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Seasonal Variations of Limnological Parameters in the Coastal West Bengal, India

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Abstract

Investigations on the limnological factors were done at three different sampling stations viz. Light house (Station 1), Kachuberia (Station 2) and Haldia (Station 3) during 1998 to 2000. All limnological showed spatial and temporal variation in every year. Highest COD and lowest DO values were observed in Station 3 while highest DO and lowest COD values were recorded in Station 1. Average salinity was 17.92, 9.63 and 3.14 ppt in respective stations. The pH did not vary much among the sampling stations. Average pH was 8.21, 8.08 and 8.09 in Station 1. Station 2 and Station 3 respectively. Concentrations of different nutrients such as nitrate phosphate and silicate were found to be high in Station 3 compared to Station 1 and Station 2.

Key words : Seasonal variations, Coastal waters, Nutrients, Salinity, Hooghly estuary.

In India, there is a considerable discharge of effluents from various sources into the major rivers and estuaries which deteriorate the conditions of existing aquatic organisms. Due to discharge of different types of pollutants in Indian water bodies, gradual disruption in the production of food chain organisms and as a consequence gradual decline of fish yield was investigated (Jhingran 1983). The present study is restricted to Hooghly estuary – the principal artery of the Hooghly-Matlah estuarine complex. On its way it receives river Rupnarayan, Saptamukhi, Thakuran, Gossaba, Ichhamati and Raimangal forming a network the Hooghly-Matlah estuarine complex and finally opens into Bay of Bengal. The chain of industries situated in the western bank of Hooghly estuary releases thousand of toxic chemicals into the estuary every day through untreated or partially treated effluents. Hooghly estuary, being the down stream extension of the river Ganga, also receives huge amount of toxic materials from the upper polluted part of the river (Mathur et al. 1987, Agrawal 1996). The physico-chemical factors such as temperature, salinity, pH, dissolved oxygen and nutrients (NO_3, PO_4, SiO_3) plays an important role for survival of animal and plant life in esturine environment. The nutrients determine the fertility of the ambient aquatic media (Harvey 1955). Seapage of petrolium from large ships carrying petrolium products to the newly constructed port of Haldia (Station 3) is also a common incidence in Hooghly estuary. The estuary run through two highly urbanized cities like Kolkata and Howrah, receives large amount of domestic sewage and inorganic pollutants (Deb and Santra 1997, Sasmal 2004). The present study was made to determine the spatial and temporal variation of the limnological factors in relation to coastal water pollution.

Methods

The Station 1 (Light house) is located in the southernmost tip of Sagar Island, at the confluence of the Hooghly and Bay of Bengal and the Station 2 (Kachuberia) is located in the northern part of Sagar Island. The Station 3 (Haldia) is located in the upper part of the Hooghly estuary at the confluence of Hooghly and Haldi river.

Surface water samples were collected at monthly intervals from the study areas for the estimation of various physico-chemical parameters. Random samples of water were collected during January 1998 to December 2000 from each station and were pooled together to make duplicate set of each sample for each station. Water samples were collected from 50-cm depth in each station. For determination of NO_3-N, PO_4–P and SiO_3–Si water samples were filtered

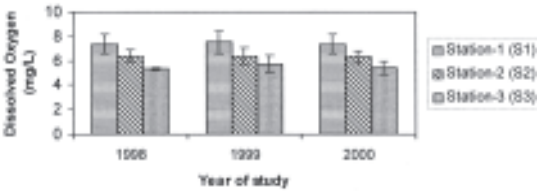

Figure 1. Yearly variations of dissolved oxygen (mg/l) in the three sampling stations.

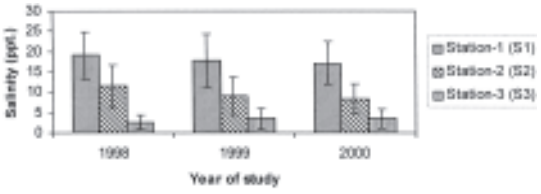

Figure 3. Yearly variations of salinity (ppt) in the three sampling stations.

through Whatman filter paper no. 1 and was acidified with 1 ml HCl–1 and was stored in borosilicate glass bottles. For dissolved oxygen estimation, water samples were collected in 100 ml reagent bottles and were immediately fixed by manganous sulphate and alkaline potassium iodide (1 ml each). For determination of other parameters (pH, salinity, and chemical oxygen demand) water samples were collected in air tight neutral polyethylene bottles. A ll samples of water were immediately brought to the laboratory for estimation. The physico-chemical parameters were determined within 12-24 h of collection. Salinity was estimated with the help of a salinometer and pH was measured using a Elico pH meter. Dissolved oxygen was estimated by the modified Winkler's method. Water samples were filtered using a millipore filtering system and dissolved in organic phosphate, nitrate and silicate, adapting the methods (APHA 1995). The physico-chemical parameters were compared between the stations separately for each year of study, using one way ANOVA (Gomez and Gomez 1984).

For the sake of convenience and easy interpretation, a calendar year (of study) was divided into three seasons viz. pre-moonson or summer (March-June), monsoon or rains (July-October) and post-monsoon (November-February).

