



Turbidity Impact on Water Quality Index of the Aquatic Ecosystem at the River Niger Basin in Asaba, Nigeria

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Turbidity is the rate of physical disturbance of water, optically attributed to colour cloudiness due to particulates contamination like tiny suspendable materials. Its occurrence expectably tends to influence water quality index of river basins. This poses treat to the water usages extending to even agriculture otherwise a major source of food for man. The portable water turbidimeter was used in obtaining the turbidity level of the river water, used in classifying the turbidity status, and evaluating the impact in response to the water quality index otherwise an indicator of the general water quality. The conclusive results showed that on average, turbidity and water quality index for various hours were 3NTU and 77% in all, 4NTU and 77% at late hours, 5NTU and 76% at mid-day, 1NTU and 78% at early hours. That on minimal turbidity and water quality index was 2NTU and 78% on average, as well as in late hours, 3NTU and 78% at mid-day hours, and 1NTU and 78% at early hours. And, the maximum turbidity and water quality index were 6NTU with 72% on average, 7NTU with 72% at late hours, 11NTU with 66% at mid-day hours, and 2NTU with 78% at early hours. It was conclusively found that turbidity impacts on water quality index were in inverse order of the higher turbidity value attributive to the lower water quality index value, as well as the lower turbidity value associative to higher water quality index value. And, that the minimal turbidity in the river system were approximately 1NTU with 78% WQI, while the maximum was 11NTU with 66% WQI.

ABSTRACT



Keywords: Turbidity; Water Quality Index; River Basin; Types of Basins; Aquatic Ecosystem

Introduction

The idea of monitoring water quality originated from Germany in the year 1850, aimed at water purity with respect to microorganisms harmful indication (Rajkumar *et al.*, 2022). This significance at present remains prominent in the management of water bodies. Rajkumar *et al.*, (2022), added that the river water classification system was developed in 1978, used by various countries for pollution assessment using parameters like turbidity, microorganisms, smell, *etc.* These and other water quality contributors point on the improvement of waterbodies. The improvement is influenceable by level of understanding which is associated to adequate study resultable to efficient management capacity. More than half population of human on earth (60% coastal dwellers) rely on quality water (Okolotu, and Oluka, 2021), for various purposes including for healthy waterbody system, agricultural production, general livelihood, *etc.* The specific demand for water varies majorly with location, water availability, and people. Millions in hundreds of persons in the West Africa rely on the river Niger basin for drinking, fish for eating, irrigation for growing crops, hydroelectric power, and necessary productive processes (UNIDO, 2021).

Turbidity refer to physical cloudiness with respect to solid matter (algae, sludge, planktons, clay, silt, sand, *etc.*) suspension in water, resultable to colour contamination. It is the fluid physical property that describes cloudiness, haziness, or optical transparency reduction, as a result of light transmission blockage by suspended materials presence in liquid (Matos *et al.*, 2024). Turbidity is an indicator of potential health status of an aquatic ecosystem, as well as, impact on water quality with respect to constituent harmful pathogens and contaminants (Tyler *et al.*, 2022). It is influenceable by erosion sediment movement, organic matter especially of dissolved forms mostly algae blooms, decaying materials like plants, agricultural effluents like fertilizers and other discharges, sludge and wastewater inflow, mining operations, heavy rain of high storm, river bed disturbances by bottom-dwelling organisms, *etc.* It is representable using the measurement unit of Nephelometric Turbidity Units otherwise NTU. Formazin turbidity unit otherwise FTU, is also a measurement unit of turbidity, convertible with the Nephelometric Turbidity Units, NTU (Bozorg-Haddad *et al.*, 2021). Turbidity impacts are vital in water facilities aspects for examples, fisheries, aquaculture, water treatment plants, wastewater treatment plants, and, industrial water treatment systems (Matos *et al.*, 2024). Health impacts include nausea, eye irritation, skin scratching, ear irritation, dizziness, and unease breathing (Getahun *et al.*, 2024).

