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Changes in Surface Water Physico-Chemical Parameters following the Dredging of Otamiri and Nworie Rivers, Imo State of Nigeria

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Abstract

In an attempt to study the environmental impact of dredging on water quality, surface water quality parameters were monitored from June 2008 to October 2010. Samples were collected before and after dredging. Collected samples were analysed from five stations within the study area. The water physico-chemistry prior to dredging was consistent with that of researches done previously in that area. As a result of dredging however, the pH of the dredged canal was decreased from a mean value of 6.5 to 6.04, similarly dissolved oxygen(DO) decreased from 13.88mg/l to 8.66mg/l, while TSS, BOD_5 and COD_5 decreased slightly after dredging. Acidity and alkalinity values did not show significant changes. Results of the ten-months post dredging monitoring of the Rivers water revealed that the water quality improved slightly during this period. The pH, DO, and TSS appreciated, while BOD_5, COD_5 turbidity, Total hardness, Acidity, Alkalinity, and Electrical conductivity depreciated to values close to pre-dredging concentration levels. We therefore concluded that the impact of dredging on the water quality is localised and short term.

Keywords: Dredging, water quality, physico-chemical, otamiri and nworie rivers.

Introduction

Surface water typically transports three types of sediment namely: Dissolved load, suspended load and bed load. Chemical weathering in rocks produces ions in solution (e.g. Ca^{2+}, Mg^{2+} and HCO_3^-), hence a dissolved load. Suspended sediments make surface water look cloudy or opaque; the greater the suspended load, the muddier the water. Bed load (silt, sand and gravel) settle on the bottom of the channel[1].

Surface water quality (SWQ) assessment/measurement falls into the following three categories:

Physical characteristic: Temperature, colour, suspended solids and turbidity.

Chemical characteristics: Nutrients, Minerals, Metals, Total Solids, DO, BOD_5, COD_5, pH, Electrical conductivity, organic compounds, etc.

Biological Characteristics: types and quantities of aquatic plants, animals, algae, bacteria and protozoa parasites [1, 2].

Dredging of several locations of Otamiri Rivers and Nworie Rivers (a tributary of Otamiri River) were done in Owerri municipal and Owerri West local government of Imo State of Nigeria. Environmentalists have expressed fears over the impact of the dredging activities on the surface water quality of the affected Rivers, which harbour aquatic life and serve as the sole source of treated water and recreation in the area[1]. In addition, turbidity plumes created as a result of dredging have been reported to cause a reduction in the population of phytoplankton and zooplankton[3]. During Dredging, waterway sediment, soil, creek banks and vegetation along the way of are typically removed and deposited as dredge spoils at the bank of the newly dredged canal. Since the dredged materials are uncapped and unconfined leachates with high turbidity often return to the body. This practiced have caused a number of environmental impacts including altered topography and hydrology, acidification and water contamination, which has resulted in vegetation damage and fish kill[4-8].

Bed sediment is a reservoir for heavy metals and is regarded as serious pollutants of aquatic ecosystems due to their environmental persistence, toxicity and ability to be incorporated into food chains[9].

Material and Methods

Sampling and Sample Storage: For the purpose of this study, five (5) sample stations 1, 2, 3, 4 and 5 were established on the Rivers, (7^oE, 5^o27N). Station 1 at reservoir base area and it serves as control. Station 4 at Aba Road, about 2km downstream of Station 1, was there is massive solid waste dump. Station 2 at Nekede, about 3km downstream of station 4, where massive sand excavation is going on. Station 3 at FUTO, about 3km downstream of station 2, where dredging went on and station 5 at Nworie, a tributary of Otamiri River about 4-5km close to the point of confluence, where there was massive dredging.

Surface water was collected periodically. On each occasion samples were taken from triplicate spots at each station to form one composite sample and the mean values noted for that season. Water samples were collected at 30cm below surface using 1 litre polythene bottle with screw caps.

During sampling, temperature, pH, turbidity, electrical conductivity, and total suspended solid were determined in-situ using thermometer, digital pH meter (Hach EC 20), turbidimeter (Hach 2100) and electrical conductivity/TSS meter (Hach CO 150) respectively. Separate samples were collected for dissolved oxygen (DO), chemical oxygen demand (COD_5) and Biochemical oxygen demand (BOD_5) (using 125 ml reagent bottle with ground stopper). Standard methods were used for the laboratory analysis. Titrimetric method was used for the determination of acidity and alkalinity, gravimetric method was used for suspended solids, Winkler's' method was used for BOD_5, and DO, open reflux dichromate oxidation method was used for COD_5.

