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HUMAN PRESSURE AND ITS ENVIRONMENTAL EFFECTS ON THE ONUIMO REGION OF THE IMO RIVER

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Abstract:
This study assessed the impact of anthropogenic activities on water quality in the Onuimo section of the Imo River, southeastern Nigeria. Weekly water samples were collected over 12 weeks (May–July 2017) from four stations along the river. Parameters measured included temperature, transparency, pH, Total Dissolved Solids (TDS), Biological Oxygen Demand (BOD), Dissolved Oxygen (DO), and concentrations of heavy metals. Temperature showed no significant variation across stations except in May, while transparency varied significantly except in July. pH levels were consistent among stations in July. Station C exhibited significant differences in several parameters throughout the period, indicating localized anthropogenic impacts. Heavy metal levels did not significantly differ among stations, but overall data suggest pollution influences linked to human activities, particularly at Station C. The findings underscore the need for continuous monitoring and pollution control to protect the aquatic ecosystem and maintain sustainable water quality in the Imo River.

Keywords: *Anthropogenic impact, Water quality, Imo River, Heavy metals*

Introduction

Quality water is essential for ecological balance and economic development. Scarcity of water is on the increase; hence the need for proper planning, monitoring and management of water as a natural resource (Bamgbose and Arowolo, 2007).Rivers are among the oldest water bodies in the world (Higler, 2012), and its pollution has become a major problem facing most developing nations. Surface waters (rivers, streams, and lakes among others) are increasingly being contaminated with domestic, agricultural, and industrial wastes in Sub-Saharan Africa (Ojekunle, 2000). Runoff from roads and impervious surfaces is a major source of water pollution as they pick up gasoline, motor oil, heavy metals, trash and other pollutants which are washed directly into streams and rivers (Alum-Udensi *et al.,* 2016). The standard of waste management is poor and outdated in many developing countries, with little or no documentation of waste generation rates and composition (Achankeng, 2003).The problems of water pollution was in the past attributed mainly to industrial effluents, and therefore thought to be a concern only for the industrialized countries, it is currently now a global issue as development and industrialization has taken different forms and has spread universally.

Freshwater bodies receiving effluents are usually characterized by higher than average biochemical oxygen demand (BOD) loadings, dissolved oxygen, ecological status, productivity and health of a river (Moshood, 2008), as well as high concentrations of major ions and heavy metals (Ademoroti, 1982; Ogunfowokan and Fakankun; 1998). The source and nature of contamination however vary from one nation to the other. Ineffective and insufficient waste management is one of the most pressing

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environmental problems facing many cities in the developing world. (Coker *et al.*, 2008). Human activities affect rivers (Iyiola, 2014) and aquatic lives (Alum-Udensi, 2016). The Onuimo section of the Imo River is a beehive of activities following the location of a market on the bank of the river by the Imo state government. Rivers and streams are unique, and the quality of an aquatic ecosystem is dependent on the physicochemical qualities of water and the biological diversity of the system (Irfanullah, 2006). There is little or no existing data on the pollution status of this section of the river. This work will therefore breach this information gap by assessing the physical and chemical parameters as well as heavy metal content of the water body. This will serve as benchmark information, safe guard the health of the river towards future and continuous pollution by anthropogenic activities, as well as determine the pollution level of the river.

Materials and Methods

The research was carried out in Onu-imo River which lies between longitude $5^0$50'56N and latitude 7^0 14'20W. Physical parameters were determined *in-situ* while the chemical and heavy metals analysis was carried out at the Department of Fisheries and Aquatic Resources Management laboratory, Michael Okpara University of Agriculture Umudike, Nigeria.

