

Seasonal Variation of the Water Quality Parameters and its Influences in the Mahanadi Estuary and near Coastal Environment, East Coast of India

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Abstract: The distributions of water quality parameters viz. temp, salinity, dissolved oxygen (DO), biochemical oxygen demand (BOD), total suspended substances (TSS), nutrients [$\text{NO}_2\text{-N}$, $\text{NO}_3\text{-N}$, $\text{NH}_4\text{-N}$, $\text{PO}_4\text{-P}$, $\text{SiO}_4\text{-Si}$, total nitrogen (TN), total phosphorous (TP)] and Chlorophyll-a (Chl-*a*) were studied in the Mahanadi river and costal environment of Paradip in two different seasons i.e. post-monsoon and summer during 2006-2007. Results of nutrient concentrations were exhibited higher indicates that large inputs possibly from two major fertilizer plants, municipal sewage from Paradip town and agricultural runoff. In the estuary most of the nutrients showed higher values (NO_3 7.23 $\mu\text{mol/l}$, NH_4 6.32 $\mu\text{mol/l}$, PO_4 16.03 $\mu\text{mol/l}$ and SiO_4 15.32 $\mu\text{mol/l}$) during post-monsoon as compared to the costal stations. The PO_4 , TN, TP and $\text{SiO}_4\text{-Si}$ showed a well-defined pattern of distribution with higher concentration in estuarine water of Mahanadi estuary during summer.

Key words: Water quality • Nutrients • Pollution • Industrial wastes • Domestic sewage • Mahanadi estuary

INRODUCTION

The environmental pollution is the major problem in the marine environment. Industrialization and rapid increase in human population have resulted in transformation of the natural environment. The environment became hostile, posing many threats to health and welfare because of pollutants released into the environment [1]. The environmental impacts of municipal wastewater and industrial effluents discharge on receiving water are numerous and inputs of contaminants can affect the aquatic biota as well as the health of the coastal environment [2]. The surface water quality is very sensitive issue due to anthropogenic influence as well as natural processes (changes in precipitation inputs, erosion, weathering of crustal materials)degrades surface water and impair use for drinking, industrial, agricultural, recreation and other purposes [3]. Estuaries constitute a major interface between land and the ocean and have been regarded as one of the most important aquatic

system. The progressing of large industries in Paradip has become a threat to the health of the Mahanadi estuarine and coastal water environment. The sewage from urban areas and industrial wastages contributes a constant source of pollutants, where as the surface runoff is a seasonal phenomenon largely affects by climate in the basin. The urban inputs, agricultural runoff and industrial inputs play a vital role in nutrient cycling, water quality, eutrophication, biota abundance and overall food web dynamics in estuarine and near shore ecosystems. Apart from this, fishing activities near the estuary also influence the water quality parameters [4]. Mahanadi is one of the major rivers in India and is the largest river of Orissa state having the annual discharge of 66,640 mm^3 . The average annual rainfall is 1572 mm, of which 70% [2] is precipitated during the southeast monsoon but mid June to mid October. The growth of industrialization and urbanization in the upstream and estuarine region of Mahanadi, the largest river in Orissa is putting unique pressure on estuarine and coastal resources.

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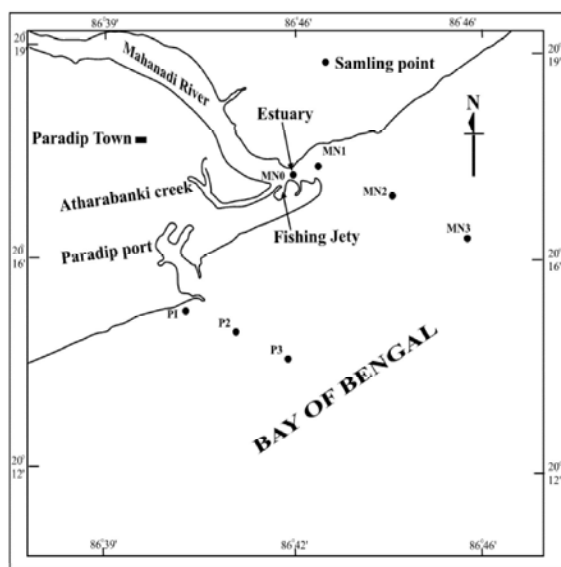


Fig. 1: Station location map of the study area

The water quality of Mahanadi river and estuarine system has been studied by many researchers [2, 5-7]. To know the present status of the pollution, the water quality parameter in estuarine along with the coastal environment in Paradip was studied on seasonal basis.

