

Environmental Impacts of Sand Dredging in Awoyaya, Lagos State, Nigeria

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Abstract

The research analysed the environmental impacts of sand dredging in Awoyaya, Lagos State. Water and soil samples were collected from three different locations in the study area. The results of water analysis reveals that average pH of water is 6.16, the average temperature of water is 27.55°C, the average chloride of water is 0.11mg/l, the average turbidity of water is 118ppm, the average sulphate of water is 45.67ppm, the average total dissolve solid in water is 98.3mg/l, the average total suspended solid in water is 114.1mg/l, the average total solid of water is 213ppm, the average iron present in water is 0.07ppm, and the average Zinc present in water is 0.015ppm. The results of the physiochemical and geochemical parameters of soil show that the average pH of soil is 7.78, the average organic carbon, organic matter, nitrogen and phosphorous of soil are 0.42%, 0.72%, 0.05%, and 10.73% respectively and the average values of SiO₂, TiO₂, Al₂O₃, Fe₂O₃, MgO, CaO, Na₂O, K₂O present in the soil are 80.97%, 1.64%, 1.33%, 1.55%, 1.00%, 0.20%, 0.21%, 0.15 respectively. The analysis carried out shows that the dredging in Awoyaya has little impact on water and soil in the dredging area.

Keywords: Environmental impact, Turbidity, Temperature, Organic Carbon, Organic Matter, Total dissolved solid, total solid, total suspended solid.

1. Introduction

Mining Industries and Mining practice in particular, are vastly known for their hazardous working conditions and the unstable nature of the earth-crust which mineral extraction causes thereby threatening the life and properties of the society (Abubaker *et al.*, 2011). A lot of waste materials are been deposited at the mining sites which consequently pollute the environment and also the underground and the surface water of the surrounding. Solid minerals and their products have served the need of humanity from immemorial and will continue to do so perpetually (Okonkwo, 1998). According to Okonkwo (1998), solid minerals exploration and exploitation are related integrally with the environment. They disturb landscape, soil, surface water, underground water and air. Minerals and their products are essential, and so also is a clean environment.

There arises the need to set standards in the degree of disturbance to the environment. Any attempt to maintain a 'zero' disturbances as a standard would result in 'zero' exploration activities, mining and processing, with 'zero' availability of minerals and their products to the industry. Standard that should be set must, therefore, be such that will create a reasonable compromise between these activities and the environment. Disturbance arising from dredging operations should be controlled to the barest minimum during the operations and adequately normalized thereafter (Abubaker *et al.*, 2011).

Sea sand has become a very important mineral for the expansion of the society in terms of size. In many cases, the reasoning behind doing a dredge of an area is to keep the sediment from building up. In some waterways, for example, if too much sediment builds up, larger ships may not be able to use the waterway. In this same way, dredging can also be used to increase a channel's or river's water capacity to help relieve flooding in some areas. There are some other reasons for dredging. Dredged up sediment and sand from the bottom of the ocean can be deposited on the beach to help rebuild the lost sand. Sand gained from dredging can also be used in land reclamation projects and other construction projects. The dredging activity pollutes the environment and the water source of the area, thereby endangering the life people and aquatic animal in the area. Most studies conducted on the effect of mining in Nigeria shows that the landscape is continually being destroyed by mining activities by creating tunnels and excavating the soils (Robert, 1998). In this study, the environmental impacts of dredging activities in Awoyaya, Lagos State is considered.

2. Materials and Methods

2.1 Sample Collection

Soil samples were taken from the stockpiling area from three different locations. The soil samples were carefully collected and sealed in polythene bags to preserve the moisture content which were then transported to the laboratory for analysis. Water samples were also collected at three different locations on the lagoon; sample A was taken at the sea shore, Sample B was taken at 10m from the sea shore and sample C was taken at the point of dredging.

2.2 Sample Preparation

After the soil samples have been collected from the dredging sites, they were taken to the laboratory for soil analysis. The samples were air dried and were sieved to reduce the size to 20mm. The samples were later weighed and stored in a cool dry environment to allow the soil samples to be accurately analysed. Also the water samples were stored in a cool environment for accurate analysis.

