximum value was observed at Station-1 in monsoon period and the minimum was observed in post-monsoon period. In monsoon period the TSS value was high due to floating materials like fine silt and detritus carried by rainwater from the catchment.

3.3 Inorganic Nutrients (Nitrate, Ammonia and Phosphate)

The nitrate (NO_3^-) concentration ranged from 0.03-0.63mg/L. Maximum concentration of NO_3^- was observed at Station-4 in pre-monsoon period and minimum was in post-monsoon period at Station-3. Presence of NO_3^- ion could be due to the anthropogenic sources like domestic sewage, agricultural wash offs and other waste effluents containing nitrogenous compounds. The higher concentration of nitrate at Station-4 during pre-monsoon period was due to the addition of domestic municipal sewage. Such source of nitrate was also reported from Mahanadi estuary (Sunderay, e.t. 2006). The NH_4^+ concentration varied from 0.03-0.17mg/L during this period. The observed concentration of NH_4^+ was less than that of nitrate. NH_4^+ concentration was maximum at Station-2 in pre-monsoon period and minimum was observed in post-monsoon period at the same point. Lower concentration of NH_4^+ indicates minimal influence of industrial effluents. PO_4^{3-} concentration varied from 0.04 to 1.15 mg/L, maximum value being at Station-6 in post-monsoon period. This could be due to agricultural runoffs from fields. Among these

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nutrients PO_4^{3-} concentration was observed to be relatively lower than the other two, but all the values were well within the limits.

3.4 Gross and net production

During the study period, the gross production ranged 0.62 to 2.21mgC/L/day. The average gross production was 1.16mgC/L/day, also the net production varied from 0.18 to 1.27mgC/L/day; the average net production was 0.57mgC/L/day. The maximum value of gross production was at station-5, probably because of the higher phytoplankton biomass and low salinity as well as due to the presence of higher concentration of nitrogen and phosphorus leading to the growth of phytoplankton at station-5, The primary productivity was affected due to high turbidity in pre monsoon and post monsoon periods at station-5 and station-6, The primary productivity at Station-4 during the monsoons were high due to the interaction of tides and riverine flow at Station-4.Due to high intensity of sunlight at the surface water during pre-monsoon, the productivity was higher as compared with monsoon and post monsoon seasons.

Correlations of different parameters are shown in Table-2.pH had good correlation with DO and BOD .Conductance had good correlation with salinity, total hardness and TDS.

