INVESTIGATION OF POLLUTANTS IN APAPA WATERS, LAGOS, NIGERIA

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Abstract: Water quality assessment of Apapa waters, at the specified sites of Lagos lagoon susceptible to high level of pollution in the Apapa jetty, Apapa dockyard and Daddo terminals of the Lagos Lagoon was conducted. Water samples were analyzed for different physical and chemical parameters; pH, alkalinity, acidity, conductivity, turbidity, biological oxygen demand (BOD), chemical oxygen demand (COD) and dissolved oxygen (DO), total hardness (TH), major cations and anions, and some heavy metals using standard methods and procedures. The ranges of these parameters were found to be comparable to those reported by Lagos state environmental protection agency (LASEPA) and World Health Organization (WHO) except for TSS, TDS, TS, chloride, nitrogen, sulphate, phosphate, manganese and nickel which were found in higher concentrations above LASEPA limits. Results showed that the Shores of the Lagos lagoon at Apapa dockyard and Daddo terminal become progressively polluted by the waste materials discharged along its course due to large volume of port and industrial activities. The Lagoon is currently facing various environmental and ecological challenges at these locations. It is recommended that aggressive enlightenment campaigns should be organized for the residents of Apapa community. There should also be a strict enforcement of relevant laws concerning the abuse of water bodies for sustainable development.

Keywords: Alkalinity, biological oxygen demand, conductivity, physicochemical, pollution, heavy metals

Introduction

The large volume of port activities in a nation is a mark of its industrialization. Lagos, the commercial center of Nigeria is enriched with port facilities which include the Apapa-wharf with a dockyard where shipping activities take place. Pollutants of both natural and anthropogenic origin constantly influence the harbor (Majolagbe & Bamgbose, 2007).

Uncontrolled discharge of untreated wastewater, sewage, sediment, wood waste, refined oil, waste heat, municipal and industrial effluents into the lagoon has degraded the quality of surface water beyond the acceptable limits (Onyema, 2007; Chukwu & Nwankwo, 2004; Kennish & Paerl, 2010). Dockyard, a restricted area with low circulation of sediment is thus a good location where sediment associated pollutants accumulate (Majolagbe & Bamgbose, 2007). Sediment had been used in many studies to evaluate the safety and quality status of aquatic environment (Claudia *et al.*, 2004; Alman, 2006; Ololade, 2008).

Umo & Nitonye (2015) identified marine pollutants which include oily water discharge from tanker accidents, accidental oil discharge during routine operations, wastewater, garbage and solid

Verma & Singh (2013) showed that as the temperature increase, the BOD and COD increases because lesser amount of oxygen remains dissolved in the sample. Eruola *et al.* (2011) reported that decrease in DO resulted in increase in BOD, COD and total suspended solids in Ikopoba river. Akpata *et al*. (1993) reported that high total suspended solid, high biochemical oxygen demand, low dissolved oxygen content and heavy microbial load are evident at organically polluted sites in the Lagos Lagoon.

Trace metals accumulation in the upper sediment had been found to be toxic resulting in decreased survival, reduced growth, or impaired reproduction, and lower species diversity of the sediment-dwelling organisms and fish (Baptista *et al.*, 2000; Okafor & Opuene, 2007; Parizanganeh *et al.*, 2007; Praveena *et al.*, 2007; Sardans, 2011; Vallilus, 2003).

This study is aimed at assessing the various pollutants in the Lagos Lagoon sites along Apapa jetty, Apapa dockyard and Daddo terminals. The results will form the baseline for designing pollution control strategies.

Materials and Methods

Study area

The Apapa water was located at Lagos Apapa Wharf; coordinates6°26'43" N, 3°25'34" E).

The location is the Nigerian port harbor; bodies of water where ships are anchored temporarily while being loaded or discharged of their cargoes. Ships scheduled for cargo handling operations can be at anchor for more than 24 h and seven working days in a week. This activity duration is considered sufficient time within which ship generated waste water discharges can occur.

Three sampling points; Apapa Jetty, Apapa dockyard and Daddo Terminal were randomly selected from the study area.

Sample collection

Six water samples; two from each sampling point were collected with sterile 75 cm screwed top plastic bottles. These were stored at a temperature of 4°C. To avoid staleness of samples, the pollution indicator parameters were determined within six hours of sample collection.

Laboratory analysis

The Standard Methods for Examination of Water and Waste Water was adapted (APHA, 2005).

Determination of the physical parameters

Hydrogen Ion concentration (pH)

The pH was measured with a HI3220 pH meter.

Temperature

This was determined by means of a mercury thermometer calibrated in 0.2°C units from 0 to100°C.