Results and Discussion

The pH values at all the stations before the dredging were quite close, ranging from 6.4 to 6.8. The pH reduced slightly following dredging. Acidity and alkalinity values improved gradually throughout the remaining sampling period. The effect of temperature on the acidity is minimal, since temperature remained relatively stable during the study period. However, previous studies indicated that Niger delta waters are well buffered with pH ranging from neutrality to slightly alkaline. Therefore, it is the presence of the unconfined dredged materials deposited adjacent to the canal that is helping to sustain the acidity of the canal via pyrite oxidation[10].

Turbidity of all the stations remained stable and similar before and after dredging. During the dredging process, turbidity plumes were observed with turbidity and TSS increasing drastically at the dredging stations.

Turbidity plumes have been reported to negatively impact estuarine organisms during dredging and disposal of dredged spoils, causing dredging of primary productivity[10]. The study carried out during the dredging of the Cross River estuary, South East of Nigeria shows that water transparency decreased by over 25-50% for over a distance of 12km and that this effect was still persistent 18 months after dredging.

The reason for the prolonged effect was attributed to the washing of leachates into the river from unconfined spoil dumps. Other studies have reported similar impacts following dredging.

Electrical conductivity and BOD_5 showed similar pattern from station 1 down to station 5 i.e., gradual decrease downstream, before and after dredging[10].

Dissolved oxygen values showed gradual reduction downstream across the five stations and further reduction after dredging process, i.e., from a maximum of 16.1mg/l in the pre-dredging stage to (5.6 and 6.0) mg/l after dredging. Thus dispersion of organic matter, TSS downstream and oxidation of resuspended organic matter and pyrite after dredging are directly linked to DO depletion downstream and after dredging respectively. Resuspended organic matter and other oxygen-demanding substances are released as a result of dredging. BOD_5 and COD_5 showed a general increase and correlated negatively with DO.

Total hardness varied at the respective site irrespective of the dredging operations. The same pattern was noted before and after the dredging operation. However, there was a slight decrease in total hardness after dredging.

Conclusion

The study shows that the dredging of Otamiri and Nworie (a tributary of Otamiri River) rivers near Owerri, triggered some physico-chemical changes of the water body particularly pH, TSS, DO, BOD_5, COD_5, turbidity, conductivity, acidity and alkalinity. Most of these physico-chemical changes were localized and short time (i.e. returning close to pre- dredging levels in less than ten months).

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Table-1
Recorded Values of Some Physico-Chemicals Parameters of Surface Water at various sites

	Acidity	Alkalinity	pH	E/CNDTVY	BOD-5	COD-5	DO	TSS	T-Hardness	Turbidity
SS1	4.1	2.4	6.4	22	18.45	43.83	16.1	42.1	10.12	0.04
SS2	3.8	3.1	6.5	26	15.63	45.4	14.6	60.2	10.27	0.04
SS3	4.5	4	6.4	24	16.23	40.41	15	43.1	17.5	0.04
SS4	2	3.1	6.8	24	13.8	53	11.3	81.7	5.05	0.04
SS5	2	4	6.4	20	17.37	47.6	12.4	23.4	1	0.04
MAX	4.5	4	6.8	26	18.45	47.6	16.1	81.7	17.5	0.04
MEAN	3.28	3.32	6.5	23.5	16.296	46.05	13.88	50.1	8.788	0.04
MIN	2	2.4	6.4	20	13.8	40.41	11.3	23.4	1	0.04

Table-2
Recorded values of some Physico-Chemical Parameters of surface water at arious sites at Posttdredging Stage 13/02/2010

	Acidity	Alkalinity	pH	E/CNDTVY	BOD-5	COD-5	DO	TSS	T-Hardness	Turbidity
SS1	4	2	6.22	20	12.8	39.6	9.6	40	8	0.03
SS2	4	3.2	6.15	26	11.52	32	8	60	8	0.04
SS3	4.8	4	6.4	25	11.52	32	8.8	40	16	0.03
SS4	2	3.3	6.1	24	9.6	40	5.6	80	4	0.03
SS5	2.4	4	6.37	19	12	38.6	8	20	0.8	0.02
MAX	4.8	4	6.4	26	12.8	40	9.6	80	16	0.04
MEAN	3.44	3.28	6.248	22.8	11.49	36.44	8	48	7.36	0.03
MIN	2	2	6.1	19	9.6	32	5.6	20	0.8	0.02

Table-3
Recorded values of soil Physico-Chemical Parameters of surface water at various sites at Post-Dredging Stage 10/10/2010