Four sample stations were mapped. Station A (the upstream where there is little or no human activities); Station B (beside the timber factory); Station C was (beside Onuimo market); and Station D (further downstream). Each of these stations had three sampling points. Samples were collected weekly from the sites for a period of 3 months (May 2017 – July 2017).Water samples were collected from the sites between 6.00 hours and 9.00 hours. The samples were transported to the University the same day. The distant between the points was 100meters apart. Plastic sampling containers were used for water sample collection. The containers were properly cleaned before use and rinsed with river water at sampling site. The sampling were done in the middle stream by dipping each sampling bottle at approximately 20 -30 cm below water surface (APHA, 1999).

The following water parameters were sampled: Temperature, Transparency, pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), and Total Dissolved Solids (TDS) (APHA, 1999). The following heavy metals were determined; chromium (Cr), iron (Fe), zinc (Zn), and lead (Pb). They were analysed using an Atomic Absorption Spectrophotometer (AAS) at different wavelength and the value for each heavy metal was recorded.

The data obtained were analysed using Analysis of Variance (ANOVA), and means separated using Duncan's Multiply Range test.

Results and Discussion

Table 1 shows the physical parameters of the Onuimo section of Imo River during the period of study. Temperature showed no significant differences ($p>0.05$) amongst the points except in the month of May. In the month of May, there were significant differences ($P<0.05$) between Section B and D, while there exist no significant differences ($p>0.05$) between Sections A and C. There were significant differences ($P<0.05$) amongst the various sections in transparency, except in the month of July. Figure 1 shows the physical parameter of the different points for the entire period. Temperature is highest in points B and D. transparency on the other hand decreases from Point B to D whereas point C has the highest value in terms of pH. Temperature is an important factor that influences primary production in rivers and depends on the climate, sunlight and depth (Ayoade, 2009). The normal range to which fish is adapted in the tropics is between 8^0C and 30^0C. Water temperature ranged between 28.0±0.2 2and 29.2±0.12. This is within the recommended range by Mustapha (2008).This result is similar to Fafioye *et al.* (2005) who reported a range of 26.5℃ -31.5℃ in Omi water body, Ago iwoye, Ogun state, Nigeria and agree with previous reports for temperatures in the tropics (Atobatele and Ugwumba, 2008; Ayoade *et al.*, 2006). Ayoade *et al.* (2006) recommended temperature range of 20^0C-30^0C for optimum fish growth.

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The reduction in water transparency could be as a result of dumping of mill waster and refuse into the river; and run offs characteristic of the wet season. There was a generally low transparency in the month of July which is the peak of rainfall.

There were no significant difference (p>0.05) among the sections for pH in the month of July. There were no significant difference (p>0.05) amongst sections B and D for the month of May and June, and these were significant different (p<0.05) from the other points. The pH range observed during the period of this study is within the acceptable range for inland waters (pH 6.5 - 8.5), as reported by Mahar (2003). Boyd and Tucker (1998), reported pH range of 6.09 - 8.45 as ideal for supporting aquatic life including fish. All the physical parameters studied fall within the standard guideline (WHO, 2018), except for the low pH in the month of May which could be due to anthropogenic acidification of allochthonous organic matter especially at section C which is by the market. The combined effects of run-off from adjourning agricultural lands and photosynthetic activity of macrophytes could be responsible for the high mean value of pH recorded during the month of June and July. The increased organic matter brought in by rain as a result of runoff tends to reduce dissolved oxygen through utilization of organic dehydration giving rise to a fall in pH (Atobatele and Ugwumba, 2008). Mustapha (2008) reported that the slight acidity in the dry season may be due to high carbon dioxide concentration occurring from organic decomposition.

Table 1: Physical characteristics of Onuimo section of Imo River during the period of study.