2.3 Soil Analysis

2.3.1 Determination of Soil Organic Matter

The Walkley and Black (1934) procedure for measuring decomposable organic matter in the soil was adopted. In this analysis, soil samples were grounded into fine powder and 1g of each of the samples was weighed in duplicate and transferred to the 250ml conical flask each. 10ml $K_2Cr_2O_7$ was later added to each. 20ml concentrated H_2SO_4 was added to each rapidly and the soil immediately swirled the flask gently until the soil and the reagent were mixed, then swirled vigorously for one minute. The flasks were later rotated again and allowed to stand on a sheet of asbestos for about 30mins. After standing for 30mins, 100ml of distilled water was added to each. 3 to 4 drops of ferroin indicator was added to each and titrated with 0.5M Iron (II) ammonium sulphate. At this point, the ferrous sulphate was added to each drop by drop until the colour change rapidly from green to brownish red. A blank titration was made but without soil. The reaction was $K_2Cr_2O_7$ oxidizing and the excess $K_2Cr_2O_7$ is titrated with the Iron (II) solution. The percentage of matter of the carbon in the organic matter can be gotten using Equation 1.

$$\% \text{ soil organic carbon} = \frac{(Me.K_2CrO_7 - MeFeSO_4) \times 0.003 \times 100 \times F}{\text{Weight of air-dried soil sample}} \quad (1)$$

where, $Me.K_2CrO_7$ is Titre value, Me is Milli - equivalent (used for normality), $MeFeSO_4$ is Titre value of sodium solution, and F is Correction factor.

2.3.2 Nitrogen Determination

The soil samples were grounded to pass through 0.5 sieve and 0.5g weighed out into a dry 500ml Macro Kjeldahl flask, 20ml of distilled water was added to each and then swirled for a few minutes before allowing them to stand for 30minutes, one tablet of mercury catalyst and 10g of K_2SO_4 were added to each of the samples, followed by 30ml of concentrated H_2SO_4 , heat was applied at a low temperature on the digestion stand until water was removed from each of the samples and nothing ceased. The heat was then increased until digest cleared after which the mixtures were boiled for 5hours.

The digests were cooled and 100ml of distilled water was added to them and then transferred into a bigger (750ml) macro Kjeldahl flask with the sand particles retained in the original digestion flask. The sand residues were then washed with 50ml of distilled water four times and the aliquot transferred to the 750ml flask on each occasion.

50ml of H_3BO_3 indicator solution was measured into 500ml Erlenmeyer flask and placed under the condenser of the distillation apparatus for each of the samples. The 750ml Kjeldahl flask was then attached to the distillation apparatus and 150ml of 10N NaOH poured through the distillation flask by opening the funnel stopcocks. Distillation was then commenced and 150ml of distillate collected for each of the samples. The ammonium nitrogen in the distillates was determined for each of the tested samples by titrating with 0.01N standard HCl with the endpoints being indicated by a colour change from green to pink.

2.3.3 Determination of Phosphorous

The two most widely used methods for the total P extraction in soil are digestion with $HClO_4$ and fusion with Na_2CO_3 . For this research work, $HClO_4$ digestion was used followed by the colorimetric determination.

2g of finely grounded soil was weighed into 25ml conical flask. 30ml of HClO_4 was added. It was digested on a hot plate in a fume cupboard at 130°C until the solution appeared clear. The temperature was increased when necessary. When digestion was completed, white fume of HClO_4 appeared and soil residue became white. It was not heated to dryness to avoid explosion. HClO_4 was added when necessary. The flask was removed and cooled to room temperature. 50ml of distilled water was added and filtered into and 100ml standard flask and the volume was made up to 100ml mark P concentration was determined calorimetrically.

2.3.4 Determination of Soil pH

In the principle of a pH meter, the glass indicator was connected to the amplifier input while the reference electrode was connected to the amplifier output. The electrical part was completed when both electrode were immersed in the test solution which acted as an electrical cell thereby generating a cell potential, E cell.

10g of 2mm sieve air dried soil sample was weighed into 100ml beaker. 20ml of distilled water was added to it. The suspension was stirred several times over a 30minute interval with a glass rod. The pH of the soil in the beaker was measured.

2.3.5 Exchangeable Cations

Exchangeable Ca, K, Na and Mg in the soil sample were determined. 5g of air dried soil which had been through a 2mm sieve was transferred into a centrifugal tube. To this was added 3ml of $\text{NH}_4\text{O AC}$ and shook on a mechanical shaker for 2hrs, then centrifuged at 2000rev/min for 5min. The clear supernatant was decanted into a 100ml volumetric flask and another 30ml of $\text{NH}_4\text{O AC}$ solution was added to the residue, shook for 30min and centrifuged. The supernatant was transferred into the same volumetric flask and the steps repeated again before the flask was made up to mark with $\text{NH}_4\text{O AC}$ solution, (Ca^{2+}), K^+ were determined by atomic absorption spectrophotometer.

