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Downstream Sediments Analysis of Dredged Site along Onuebum/Agura Axis of Ekole Creek, Nigeria

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ABSTRACT: *Water is vital for the survival of living organisms, but the water sediments reduce the availability of the fresh water for use, hence the need to manage it through dredging. This study analysed the sediments of Downstream of the dredged Ekole creek, where sediment samples were collected from the; Upstream, Dredge point I, Dredge point II and Downstream. The pH, Electrical Conductivity (EC), Nitrate, Fe, Pb, Cr, Mn, Ni, Zn and Cu were analysed from the sample using standard methods. It was observed that the Downstream pH increased to 7.79 from 7.17 pH of the Upstream, though it is reduced at Dredge point I (6.37) and latter increased to 6.57 at Dredge point II; similar trend was noticed for EC concentration; 37µS value of Downstream is higher than 33µS Upstream that is increased to 160µS Dredge point I, but dropped at Dredge point II to 31µS however, the Nitrate concentration at the Upstream was 0.0018 mg/kg, raised at Dredge point I to 0.065 mg/kg then dropped at Dredge point II and the Downstream to 0.0562 mg/kg and 0.0174 mg/kg respectively. Low concentration of heavy metals were found in the Dredge points of the sediment samples while high levels were found at the Upstream and Downstream points. Sediments at Downstream are more alkaline with higher EC, low nitrate but, more iron. It can be inferred that, the dredging activities increases the pH and heavy metals of the sediment in the water, at the Downstream. Hence water at the Downstream is less toxic and can be used.*

Keywords: *Sediments, Water, ions, heavy metals, Upstream*.

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I. INTRODUCTION

There is no amount of money use in maintaining a river to provide water quality steadily and enhance productive ecosystem for the aquatic life either plant or animal that is too much, since water is greatly voluminous in the planet and it is essential for living. Smol (2008) asserts that the water coverage on the earth's surface is approximately 75%; but quickly noted that very small portion is fresh and is readily available for use. However the fresh and accessible portion of water is becoming unavailable for use because of water impurities thereby affecting the water quality. One of the enemies to water quality is turbidity. It blocks sunlight reaching deeper into the water body, thereby retarding photosynthesis in aquatic plants (Phytoplankton) systems (Narayanan, 2009). It reduces Dissolved Oxygen (DO) in the water column, and the value of water because of its poor aesthetic value. Turbidity in water is caused by suspended particle and colloidal matter such as clay, mud, silt, finely divided organic and inorganic matters either due to natural causes or due to release of pollutants into the water body, soil erosion, high levels of algae population and sediments stirred up from the seabed or riverbed by mining activities. The sediment stirred from the water bed and the Suspended Sediments (SS) are the basic content of the turbidity. It is clear therefore that sediment disturbs and alters the turbidity of water and affects the photosynthetic process of food manufacturing in plant, and the eutrophic state of surface water (Huang , 2009). The two classifications of the sediment material based on their sources are identified as: allochthonous and autochthonous. The allochthonous are the materials transported into water body whose origin is outside river or water body, like the eroded; clay, silt or soil particles, pollen grain, leave from trees or contaminants from a smoke stack and other, while autochthonous materials, originated from the water body which includes dead aquatic organic matters both plant and animal and the chemical matters that result from different processes happening in the river (Smol, 2008) .

Håkanson and Jansson (1983) reveal that sediments are distributed as a result of; flow rates, topography, and climate, this give birth to three zones namely an erosion zone, a transportation zone, and an accumulation zone. The third zone is most important to paleolimnologists, because it is the least affected by windy turbulence and other processes like dredging, to them sediments in the accumulation zone provide the most reliable record of past environmental alteration. Moreover sediments are said to be source of nutrient and sink in water bodies (Bloesch, 1994; Qin and Zhu 2006; Wang 2016), it can be a sink by adsorption, sedimentation, and mineralization of suspended particles (Gelencsér et al., 1982, Søndergaard, 2003), be as it may, it must be noted sediments distribution varied by activities like wave action, flooding, dissolved oxygen, pH, water temperature, and anthropogenic activities (Pfenning 1997, Percuoco 2015, Li 2018. Chen et al., 2020) which give rise to nutrients availability from sediments (Wu 2012) However, sediment disturbance is greatly caused by wind-wave action, shipping, and movements of aquatic animals (Zhang 2017,Luo 2020)