PARAMETER	MONTH	Section A	Section B	Section C	Section D
Temperature	May	28.0±0.22[c]	29.2±0.12[a]	28.1±0.20[c]	28.6±0.22[b]
	June	28.5±0.22[a]	28.4±0.12[a]	28.4±0.32[a]	28.8±0.23[a]
	July	28.9±0.02[a]	28.9±0.22[a]	28.7±0.22[a]	28.7±0.20[a]
Transparency	May	35.0±0.21[d]	37.0±0.01[c]	38.0±0.13[b]	38.5±0.22[a]
	June	50.0±0.22[a]	47.0±0.16[b]	42.0±0.24[d]	45.0±0.02[c]
	July	29.0±0.12[b]	31.0±0.23[a]	31.0±0.22[a]	26.0±0.12[c]
pH	May	5.8±0.17[b]	5.9±0.15[a]	5.3±0.20[c]	5.9±0.12[a]
	June	7.0±0.20[a]	6.4±0.22[b]	5.8±0.32[c]	6.4±0.21[b]
	July	7.0±0.20[a]	6.9±0.21[a]	6.9±0.20[a]	6.9±0.24[a]

Mean values with the same superscripts letters in the row were not significantly different (p>0.05)
Data are mean value of the triplicate of the treatments ±standard deviation.

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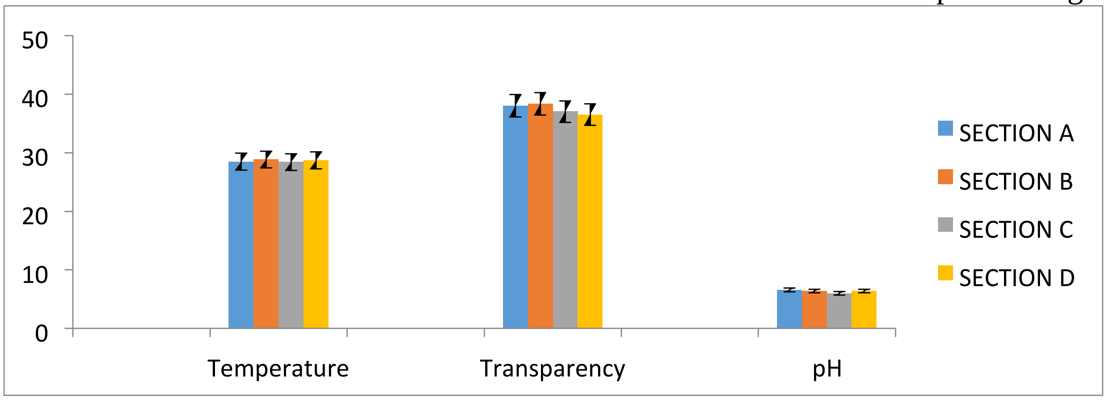

Figure 1: physical parameters of the sampled site at different sections.

Table 2 shows result of the chemical properties of the river. There were no significant differences (p>0.05) between Section B and C for the months of May and July for dissolved oxygen, however, there were significant differences (p<0.05) in dissolved oxygen between sections A and D for the same months. Biochemical oxygen demand showed no significant difference (P>0.05) amongst the Sections for the months of May. There were significant differences (p<0.05) among sections in the month of July with section D having a high demand of 2.7mg/l and point A the least with 1.9mg/l. The total dissolved solids concentration ranged from 13.0±0.2to 56.0±0.2 mg/l. Section C showed consistent significant differences (p<0.05) from the other points for the whole months. Figure 2 show the chemical parameters of the different sections at the end of the experiment. Sections C and D are high in dissolved oxygen and biological oxygen demand. However, Section C has the highest total dissolved solids value. Dissolved oxygen is an important indicator of water quality, ecological status, productivity and health of a river (Moshood, 2008). The quantity of dissolved salts and temperature greatly affects the ability of water to hold oxygen (Araoye, 2008; Abolude *et al.,* 2012). The dissolved oxygen values in May and June were observed to be critically low. This could be as a result of human activities on the water and low water volume which is characteristic of the dry season while the increase in the month of July could be as a result of high water volume which is a characteristic of wet season.