Turbidity

Turbidities of collected samples were measured using a Hannah HI3220 multi-parameter water quality meter.

Conductivity/TDS

Measurements were carried out by means of a HM digital Conductivity/TDS meter (APHA, 2005).

Total dissolved solids (TDS)

TDS was determined using the Horiba TDS meter and TDS is reported in mg/L (APHA, 2005).

Total suspended solids (TSS)

This was determined according to APHA (2005).

Determination of the chemical parameters

Total alkalinity, total acidity, dissolved oxygen, biological oxygen demand and total hardness were determined using standard laboratory methods Lenore *et al*. (2005).

Determination of the cations and anions

Concentrations of calcium, magnesium, chloride, nitrate, sulphate, phosphate and phosphorous were determined using Atomic Absorption Spectrophotometer (APHA, 2005).

Heavy metals

The concentrations in mg/L of heavy metals in the collected samples were determined (after nitric acid digestion) by means of an Atomic Absorption Spectrophotometer (APHA, 2005).

Statistical analysis

The data were analyzed using two way analysis of variance. Further analysis was carried out using Pearson's Correlation Coefficient at 5% level of significance ($P < 0.05$).

Results and Discussion

Figure 1 showed the variations in hydrogen ion concentrations along the APAPA water at the selected sampling points. Water from the Apapa jetty was slightly basic (7.2), those from Apapa dockyard neutral (7.0) while those from Daddo terminal slightly acidic (6.95). There is however no significant difference between the pH values at the various sampling points. This is in agreement with the requirement for pH in accordance to Lagos state environmental protection agency (LASEPA) that pH should be between 6.5 and 8.8 (Table 1). Water from the sampling points had normal temperature in line with the LASEPA standard (Table 1). However, turbidity was slightly high at the Daddo terminal and Apapa jetty axis. This is probably as a result of sailing activities around the area.

Figure 2 showed the variations in the TSS, TDS and Total solid. APAPA jetty had the highest value of TSS (18480 mg/L), followed by Apapa dockyard (Fig. 2). The mean TSS values at all the sampling points were higher than the permissible limit specified by LASEPA for drinking warer (25.00 mg/L, Table 1). Apapa dockyard had the highest mean value of TDS (21050 mg/L), followed by Daddo terminal Fig. 2). There are significant differences between the mean TDS values at Apapa dockyard and those at the other sampling points ($P < 0.05$). The mean TDS values of all the sampling points were extremely high values compared with the LASEPA permissible range, (500.00 mg/L, Table 1).

Figures 3a-c showed the mean concentrations of chloride, nitrate, Sulphate, phosphate and phosphorus. The mean concentrations of chloride and nitrate were very high at all sampling points compared with the LASEPA standard (Table 1). The mean Chloride ion concentration was highest at APAPA dockyard (51428.5 mg/L) and slightly varies in distribution with the lowest observed at APAPA jetty (500 mg/L, Fig. 3a). The high levels of Chloride and Sulphate recorded in this study (Figs. 3a and 3b) were suggestive of organic pollution and nutrient enrichment. There are significant differences in the mean concentrations of chloride and sulphate at the various sampling points ($P < 0.05$).

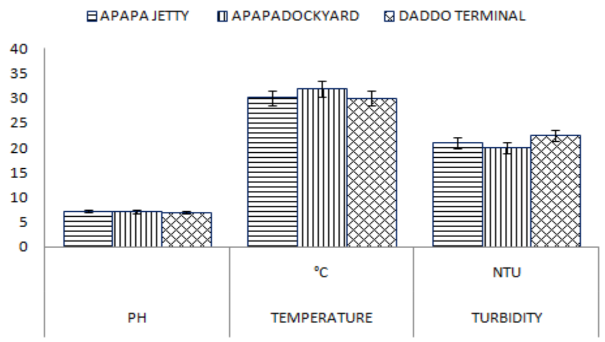

Fig. 1: Distribution of PH, temperature and turbidity at the three sampling points

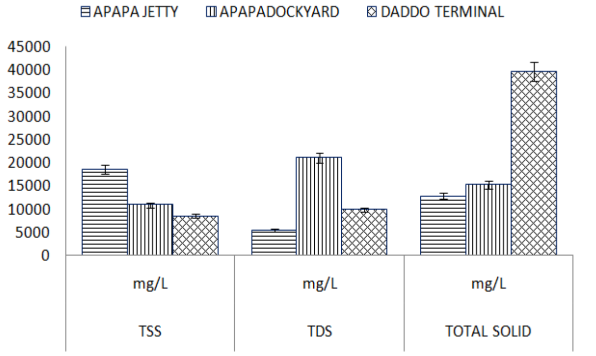

Fig. 2: Distribution of total suspended solid, total dissolved solid and total solid at the three sampling points

