FULL LENGTH RESEARCH ARTICLE

NUTRIENT LEVELS IN GUINEA CURRENT LARGE MARINE ECOSYSTEM (GC – LME) WATERS

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ABSTRACT
As part of the UNIDO/GEF/GCLME capacity development programme in the GC-LME countries, water and sediment samples were collected at some stations off Lagos Bar and off the Niger Delta. The nutrient levels were determined spectrophotometrically after appropriate color development following standard methods. Phosphate levels were relatively higher in the sediments. Phosphate and Nitrate levels in the water samples were higher than natural background levels. However, the phosphate and Nitrate levels obtained were similar to those obtained in previous studies on selected wetlands in Ghana. Nitrate levels were relatively higher in water samples while nitrite levels were generally lower than Nitrate levels.

Keywords: nutrients, GC-LME – Guinea Current Large Marine Ecosystem, gulf of guinea, nitrate, nitrite, silicate, available phosphate, human activities, land-based pollution, marine pollution.

INTRODUCTION
Sustainable patterns of human activity in coastal areas are very crucial (WHO 1997). Nutrients inputs to coastal, marine and freshwater ecosystems around the world have increased markedly during the past century due to increasing human activities (Galloway 1995).

The nutrient pollution of marine waters is however primarily that of nearshore waters due to land-based inputs (Conkright *et al*. 1999). Most of the pollution load of the oceans, including municipal, industrial and agricultural wastes and run-off, as well as atmospheric deposition, originate from land-based activities and affects the marine environment's most productive areas (WHO 1997). The resultant risks to marine life and human health have been identified as sewage, persistent organic pollutants, radioactive substances, heavy metals, oils (hydrocarbons), nutrients, sediment mobilization and litter (UNEP 1995).

Seawater is a dilute solution of several salts derived from weathering and erosion of continental rocks (Shykind *et al.* 2007). The major nutrients, although not abundant in comparison with the major ions, are extremely important in the biological productivity of the sea. Nutrients such as nitrate and phosphate are naturally present in seawater and are essential for growth of phytoplankton and other algae which form the base of the ocean food chain (Luke & William 2003).

Nitrates, Nitrites, Phosphates and Silicates are important nutrients required along with essential minor elements for optimal productivity in the marine ecosystem. Apart from their natural levels in marine waters, they also gain ingress into the marine environment through direct or indirect inputs from storm waters, domestic and agricultural effluents, and their levels could serve as pollution indicators.

Trace metals are of specific importance for certain organisms, but carbon, nitrogen, phosphorus, and oxygen are almost universally important to marine life (Shykind *et al*. 2007). Carbon is found mainly as bicarbonate, nitrogen as nitrate, and phosphorus as phosphate.

The objective of this study was to measure nutrient (phosphate, nitrate, nitrite, and silicate) levels in the Gulf of Guinea as part of the UNIDO/GEF/GCLME capacity development programme in the GC-LME countries

MATERIALS AND METHODS
The locations of the sampling sites are shown in Fig. 1. Stations 1 to 7 are off Lagos bar while stations 8 to 15 are located off the Niger Delta.

Sample collection and preparation: Samples were collected at various sites from a depth of about 10 cm below the water surface. Each sample was collected in an acid-cleaned polypropylene bottle, which was rinsed three times with the sample solution prior to collection. Filtering (Whatman GF/C, 1.2 mm pore size filters) of the samples was immediately carried out to remove any large particles, plankton and bacteria. Poisoning with mercuric chloride (1 drop saturated solution per 100 mL of sample) was also used to further aid in the preservation of the samples.

During transport back to the laboratory the samples were kept in an ice cooler and upon arrival they were refrigerated at 4 °C and analysed within 1 week.

Determination of phosphates in water samples: Ammonium molybdate and antimony Potassium Tartrate, in an acidic medium were added to filtered samples (APHA 1981). The phosphate present formed Antimony-phospho–molybdate complex. This complex was reduced to an intensely blue-coloured complex by adding Ascorbic acid. The colour is proportional to the phosphate concentration. Only orthophosphate forms blue colour in the determination. Blank and standards were incorporated, and specified required time of 25min (minimum) was allowed for proper colour development. Measurements were taken spectrophotometrically at 880nm.