Study Area: Mahanadi drainage basin is the biggest along the east coast of India. The tidal estuarine part of the river covers a length of 10 km and has a basin area of 9 km². Tidal cycle is semi-diurnal and is principally a wave-dominated coast during the southwest monsoon season and during the non-monsoon period it is mixed wave and tide dominated. Paradip port situated at the northern end of Bay of Bengal and act as important shoreline harbours along the east coast of India. Apart fishing harbour activities at the estuary this affects the water quality greatly. The effluents in Mahanadi estuary mostly receive from fertilizer plants, small industries and domestic sewages of Paradip and surroundings. Atharbanki creek that flows to the Mahanadi estuary heavily loads with municipal sewage, phosphates and solid wastes. The anthropogenic and port activities also largely influence the estuarine environment of Mahanadi and meets Bay of Bengal at Paradip coast as shown in (Fig. 1).

MATERIALS AND METHODS

Along the Paradip coast, two transects (Paradip and Mahanadi) perpendicular to the shoreline were selected

for the present investigation (Fig. 1). Each transect comprises of three stations located at 0, 1 and 5 Km from the shoreline. Water samples were collected in November 2006 and February 2007 from all the stations of these two transects along with estuary during low and high tide periods. Surface water samples were collected with the help of "Aquatrap" water sampler. Water temperature and pH were measured by using WTW Kit in the field. The parameters Salinity, (DO), BOD and TSS were analysed by the standard methods [8]. The Nutrients and Chlorophyll-a pigment were determined by UV- visible spectrophotometer (Perkin Elmer, Lambda 35) as described in methods of seawater analysis [9]. For the determination of Chlorophyll-a concentration 1 liters of the sea water samples were vacuum filtered on GF/C filter. After blotting out the water properly, each filter with the phytoplankton mass was transferred to 16ml PP (polypropylene) centrifuge tube with air tight cap. This was immediately frozen by pouring some liquid nitrogen and kept frozen at <math><0^{\circ}\text{C}</math> in freezer. On the final day, 7ml of ice-cold 90% acetone was poured in each tube, submerging the filter. All the tubes were then placed in ice-bucket containing ice mixed with salt so that the temperature is maintained below

RESULTS AND DISCUSSION

Seasonal variations of water quality parameters in surface water at Paradip and Mahanadi coastal transect along with estuary are given in (Fig. 2). Water temperature in coastal water of Paradip and Mahanadi varied between

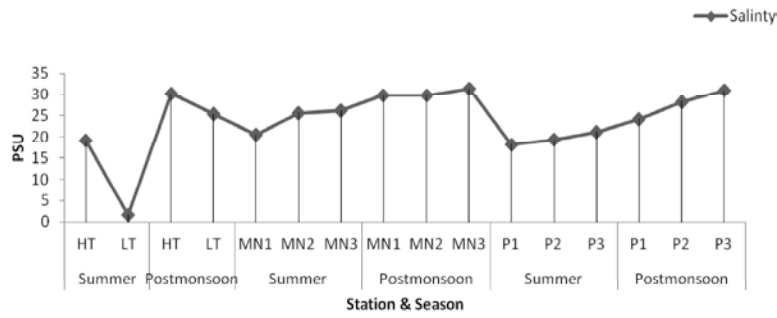


Fig. 2: Seasonal variation of salinity in Mahanadi estuary and coastal water during 2006.