Water quality index refers to the quality summation of water condition expressed from 0 to 100, based on already set standard. Water quality index describes water suitability for usage, using simplified single quality information ranging from 0 to 100 values thereby reducing unnecessary bulkiness (Chidiac *et al.*, 2023). It is communicably easy for non - water experts (Lukhabi *et al.*, 2023). Water quality index provide avenue for evaluation and monitoring of water condition at global level enabling regional comparison, identification of changes, as well as trends prior time (Siriwardhana *et al.*, 2023).

River basin is a depressed natural water catchment land area, with flow capacity for water conveyance. The main types of water basins are the structural basins, river drainage basins, and the ocean basins (NGS, 2024). River basins are watersheds that receive discharges from nearby tributaries as well as drainages, allowing water outlet flow to bigger waterbodies like bigger rivers, oceans or seas. The existing river basins globally are about 310 in numbers, occupying about 63,000,000 km² of expandable land area, with its collective regions covering upto 52% of landmasses on earth (Islam *et al.*, 2024). The structural basin is naturally formed by tectonic activities like changes due to shifts in the earth tectonic plate leading to reshaping of land area, and is influenced by erosion and weathering processes. It results from overtime tectonic uplifting otherwise tectonism. It thus takes long duration of time to form, and mostly exist around desert regions. The oceans being the largest of all waterbodies on earth possess the largest basins. The five main ocean basins are Atlantic basin, Southern basin, Pacific basin, Arctic basin, and, Indian basin (NGS, 2024). The ocean basins were carved out from the depressed sides of various continents. There are however relatively based on the global oceans landforms. The River Niger basin (a typical example of river basin) is presented in figure one (1) below;



Figure 1: The River Niger basin (UNIDO, 2021).

Aquatic ecosystem refers to the combinant purpose of aquatic living organisms and their environment for routine ecological role. The idea of ecosystem came into existence within the era of 1930s (Yu *et al.*, 2021). It points to the functions played as the aquatic animals, plants, and other microorganisms interact together with their aquatic environments to deliver expected service. It involves units of living things like plants, water animals, microbes, *etc.*, and non living things like water, river bed, sediments, *etc.*, all combining to function singularly as a waterbody system. Eco relates to response while system relates to organize. Ecosystem thus fuels responses to an organized natural community of living and non living things. In the singular earth ecosystem, every living thing is connectively related for example, indirectly through food chains, metabolism, and others (Sutton, and Anderson, 2024). Ecosystems of various types are presented in figure two (2) below;

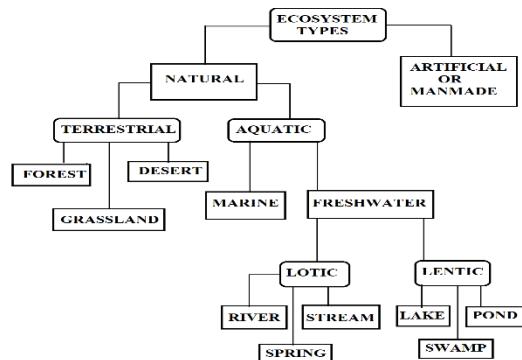


Figure 2: Different types of ecosystems

Materials

The River Niger basin in Asaba, Nigeria was the study area, located in Delta State of Nigeria, in West Africa. This river records the largest in Asaba, delta state, and in Nigeria. It possesses a confluence at the Otu - Ogwu area of Asaba. The geographical location is presented in figure three (3) below;



Figure 3: The study area (by satellite aerial photography)

Other materials include: water turbidimeter, computerized mobile digital set, satellite sensing software, hydro indicator, etc.

Methods

The portable water turbidimeter which utilizes the rate of light scattering upon focussing on water with particles which indicates the scattering due reflectance, resultable to possibly high light scattering (high water particles, high turbidity level, and low water clarity), or, low light scattering (low water particles, low turbidity level, and, high water clarity) was used in ascertaining turbidity level of the river water. This was classified for turbidity status, deployed in water quality index acquisition, and evaluated with occurring trend in response to the water quality at the river through the water quality index classification.