Determination of nitrate-nitrite in water samples: Nitrate was reduced to nitrite by cadmium reduction (APHA 1981). The nitrite (originally present plus reduced nitrate) was determined by diazotizing

FIG 1. MAP OF GULF OF GUINEA SHOWING THE SAMPLE COLLECTION REGIONS FROM LAGOS BAR TO THE NIGER DELTA.

with sulphanilamide and coupling with N-(1-naphthyl)–ethylenediamine dihydrochloride to form a highly coloured azo dye which was measured spectrophotometrically. Separate, rather than combined nitrate-nitrite values were obtained by carrying out the procedure first with, and then without the initial cadmium reduction step. The difference gives the actual values for the nitrates present. Blank and standards were incorporated. Measurements were taken spectrophotometrically at 520nm.

Determination of silicate in water samples: Silicate and Phosphate in the sample react with molybdate ion under acidic conditions to form yellow Silicomolybdic acid and Phosphomolybdic acid complexes respectively (APHA 1981). Citric acid was added to destroy the Phosphate complexes. Silicate was then determined by measuring the remaining yellow colour at 812nm. Blank and standards were incorporated.

Extraction and determination of nutrients in sediment samples: Extraction of sediment samples was carried out by weighing 2.5g of air-dried sample into an extraction flask. This was followed by the addition of respective extraction solution.

Available Phosphate 25ml of Bray P-1 extraction solution (0.025N HCl & 0.03N NH_4F) was added and shaken immediately for 15 mins and filtered (Bray & Kurtz 1945). Extracts from the extraction process was then determined for nutrient using the respective spectrophotometric determination as for phosphate in water samples.

Nitrate – Nitrite 25ml of 1M KCl was added and shaken for 30mins. The sample was then filtered through Whatman No. 42 filter paper (USDA 2004). The extract was then taken through the same process as for nitrate – nitrite determination in water sample.

Silicate Aqueous extraction (USDA 2004) was carried out for silicate extraction. A 2.5g air-dried sediment sample of <2mm was shaken for 30min in 25ml of reversed osmosis deionised water. The sample was then centrifuged until solution is free of sediment mineral particles, and then filtered until clear extract was obtained. The extract was then taken through the same process as for silicate determination in water sample.

RESULTS

The nutrient results for water and sediment samples collected at 15 different locations are as presented in Tables 1 and 2 respectively. The distribution pattern of these nutrients along the sample locations are as charted in Figs 2 and 3.

DISCUSSION

The mean values in ppm for Phosphate (0.027 – 1.027), Nitrate (0.279 – 5.024), Nitrite (0.008 – 0.152), and Silicate (1.10 – 4.24) in the Gulf of Guinea waters were found to be 0.302, 2.067, 0.065, and 2.189 respectively. The nutrient results for sediment samples collected at 15 different locations are as presented in Table 2 with a mean values in ppm 1.970, 0.654, 0.027, and 13.933 respectively.

The values recorded for phosphate were found to be higher in sediment samples than in water. This may be due to the relative insolubility of phosphate in water, and also its high depositional tendency. The mean value for phosphate in the seawater samples (0.302ppm) was found to be higher than the value expected in natural marine water (0.01ppm) (Chika 2002). Also, phosphate values from selected wetlands in Ghana (Chika 2002) established some similarities with the phosphate values from this work.

TABLE 1. RESULTS OF NUTRIENTS LEVEL IN GULF OF GUINEA WATERS

Locations/ Coordinates		Nutrients (ppm)			
		Phosphate	Nitrate	Nitrite	Silicate
1	06^0 20.450 ^{N} 003^0 25.507 ^{E}	0.466	0.279	0.061	2.60
2	06^0 20.140 ^{N} 003^0 27.022 ^{E}	0.127	2.246	0.069	1.10
3	06^0 21.484 ^{N} 003^0 24.593 ^{E}	0.084	5.024	0.023	1.74
4	06^0 18.775 ^{N} 003^0 28.275 ^{E}	0.857	2.430	0.048	2.22
5	06^0 20.00 ^{N} 003^0 24.01 ^{E}	0.260	1.720	0.152	1.40
6	06^0 26.00 ^{N} 003^0 30.00 ^{E}	0.093	3.628	0.122	3.19
7	06^0 20.619 ^{N} 003^0 25.920 ^{E}	0.105	1.362	0.053	2.46
8	05^0 34.15 ^{N} 004^0 56.88 ^{E}	0.071	2.204	0.018	1.87
9	05^0 34.33 ^{N} 004^0 55.47 ^{E}	0.136	0.360	0.078	2.14
10	05^0 35.92 ^{N} 004^0 56.86 ^{E}	0.366	1.460	0.026	1.90
11	05^0 35.12 ^{N} 004^0 55.48 ^{E}	1.027	3.636	0.108	1.67
12	05^0 35. 47 ^{N} 004^0 56.18 ^{E}	0.510	0.852	0.008	4.24
13	05^0 34.27 ^{N} 004^0 55.86 ^{E}	0.048	1.128	0.034	3.22
14	05^0 34.57 ^{N} 004^0 57.70 ^{E}	0.324	3.096	0.142	1.44
15	05^0 33.89 ^{N} 004^0 56.55 ^{E}	0.058	1.574	0.026	1.65

