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Understanding the Influence of Stream-Flow, Suspended Solids, and Turbidity on Water Quality of OSE River, ONDO State.

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Abstract: Increased sediment and nutrient loading in rivers adversely affect the river quality. Water quality and river flows are correlated and this correlation varies spatially as well as temporally. Turbidity is an optical property of a liquid that causes light rays to scatter and absorb rather than transmit in straight lines through the sample. Turbid water results from the presence of suspended and dissolved matter such as clay, plankton, other microscopic organisms, organic acids and dyes. Although water is important to life, it is one of the most poorly managed resources in the world. The quality of water resources in any ecosystem provides significant information about the available resources for supporting life in the ecosystem. Therefore, the knowledge of the status of water bodies in terms of turbidity and suspended solids is quite essential for proper management of water environments. This study assessed the quality of water in Ose River in relations to streamflow, suspended solids and turbidity, because of its significance as the primary drinking water source for Owo town and its environs. Data and samples were collected over period of four months spanning through two seasons i.e. dry and wet seasons. These were analysed and results showed fluctuation of turbidity and TSS under changing flow conditions.

Keywords: Water quality, Influence, Turbidity, Velocity, Suspended Solids.

I. INTRODUCTION

Water quality describes the condition of the water, including chemical, physical, and biological characteristics, usually with respect to its suitability for a particular purpose. Water quality is affected by a wide Range of natural influences (Maybeck, et al, 1996). The most important of the natural influences are ecological, hydrological and climatic. Water quality is measured by several factors such as the concentration of dissolved oxygen, bacteria levels, the amount of salt (salinity) or the amount of materials suspended in the water (turbidity)

Increasing population and industrialisation have resulted in a variety of impacts on the river systems, while increasing the demand for higher quality water. Increased sediment and nutrient loading in rivers adversely affect the river quality. Water quality and river flows are correlated and this correlation varies spatially as well as temporally. Turbidity is an optical property of a liquid that causes light rays to scatter and absorb rather than transmit the straight lines through the sample. Turbid water results from the presence of suspended and dissolved matter such as clay, plankton, other microscopic organisms, organic acids and dyes (ASTM, 2007).

The size of the particulate matter in suspended sediment varies in proportion to the energy of the river (Paul, 2005). Particles greater than 50µm (i.e. sand) will fall out of the water column in seconds, once the water is calmed.

Silt-sized particles (50 – 2µm) can remain the suspension for minutes in still water, while clay-sized particles (<2µm) can remain in suspension indefinitely. Deborah J, et al (2014) showed that visual clarity in downstream ecosystem is strongly related to total suspended solids. Reduced visual clarity owing to fine sediment constrains behaviour of some aquatic animals and degrades recreational amenity (Davies-Colly and Smith, 2001). While fine sediment is part of a natural river system, when present in excessive amounts, it becomes a pollutant (Ryan, 1991).

Suspended sediment and turbidity are thought to increase with increasing stream size, stream order, and drainage area because of the accumulation of sediment and nutrients from the watershed and stream banks (Thorp, et al 2006). The level of suspended solids in rivers changes rapidly and unpredictably with changing water depths and velocities related to anthropogenic causes or natural hydrologic events making the quantification of suspended solids critical (Susfalk et al, 2008). Although water is important to life, it is one of the most poorly managed resources in the world (Fakayode, 2005). The quality of water resources in any ecosystem provides significant information about the available resources for supporting life in the ecosystem (Rajesh et al, 2002). Therefore, the knowledge of the status of water bodies in terms of turbidity and suspended solids is quite essential for proper management of water environments. The objective of this study is to assess the quality of water in Ose River because of its significance as the primary drinking water source for

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Owo town and its environs. Human activities along the Ose River banks have increased substantially in the past few years. These activities have been causing significant impacts on the quality and clarity of water in the river creating a need to monitor the quality of water. Results of this study could be useful in monitoring turbidity levels to meet water quality standards, to prevent adverse effects on aquatic life, and to enhance aesthetic and recreational values.

1.0 MATERIALS AND METHODS

1.1 DESCRIPTION OF STUDY/SAMPLING AREA

Ose River is an integral facet of Ondo State – Nigeria, as it is utilised surface water source for drinking water for Owo township and its environs. The river lies within the coordinates 7° 18` 34.1″N and 5° 39` 52.9″S, it flows through Owo Local Government Area and Akoko in a south-eastern direction. It is a tidal river which is characterised by a long wet and dry season. Wet season starts from April till October, during which 80% of the annual rainfalls, with peak of the rainfall in June and September. Annual rainfall averages 1,830 millimetres. Average temperature ranges from 24ºc in August to 29ºc in February. Relative humidity is high, between 80% and 100% (www.ondostate.gov.ng). It consists of vegetation rainforest climate which is close to the mangrove belts, with major species such as Avecinia Africana, Rhizophora, Racemosa, Nypa Frintacius (palm) and tropical rainforest climate which is influenced by temperature and rainfall. The human activities of the people living around the river include fishing, hunting, and wood logging.