Therefore, sediments management is very crucial, one methods that is rarely employed is Dredging, which is the removal of sediments from a water body, transporting, and depositing in a different but far location. (Vivian and Murry, 2009). According to Jain el tal., (2003), dredging is usually resorted at sediment management when other methods are not viable or successful. Dredging is a global and an aged long activity carried out to remove sediments from a water body or waterways, in order to improve the depth of such waterways when sediments become obstructive to both the free flow of water and also transportation, it is a maintenance strategy , it is advantageous in land reclamation, prevention of flood, storm protection, remediation of contaminated sediments, mining and provision of material like sand for construction (Brunn et al., 2005; Thomsen et al., 2009; CEDA, 2011; Tillin et al., 2011; WODA, 2013).

Impacts of dredging has being established by researches; it impacts the marine environment, the habitats and associated fauna and flora both; positively and negatively .(see reviews by Newell et al., 1998; Thrush and Dayton, 2002; Hitchcock and Bell, 2004; Erftemeijer and Lewis, 2006; Tillin et al., 2011; Erftemeijer et al., 2012). Also the nutrients released at dredging are greater than those released from static water body, were dredging is not carried out, more so, for unstable hydrodynamics, the release rate from the bottom sediments exceeds; the surface sediments in the region where dredging did not take place. (Chen *et al*., 2021)

In order to manage the sediments disturbance, the impacts of dredging on sediments at the downstream is must be analyze; therefore this research seeks to analyze the sediments at after dredging at the downstream of the Nun River. The parameters of sediment samples that will be analyzed are; pH, Nitrate, Lead, Iron, Copper, Manganese, Nickel, Chromium and Zinc.

II. MATERIALS AND METHODS

2.1 The Study Area

The study site is along Onuebum/Agura axis of Ekole Creek, which is surrounded some other communities like Ekolo, Otuokpoti, Ikasikara, Otuegwe ,Otuogori of Yenagoa Local Government Area (LGA) of Bayelsa State as seen in Figures 1 and 2, which is geographically located within; the latitudes 4°49’N and 5°23'N and longitudes 6°10' E and 6°33'E (Koinyan et al. 2013).

Fig.1: Map of Nigeria Showing Bayelsa State

Fig. 2: Satellite Image of Study Location

2.2 Description of Sampling Locations

Within the study area four sampling points were taken. Two on-going dredging sites were located about 200 m apart and were labeled “Dredge point I and Dredge point II”. Two more sampling points were taken at about two kilometers (2 km) away from the dredge sites and were titled “upstream and downstream”; where no dredging took place. The upstream point was 2,081.89m from Dredge point I which was used as the control point, while the downstream point was 1,952.25 m from Dredge point II which acted as the effect monitoring point. At all these four sampling locations, the sampled sediment was taken laboratory for analysis. A total of eight samples were taken into plastic containers previously rinsed with the water sample itself and placed in coolers and sent same day to specialized sediments testing laboratory.