Table 1: Different water quality parameters of Dhamra Estuary

Seasons	Stations	pH	Conductance ms/cm.	Turbidity NTU	Salinity gm/l.	DO mg/l	BOD mg/l	Total hardness mg/l	TDS gm/l	TSS gm/l	NO_3^- mg/l	NH_3 mg/l	PO_4^{-3} mg/l	GPP	NPP
Premonsoon	Sta-1	7.6	45.93	9.25	30.24	6.63	2.69	5655.24	63.85	0.65	0.25	0.05	0.66	1.2365	0.40775
	Sta-2	7.9	46.03	47.09	30.54	6.66	2.64	5621.56	52.52	0.65	0.21	0.17	0.04	1.15075	0.3545
	Sta-3	7.8	45.55	21.45	29.77	6.84	2.81	5578.93	62.89	0.62	0.17	0.06	0.04	0.9105	0.4785
	Sta-4	7.9	44.53	38.75	29.09	6.64	2.36	5432.42	57.73	0.73	0.63	0.05	0.40	1.1825	0.82125
	Sta-5	7.9	42.03	112.75	27.15	6.72	2.46	5091.68	56.64	0.81	0.55	0.07	0.33	2.2145	0.914
	Sta-6	7.7	34.20	53.67	23.21	6.45	2.29	4000.49	45.64	0.74	0.37	0.07	0.05	1.45325	1.274
Monsoon	Sta-1	7.7	38.02	1.89	24.65	6.23	2.48	4513.74	49.67	1.48	0.44	0.08	0.12	0.8465	0.38825
	Sta-2	7.7	36.38	2.60	24.04	6.17	2.09	4321.96	44.27	1.25	0.33	0.06	0.09	1.0745	0.619
	Sta-3	7.8	27.63	3.51	17.55	6.32	1.89	3439.62	37.67	1.02	0.37	0.06	0.14	0.81025	0.182
	Sta-4	7.6	23.12	3.97	16.12	6.28	1.75	2961.49	30.08	0.78	0.18	0.05	0.14	1.6735	0.284
	Sta-5	7.5	11.19	6.13	9.73	6.07	1.26	1766.53	19.48	0.51	0.23	0.05	0.12	1.00425	0.5345
	Sta-6	7.5	3.97	11.33	5.35	6.00	1.36	969.68	12.55	0.59	0.28	0.06	0.20	0.85775	0.422
Postmonsoon	Sta-1	8.0	27.58	4.82	17.38	7.15	2.64	3200.34	28.32	0.38	0.14	0.03	0.62	0.948	0.53475
	Sta-2	7.9	27.27	7.88	17.14	7.21	2.49	3183.82	27.93	0.47	0.08	0.04	0.62	1.24875	0.7175
	Sta-3	7.9	26.02	30.64	16.48	7.36	2.70	2994.94	27.16	0.44	0.03	0.03	0.82	1.277	0.7485
	Sta-4	7.9	23.58	15.83	15.33	7.24	2.33	2703.57	24.15	0.57	0.30	0.04	0.91	1.42025	0.841
	Sta-5	7.8	15.76	49.48	10.03	6.26	1.90	1654.24	15.55	0.57	0.34	0.03	1.12	1.05475	0.4755
	Sta-6	7.8	12.95	30.10	7.59	6.98	2.81	1475.85	12.74	0.49	0.26	0.04	1.15	0.6215	0.3715

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Min	7.5	3.97	1.89	5.35	6.00	1.26	969.68	12.55	0.38	0.03	0.03	0.04	0.62	0.18
Max	8.0	46.03	112.75	30.54	7.36	2.81	5655.24	63.85	1.48	0.63	0.17	1.15	2.21	1.27
Avg	7.8	29.54	25.06	19.52	6.62	2.27	3587.01	37.16	0.71	0.29	0.06	0.42	1.17	0.58

The good correlation suggests the dependence of the same. Salinity showed correlation with total hardness and TDS whereas DO being correlated with BOD. The good correlation between total hardness and TDS suggests interdependence of the two. Rest of the parameters had shown no intra-correlation such as Turbidity, BOD, TSS, NO_3^-, NH_3, $PO_4^{3-,}$ GPP and NPP. Turbidity is positively correlated with GPP and NPP which indicates that the turbidity in estuary is partly contributed by the presence of phytoplankton.

Principal component analyses (PCA) was carried out and the results along with the eigen values and percentage of variance is presented in Table-3. The three factors accounted for 76.6% of total variance, which was sufficient to describe the data structure. The PC-1 contributed 35.64% showed +ve loading of total hardness, salinity, conductance, TDS, NH_3**,** TSS, pH and BOD along with negative loading of PO_4^{3-}. Positive loading of salinity, total hardness**,** conductance, TDS are common phenomenon in a estuarine environment (Panigrahi, e.t 2007) where as positive loading of NH_3 and BOD supports decomposition of organic materials by the microbial organisms within the ecosystem. The PC-2 contributed 23.35% of the total variance and positive loading of NH_3, turbidity, PO_4, NO3, GPP, NPP, DO and TSS. This factor clearly explains that the nutrient enrichment to the estuary maintains the productivity through proper phytoplankton growth (Panda, e.t. 2006) and the turbidity in the ecosystem is partly contributed by the phytoplanktons. The PC-3 explains 17.64% of total variance and positive loading of turbidity, NPP, DO, pH, PO_4, BOD was marked. Positive loading of NPP, DO, and BOD indicates that the healthy state of the ecosystem maintained by the proper nutrient supply, phytoplankton growth as well as decomposition of organic materials in the ecosystem (Upadhyay, e.t.1988 ;Panigrahy, e.t. 1999).