	Acidity	Alkalinity	pH	E/CNDTVY	BOD-5	COD-5	DO	TSS	T-Hardness	Turbidity
SS1	3.8	2.5	6.1	22	13.8	40.5	9.8	32.05	8.1	0.03
SS2	4	3	5.9	27	12.12	34	9.5	51.05	8	0.02
SS3	4.5	4	6.1	26	12.2	32.05	9.5	40	16.5	0.04
SS4	2	3.2	6	24	11.04	41.5	6	71	4	0.04
SS5	2	4	6.1	20	14.54	39.6	8.5	21	1	0.02
MAX	4.5	4	6.1	27	14.54	41.5	9.8	71	16.5	0.04
MEAN	3.26	3.34	6.04	23.8	12.74	37.53	8.66	43.02	7.52	0.03
MIN	2	2.5	5.9	20	11.04	32.05	6	21	1	0.02

Figure-1
Pictures of sample stations 5 and 3 during dredging. Station 1 at far right

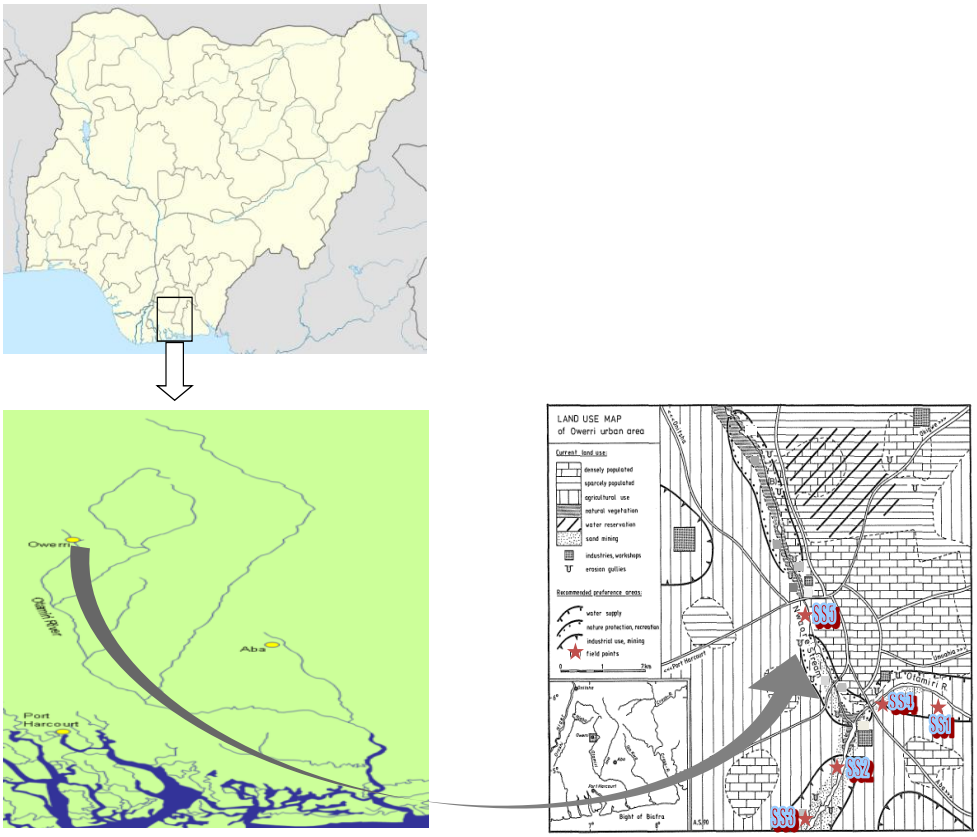

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Figure-2
Map of Owerri showing sampling points and Land usage

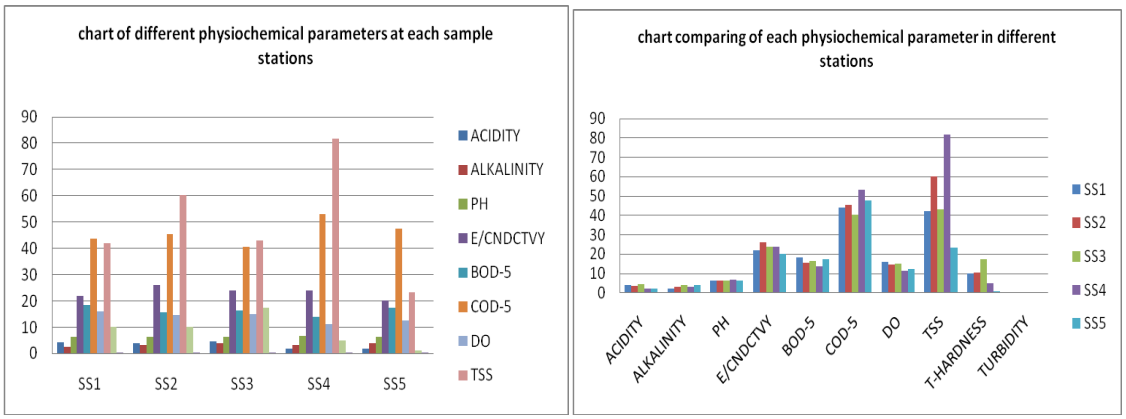

Figure-3
Graphs showing changes in physico-chemical parameters just before dredging (10/06/2008)