Biological oxygen demand (BOD) indirectly shows the amount of putrescible organic matter degradable by microbial metabolism in the water medium. Adakole *et al.* (2008); and Abolude *et al.* (2012) reported that BOD is a fair measure of cleanliness of any water on the bases that values of less than 2 mg/l are clean, 3-5 mg/l, fairly clean and 10 mg/l definitely bad and polluted.It is often used as a measurement of pollutants in natural and waste waters and to assess the strength of waste, such as sewage and industrial effluent (Zeb *et al.*, 2011). The study show that the BOD concentration of Onuimo section of Imo river water fell under the maximum permissible limits of the WHO (2018).

Total dissolved solid (TDS) is a measurement of inorganic salts, organic matter and other dissolved materials in water (USEPA, 1976). A high concentration of dissolved solids increases the density of water and affects osmo-regulation of fresh water organisms, reduces solubility of gases and suitability of water for drinking, irrigational and industrial purposes (Boyd and Tucker, 1998). TDS concentrations are used to evaluate the quality of freshwater systems (Manora, 2012). Section C showed the highest values of TDS throughout the study period. This could be as a result of activities in the market leading to the dumping of refuse and discharge of abattoir wastes into the river. Dissolved solids determination are important in water quality studies, though no serious health effect has been associated with dissolved solids ingestion in water but some regulatory agencies (EPA, 2001) recommended a maximum dissolved solids value of 500mg/l in drinking water supplies.

Table 2: chemical characteristics of OnuImosection of Imo River during the period of study.

PARAMETER	MONTH	Section A	Section B	Section C	Section D
Dissolved oxygen	May	4.9±0.2^{a}	5.4±0.0^{b}	5.2±0.2^{b}	4.8±0.1^{ab}
	June	8.0±0.1^{a}	7.2±0.2^{c}	7.6±0.1^{b}	8.2±0.0^{a}
	July	7.8±0.1^{a}	7.6±0.2^{b}	7.7±0.0^{b}	7.5±0.2^{c}
Biochemical oxygen demand	May	2.2±0.2^{a}	2.4±0.0^{a}	2.1±0.2^{a}	2.2±0.2^{a}
	June	3.4±0.1^{a}	2.7±0.3^{b}	3.3±0.2^{a}	3.4±0.0^{a}
	July	1.9±0.2^{c}	2.4±0.3^{ab}	2.2±0.1^{b}	2.7±0.2^{a}
Total dissolved solids	May	17.0±0.3^{b}	17.0±0.2^{b}	38.0±0.1^{a}	17.0±0.2^{b}
	June	15.0±0.2^{c}	17.0±0.0^{b}	56.0±0.2^{a}	15.0±0.2^{c}
	July	14.0±0.1^{c}	13.0±0.2^{d}	22.0±0.2^{a}	15.0±0.3^{b}

Mean values with the same superscripts letters in the row were not significantly different (p>0.05)
Data are mean value of the triplicate of the treatments ± standard deviation.