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Table2. Correlation Matrix of different water quality parameters along Dhamra estuary during the study period.

	pH	Condt. ms/cm	Turbidity NTU	Salinity gm/l	DO mg/l	BOD mg/l	TH mg/l	TDS gm/l	TSS gm/l	NO_3^- mg/l	NH_3 mg/l	PO_4^{3-} mg/l	GPP	NPP
pH	1.000													
Condt.	0.365	1.000												
Turbidity	0.354	0.274	1.000											
Salinity	0.282	**0.994**	0.264	1.000										
DO	**0.768**	0.186	0.128	0.113	1.000									
BOD	**0.673**	0.622	0.232	0.553	**0.744**	1.000								
TH	0.286	**0.993**	0.253	**0.997**	0.121	0.558	1.000							
TDS	0.148	**0.961**	0.261	**0.976**	0.000	0.472	**0.980**	1.000						
TSS	-0.229	0.359	-0.123	0.369	-0.536	-0.095	-0.365	-0.418	1.000					
NO_3^-	-0.004	0.288	-0.449	0.299	-0.405	-0.127	-0.298	-0.377	-0.524	1.000				
NH_3	0.011	-0.454	0.245	-0.495	0.234	0.111	0.490	0.443	0.299	0.141	1.000			
PO_4^{3-}	0.377	-0.353	0.090	-0.428	0.549	0.304	-0.428	-0.485	-0.513	-0.182	-0.566	1.000		
GPP	0.154	0.311	0.622	0.322	0.147	0.035	0.306	0.300	0.025	0.216	-0.059	-0.090	1.000	
NPP	0.267	0.195	0.511	0.197	0.302	0.169	0.155	0.158	0.146	0.254	-0.140	0.038	0.540	1.000

Table 3. Principal component analysis (PCA)

Parametres	PC-1	PC-2	PC-3
Total hardness(mg/l)	0.964		0.171
Salinity(gm/l)	0.96		0.196
Conductance(ms/cm)	0.951		0.192
TDS (gm/l)	0.946		0.199
NH3 (mg/l)	0.611	0.244	
DO(mg/l)		0.965	0.384
BOD (mg/l)	0.506	-0.351	0.213

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pH	0.202	0.778	0.232
PO_4^{-3} (mg/l)	-0.54	0.636	0.32
TSS (gm/l)	0.511	0.575	
Turbidity(NTU)		0.531	0.844
GPP		3.55E-01	0.796
NPP		0.208	0.777
NO_3^- (mg/l)	0.279	0.432	0.557
Eigen values	**4.99**	**3.27**	**2.47**
% of Variance	**35.64**	**23.35**	**17.64**
Cumulative %	**35.64**	**58.99**	**76.63**