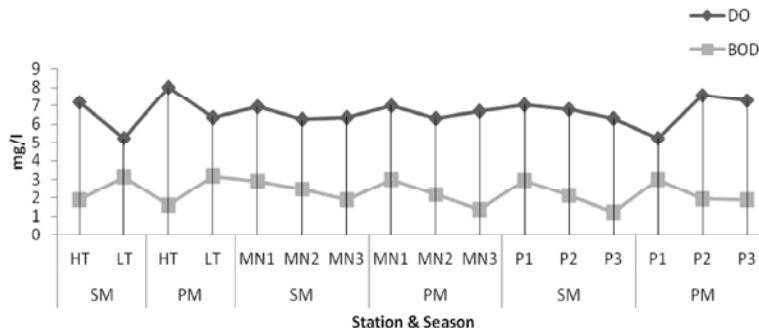


Fig. 3: Seasonal variation of dissolved oxygen (DO) and biochemical oxygen demand (BOD) in Mahanadi estuary and coastal water during 2006.

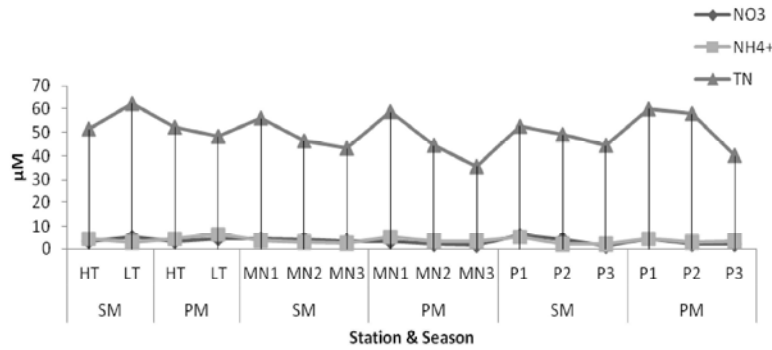


Fig. 4: Seasonal variation of nitrate (NO₂ -N), ammonia (NH₄⁺) and total nitrogen (TN) in Mahanadi estuary and coastal water during 2006.

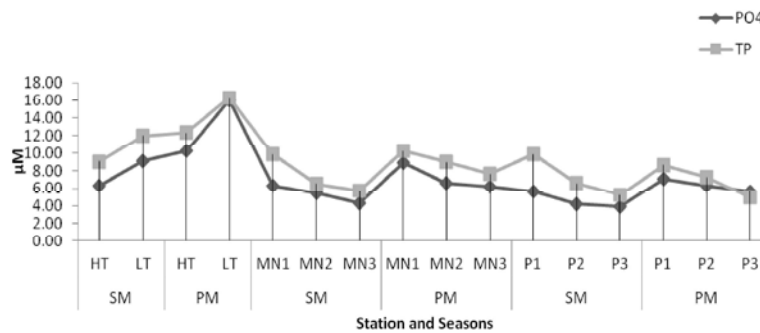


Fig. 5: Seasonal variation of phosphate (PO₄ -p) and total phosphorus (TP) in Mahanadi estuary and coastal water during 2006.

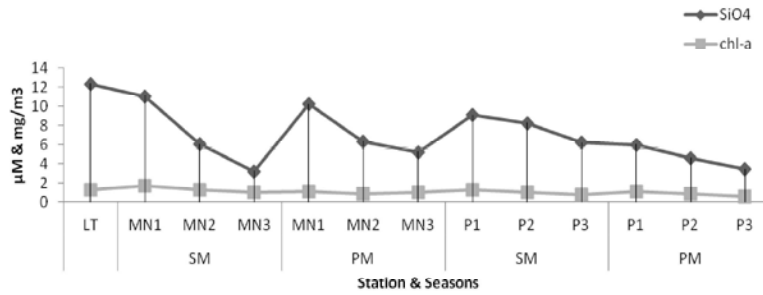


Fig. 6: Seasonal variation of silicate (SiO₄-Si) and chlorophyll-*a* in Mahanadi estuary and coastal water during 2006