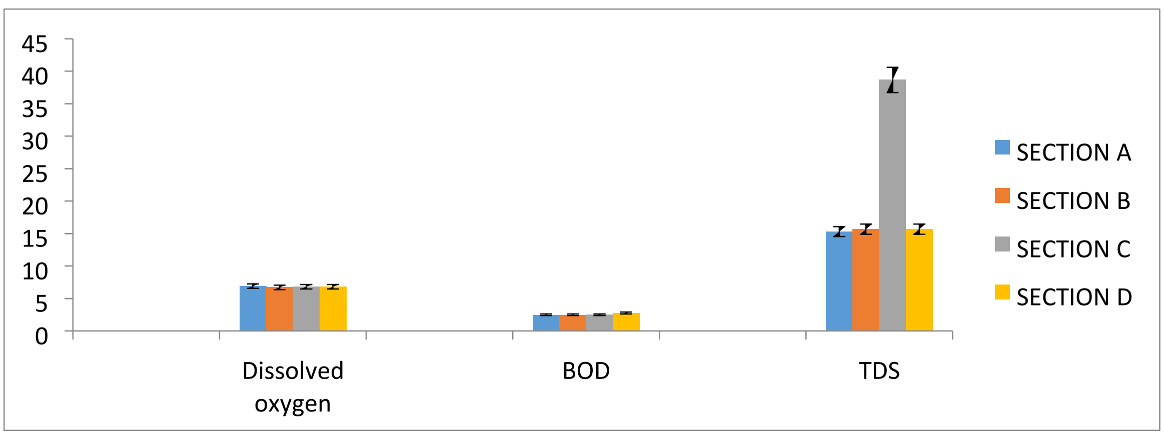

Figure 2: Chemical parameters of the sampled site at different Sections.

Table 3 shows the results of heavy metals present in the water samples. The mean concentration of zinc from the sampled sections in different months ranged 0.21±0.21 mg/l to 0.54±0.22 and showed no significant difference (p>0.05) amongst the sections. Chromium ranged from 0.01±0.24 to 0.21±0.23. Chromium showed no significant difference (p>0.05) among the sections in the various months. Lead and iron also showed no significant differences (p>0.05) among the sections in the various months. However, it was generally observed that the values for the month of July in all the sections were lower than the two preceding months for the heavy metal variables measured. This may be due to the fact that during the month of May, the quantity of the water is reduced in all the sections and the concentration therefore increased. Figure 3 shows the value for the various sections at the end of the experiment. Sections C and D show higher zinc and chromium values. Highest value for lead and Iron were observed in sections C and B respectively.

Heavy metals from weathered soils and rocks, mining and metallurgical releases and industrial emissions causes stress in water (Boari *et al.,* 1997; Adams, 2001), and this may expose microflora or micro fauna, aquatic lives and humans who depend on such waters to contamination (Edorh, 2007). Chromium is a key element in the metabolism of sugar in plants and animals and also regulates the rate of insulin molecules in transporting glucose into the cells for glycolysis. High concentrations of

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Chromium and the other heavy metals were observed in the month of May. Reduced water volumes during that period following lower rainfall at that time could have resulted in higher concentration of the elements. This situation is also reported by other studies at different places (Olatunji and Osibanjo, 2012). The result of this study is in contrast to the findings of other studies that reported Chromium below the recommended standard (Akintujoye *et al*., 2013) and quite different from other studies that reported higher concentrations of Chromium beyond the recommended standard (Hong *et al.,* 2014; Olatunji and Osibanjo, 2012). Zinc and chromium were within the permissible limits (WHO, 2018). The generally high values of chromium and other heavy metals may be due to the fact that other factors other than seasons and anthropogenic activities are impacting on their concentration in the river.

Lead is well-known as cumulative poison that has several damaging effects on public health even at trace concentration in the body of humans and organisms (Hong *et al*., 2014) and concentration in beyond recommended standard is be detrimental to health. The high concentration of lead in section C could be attributed to the impact of anthropogenic activities at the market site such as dumping of wastes which will eventually leached directly into the River. This find is similar to the findings of Olatunji and Osibanjo (2012), who reported higher values of lead during the dry season in lower River Niger drainage in North central Nigeria. Eneji *et al*. (2011) reported lead concentration within the drinking water quality standard in River Benue which differs significantly from the findings of this study. Lead was not within the acceptable limits set by WHO (2018).

The high incidence of iron at point B is an indication of an increased disposal of iron related effluents into the river. This may have come from the machineries and or equipment used in the timber industry. However, iron was still within the acceptable limits set by WHO (2018).

This result is in contrast to the result of other studies elsewhere that reported iron in surface water beyond the acceptable limits (Akintujoye *et al.,* 2013). Similarly, the result of this study is similar to the findings of other studies that reported iron concentration in surface waters within the acceptable limit for drinking water quality (Abah *et al.,* 2013).

Table 3: Heavy metal concentration of Onuimosection of Imo River during the study.