Results and Discussion

Dissolved Oxygen and Chemical Oxygen Demand

Seasonal fluctuations of dissolved oxygen (DO) and chemical oxygen demand (COD) in all the sampling stations are shown in Table 1. Distinct variation was found for both the parameters among the sampling stations (Fig. 1 and 2). Dissolved oxygen (DO) concentration of water was lower in Station 3 than other two stations while chemical oxygen demand (COD) values of this station was much higher than other two stations (Table 1, Fig. 1 and 2). The chemical oxygen demand (COD) ranged from 12 to 46.26 mg/liter. Maximum values were recorded in Station 3 during March 1999 and March 2000 (40.00 and 46.26 mg/liter respectively). Minimum values were recorded from Station 1 and Station 2 during September (12.00 to 15.42 mg/liter). The low DO concentration recorded duting the summer season was probably due to the biochemical oxidation of organic matter (Mukherjee et al. 1986, Sasmal 2004).

Salinity

Salinity varied widely between seasons and stations. Maximum salinity was recorded during pre-monsoon (March to June) with a sharp decline dur-

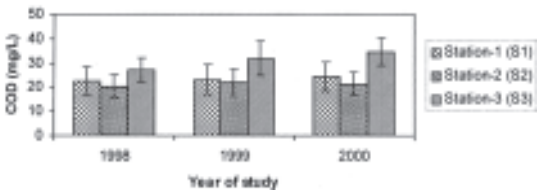

Figure 2. Yearly variations of COD (mg/l) in the three sampling stations.

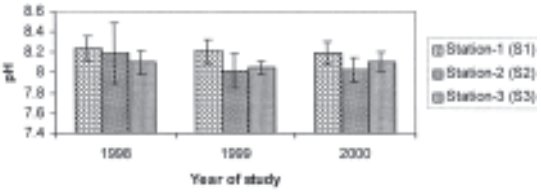

Figure 4. Yearly variations of pH in the three sampling stations.

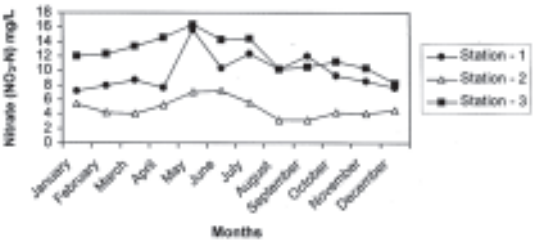

Figure 5. Monthly variation of nitrate (NO_3-N) mg/l for the different sampling stations.

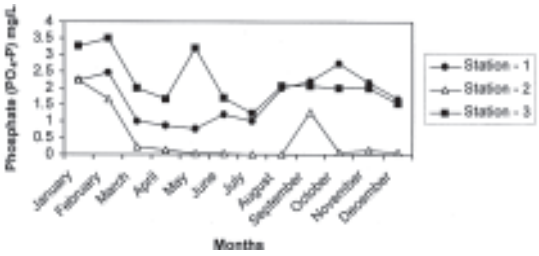

Figure 6. Monthly variation of phosphate (PO_4-P) mg/l for the different sampling stations.

ing monsoon (July to October) (Fig.3). The same trend was observed for all the stations. However, Station 1, being close to sea, showed much higher salinity than the other two stations throughout the study period while Station 3, being far from the sea, showed the minimum range of salinity (0.27 to 8.99‰). Salinity ranged from 22.76 to 27.17, 12.85 to 12.37‰ amd 3.10 to 6.97‰ during pre-monsoon respectively in Station 1, Station 2 and Station 3 (Table 1). Ranges of salinity observed during monsoon period were 6.54 to 19.67‰, 3.24 to 10.53‰ and 0.27 to 2.95‰ in Station 1, Station 2 and Station 3 respectively.

Salinity is one of the important factors which influences the functional physiology and reproductive activity of organisms thereby affecting floral and fungal abundance (Sarma et al. 1988). Higher salinity could be due to the continuous evaporation of water especially during the summer and pre-monsoon seasons, a feature reported earlier from other parts of the Indian coasts (Harikantra and Parulekar 1990). Low salinity recorded during the monsoon season was due to the high dilution of coastal water as a consequence of massive freshwater input into the sea through the rivers.

pH of Water

Average pH for the entire investigation period was 8.21, 8.08 and 8.09 in Station 1, Station 2 and Station 3 respectively (Table 1). Although pH of water showed a seasonal fluctuation it did not vary among the sampling stations during the investigation period (Fig.4). The lower pH observed during the monsoon season was perhaps due to the mixing of river water with sea water followed by the rainfall. The water seemed to have a high buffering capacity as a result of which only narrow fluctuation in pH was observed.

Dissolved Nutrients (PO_4, NO_3 and SiO_3)

Seasonal fluctuations of phosphate (PO_4-N) ni-

Table 1. Summary of physico-chemical parameters (mean ± SD) for each year of study plus one way ANOVA results.