Table 1: The variation of mean, standard deviation (SD) values of environmental variables in the Mahanadi and Paradip coastal water

	Mahanadi estuary Mean±SD	Mahanadi coastal Mean±SD	Paradip coastal Mean±SD
Water temperature	26.90±1.52	24.70±3.22	26.93±1.23
SSC	17.00±11.90	14.62±8.19	11.55±3.53
pH	7.83±0.36	7.61±1.64	8.50±0.18
Salinity	19.06±11.67	27.24±3.97	23.70±4.97
DO	6.68±1.11	6.58±0.30	6.99±0.47
BOD	2.46±0.73	2.29±0.62	2.18±0.68
NO ₂	0.83±0.33	0.50±0.25	0.51±0.23
NO ₃	4.05±0.90	3.07±0.97	3.31±1.87
NH ₄	4.38±1.41	3.41±0.98	3.28±1.19
TN	53.57±5.71	47.35±8.45	50.70±7.54
IP	10.43±3.85	6.30±1.56	5.47±1.20
TP	12.41±2.84	8.16±1.77	7.09±1.87
SiO ₄	12.14±1.53	7.01±2.94	6.26±2.10
Chlorophyll- <i>a</i>	1.42±0.51	1.16±0.30	0.93±0.25

as well as effluents from fertilizer industry situated upstream of the Mahanadi estuary [2]. The BOD ranged between 1.35 to 3.21 mg/l in coastal water. Higher BOD was found in estuary water as compared to the coastal water due to the large amount of municipal sewage wastes, effluents from industries. Atharbanki creek carries all the sewage Paradip township and industrial effluents from fertilizer industry direct in to the estuarine environment. Increase in the DO and decrease in BOD were observed from shore to offshore stations. Suspended solids varied from 6.96 to 35.35 mg/l that were well within the permissible limits [11]. The variations of nutrients concentrations in coastal water ranged between 0.36 μmol/l to 1.25 μmol/l of NO₂, 1.65 μmol/l to 5.32 μmol/l of NO₃, 2.69 μmol/l to 6.32 μmol/l of NH₄, 35.62 μmol/l to 62.35 μmol/l of TN, 6.21 μmol/l to 16.03 μmol/l of PO₄, 7.65 μmol/l to 16.31 μmol/l of TP and 5.21 μmol/l to 10.02 of μmol/l SiO₄. In general the nutrient concentrations were higher in estuary water as compared the coastal water. The higher concentrations of PO₄, TP, SiO₄ in Mahanadi transect compared to those in Paradip transect may be due to the impact of riverine discharges and effluents from phosphatic fertilizer plants that situated near the estuarine

region [11]. The Chl-*a* concentration ranged from 0.85 to 2.16 mg/m³ in coastal transects of Mahanadi and Paradip. The Chl-*a* concentration was to be higher in estuarine water compared to the coastal transects, which could be due to the higher abundance of phytoplankton and nutrients.

CONCLUSION

The costal environment is under stress of municipal sewage and industrial effluent discharge by receiving huge water inputs of contaminates which could be hazardous to the living organisms. The organic sewage is reflected through the high BOD and lower DO in the Mahanadi estuary during low tide. The higher concentration of PO₄, TP, TN, SiO₄ and BOD in Mahanadi coastal water compared to the Paradip coastal water due to the effluent discharge by the industry and fertilizer plants. The seasonal nutrient variations exhibit higher value during post monsoon as compared to the summer, which might be due to river runoff. There were no regular variations of pH and water temperature in the water quality within 5 km from shoreline. The analysis need to be more thoroughly for finding the spatiotemporal changes in estuarine environment under time series observation for the sustainable ecosystem management as the contaminated with higher value of exceptional PO₄, TP, TN and SiO₄ including physical and biological parameter input alter the ecology of the costal environment that causes greatly affecting the overall biotic community of the ecosystem.

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