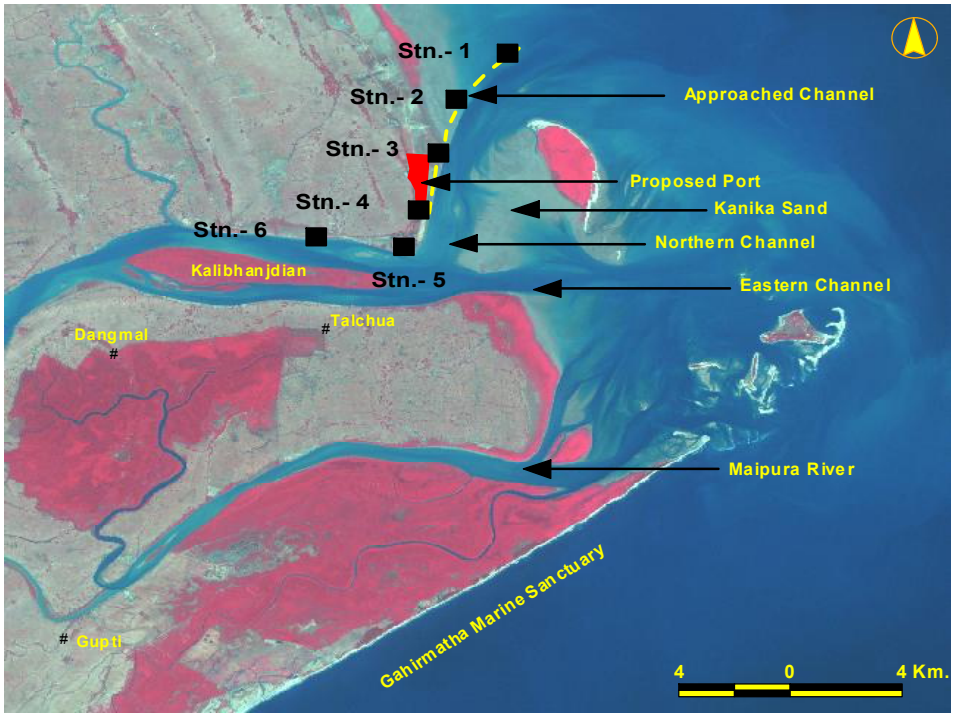

Figure 1: Selected points of Dhamra estuary

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4. Discussion

There was no significant change in the pH value during the observation period; the observed values were in the range 7.5 to 8.00. There was a considerable decrease in DO from the deep marine region towards inner riverine Station (Station-1) to (Station-6). Total hardness, salinity, conductance and turbidity decreased in the similar direction, i.e., from Station-1 to Station-6. Concentration of nutrients like nitrate, phosphate, ammonia was within the permissible limits. BOD remained less than 3 in all cases, showing normal microbial activity. Physico-chemical parameters affected the primary production in different seasons; the primary production varied from season to season with the load of nutrient salts in addition to phytoplankton species. The physico-chemical of chemical characteristics of river water in the study area suggested that there was no harmful chemical contamination. If proper measures are taken for the treatment of sewage before discharge and restrictions are put on various anthropogenic activities upstream, the estuary would remain healthy in the long run.

5. References

1. Morris, A. W., Allen, J. I., Howland, R. J. M., and Wood, R.G. (1995). The estuary plume zone: source or sink for land-derived nutrient discharges? Estuarine, Coastal and Shelf Science 40: 387-402.

2. APHA, (1998).Standard methods for examination of water and wastewater, American Public Health Association, New York.

3. Grasshoff, K., Ehrhardt, M., and Kremling, K. (1999). Methods of Seawater Analysis. pp.159-226.

4. Trivedy, R. K.,and Goel, P. K., (1984). Chemical biological methods for water pollution studies. *Env. Pub. Karad, India*: pp.104

5. Strickland, J.D.H.,and Parson, T.R.,(1972). A practical handbook of seawater analysis. *Bull.Fish.Res.Bd. Canada*. **167**:pp. 1-311.

6. Ghavzan, N. J., Gunale, V. R., and Trivedy, R. K., (2006). Limnological evaluation of an urban fresh water river with special reference to phytoplankton. Pollution research. 25 (2): pp 259-268.

7. Sunderay, S. K., Panda, U. C., Nayak, B. B., and Bhatta, D., (2006). Multivariate statistical techniques for the evaluation of spatial and temporal variation in water quality of Mahanadi river-estuarine system (India) a case study. Environmental Geochemistry and Health 28: pp317-330.

Research Article ISSN 0976 – 4402

8. Panigrahi, S. N., Acharya, B. C., Panigrahy, R. C., Nayak, B. K., Banarjee, K., Sarkar, and S. K., 2007. Anthropogenic impact on water quality of Chilika lagoon ramsarsite: a statistical approach. Wetlands Ecol Manage 15: pp113-126.

9. Panda U. C., Sunderay, S. K., Rath, P., Nayak, B. B., and Bhatta, D., (2006). Application of Factor and cluster analysis for characterization of river and estuarine water systems- A case study: Mahanadi River (India). Journal of Hydrology 331: pp 434- 445.

10. Upadhyay, S. (1988). Physico-chemical characteristics of Mahanadi estuarine eco-system. East coast of India. Indian Journal of Marine Sciences 17: pp19-23.

11. Panigrahy, P. K., Das, J., Das, S. N.,and Sahoo, R. K., (1999). Evaluation of the influence of various physico-chemical parameters on coastal water quality, around Orissa, by factor analysis. Indian Journal of Marine Sciences 28: pp 360-364.