Figure 1. River Ose. (Source: Google map, 2019).

1.2 SAMPLING STATIONS

For the purpose of this study, two locations were chosen. Station 1 is located in the direction of water-flow before it gets to the bridge across the river. Station 2 is located immediately the flow gets across to the other side of the bridge in the direction of flow. The stations were 20 metres apart. At each station, the river width was divided into five equal sub-stations along the width of the river.

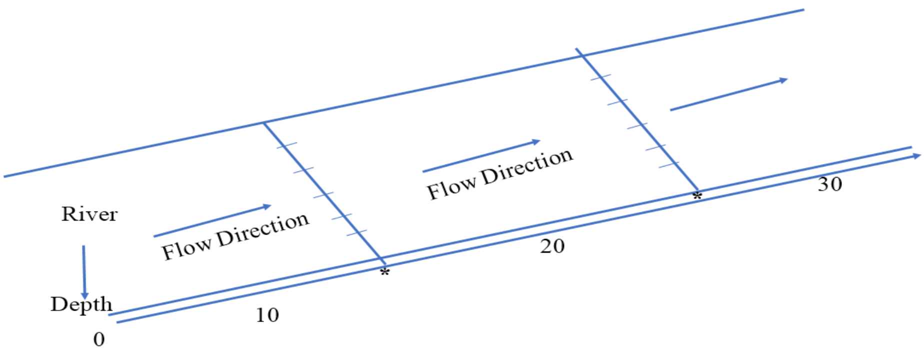

Figure 2. Cross-sectional area of the river showing the sub-divided width

1.3 DATA/SAMPLES COLLECTION

Data and samples were collected over a period of four months spanning through two seasons i.e. dry and wet seasons (November – December, 2017 and May – June, 2018). Discharge (Q) was obtained by calculating the integral of the river velocity (v) over the cross-section area of the flow (A), where (v) was measured perpendicular to the cross-section

$$Q = \int v dA$$

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The velocity (v) was measured in intervals along the cross-section by means of a current-metre. Water samples were collected in plastic sampling bottles measuring 1 litre each. The bottles were immersed into the river about 6cm below the water surface, filled to capacity and properly closed. The samples in the bottles were transported to the laboratory for proper analysis.

II. RESULTS AND DISCUSSION

The summary of data and sample results are presented in Table 1- 4 below. These values were plotted graphically to show the inter-relationship (Figure 3 – 6).

Table 1. Data and Sample results for the month of November 2017 (Representing dry season)

Section	Depth (m)	Flow (m/s)	Turbidity (NTU)	Total Suspended Solid (mg/L)
1	0.6	0.24	7.0	30.0
2	0.9	0.35	9.0	35.0
3	1.2	0.37	9.0	35.0
4	1.2	0.44	12.0	45.0
5	0.75	0.28	8.0	30

Table 2. Data and Sample results for the month of December 2017 (Representing dry season)

Section	Depth (m)	Flow (m/s)	Turbidity (NTU)	Total Suspended Solid (mg/L)
1	0.45	0.22	7.0	30.0
2	0.72	0.29	9.0	35.0
3	1.77	0.33	9.0	35.0
4	1.80	0.40	11.0	40.0
5	0.69	0.22	9.0	28.0

Table 3. Data and Sample results for the month of May 2018 (Representing Raining season)

Section	Depth (m)	Flow (m/s)	Turbidity (NTU)	Total Suspended Solid (mg/L)
1	0.90	0.48	46.0	57.8
2	1.00	0.52	60.0	58.1
3	1.30	0.58	66.0	58.1
4	1.30	0.58	66.0	58.7
5	1.00	0.50	65.0	58.4

Table 4. Data and Sample results for the month of June 2018 (Representing Raining season)

Section	Depth (m)	Flow (m/s)	Turbidity (NTU)	Total Suspended Solid (mg/L)
1	0.90	0.58	65.0	57.1
2	1.00	0.69	65.0	58.1
3	1.30	0.80	85.0	58.7
4	1.30	0.80	85.0	58.7
5	1.00	0.70	68.0	58.4

