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#### RESEARCH ARTICLE

# ANALYSIS OF WATER QUALITY DETERIORATION IN NWORIE RIVER, OWERRI-IMO STATE, SOUTHEAST, NIGERIA

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### ABSTRACT

Due to indiscriminate activities of man through sand excavation, sand mining and illegal waste disposal within the watershed the study evaluated the effect of these activities on selected water quality parameters of Nworie River in Owerri -Imo State, Southeast Nigeria. The study area was divided into Upstream, Midstream and downstream. The river was sampled and the raw data from water sampling were subjected to laboratory analysis; results obtained were matched with standards. The results showed that the average pH of the river was 7.4; upstream and midstream had higher pH values than the downstream with low pH and these were within the permissible limit. Biological oxygen Demand (BOD) of the river were 75mg/l, 60mg/l and 56mg/l at the Upstream, Midstream and downstream with an average value of 64 mg/l. The river had a mean turbidity value of 76NTU and mean Total Dissolved solids (TDS) value of 272mg/l which were above the permissible limit. Calcium (Ca<sup>2+</sup>) did not exceed the standard limit while magnesium exceeded the standard limit by 68% at the Upstream. Nworie river had mean water conductivity value of 93 µS/cm; water conductivity at the Midstream and downstream were within the permissible limits while the Upstream had 6% increase above the acceptable limit. It was observed from this study that Nworie river exhibited three different colours of light-green, dark-green and brownish-muddy colour respectively at the Upstream, Midstream and Downstream which could be attributed to the level of erosional deposits and sediment loads from the degraded watershed. Further degradation of the watershed should be avoided by practising good soil conservation measures, ensuring that indiscriminate activities of inhabitants of the area are stopped and since environmental balance, land degradation, water management and food security are strongly linked, each must be addressed in the context of the other to have a measurable impact to the society.

#### **KEYWORDS**

colour, conservation, erosion, river, variation.

#### 1. Introduction

Water is the most important natural resource and valuable natural asset which forms the major constituent of the ecosystem. It is vital to the existence of all living organisms but this valued resource is increasingly being threatened as human population grow. The quality of any body of surface or ground water is a function of either or both natural influences and human activities (Kolawole et al., 2008). Rivers are the most important freshwater resource for man, unfortunately river waters are being polluted by indiscriminate disposal of sewage, industrial waste which affects their physical and chemical characteristics as well as microbiological quality (Koshy and Nayar, 1999). The extent of discharge of domestic and industrial effluents is such that rivers receiving untreated effluent cannot provide the dilution necessary for their survival as good quality water sources.

The quality of water sources deteriorates due to point source and nonpoint source pollution. Point source pollution includes industrial effluents and discharges from municipal waste water treatment plant while nonpoint source pollution includes agricultural runoff, seepage of septic tank effluents, indiscriminate waste dumping into streams and rivers (Deepika and Singh, 2015). Water quality along with quantity determines the health of freshwater ecosystems affecting the suitability of water for drinking and agriculture Land degradation represents a downward trend in the environmental resource such that their level of use in human society decreases at an increasing rate (FAO,1994). According to Lal, 1994 there are three principal types of land degradation and these include; physical, chemical and biological land degradation. Significant among the physical land degradation is erosion which remains one of the critical environmental issues in southeastern Nigeria and most times reduces cropland productivity and contributes to the pollution of adjacent watercourses

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Nworie river watershed ordinarily should provide economic and agricultural resources however, the watershed is faced with ecological stress due to indiscriminate activities of man which ranges from sand mining, excavation, and discharge of untreated waste resulting in various forms of degradation (Nwosu et al., 2021). Therefore, the main objective of this study was to evaluate the effect of land degradation on selected water quality parameters of Nworie River Owerri –Imo State Southeast, Nigeria while the specific objectives were to investigate some physical and chemical properties of Nworie River and their relationship to land degradation as well as to compare some of these properties with standards.