Results

The obtained results are presented in tables one to four (1 - 4), and figures four to seven (4 -7) below;

Table 1: The results from the early hours

S/N	Month	Turbidity Level	Turbidity Rating	Water Quality Index, WQI	Water Quality Index Classification	Impact
1	January	1	Low	78	Good	22
2	February	1	Low	78	Good	22
3	March	1	Low	78	Good	22
4	April	1	Low	78	Good	22
5	May	1	Low	78	Good	22
6	June	1	Low	78	Good	22
7	July	2	Low	78	Good	22
8	August	1	Low	78	Good	22
9	September	1	Low	78	Good	22
10	October	1	Low	78	Good	22
11	November	2	Low	78	Good	22
12	December	1	Low	78	Good	22
Total	-	14	-	936	-	264
Average	-	1	Low	78	Good	22

Table 2: The results from the mid-day hours

S/N	Month	Turbidity Level	Turbidity Rating	Water Quality Index, WQI	Water Quality Index Classification	Impact
1	January	5	Low	78	Good	22
2	February	3	Low	78	Good	22
3	March	3	Low	78	Good	22
4	April	3	Low	78	Good	22
5	May	5	Low	78	Good	22
6	June	7	Low	72	Good	28
7	July	8	Low	72	Good	28
8	August	11	Medium	66	Medium	34
9	September	6	Low	72	Good	28
10	October	3	Low	78	Good	22
11	November	5	Low	78	Good	22
12	December	5	Low	78	Good	22
Total	-	64	-	906	-	294
Average	-	5	Low	76	Good	25

Table 3: The results from the late hours

S/N	Month	Turbidity Level	Turbidity Rating	Water Quality Index, WQI	Water Quality Index Classification	Impact
1	January	4	Low	78	Good	22
2	February	2	Low	78	Good	22
3	March	2	Low	78	Good	22
4	April	3	Low	78	Good	22
5	May	3	Low	78	Good	22
6	June	4	Low	78	Good	22
7	July	7	Low	72	Good	28
8	August	7	Low	72	Good	28
9	September	3	Low	78	Good	22
10	October	3	Low	78	Good	22
11	November	3	Low	78	Good	22
12	December	4	Low	78	Good	22
Total	-	45	-	924	-	276
Average	-	4	Low	77	Good	23

Table 4: The results from the average

S/N	Month	Turbidity Level	Turbidity Rating	Water Quality Index, WQI	Water Quality Index Classification	Impact
1	January	3	Low	78	Good	22
2	February	2	Low	78	Good	22
3	March	2	Low	78	Good	22
4	April	2	Low	78	Good	22
5	May	3	Low	78	Good	22
6	June	4	Low	78	Good	22
7	July	6	Low	72	Good	28

8	August	6	Low	72	Good	28
9	September	3	Low	78	Good	22
10	October	2	Low	78	Good	22
11	November	3	Low	78	Good	22
12	December	3	Low	78	Good	22
Total	-	39	-	924	-	276
Average	-	3	Low	77	Good	23

The chart for the early hours values is presented in figure four (4) below:

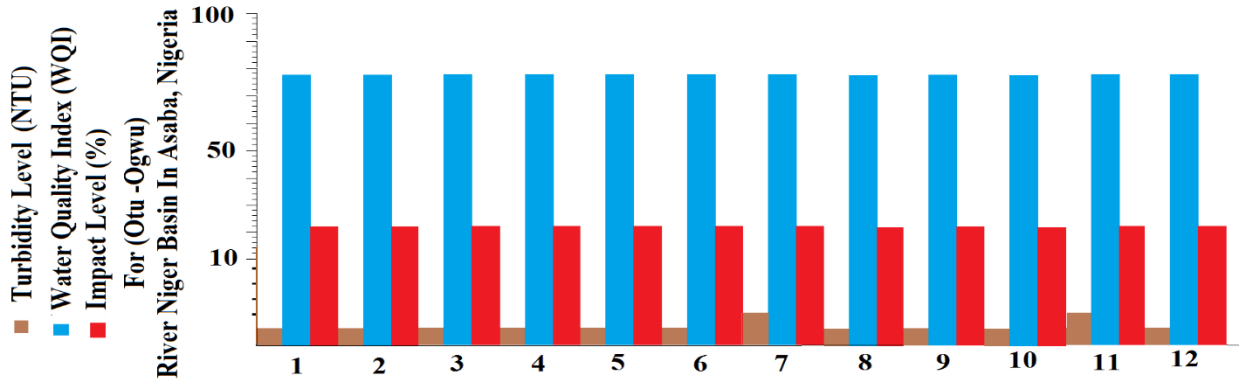


Figure 4: Early hours chart of turbidity levels, water quality index, and impact level