TABLE 2. RESULTS OF NUTRIENTS LEVEL IN GULF OF GUINEA SEDIMENT

Locations/Coordinates		Nutrients (ppm)			
		Phosphate	Nitrate	Nitrite	Silicate
1	06^0 20.450 ^{N} 003^0 25.507 ^{E}	1.139	0.504	0.026	16.45
2	06^0 20.140 ^{N} 003^0 27.022 ^{E}	2.545	0.320	0.037	14.36
3	06^0 21.484 ^{N} 003^0 24.593 ^{E}	1.840	0.716	0.012	8.14
4	06^0 18.775 ^{N} 003^0 28.275 ^{E}	3.381	0.144	0.028	15.72
5	06^0 20.00 ^{N} 003^0 24.01 ^{E}	2.015	0.310	0.018	20.69
6	06^0 26.00 ^{N} 003^0 30.00 ^{E}	1.610	0.426	0.048	9.21
7	06^0 20.619 ^{N} 003^0 25.920 ^{E}	1.474	0.280	0.006	11.08
8	05^0 34.15 ^{N} 004^0 56.88 ^{E}	2.017	1.241	0.073	18.77
9	05^0 34.33 ^{N} 004^0 55.47 ^{E}	1.583	0.730	0.015	10.28
10	05^0 35.92 ^{N} 004^0 56.86 ^{E}	1.644	0.326	0.008	13.37
11	05^0 35.12 ^{N} 004^0 55.48 ^{E}	3.580	0.412	0.021	8.49
12	05^0 35. 47 ^{N} 004^0 56.18 ^{E}	1.243	1.269	0.034	12.65
13	05^0 34.27 ^{N} 004^0 55.86 ^{E}	0.976	1.492	0.013	16.96
14	05^0 34.57 ^{N} 004^0 57.70 ^{E}	1.948	0.875	0.062	20.42
15	05^0 33.89 ^{N} 004^0 56.55 ^{E}	2.562	0.761	0.009	12.41