#### 1.1 Study Area

Owerri; the capital of Imo State Nigeria has a population of about 1,401,873 (Owerri-Wikipedia, 2016). It is approximately 100sq/km in area. Owerri is bordered by the Otamiri River to the east and Nworie river to the west (Acholonu, 2008). Owerri has maximum and minimum temperatures of 33% c and 23% c respectively. The study area (Nworie river) lies within latitude 5%29 to 5%49 and longitude 07%01 to 7%25 standing on an elevation of 77m upstream,55m midstream, and 45m downstream above the sea level; Handheld Global Positioning System (GPS). Nworie river watershed has an annual rainfall of 2500mm.Soils of the study area are coastal plain sands of Benin formation (figure 2); the river is about 8km in its total length with its source at Ubomiri in Egbeada which joins Otamiri river at Nekede. The river flows through the back of Federal medical centre, Alvan Ikoku College of Education and Holy ghost College, Owerri. These institutions discharge their untreated waste into the river as recorded (Alinnor and Obiji, 2010; Nwosu et al., 2021).

The study area is covered by depleted rainforest vegetation; grasses and broad leaf weeds like *Panicum Maximum (Guinea grass)*, *Pennisetum Purperum (Elephant grass)*, *Axonopus Compressus(Carpet grass)*, *Elusine Indica(Goose grass)*, *Centrosema Pubescens, Calapagonium Mucunoides, Aspillia Africana,Andropogon Gayanus (Gamba grass)* as well as few forest species e.g palm trees, mango trees, cashew tree. Farming is the major occupation of the inhabitants of the area while Sand mining and excavation are the major activities within the study area. Nworie river catchment is approximately 30sq/km (Imo State Ministry of lands, survey and Urban Planning, 2010). Nworie river watershed is subject to intensive human activities resulting in the discharge of many untreated waste thus leading to various forms of degradation such as erosion especially gully erosion.

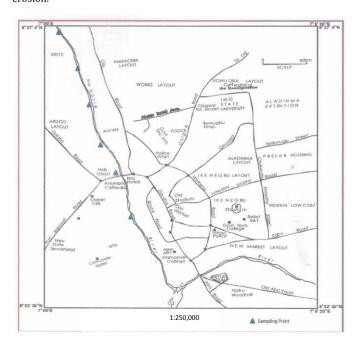


Figure 1: Location of the the strong of the

#### 2. MATERIALS AND METHODS

### 2.1 Water Sampling

One litre capacity Plastic containers were used to collect water samples from the upstream, midstream and downstream of the Nworie River. The plastic containers were firstly rinsed with the stream water before final

sampling; this provided an even mixing of the river water. Each of the water samples was labelled and stored under a room temperature for laboratory water analysis.

#### 2.2 Laboratory Water Analysis

- Turbidity: Suntex digital turbidometer model was used to determine the optical clarity of the water sample. The instrument measures the scattering of light and provides a relative measure of turbidity in water.
- ii. Total Dissolved Solids (TDS): Gravimetric method was used using a filter membrane instrument 100mls aliquot of water sample was filtered through a dry pre-weighed 0.45μm filter paper. The filter paper was oven dried at 105°C for 1hr, after drying the filter paper was allowed to cool and weighed. The difference in weight gives the TDS and expressed in mg/kg.
- iii. Biological Oxygen Demand (BOD): Water samples were incubated for 5 days at room temperature of about 20°C in a light tight environment. After 5 days the level of dissolved oxygen was determined by conducting the dissolved oxygen tests. BOD of the water sample is determined by subtracting the dissolved oxygen from the dissolved oxygen level found in the original water sample before 5 days incubation expressed in mg/L.
- Water pH: This was determined using pH meter after calibrating with standard buffer sample.
- v. Conductivity: Water conductivity was determined by the use of conductivity meter
- vi. Calcium, Magnesium and Potassium: These were determined through the use of spectrophotometer. A known volume of the water sample was evaporated using phenol disulphuric acid after which distilled water and ammonia were added. The metal in the water was then measured spectrophotometrically using metal standard

## 2.3 Data Analysis

Descriptive Statistical tools such as mean and standard deviation were used and results obtained were matched with standards.