Fig 3: Dredger at Dredge point l

Fig 4: Dredger at Dredge point ll

2.3 Geographical Positioning of Sampling Locations

Global positioning system (GPS) was applied to obtain the geographical coordinates of the sampling locations. Positions at each sampling station during the fieldwork activities were achieved with the aid of a Magellan global positioning system, using Model Explorist 300 hand held GPS. At each sampling location, coordinates at which sampling actually took place were marked and transferred into the field note book. Geographical coordinates in Minna East Belt (CRS), Coordinates converted to World Global positioning system (WGS84) and Sampling Location Names are presented in Table 1 below

Table 1: Geographical Coordinates of the Study Area

S/N	Location Name	Coordinates Reference System (CRS) Nigeria Minna, East Belt		Sample Coordinates Converted to WGS84 (Lat, Long)	
		Easting (m)	Northing (m)	Lat	Long
1	Dredge Point I	417444.019	97239.783	6° 15' 47.8"	4° 51' 04.7"
2	Dredge Point II	418051.192	95256.379	6° 16' 07.9"	4° 50' 00.7"
3	Upstream (Control Point)	418040.518	95239.957	6° 16' 07.6"	4° 50' 00.2"
4	Downstream (Effect monitoring point)	417050.784	93569.596	6° 15' 36.2"	4° 49' 05.8"

2.4 Methods for Sediment Samples

The sediment was digested in preparation for analysis. The sediment/soil sample was dried under fan completely for 24 hrs. Then the sample was crushed with mortar into pestle, it was passed through a filter to remove grit and dirt. 5 g of the sample was then weighed and 50 ml of 1:1 nitric acid was added. The resulting mixture was kept in an oven at a temperature of 110°C for 2 hours, filtered through a filter paper and the filtrate used for spectrophotometric analysis for nitrate, phosphate and heavy metals using standard methods (APHA, 1971). Samples for pH determination were not acid-digested. 5 g of dried, crushed and sieved samples were dissolved in 50 ml of distilled water and the pH of the resulting solution was determined using a standardized pH meter.

2.5 Methods for Heavy Metals Determination Sediment Samples

UV spectrophotometric determination of sediment samples followed methods described by APHA (1971) according to the following details using SPECTRUM LAB 22PC spectrophotometer.

2.6 Atomic Absorption Spectroscopy

AAS was used to determine the following metals according to methods described by APHA (1971) using the following details:

Table 2: Result of AAS Analysis

Metals	Fuel and oxidant combination	Wavelengths (mμ)	References
Chromium	Air-acetylene	357.9	APHA, 1971
Copper	“” “”	324.7	“” “”
Iron	“” “”	248.3	“” “”
Lead	“” “”	283.3	“” “”
Manganese	“” “”	279.4	“” “”
Zinc	Air-acetylene	213.8	APHA,1971

III. RESULTS AND DISCUSSION

Results of analysis of sediment samples collected from the study locations in Ekole Creek, are presented in Tables 3 and their correlations are also presented in Table 5

3.1 River Depth Analysis at the Sampling Points

Table 3 shows the results of river depth variation at the study area. Generally, the depth at Dredge point I was highest (21 m) followed by that at Dredge point II (17.73 m) and downstream points (12.7 m). This indicates that alterations have been made to the bottom profile of Ekole creek as a result of dredging activities.

3.3 Determination of pH and Nitrate Sediment of Ekole Creek

Table 4 shows the variation of sediment quality of Ekole creek. Sediment analysis showed a high pH of 7.17 at the upstream which is a little bit alkaline, but reduced at Dredge point I (6.37) and latter increased to 6.57 which were more acidic. Downstream pH increased to 7.79 to show more alkaline sediment. Similar observations were made for EC. Upstream value was low with an increased Dredge point I concentration (33-160 µS), it dropped at Dredge point II to 31 µS and latter increased at the Downstream 37 µS. This shows more iron in the sediments. It can be inferred that, the dredging activities increases the pH of the sediment in the water, at the Downstream of the Ekole Creek. Nitrate however showed a different trend. The levels at the Upstream were very low (0.0018 mg/kg), got high at Dredge point I (0.065 mg/kg) and dropped at Dredge point II and the downstream (0.0562 mg/kg and 0.0174 mg/kg respectively). It showed that dredging aids the decomposition of organic matter in the sediments. The levels of nitrate in the sediment are within the WHO (2015) limits.