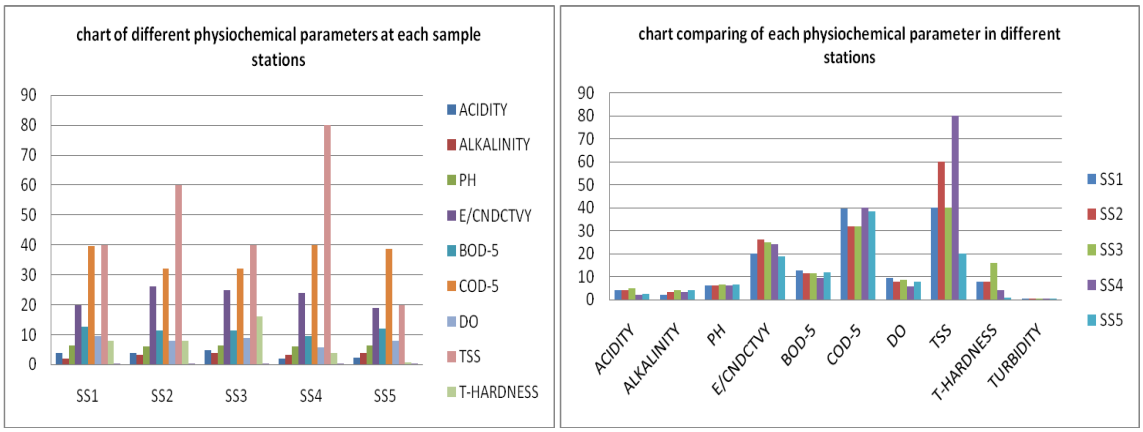

Figure-4
Graphs showing changes in Physico-Chemical parameters just after dredging (13/02/2010)

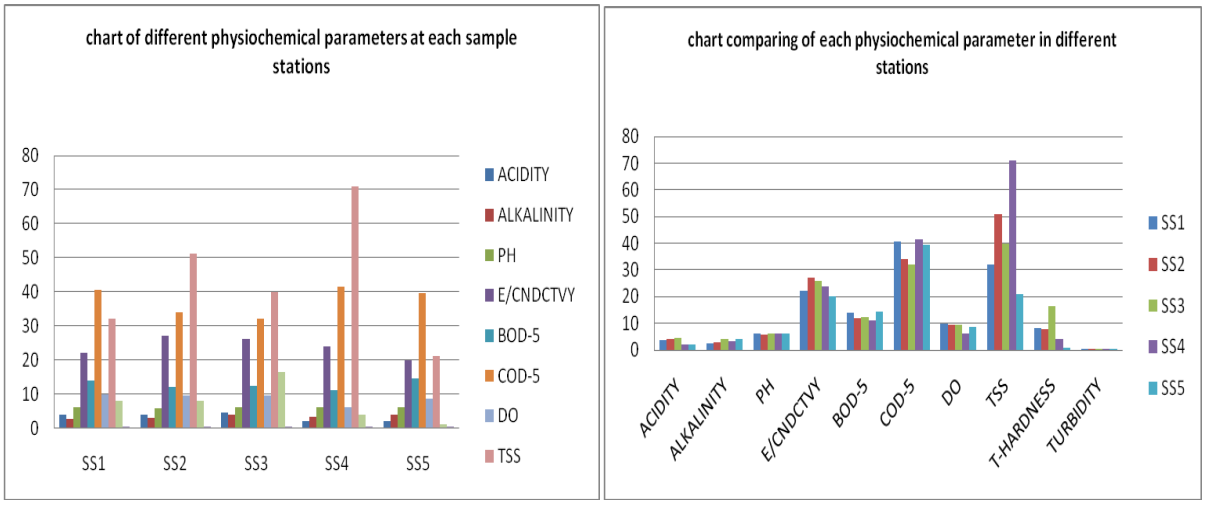

Figure-5
Graphs showing changes in physico-chemical parameters much after dredging (10/10/2010)