#### 3. RESULTS AND DISCUSSION

The results of water quality parameters analysed are shown in table 1. It was observed that Nworie river exhibited different colours in different sections. Upstream had a greenish colour, midstream had a dark-greenish colour while downstream had a brownish- muddy colour as shown in figures 3,4 and 5. Variation in the colour could be attributed to the level of erosional deposits and sediment loads in the river which affected the water quality. The pH of Nworie river at the Upstream, Midstream and downstream were 7.86,7.56 and 6.85 respectively. The mean pH was 7.4. The pH upstream and midstream was higher (7.86 and 7.56) than the downstream which had low pH (6.85). High pH tend to facilitate the solubilization of ammonia, heavy metals and salts; precipitation of carbonate salt is encouraged while low pH values tends to increase carbondioxide carbonic acid concentrations and (www.researchgate.net/River water monitoring). However, the pH of the river when compared with WHO and NAFDAC standards were found to be within permissible limits. Organic waste reduces pH of water to acidic level (Dublin-Green and Tobor, 1992). Again, Umunnakwe et al., 2009 reported discharge of untreated organic waste into river to have lowered the pH, this was observed at the downstream where deposition of untreated waste from Federal medical centre and Alvan Ikoku college of Education was visible.

Biological oxygen demand is a measure of amount of dissolved oxygen needed by aerobic biological organisms to breakdown organic material present in a given water body at certain temperature. From the study; there were 75mg/l, 60mg/l and 56mg/l values of BOD obtained respectively at the upstream, midstream and downstream. Nworie river had a mean BOD value of 64mg/l. High BOD indicates high content of easily degradable, organic material in a river while low BOD indicates low volume of organic materials difficult to breakdown (<a href="https://www.envirotechonline.com">www.envirotechonline.com</a>). BOD of Nworie river was above the permissible limits of WHO and NAFDAC and this could be attributed to high level of solid waste deposited into the river which polluted the river. The high BOD observed

was an indication of pollution, this collaborated with the findings (Umunnakwe et al., 2011; Acholonu et al., 2008).

Results obtained shows that water turbidity at upstream, midstream and downstream were 85NTU, 78NTU and 65NTU respectively. Nworie river had a mean turbidity value of 76NTU; this was above WHO permissible limit. Turbidity ranged from 65 to 85NTU. Turbidity is a measure of suspended particulate matter in a water body which interferes with the passage of a beam of light through the water. High turbidity reduces light penetration which in turn impairs photosynthesis of submerged vegetation and algae. This may suppress productivity of aquatic life. Low turbidity indicates aquatic diversity (www.epa.ie). From the results, it was observed that upstream, midstream and downstream had high turbidity which were above the standard permissible limit; with the highest value recorded at the upstream followed by midstream and downstream. The high turbidity of Nworie river could be attributed to increased sediment load (which reduces the depth of the river) from market construction going on within the period of the study as well as erosional deposits. Again, it was observed that the sand mining machines release oil/grease into the river in the course of its operation which could impair the clarity of the river thus endangering aquatic species.

There were 276mg/l, 272mg/l and 268mg/l of TDS at the upstream, midstream and downstream respectively. The Total dissolved solids mean

value as obtained was 272mg/l for Nworie river. TDS measures the number of dissolved solids in a river; TDS values obtained in Nworie river was high and above the permissible limits and could be attributed to anthropogenic activities thus making Nworie river unsuitable for drinking. Nnaji and Duru found Nworie river to be above the safe limits (Nnaji and Duru, 2006). However, water classification by level of TDS (<500mg/L) revealed Nworie river to be a freshwater. Presence of calcium (Ca²+) and magnesium (Mg²+) in water indicates hardness, it was observed in this study that calcium did not exceed the safe limit whereas magnesium exceeded the permissible limit of WHO by 68% at the upstream and within safe limit of NAFDAC at the upstream. Potassium (K+) was observed to be within the permissible limits of WHO.

From the results obtained, the water conductivity at the upstream, midstream and downstream were  $106\mu\text{S/cm},\,94\mu\text{S/cm}$  and  $78\mu\text{S/cm}$  respectively with a mean value of  $93\mu\text{S/cm}$ . Water conductivities at the both the midstream and downstream were observed to be within the acceptable limits whereas upstream recorded 6% increase above the acceptable limit. The higher increase observed at the upstream could be the effect of material and erosional deposits from the surrounding watershed. Conductivity measures the ability of water to conduct an electric current; thus the greater the content of dissolved salts in the water, the more current the water carries.