Table 3: Variation of River Depth of Ekole Creek

Dredge Pt1		Dredge Pt2		Downstream		Upstream	
Interval (m)	Depth (m)	Interval (m)	Depth (m)	Interval (m)	Depth (m)	Interval (m)	Depth (m)
0	0.51	0	1.39	0	1.39	0	1.43
20	1.39	20	1.69	20	2.96	20	2.13
40	1.80	40	2.1	40	3.14	40	3.29
60	5.74	60	6.04	60	3.33	60	3.48
80	8.71	80	9.01	80	5.23	80	5.38
100	8.33	100	8.63	100	7.44	100	7.59
120	12.41	120	9.22	120	9.54	120	8.81
140	15.03	140	11.09	140	11.02	140	8.21
160	17.78	160	15.74	160	12.79	160	8.01
180	20.98	180	17.73	180	10.21	180	7.94
200	21.50	200	17.72	200	9.47	200	7.51
220	14.57	220	14.87	220	7.81	220	7.52
240	8.41	240	8.71	240	5.74	240	5.89
260	4.11	260	4.41	260	4.35	260	4.5
274	2.14	279	2.44	273	1.78	277	1.93

Table 4: Analysis of Sediment Quality of Ekole Creek

Sediment Quality Parameters	Upstream	Dredge 1	Dredge ll	Downstream
Sediments:				
pH	7.17	6.37	6.57	7.79
Electrical Conductivity (µS)	33	160	31	37
Nitrate (mg/kg)	0.0018	0.0650	0.0562	0.0174
Total Iron (mg/kg)	3.08	1.17	1.15	3.05
Lead (mg/kg)	6.422	5.612	5.418	6.336
Chromium (mg/kg)	99.498	32.857	32.286	107.182
Manganese (mg/kg)	0.506	0.402	0.382	0.504
Nickel (mg/kg)	52.098	51.864	50.220	51.304
Zinc (mg/kg)	7.6902	7.0966	6.6832	7.3787
Copper (mg/kg)	0.718	0.414	0.462	0.846

3.4 Analysis of Heavy Metals Sediment Samples in Ekole Creek

Variations were noticed for Iron (Fe) in the sediment samples. The sediment samples had higher concentrations of Iron for all the sampling locations. The Iron concentrations at the dredged sites were lower, that is 0.414mg/kg and 0.462mg/kg, than those of the Upstream and Downstream sections; 0.718 mg/kg and 0.846 mg/kg respectively as seen in Fig .5. Concentrations of Lead (Pb) at the upstream and downstream were higher than those at the Dredge points in the sediment samples. Lead was high at the downstream point because of re-suspension owing to the increased value in the sediments, shown in Fig. 6. Chromium concentrations in the sediment samples were overly high. At all the sampling points, values of Cr were higher in the sediments than the water column, as represented in Fig. 7. Generally, low levels of heavy metals were found in the Dredge points of the sediment samples while high levels were found at the Upstream and Downstream points.