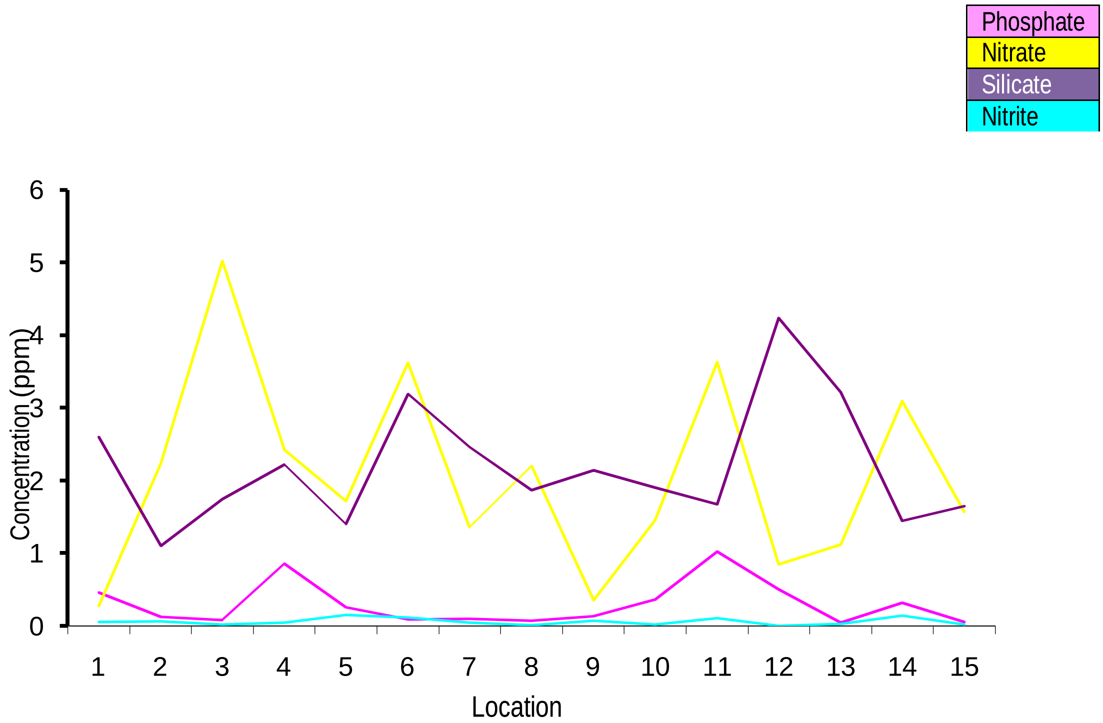

FIG. 2. DISTRIBUTION PATTERN OF NUTRIENTS IN WATER ALONG THE SAMPLE LOCATIONS

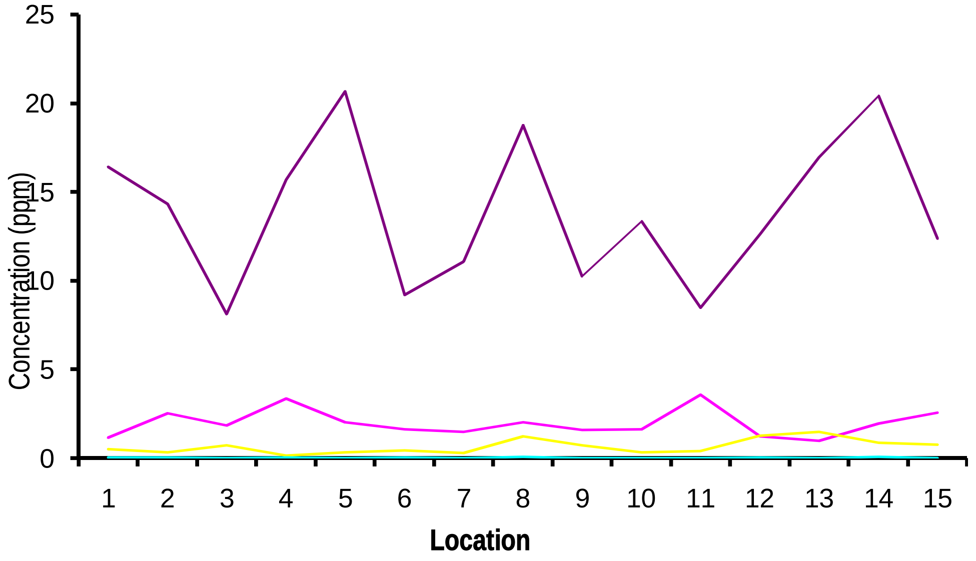

FIG. 3. DISTRIBUTION PATTERN OF NUTRIENTS IN SEDIMENT ALONG THE SAMPLE LOCATIONS

Due to the solubility of nitrate in water, values recorded for nitrate, were found to be higher in water than in sediment samples (Figs. 2 & 3).

Nitrite concentrations were found to be generally much lower than nitrate in both water and sediment (Figs. 2 & 3). The mean value for nitrates in the seawater samples (2.067ppm) was found to be higher than the value expected in natural marine water (0.25ppm) (Chika 2002). Nitrate values from selected wetlands in Ghana also establish some degree of conformity with the values arrived at in this work.

In many lakes, including the sea, the process of eutrophication gets speeded up by human activities. In Nigeria, the ever growing population size has forced a large number of the citizenry to reside in the coastal region, thereby increasing the nutrient influxes from human activities. Many industries are now siting their plants close to harbors for easy access to imported raw materials. All these activities along the coastline introduce both solid and liquid wastes that would increase the nutrient levels in the marine ecosystem. It is therefore evident that the slightly increased levels of nutrients observed in this study could be as a result of increased coastal activities in the GCLME regions.

There is need for periodic sample collection and analyses of both water and sediment samples from the gulf of guinea to monitor the levels of nutrients, and to compare these levels with standards for natural marine ecosystem. Also, Best Management Practices (BMPs) of all the activities along the coastline that translate to reduced nutrient influxes must be ensured. These are obligations to be shouldered by all the GCLME countries.

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