Table 1: Comparison of water parameters sampled at various points in Nworie River with standards								
Water parameters	Upstream	Midstream	Downstream	Mean	S.D	wно	NAFDAC	
рН	7.86	7.56	6.85	7.4	6.55	6.5-8.5	6.5-8.5	
BOD mg/L	75	60	56	64	10.02	50	NGV	
Turbidity (NTU)	85	78	65	76	10.15	50	NGV	
Total dissolved solids (TDS) Mg/L	276	272	268	272	3.27	250	100	
Potassium (K+)Mg/L	0.78	0.85	0.65	0.76	0.10	6.0	NGV	
Calcium (ca2+) Mg/L	2.25	2.60	1.55	2.13	0.53	70	NGV	
Magnesium	1.18	0.0	0.85	0.98	0.18	0.5	0.20	
Conductivity (μS/cm)	106	94	78	93	14.05	100	NGV	

Note: NGV = No Guideline Value WHO=World Health Organisation NAFDAC= National Agency for food, drugs administration and control.

Table 2: Standards and guideline for water Quality Evaluation							
Water parameter	WHO	NAFDAC	USEPA				
рН	6.5-8	6.5-8.5	6.5-8.5				
Biological oxygen Demand (Mg/L)	50	NGV	NGV				
Turbidity (NTU)	50	NGV	NGV				
Total Dissolved solids (Mg/L)	500	100	NGV				
Potassium (Mg/L)	6.0	NGV	NGV				
Calcium (Mg/L)	75	NGV	NGV				
Magnesium (Mg/L)	0.5	0.20	NGV				
Electrical Conductivity (μS/cm)	300	NGV	NGV				
Ammonia (Mg/L)	1.5	NGV	NGV				
Chloride (Mg/L)	250	NGV	250				
Iron (Mg/L)	0.3	NGV	0.3				
Lead (Mg/L)	0.01	NGV	0.015				
Arsenic (Mg/L)	0.01	NGV	0.01				
Copper (Mg/L)	2.0	NGV	1.3				

Note: NGV= No guideline value WHO=World Health Organisation NAFDAC= National Agency for Food, drugs, Administration and control USEPA= United states Environmental protection Agency.



Figure 3: Upstream (Greenish colour)



Figure 4: Midstream (Dark- Greenish colour)



Figure 5: Downstream (Brownish-muddy colour)

### 4. CONCLUSION

Significant effect of land degradation on the water quality of the river was evidenced in the level of constituents found in the analysed water samples which were above the desirable limits; thus unsafe for drinking and human consumption. The high sediment load and erosional deposits into the river increased the turbidity thus reduced the amount of light penetration which otherwise would have been utilized by algae and submerged vegetation for photosynthesis. Biological oxygen demand of the river was high due to high level of solid waste disposal into the river by the inhabitants of the area. It therefore means that the river was under a serious threat by the action of human activities especially the inhabitants of the area thus the need for all stakeholders to ensure that good soil conservation practices and measures are put in place to avoid further deterioration of the watershed.

#### RECOMMENDATIONS

Based on my findings, the following recommendations are made and these include:

- Periodic dredging of Nworie River is recommended, this would ensure that river obstructions are removed and in turn clears the water ways thereby increasing its carrying capacity. The excavated materials could equally be used to build up the river banks to curtail the erosion of the banks of the river.
- ii. Relevant agencies saddled with the responsibility of ensuring waste disposal should be up and doing in their quest for ensuring that indiscriminate waste disposal into the river is stopped, inhabitants of the study area should be enlightened on the dangers of dumping solid waste along the river courses.
- iii. Environmental Laws should be enacted and if already enacted should be enforced on individuals mining and excavating sand in negligence to outlined guidelines and procedures. Defaulters should be sanctioned
- iv. Since environmental balance, land degradation and food security are strongly linked, each must be addressed in the context of the other to have a measurable impact to the society.

#### **FUTURE WORK**

For ease of data collection and delineation GIS should be incorporated. Future work should equally consider sampling the aquatic life and plants

especially vegetables within the watershed for heavy metal presence.

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