Year of study	Variables	Station 1 (S_1)	Station 2 (S_2)	Station 3 (S_3)	*F* value	Level of significance
1998	Salinity (‰)	19.04 ± 5.90	11.52 ± 5.24	2.56 ± 1.72	37.55	$P<0.001$
1999	Salinity (‰)	17.75 ± 6.61	9.06 ± 4.74	3.42 ± 2.63	25.74	$P<0.001$
2000	Salinity (‰)	16.96 ± 5.35	8.31 ± 3.82	3.44 ± 2.54	33.97	$P<0.001$
1998	pH	8.24 ± 0.12	8.19 ± 0.34	8.10 ± 0.10	1.12	$P<0.336$
1999	pH	8.21 ± 0.12	8.02 ± 0.17	8.05 ± 0.07	7.43	$P<0.01$
2000	pH	8.19 ± 0.11	8.03 ± 0.12	8.11 ± 0.09	6.59	$P<0.01$
1998	DO (mg/l)	7.36 ± 0.77	6.37 ± 0.54	5.31 ± 0.66	28.75	$P<0.001$
1999	DO (mg/l)	7.53 ± 0.92	6.37 ± 0.67	5.73 ± 0.79	15.57	$P<0.001$
2000	DO (mg/l)	7.38 ± 0.75	6.31 ± 0.51	5.42 ± 0.56	30.39	$P< 0.001$
1998	COD (mg/l)	22.43 ± 6.12	20.33 ± 4.82	27.01 ± 5.22	4.92	$P<0.05$
1999	COD (mg/l)	23.14 ± 6.68	21.95 ± 5.70	31.71 ± 7.15	7.95	$P<0.001$
2000	COD (mg/l)	24.42 ± 5.93	21.19 ± 4.84	34.50 ± 5.87	20.94	$P<0.001$

Table 2. Summary of nutrient parameters (mean ± SD) for each year of study plus one way ANOVA results.

Year of study	Variables (mg/l)	Station 1 (S_1)	Station 2 (S_2)	Station 3 (S_3)	*F* value	Level of significance
1998	Phosphate	1.69 ± 0.69	0.49 ± 0.78	2.18 ± 0.73	16.84	$P<0.001$
1999	Phosphate	2.17 ± 0.54	1.49 ± 0.60	3.84 ± 0.56	49.51	$P<0.001$
2000	Phosphate	2.37 ± 0.72	2.23 ± 0.47	4.69 ± 0.69	55.86	$P<0.001$
1998	Nitrate	9.78 ± 2.46	4.82 ± 1.35	12.30 ± 2.31	40.75	$P<0.001$
1999	Nitrate	11.72 ± 2.70	7.20 ± 1.22	14.83 ± 2.72	32.66	$P<0.001$
2000	Nitrate	14.12 ± 2.58	8.99 ± 1.58	18.12 ± 2.80	44.93	$P<0.001$
1998	Silicate	72.54 ± 5.94	63.71± 7.64	81.06 ± 6.83	20.39	$P<0.001$
1999	Silicate	75.97 ± 5.69	70.48 ± 8.96	89.05 ± 4.09	24.72	$P<0.001$
2000	Silicate	78.91 ± 7.40	80.89 ± 8.91	92.56 ± 2.78	12.71	$P<0.001$

Table 3. Simple correlation coefficient (*r*) for physico-chemical parameters at Station 1, Station 2 and Station 3. $^{**}P<0.01$, $^{*}P<0.01$.

	PO_4- P (mg/l)	NO_4-N (mg/l)	SiO_3-Si (mg/l)
Salinity (‰)	-0.302**	-0.101	-0.418**
pH	-0.158*	0.152*	-0.236**
DO (mg/l)	-0.191**	-0.096	-0.132*
COD (mg/l)	0.372**	0.322**	0.199**

trate (NO_3-N) and silicate (SiO_3-Si) in water for Station 1, Station 2 and Station 3 have been recorded. Phosphate (PO_4-P) levels were much higher in Station 3 than the other two sampling stations. Phosphate (PO_4-P) levels increased sharply in Station 3 during 1999 and 2000 (Table 2). Simple correlation coefficient (*r*) for nitrate, phosphate and silicate with salinity, pH, DO and COD were recorded (Table 3).

Nitrate (NO_3-N) level of water also showed distinct variations among the three stations and Station 3 showed the maximum value for most of the investigation period followed by Station 1 and Station 2.

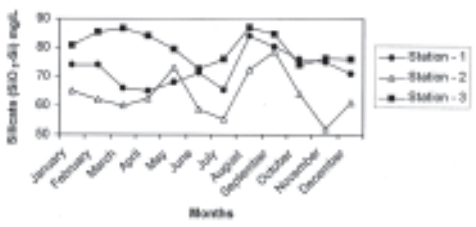

Figure 7. Monthly variation of silicate (SiO_3-Si) mg/l for the different sampling stations.

Silicate (SiO_3-Si) level also showed higher values in Station 3 although difference among stations was less as compared to phosphate (PO_4-P) and nitrate (NO_3-N) (Figs. 5, 6 and 7). Station 3 showed maximum value of silicate (72.63 to 97.02 mg/liter) and Station 2 showed minimum values of this nutrient (52.00 to 90 mg/liter) during the study period (Table2).

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