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Short communication

NUTRIENT DYNAMICS OF IMO RIVER ESTUARY, SOUTH EASTERN NIGERIA

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ABSTRACT: The physical and chemical properties of the Imo River estuary, Southeastern Nigeria were investigated between April 2001 and June 2002. Variations in water temperature, total dissolved solids, conductivity, dissolved oxygen, nitrate, sulphate, phosphate and silicate are reported. With the exception of dissolved oxygen all parameters were significantly different ($P<0.05$) in the study stations. Conductivity was positively correlated with total dissolved solids. The same holds true for phosphate and nitrate. The parameters showed both spatial and temporal variations. Temperature, TDS, conductivity, were high during the dry season while nitrate, sulphate, phosphate and silica recorded high wet season values. Flood influx into the estuary during the wet season and tidal inflow of seawater during the dry season were the two major factors that influenced the nutrient dynamics of the Imo River estuary.

Key words/phrases: Estuary, Imo River, Nigeria, nutrients, variations

INTRODUCTION

It is common knowledge that estuaries are exposed to continuous eutrophication through daily enrichment from natural systems and human wastes. Specifically, nutrient supplies to estuaries are usually coming from the sea, inflowing rivers, adjacent marshes and vegetation and from anthropogenic sources. This leads to nutrient enrichment of water and with adequate solar radiation gives rise to hydrobiological changes which may result in bloom formations (Opute, 1990). The shallow and well-mixed waters of the estuaries are often ideal sites for high rates of photosynthesis and secondary production (Pearl, 1988).

Reports on the physical and chemical characteristics of Nigerian rivers include those of Egborge (1971) on River Oshun, Adebisi (1981) on Ogun River, Opute (1990) on the Warri/Forcados estuary, Erondu and Chindah (1991) on the New Calabar River. Others include Chikere and Okpokwasili (2001) on Eleme River, Nwankwo and Jaiyeola (2001) on Lagos lagoon, Kadiri (2002) on the eastern Niger Delta and Akpan *et al*, (2002) on the Great Kwa River. There is scanty information on the limnology of Imo River despite the fact that it is one of the major rivers in south eastern Nigeria and its estuary part of the anastomosing network of creeks in the Niger Delta. The present study was undertaken to provide baseline data on the physical and chemical conditions in the estuary, investigate spatial and temporal variations and sources of nutrient input into the estuary.

MATERIALS AND METHODS

Water samples were collected for fifteen months (April 2001 to June 2002) from locations along 45 km stretch to the mouth of the river discharge into the Atlantic Ocean (Fig. 1). Station 1 was considered as the headwaters of the estuary and characterized by dense tropical rain forest swamp fringing vegetation with species of *Alstonia booneii* De Wild; *Raffia hookeri* Mann *et al.*, Wendl., *Emilia sonchifolia* ., (L.) DC, *Spondianthus preusii* and *Mitragyna ciliata.* Stations 2 and 3 were freshwater stations with marked diurnal tidal amplitude and fringing vegetation mainly mangrove swamp and dense vegetation of *Nypa fruticans.* Stations 4, 5 and 6 were characterized by brackish water, semi-diurnal tides, coastal alluvium and sandy beaches. Generally, the study area falls within the tropical rainforest zone of Nigeria characterized by rainy season (March to November) and dry season (December to February) with two rainfall peaks in July and September (Iloeje, 1991). Other activities include marine transport, fishing and lumbering.

Water temperature was measured *in situ* with mercury in glass thermometer. Dissolved oxygen was fixed on site by adopting the alkali-azide modification of Winkler's method. Total dissolved solids, conductivity, colour and turbidity were recorded with a HACH DR2000 spectrophotometer. Nutrient analyses for nitrate, sulphate, phosphate and silica were performed as outlined by APHA (1998). The samples were transported in an ice box and later stored in a deep freezer pending analyses due to the difficulty in logistics between the sampling points and laboratory facility. Another major limitation in this study is the lack of filtration of the water samples before analyses and this had a great impact on the result considering the effect of suspended matter in the water samples.

Mean and standard error for each parameter were calculated for the various sampling stations, while one way analysis of variance was computed to know the level of significant difference among the stations.