2.4 Water Sample Analysis

2.4.1 pH Determination

The measurement of the pH parameter was carried out with the pH meter (Digital) model Erner AMBH D404 NEUSSI having combined electrodes. The meter had been calibrated with buffer solution of pH 4.0 and pH 9.0 before samples were measured.

2.4.2 Temperature

The temperatures of sample were taken at the site of collection using thermometer.

2.4.3 Turbidity

Turbidity was determined using the turbid meter, it was first standardized to 10NTU 20ml, the meter was then switched on and the value was read.

2.4.4 Alkalinity

100ml of each water sample was put in the beaker, 2-3 drops of phenolphthalein indicator was titrated against sulphuric acid until the pink colour disappeared.

The result p- phenolphthalein alkalinity for OH was recorded. To the colourless above, 2 drops of methyl orange indicator was added. The titration continued until orange end point was recorded.

2.4.5 Total Dissolved Solids

A clean evaporating dish of suitable size was heated in an oven at 105°C for 2hrs and cooled. The dish was weighed and recorded (W_1). 1.50ml of sample was pipette into a beaker. A funnel was placed on a 25ml conical flask and a 5.5cm diameter of filter paper was folded with it and allowed to drain off the water sample. The filtrate was transferred into the evaporating dish and evaporated to dryness at 105°C in an oven for 3hrs. Then it was removed from the oven and cooled at room temperature in the desiccator and weighed (W_2).

$$\text{TDS} = \frac{\text{difference in weight (gm)} \times 10^6}{\text{ml of sample}}$$

(2)

2.4.6 Total Solids in Water

Gravimeter method was used in the determination of TS. 100ml of porcelain evaporating dish was placed in an oven for 1hr at 105°C, it was removed and placed in the desiccator to cool and then weighed. The weighed dish was placed in a water bath. Water sample was thoroughly mixed and 50ml of it transferred into the dish and the measuring flask was rinsed with small portion of distilled water. All suspended matter was transferred into the dish. After the sample was evaporated, the dish was dried and placed in the 105°C oven for 2hrs, and then it was removed from the oven, cooled in the desiccator and weighed. It was then returned to the oven for 10mins, cooled in the desiccator and reweighed. This was repeated until the weight was constant (Amoo *et al.*, 2005)

$$\text{Total solid in ppm} = \frac{\text{Difference in weight (gm)} \times 10^6}{\text{ml of sample}} \quad (3)$$

2.4.7 Total Suspended Solid

The total suspended solid (TSS) is the total solids (TS) minus the total dissolved solid (TDS).

$$\text{TSS} = \text{TS} - \text{TDS} \quad (4)$$

2.4.8 Chloride Determination

50ml of sample from bi-carbonate determination in the alkalinity was retained and 1ml of potassium chromate was added and the colour changed to yellow, this was titrated against 0.1M of AgNO₃ solutions by swirling the flask continuously until a brick-red point was obtained.

2.4.9 Heavy Metals

Heavy metals were analysed using AASK 451 Atomic absorption spectrophotometer (Amoo *et al.*, 2005). Standard solution of each metal was prepared from their corresponding salt solution using the metal salt of each element to be determined. 25ml of preserved acidified samples was measured after the instrument was switched on for stability. The light source current was turned on to 2 to 3 amperes and followed by the lightening of flame and adjusting the flow of fuel and oxidants. The blank standard and the sample for each metal were aspirated then the absorbance reading for the standard samples were recorded.

3. Result and Discussion

3.1 Result

The results of water analysis and soil analysis are written in Table 1, 2, and 3.

3.2 Discussion

From the water analysis result, the temperature of the samples A, B, C was 27.94°C, 27.4°C, and 27.3°C respectively. This shows that the dredging environment is cool and conducive for aquatic organisms. The pH from Table 1 ranges from 5.8 to 6.35 for the three samples, this shows that the water is acidic. The value of chloride ranges from 0.02 to 0.22mg/l the study is very low, chlorine gas is very toxic according to Thomas (1996) but chlorine ions are essential for life. The turbidity of the water sample ranges between 58 to 186mg/l Table 1.