PARAMETER	MONTH	Section A	Section B	Section C	Section D
Zinc	May	0.49±0.02^{a}	0.48±011^{a}	0.51±0.12^{a}	0.48±0.21^{a}
	June	0.47±0.12^{a}	0.46±0.01^{a}	0.52±0.20^{a}	0.54±0.22^{a}
	July	0.22±0.02^{a}	0.21±0.21^{a}	0.27±0.21^{a}	0.28±0.20^{a}
Chromium	May	0.15±0.22^{a}	0.16±0.12^{a}	0.21±0.23^{a}	0.18±0.24^{a}
	June	0.20±0.12^{a}	0.15±0.20^{a}	0.17±0.12^{a}	0.14±0.02^{a}
	July	0.01±0.24^{a}	0.03±0.11^{a}	0.04±0.13^{a}	0.06±0.32^{a}
Lead	May	0.48±0.21^{a}	0.48±0.32^{a}	0.61±0.21^{a}	0.44±0.15^{a}
	June	0.56±015^{a}	0.49±0.13^{a}	0.52±0.22^{a}	0.59±0.21^{a}
	July	0.06±0.02^{a}	0.06±0.21^{a}	0.06±0.22^{a}	0.06±0.30^{a}
Iron	May	0.9±0.12^{a}	0.9±0.12^{a}	0.8±0.16^{a}	0.9±0.17^{a}
	June	3.9±0.20^{a}	4.2±0.20^{a}	4.1±0.13^{a}	4.1±013^{a}
	July	0.9±0.22^{a}	0.9±0.23^{a}	0.8±0.11^{a}	0.9±0.16^{a}

Mean values with the same superscripts letters in the row were not significantly different ($p>0.05$)
Data are mean value of the triplicate of the treatments ± standard deviation.

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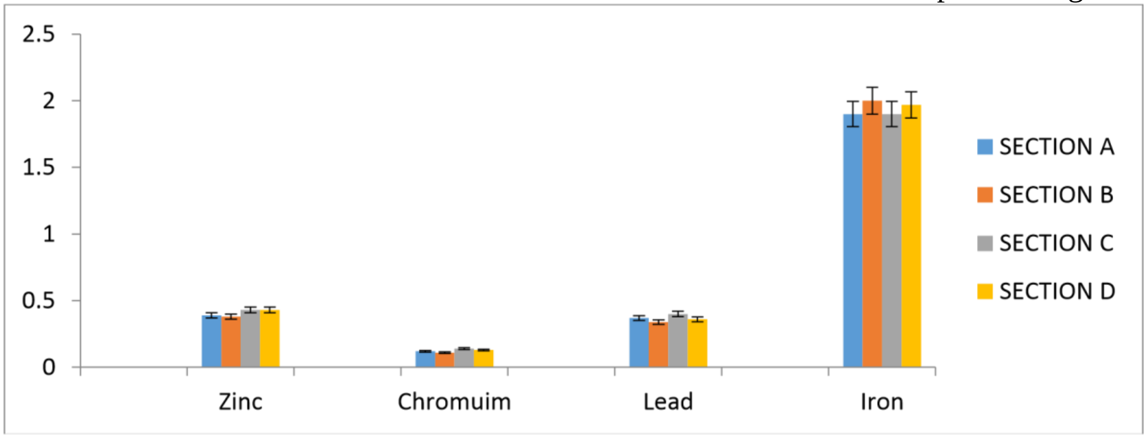

Figure 3: Comparison of Heavy metal levels of the Sections.

Conclusion

This study showed that anthropogenic activities in the area have impacts on the river. These is well evidenced by biochemical oxygen demand and very high total dissolved solids values in Sections B and C where timber effluents and market waste enter the water. The reported level of heavy metals in the water poses a threat to the health of humans who depend directly on the water for domestic use. This section of the river may not be too polluted when compared to other rivers, since most of the parameters measured were still within safe limits, however, there is a need for a continuous pollution monitoring program of the river to prevent overload.

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