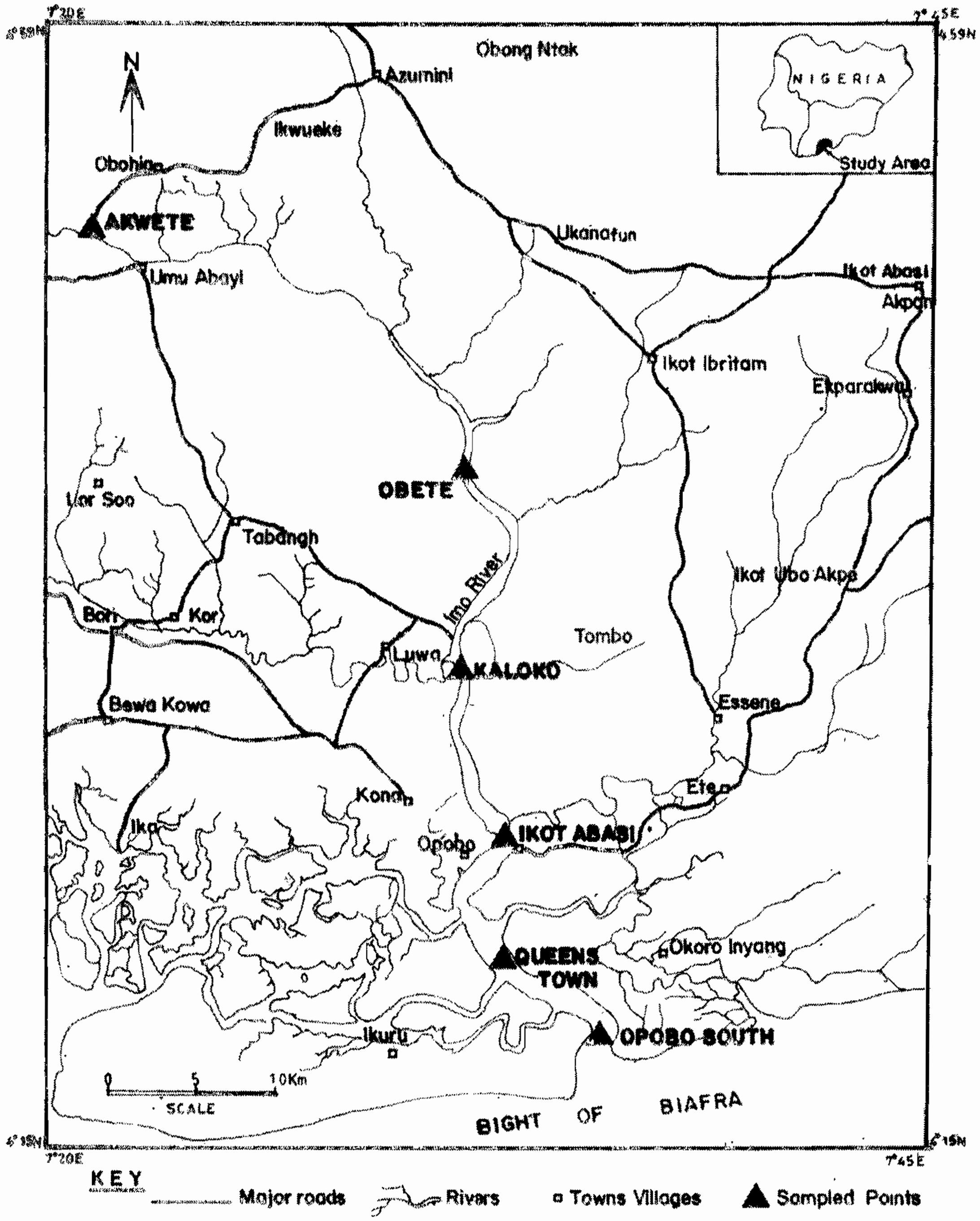

Fig. 1. Map of Imo River estuary showing sampling stations.

RESULTS AND DISCUSSION

Table 1 shows range, mean and standard error values of physico-chemical parameters obtained from the six sampling stations in the Imo River estuary. The surface water temperatures varied from 25°C to 30°C. Temperature variations were due to changes in solar radiation, cloud cover and time of sampling. Temperature variations in tropical water bodies are of minimal effect and also vary according to the seasons (Talling, 1986). The difference in sampling time as a result of the distance between the first and last stations could be responsible for the observed trend in temperature variation.

Total dissolved solids ranged from minimum value of 4.2-168mgl^{-1} at station 1 to maximum range of 516-19890mgl^{-1} at station 5. There was progressive increase in the total dissolved solids concentration downstream and this is attributable to rainy season run off from tributary streams and the fact that the lower reaches of the estuary is interconnected with the Niger Delta creek system with its attendant seasonal flood influx and tidal effect of the ocean. Conductivity values ranged from 15.3μScm^{-1} recorded at station 2 to 39780μScm^{-1} at station 5. This range is comparable with 12.0 to 46,000μScm^{-1} recorded in Bonny River – a brackish water river in the Niger Delta by Chindah and Pudo (1991). The Imo river estuary conductivity conforms widely with the general range of conductivity of the brackish waters of the Niger Delta and other Nigerian coastal waters (Nwankwo and Jaiyeola, 2001; Kadiri, 2002).

Dissolved oxygen content ranged from 4.6mgl^{-1} recorded in station 1 to 10.2mgl^{-1} in station 6. However lower values have been reported for various rivers in Nigeria. Examples include 3.5 to 7.2mgl^{-1} for Bonny river (Chindah and Pudo, 1991), 3.0-6.0mgl^{-1} for the Lagos lagoon (Nwankwo, 1994), 3.0-4.3mgl^{-1} for the Warri/Forcados estuary (Opute, 1990) and 4.0-8.33mgl^{-1} for Great Kwa river, Akpan, Offem and Nya (2002). Dissolved oxygen concentrations recorded in this study could be due to photosynthetic activity of phytoplankton population especially at stations 5 and 6. Flocculation of colloidal suspension and the attendant increase in transparency could be responsible for increased primary productivity and oxygen concentration. (Reynolds and Decsy, 1996).