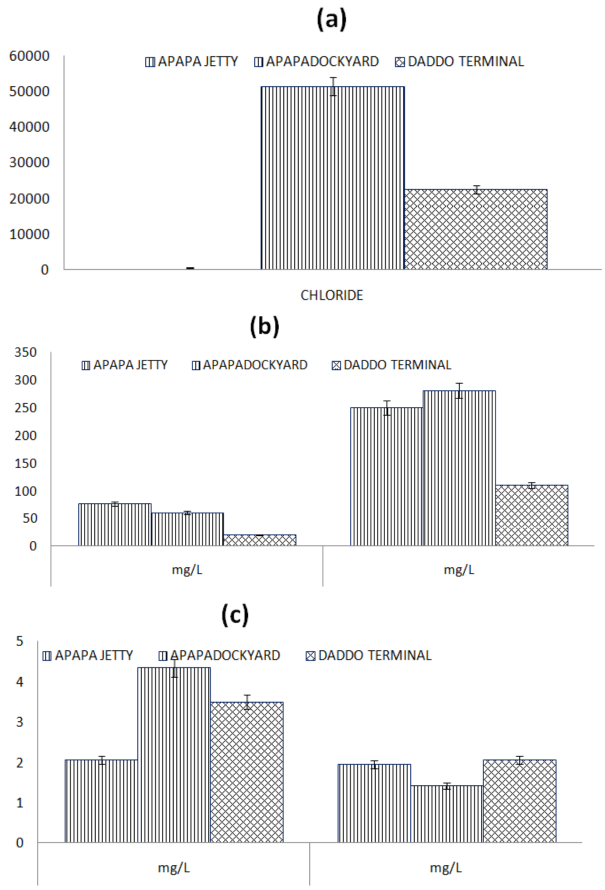

Fig. 3a-c: distribution of chloride, nitrate, phosphate, sulphate and total phosphorus of the three sampling points

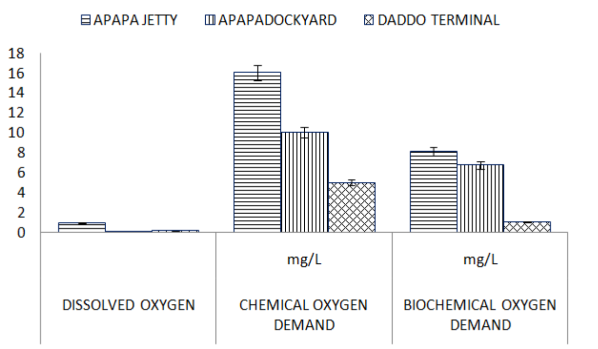

Fig. 4: Distribution of demand oxygen, chemical demand oxygen and biochemical demand of the three sampling points

Figure 4 showed the variations in the mean DO, BOD and COD of water samples from various sampling points. It is observed that Lagos Lagoon at the sampling points had similar distribution pattern of DO, BOD and COD which is in agreement with LASEPA standard (Table 1). This is thus suitable for any freshwater fauna and flora and for recreation purposes. The moderate BOD and low dissolved oxygen (Fig. 4) recorded is probably due to bacterial degradation of the organic load mainly from biodegradable wastes which drain into the river.

The high levels of turbidity, total suspended solids and low dissolved oxygen content recorded at the sampling points (Figs. 1, 2 and 4) during the study period was an indication of the deteriorating water quality and probably resulted from the discharges of industrial and domestic wastes into the lagoon. This is in line with the findings of Akpata *et al*. (1993) that high total suspended solid, high biochemical oxygen demand, low dissolved oxygen content and heavy microbial load are evident at organically polluted sites in the Lagos Lagoon.