The chart for the mid-day hours values is presented in figure five (5) below;

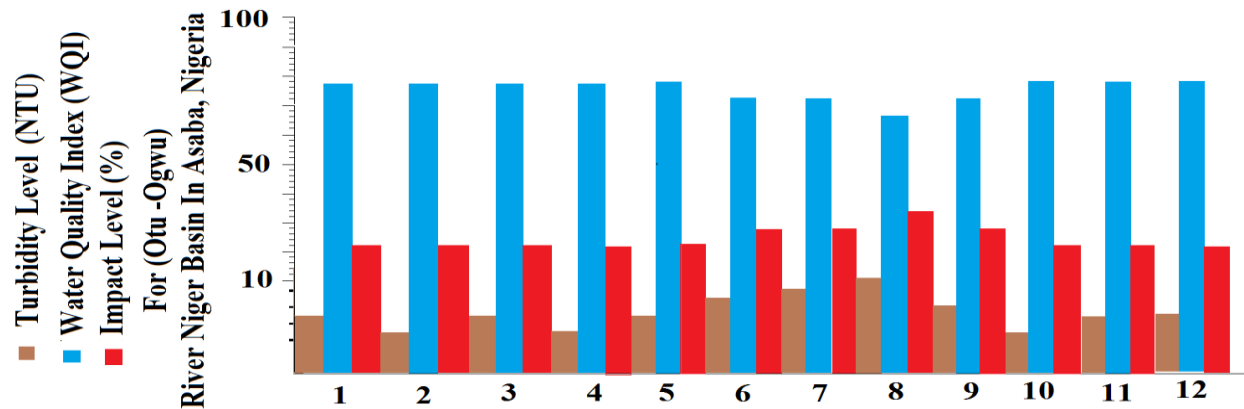


Figure 5: Mid-day hours chart of turbidity levels, water quality index, and impact level

The chart for the late hours values is presented in figure six (6) below;

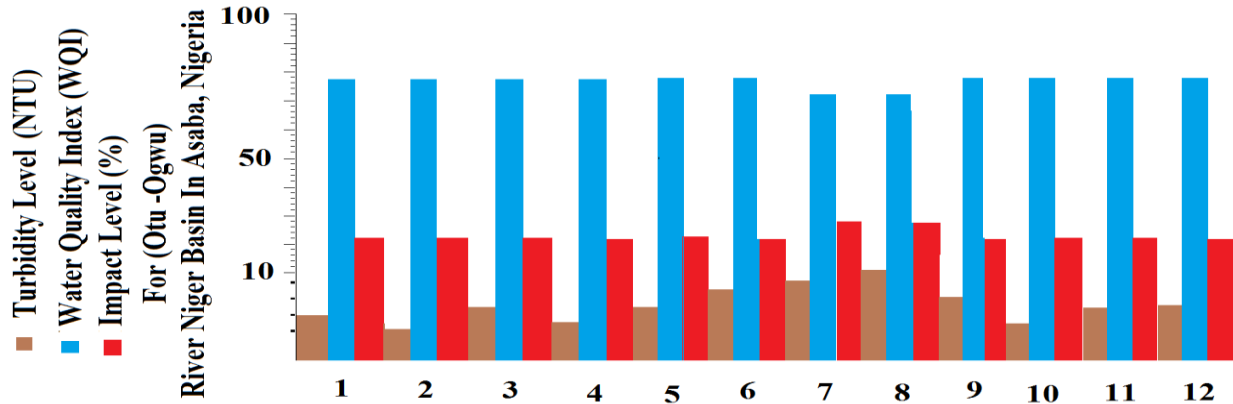


Figure 6: Late hours chart of turbidity levels, water quality index, and impact level

The chart for the average values is presented in figure seven (7) below;