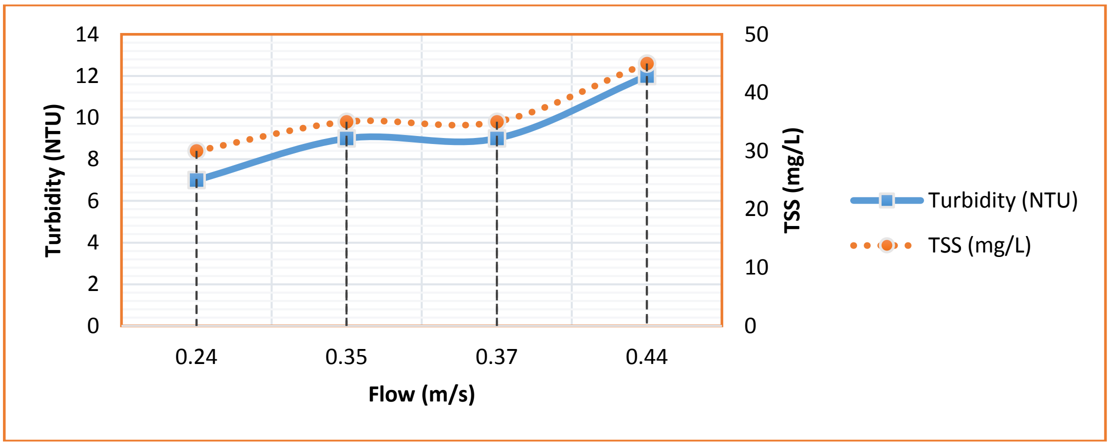

Figure 3. Line plot of Turbidity *vs* TSS in relation to Flow for the month of November 2017.

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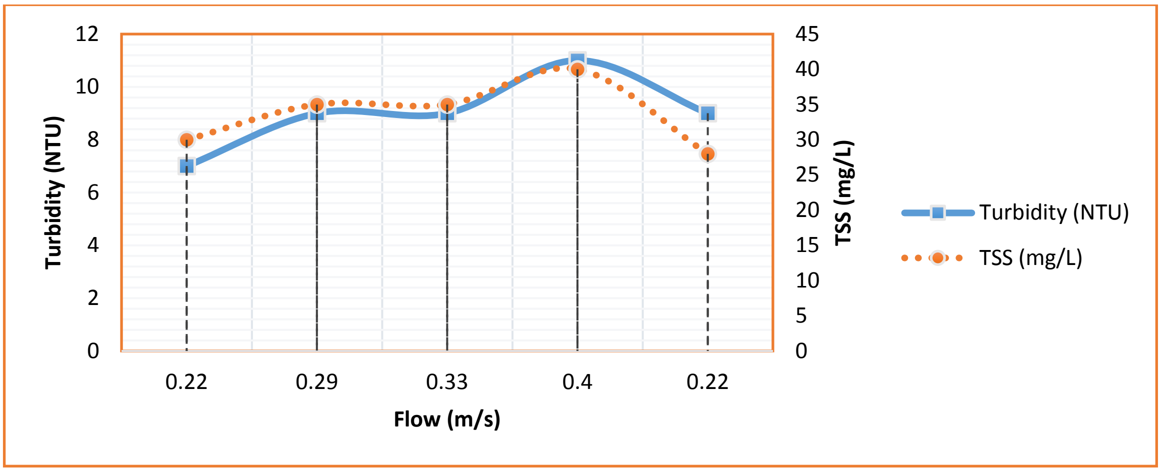

Figure 4. Line plot of Turbidity *vs* TSS in relation to Flow for the month of December 2017.