The nitrate, sulphate, phosphate and silica are some of the constituents of the nutrient composition in any body of water and their range, mean and standard error are shown in also shown in Table.1. In the present study these nutrients increased downstream in the estuary except silica which showed a reverse trend of decreasing values. Generally the nutrients variations were subject to seasonal changes due to flood influx from land drainage and tributary stream during the rainy season. Table 2 shows correlation coefficient of the various parameters investigated in the present study and reveals positive correlation between conductivity and total dissolved solids and also between nitrate and phosphate (the major limiting nutrients for phytoplankton growth and primary productivity). Tidal action could also lead to resuspension of nutrients from the sediments. Inundation of the fringing mangrove vegetation at high tides yield decaying plant and animal materials into the estuary and these are potential sources of nutrient enrichment (John, 1986). It is important to note the effect of suspended matter on the result owing to non-filtration of the samples. This no doubt could have contributed to the high nutrient concentrations recorded in this study.

Table 1. Summary of physico-chemical properties of Imo River estuary.

Parameters	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	P value
Temperature	26–29	25–29	26–30	26–30	25–30	28–30	P<0.05
(°C)	27.33±0.23	27.4±0.29	27.75±0.30	28.2±0.30	28.6±0.33	29.0±0.26	
TDS (mgl^{-1})	4.3–168	7.6–483	8.77–4136	232–8240	516–19890	5250–15529.5	P<0.001
	26.57±10.33	76.54±34.35	904.55± 435.07	4121.44±674.37	6215.33±1239.42	7469.90±1387.02	
Conductivity	18.5–242	15.3–540	17.45–8273	463–16250	1038–39780	10896–31059	P<0.001
(μScm^{-1})	47.79±14.44	128.87±46.50	1809.74± 870.23	8233.89±1335.56	1452.73±2258.73	21523±2092.37	
DO (mgl^{-1})	4.6–8.0	5.0–9.1	6.0–8.6	5.8–8.8	5.9–9.6	5.2–10.2	P>0.05
	6.84±0.24	7.16±0.30	7.45±0.27	7.43±0.24	7.86±0.30	7.27±0.48	
Nitrate (mgl^{-1})	0.01–0.84	0.04–0.88	0.01–0.31	0.04–1.27	0.95–4.32	1.09–4.3	P<0.001
	0.29±0.06	0.38±0.07	0.19±0.02	0.50±0.10	2.28±0.42	2.39±0.36	
Sulphate	0.08–0.98	0.09–0.9	0.29–3.2	0.09–9.02	0.18–10.88	7.20–18.50	P<0.001
(mgl^{-1})	0.38±0.07	0.32±0.06	1.91±0.26	3.86±0.79	5.82±0.86	10.07±1.02	
Phosphate	0.01–0.25	0.03–0.75	0.1–1.44	0.01–0.48	0.01–2.01	0.15–1.61	P<0.05
(mgl^{-1})	0.10±0.01	0.19±0.05	0.52±0.23	0.23±0.03	0.59±0.17	0.74±0.16	
Silicate (mgl^{-1})	3.0–27.0	3.2–20.0	2.0–14.44	1.45–6.50	0.38–1.02	0.25–1.05	P<0.001
	15.16±2.36	12.71±1.66	6.23±1.14	3.61±0.37	0.65±.05	0.61±0.10	

Table 2. Correlation coefficient of physico-chemical parameters in the Imo River esturay.

	TEMP	TDS	COND	ALK	DO	NITRATE	SULPH	PHOSPH	SILICATE
TEMP									
TDS	.357								
	.096								
CONDUCTIVITY	.352	.870**							
	.099	.000							
DO	-.389	-.380	-.514*	-.237					
	.076	.081	.025	.197					
NITRATE	-.445*	-.252	-.017	.306	.031				
	.048	.182	.476	.133	.457				
SULPHATE	.035	.101	.126	.330	-.148	.423			
	.451	.361	.327	.115	.299	.058			
PHOSPHATE	-.353	-.047	.106	.384	-.232	.811**	.404		
	.098	.435	.353	.079	.203	.000	.068		
SILICATE	-.588*	-.456*	-.398	-.207	.428	.116	-.651**	.152	
	.011	.044	.071	.229	.056	.340	.004	.295	

* Correlation is significant at the 0.05 level (1-tailed), ** Correlation is significant at the 0.01 level (1-tailed).

CONCLUSION

Unlike other estuarine systems in the Niger Delta, the Imo river estuary is devoid of serious oil exploratory activity and its attendant pollution. As a result of reduced anthropogenic impact allochthonous input of nutrients from wet season run off, decaying organic matter from the fringing swampy vegetation and flocculation at the freshwater and brackish water interface coupled with biological activities are responsible for high nutrient concentrations. The present study was a preliminary study to provide baseline information on the physico-chemical conditions in the estuary and proffer suggestions about possible sources of nutrient enrichment. A more detailed and articulated program could be carried out in the future to correct the lapses in the present study.

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