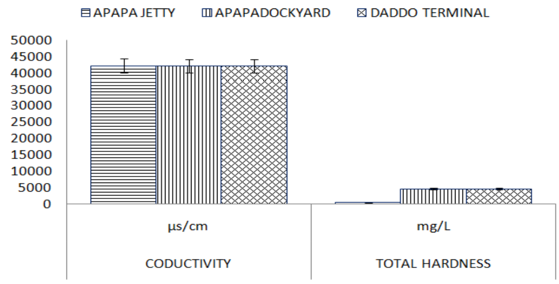

Fig. 5: Distribution chart of total hardness and conductivity

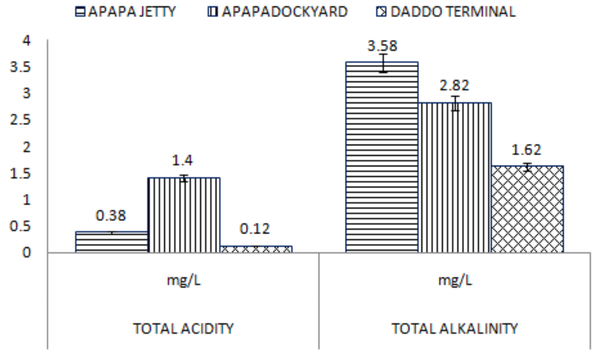

Fig. 6: Distribution of acidity and alkalinity at the three sampling points

Figure 5 showed the variations in the mean conductivity and hardness of water samples from various sampling points. The mean values of conductivity were very high at all sampling points (Fig. 5). The high value of conductivity recorded at Apapa dockyard (42000 µs/cm) was probably due to the presence of higher concentration of most cations (Chloride, Phosphate and Sulphate/Zinc, Manganese, Lead, Cadium and Nickel) and might be responsible for the hardness of the water. The water from Apapa Dockyard and Daddo terminals with high total hardness are not desirable for potable water because they would form scales on water heaters and utensils when used for cooking and consume more soap when used for washing clothes.

Figure 6 showed the variations in the mean total acidity and alkalinity of water samples from various sampling points. Apapa Dockyard recorded the highest mean total acidity (1.4 mg/L) while Apapa jetty recorded the highest mean total alkalinity (3.58 mg/L). The Higher value of the total alkalinity the three sampling points (Fig. 6) is probably due to the release of bicarbonate ions by the sediments. There is no significant difference between the mean total alkalinity at the three sampling points while there are significant differences between the mean total acidity of water from Apapa dockyard and those from the other two sampling points ($P < 0.05$).

Table 1: Descriptive statistics and comparison of the physicochemical parameters

Parameters	Units	Apapa jetty	Apapa dockyard	Dadda terminal	Mean	STD Mean	LASEPA standard
pH		7.21	7	6.95	7.05	0.14	6.5-8.8
Temprture	°C	30.1	32	30	30.70	1.13	40.00
Conductivity	µ/cm	42100	42000	42000	42033.33	57.74	-
Turbidity	NTU	21	20	22.5	21.17	1.26	-
Total hardness	mg/L	469.37	4693.12	4700.1	3287.53	2440.60	-
TSS	mg/L	18480	10900	8500	12626.67	5209.24	25.00
TDS	mg/L	5500	21050	9880	12143.33	8018..27	500.00
Total solid	mg/L	12800	15200	39530	22510.00	14788.52	52500
Total acidity	mg/L	0.38	1.4	0.12	0.63	0.68	NS
Total alkalanity	mg/L	3.58	2.82	1.62	2.67	0.99	150.00
Chloeride	mg/L	500	51428.5	22482.1	24803.53	2554349	250.00
Nitrade	mg/L	77.2	60.05	20.08	52.44	29.31	10.00
Phosphate	mg/L	2.05	4.34	3.5	3.30	1.16	2.00
Sulphate	mg/L	250.1	281.2	110.12	213.81	91.13	250.00
Total phosph0rus	mg/L	1.95	1.42	2.05	1.81	0.34	2.00
Dissolved oxygen	mg/L	0.95	0.1	0.2	0.42	0.46	Less Than 2
Chemical oxygen demand	mg/L	16	10.05	502	10.36	5..50	60.00
Biochemical oxygen demand	mg/L	8.14	6.75	1.1	5.33	3.73	30.00
Zinc	mg/L	1.68	3.34	1.5	2.17	1.01	2.00
Copper	mg/L	0.05	0.01	0.09	0.05	0.04	0.50
Iron	mg/L	5.52	3.02	0.18	2.91	2.67	10.00
Manganese	mg/L	0.02	0.76	0.4	2.39	0.37	0.20
Lead	mg/L	0.02	8.62	0.05	2.90	4.96	0.50
Cadnium	mg/L	0.04	2.09	0.06	0.73	1.18	1.00
Nickel	mg/L	008	0.61	0.55	0.41	0.29	0.01