From the soil analysis, the silica content of sand varies from 80.96 to 80.98% (high) as shown in Table 3. This shows that the dredged sand has a very high percentage of silica. Titanium dioxide is of a low order of toxicity, the value ranges between 1.63 to 1.65%, which implies that it has little or no effect on the environment. The toxicity of aluminium on organisms is a function of pH which is soluble at low pH and is leached from watershed soils by acidic deposition. The direct physiological effects of low pH and high aluminium include increased fish mortality, decreased growth, and decrease reproductive potential. The percentage of the aluminium oxide found in soil ranges between 1.32 to 1.34% which is low and the pH (7.78) is high implying that aluminium dioxide is not toxic to the

organism. The iron (III) oxide content of the soil from Table 3 is 1.55% which is minimal. Magnesium oxide from Table 3 is 1.00%. Magnesium oxide is low toxic and not considered to be hazardous to health. Calcium oxide from Table 3 is 0.20%, CaO is an effective agent for soil stabilization and aggregate modification as well as drying up muddy construction sites and a wide variety of alkaline chemical neutralization applications. Sodium oxide (0.21) is a compound of many foodstuffs, for instance of common salt. It is necessary for human to maintain the balance of the physical fluids system. Potassium oxide is 0.15% Table 3. It plays an important role in the physical fluid system of human and it assists nerve functions. Its presence is of great importance for soil health, plant growth and animal nutrition.

4. Conclusion

This research examined environmental impacts of sand dredging in Awoyaya, Lagos State. The research was conducted through data collection and physical observation of the study area. The results of water analysis shows that average pH is 6.16, the average temperature is 27.55°C, the average chloride is 0.11mg/l, the average turbidity is 118, the average sulphate is 45.67, the average total dissolve solid is 98.3mg/l, the average total suspended solid is 114.09 mg/l, the average total solid is 213ppm, the average iron is 0.07ppm, and the average Zinc is 0.015ppm. The results of the physiochemical and geochemical parameters of soil show that the average pH is 7.78, the average organic carbon, organic matter, nitrogen and phosphorous are 0.42%, 0.72%, 0.05%, and 10.73% respectively as shown in Table 4.3 and the average values of SiO₂, TiO₂, Al₂O₃, Fe₂O₃, MgO, CaO, Na₂O, K₂O are 80.97%, 1.64%, 1.33%, 1.55%, 1.00%, 0.20%, 0.21%, 0.15 respectively as shown in Table 3. The analysis carried out shows that the dredging in this area has little impact on water and soil in the dredging environment according to WHO.

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Table 1: Result of Water Analysis

PARAMETERS	Sample A	Sample B	Sample C
pH	6.32	5.8	6.35
Temperature	27.94°C	27.4°C	27.3°C
Chloride	0.22mg/l	0.02mg/l	0.1mg/l
Alkalinity	Nil	Nil	Nil
Turbidity	58ppm	110ppm	186ppm
Sulphate	32ppm	40ppm	65ppm
Nitrate	Nd	Nd	Nd
Acidity	50mg/l	15mg/l	10mg/l
TDS total dissolved solid	35mg/l	75mg/l	185mg/l
TSS total suspended solid	204.73mg/l	28.88mg/l	108.67mg/l
TS total solid	240ppm	105ppm	294ppm
Iron	0.08ppm	0.08ppm	0.05ppm
Zinc	0.02ppm	0.015ppm	0.01ppm

Table 2: Summary of Physiochemical Parameters of Soil

	pH in water 1:2	Organic carbon%	Organic matter%	Nitrogen%	Phosphorus Mg/kg
Sample A	7.78	0.42	0.72	0.05	10.73
Sample B	7.77	0.41	0.73	0.04	10.72
Sample C	7.79	0.43	0.71	0.06	10.75
Average	7.78	0.42	0.72	0.05	10.73

Table 3: Summary of Geochemical Parameter of Soil

	SiO ₂ %	TiO ₂ %	Al ₂ O ₃ %	Fe ₂ O ₃ %	MgO%	CaO%	Na ₂ O%	K ₂ O%
Sample A	80.97	1.64	1.33	1.55	1.00	0.20	0.21	0.15
Sample B	80.98	1.63	1.32	1.56	1.00	0.20	0.20	0.16
Sample C	80.96	1.65	1.34	1.54	1.00	0.20	0.21	0.14
Average	80.97	1.64	1.33	1.55	1.00	0.20	0.21	0.15

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