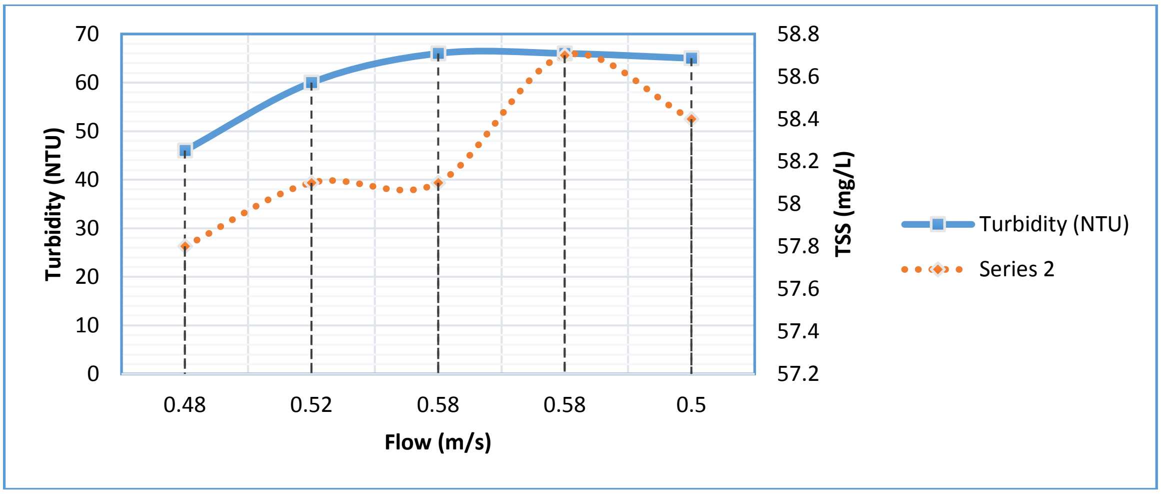

Figure 5. Line plot of Turbidity *vs* TSS in relation to Flow for the month of May 2018.

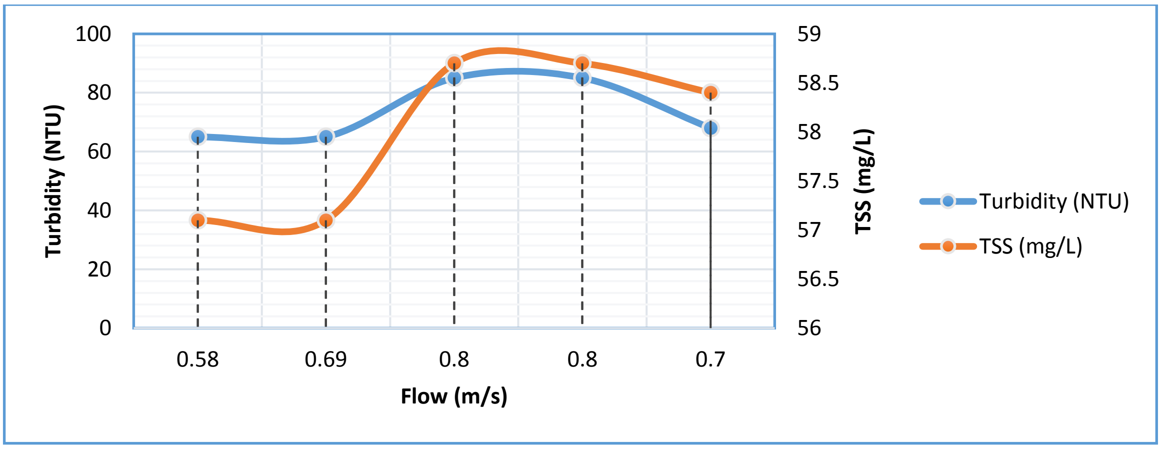

Figure 6. Line plot of Turbidity *vs* TSS in relation to Flow for the month of June 2018.

III. DISCUSSION

From the graph, it can be gathered that the increase in inflow increase the turbidity level both in dry and raining season. This can be attributed to rapid dilution/dissolution of particles by moving waster. Likewise, the TDS also varies accordingly with the flow due to the above mentioned reasons.
However, it is noted that TDS/Turbidity values are lower in dry season compared to raining season. The result might suggest that a raining event may eventually add more sediment in the river due to some erosion of river sites that carried

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some sediment from the upstream and increase the TDS concentration in the downstream. In previous study, it was reported that rainfall could cause solid erosion upstream, bringing loads of suspended solids into the rivers (Baker et al, 2007). The increased discharge or flow rate caused by the storm would also keep lighter materials in suspension than in a stable flow in the river during a dry period.

In general, study showed that an increase in TDS concentrations affecting in an increase in turbidity levels (Low Hni Xiang et al, 2011). Suspended solids have the ability to obstruct the transmittance of light in a water sample, when TDS concentration increases; light scattering intensifies (Sadar, 1998). APHA defines turbidity as the optical property of the water sample that causes light to be scattered and absorbed rather than being transmitted in straight lines.

The optical property expressed as turbidity is affected by the interaction between light and suspended particles in water. Thereafter, turbidity could provide a good estimate of the concentration of TDS in a water sample even though turbidity is not a direct measure of suspended particles in water. Past studies have been conducted and consistently showing a strong relationship between TDS and turbidity (Gippel, 1995).

However, there may be a case of obtaining lower value of turbidity number that paired up with a certain TDS concentration from a river water sample. At low TDS concentration this might be due to a fine sand-size fraction in the river samples which was quickly settles below the zone monitored by turbid meter (Holliday et al, 2003).

IV. CONCLUSION

Result of this study could be used to better understand the fluctuation of turbidity and TSS under changing flow conditions and to assess quality of water in Ose River relative to the water quality standards in practice. This prevailing water quality conditions in Ose River provide necessary information for water managers and planners to adjust water treatment strategies accordingly.

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