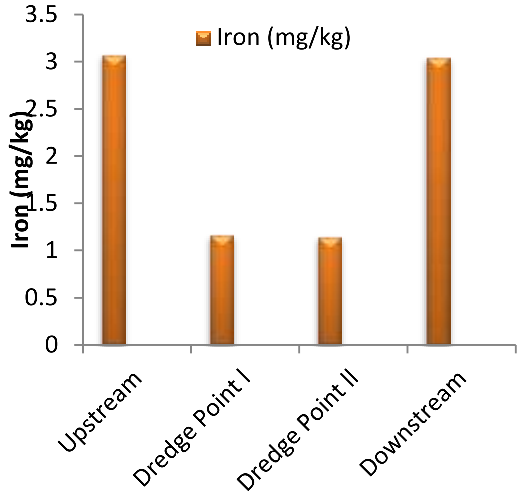

Figure 5: Iron concentration in Sediment Samples

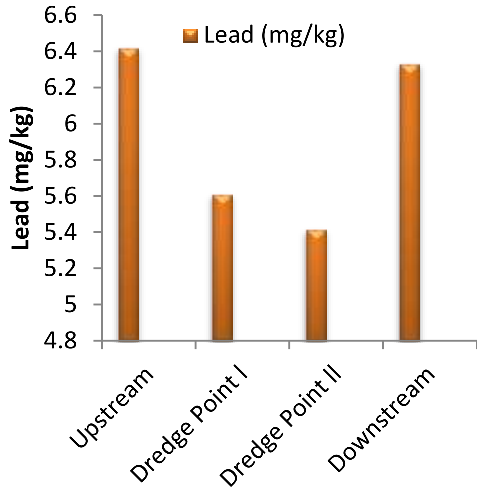

Fig 6: The Lead concentration in Sediment Sample

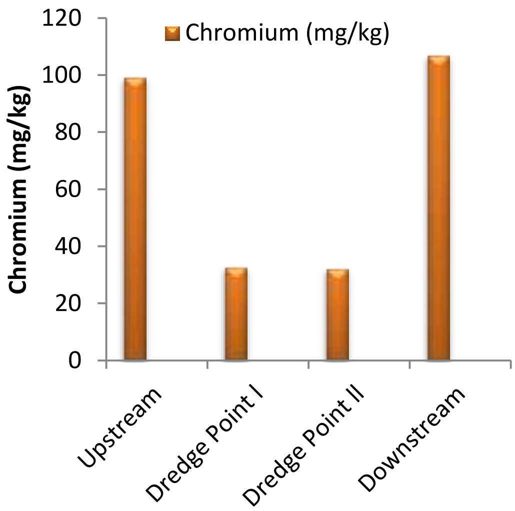

Fig. 7: Chromium concentration in Sediment Sample

3.5 Relationship between Parameters in Sampling Stations

Tables 5 showed the relationships between the pH, nitrate and heavy metals of the sediment samples which indicated that pH has a direct relationship with all the heavy metals. The most significant were: Cu (0.9880), Cr (0.9367), Fe (0.9044), Mn (0.8820), Pd (0.8491) and Zn (0.6236) respectively. Ni relationship with pH showed a direct but low correlation (0.1585). The trend observed in the sediments between pH and heavy metals showed that high pH gave rise to high concentrations of heavy metals and low pH showed low heavy metals. This is a reflection of their relative solubility in soil solution at different pH values as well as their relative result of attenuation processes like sorption and chelation with humic substances at various depths, in conformity to Akhionbare *et al.*, (2013), who stated that the high pH of water column also aided precipitation of heavy metals out of water unto the sediment, hence increasing their levels in sediment. Heavy metals concentrations hence responded to redox overturns in Ekole creek.

Table 5: Correlation (r) Matrix between the Physicochemical Parameters in Sediment of Ekole Creek

	pH	EC	Nitrate	Fe	Pb	Cr	Mn	Ni	Zn	Cu
pH	1.0	-0.5987	-0.8152	0.9044	0.8491	0.9367	0.8820	0.1585	0.6236	0.9880
EC	-0.5987	1.0	0.6403	-0.5466	-0.4159	-0.5442	-0.4451	0.4069	-0.1596	-0.6045
Nitrate	-0.8152	0.6403	1.0	-0.9719	-0.9524	-0.9509	-0.9508	-0.4276	-0.8596	-0.8924
Fe	0.9044	-0.5466	-0.9719	1.0	0.9871	0.9962	0.9932	0.4649	0.8757	0.9591
Pb	0.8491	-0.4159	-0.9524	0.9871	1.0	0.9779	0.9978	0.6003	0.9391	0.9161
Cr	0.9367	-0.5442	-0.9509	0.9962	0.9779	1.0	0.9890	0.4282	0.8465	0.9787
Mn	0.8820	-0.4451	-0.9508	0.9932	0.9978	0.9890	1.0	0.5555	0.9154	0.9403
Ni	0.1585	0.4069	-0.4276	0.4649	0.6003	0.4282	0.5555	1.0	0.8268	0.2634
Zn	0.6236	-0.1596	-0.8596	0.8757	0.9391	0.8465	0.9154	0.8268	1.0	0.7244
Cu	0.9880	-0.6045	-0.8924	0.9591	0.9161	0.9787	0.9403	0.2634	0.7244	1.0