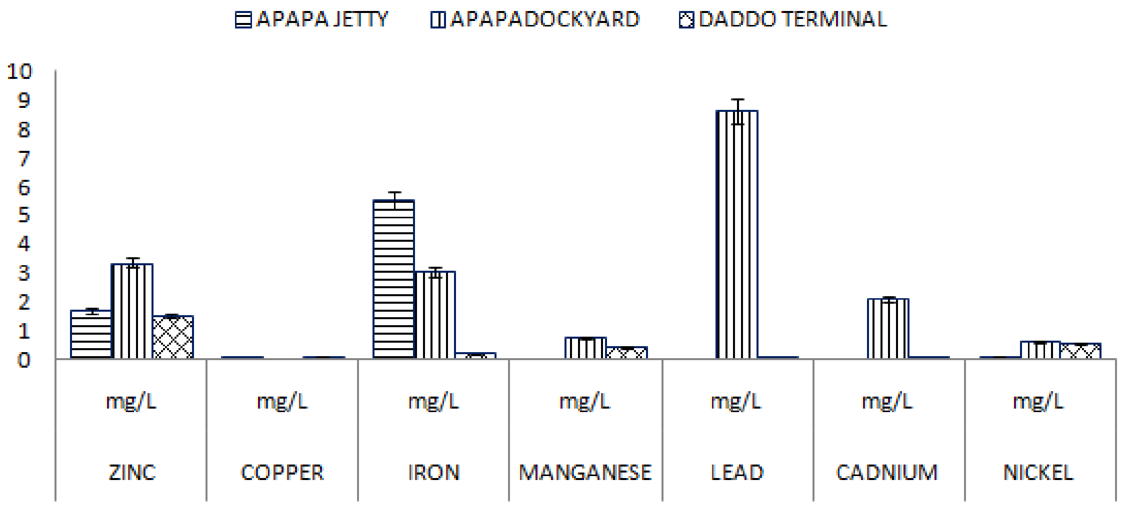

Fig. 7: Distribution chart of zinc, copper, manganese iron, lead cadmium and nickel of the three sampling points

Figure 7 showed the variations in the mean concentrations metals in water sampled from different sampling points. The concentration Zinc was found to be high (3.34 mg/L) in samples from Apapa dockyard against the permissible limit given by LASEPA (2.00 mg/L, Table 1). This high mean concentration of Zinc is probably due to the use of Zinc nodules, an important material in cathodic protection of ships and coats employed in various painting activities in the shipyard. The mean concentration of Lead was also found to be highest (8.62 mg/L) in the dockyard samples quite above the permissible limit specified by LASEPA (0.05 mg/L, Table 1). This can be attributed to the petroleum products, some geological formation and anthropogenic sources in the neighbouring communities.

The highest mean concentration of cadmium (2.09 µg/g) in samples from Apapa dockyard is higher than the LASEPA quality guideline of 1.0 µg/g (Table 1). This is probably due to the geological formation, ship-building and repair activities in the dockyard, effluent discharge from the neighbouring industrial area and top soil run off from the coastal communities in the surrounding and other remote areas. The mean concentration of cadmium was lowest at Daddo terminal probably due to the economic activities area such as fishing and local sand dredging in the eastern part of the dockyard leading to Igbologun riverside. There are significant differences between the mean concentrations of Zinc, Lead and Cadium from samples from Apapa dockyard and those from the other two sampling points.

Conclusion

In conclusion, The impact of direct discharges of industrial and domestic wastes, enrichment of surrounding wetlands and subsequent run-offs associated with rainfall ushered in low dissolved oxygen, higher total solids, reduced transparency, and consequently affected the water quality. It is an incontrovertible fact that marine pollution tremendously impacts adversely on our coastal resources in more ways than we can readily comprehend. Cloudness of water caused by particles which is related to the content of diseases causing organism in water as a result of runoff from soil, meanwhile the return of industrial water to the river (the phenomenon of thermal pollution), causes hypoxia or anoxic environment. Whereas marine pollution is something we cannot avoid having a large effect on aquatic ecosystem in a world with a rapidly growing population and technological concerns that generate hazardous pollutants, its effect can be minimized if carefully managed.

Recommendations

In other to achieve this, the following recommendations are suggested to curb the effects of marine pollution in the Nigerian coastal waters;

i. Sustained enlightenment campaign/advocacy on safer attitudes towards reducing pollution of our marine environment
ii. Training of relevant stake holders including coastal communities on modern day global practices that reduce marine pollution in all its ramifications.
iii. Economic empowerment of coastal communities to provide alternative sources of income in places where their existing vocations are perceived to contribute to marine pollution.
iv. Active collaboration with international agencies in solving localized marine pollution problems such as abandoned lost or other fishing gears (ALDFG's) challenge for example
v. Setting up a standing local scientific committee to develop the scope and guidelines/timeline for which all companies operating in Nigerian coastal waters can use as a working document/road map in combating the challenges of marine pollution.
vi. Development of relevant legislations and its implementation and enforcement.

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Conflict of Interest

Authors declare that there are no conflicts of interest.

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