Figures 8 below shows the relative abundance of metals in the sediment, it is indicated as follows; Upstream (Cr>Ni>Zn>Pb>Fe>Cu>Mn), Dredge point I (Ni>Cr>Zn>Pb>Fe>Cu>Mn), Dredge point II (Ni>Cr>Zn>Pb>Fe>Cu>Mn), Downstream (Cr>Ni>Zn>Pb>Fe>Cu>Mn) as represented in the pie charts a, b and c.

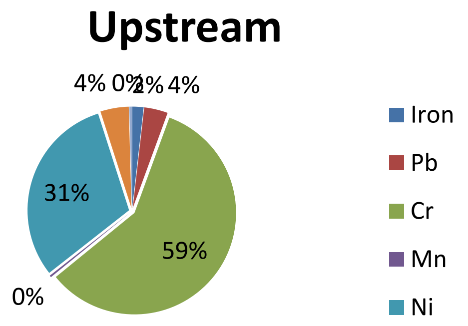

Fig 8 a

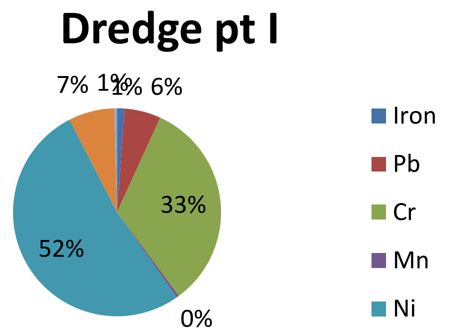

Fig 8 b

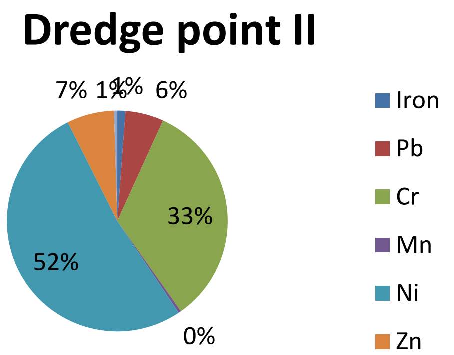

Fig 8 c

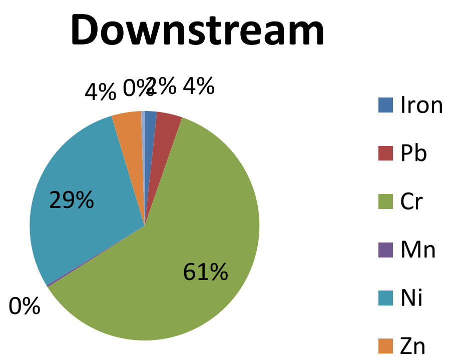

Fig 8 d

Fig. 8: Relative Abundance of Heavy Metals in Sampling Points of Sediment of Ekole Creek

IV. CONCLUSION

The study site which includes two Dredging points, Upstream and Downstream points formed four sampling points where samples for the sediments analysis were collected, the result after analysis reflect that the pH and the heavy metals of the sediments in the water, at the Downstream of the Ekole Creek is high, however nitrate showed a different trend; its concentration at the Upstream was low (0.0018 mg/kg), become high at Dredge point I (0.065 mg/kg) and dropped at Dredge point II and the Downstream (0.0562 mg/kg and 0.0174 mg/kg respectively), however its range is still within the recommended limits. This means the pH and heavy metals have direct relationship but nitrate is inversely related in the sediment at the Downstream, where the sediments are slightly alkaline, which is not injurious to use.

V. ACKNOWLEDGMENT

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