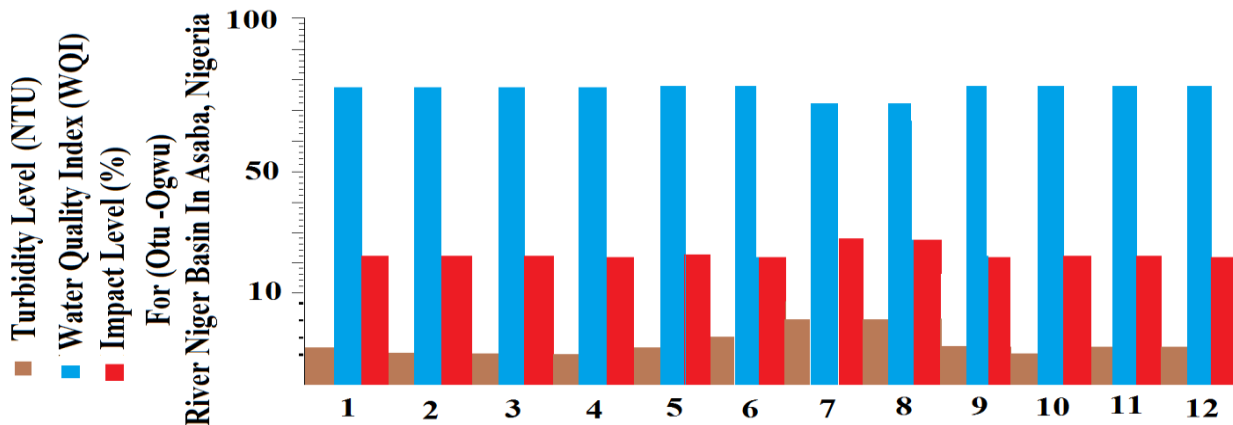


Figure 7: Chart of average turbidity levels, water quality index, and impact level

Discussion

Results obtained showed that the river water turbidity showed minimal impact on water quality index on average scale which recorded < 6 NTU with 78% respectively. This was in exclusion to the months of July and August. From 6 NTU, turbidity showed noticeable impact on the water quality index recording 72%, a slight drop on the water quality. This was still good considering the fact that the water was still usable for agriculture like irrigation. From 11 NTU, turbidity affected the water quality index to a moderate extent with 66%. This was found following August mid-day water record.

Turbidity is a result of particulate presence in water which upon removal will restore purity level. Advance techniques for turbidity management include (1) use of filtration systems like conventional filtration (involving use of charcoal filters and sand in water treatment facilities), membrane filtration (involving use of higher accuracy filtration like reverse osmosis, ultrafiltration, and microfiltration for smaller particulates removal), advanced media filters (like advanced polymers and glass of improved performance for retention of particles of various sizes), and, membrane bio - reactors (use of membrane filtration deploying microorganisms cellular activities for oxidation in waterbodies turbidity control) acknowledged by Adelodun *et al.*, (2021), to involve ultrafiltration (best), and microfiltration as the main filtrations used for its techniques, (2) sedimentation techniques like settling tanks and clarifiers (involving load reduction on downstream systems by deploying gravity for heavier sediments settlements while allowing water passage through thinner filters), and, chemical flocculation (use of coagulants to bind suspended particles, for faster and heavier settlement) notably identified by Getahun *et al.*, (2024), for its usage migration to natural coagulants from chemical based coagulants due to limitations, (3) constructed wetlands like natural filtration (use of constructed wetlands to mimic water natural purification, by deploying occurable natural microorganisms and

vegetation of plant species with water - cleansing capacity), (4) alternative methods like ultraviolet light treatment (use of UV for disinfection of bacterial and virus in water thereby reducing disinfected matters, and upon combining with filtering, creates improved turbidity status) according to Rajkhowa, (2020), is being used from early years of the 20th century, and magnetic separation highlighted by Han *et al.*, (2021), for its effectiveness in high turbidity removal (involving magnetic fields usage in removing iron - based particles from water).

Conclusion

It was concluded that on average, turbidity and water quality index for various hours were 3NTU and 77% in all, 4NTU and 77% at late hours, 5NTU and 76% at mid-day, 1NTU and 78% at early hours. That on minimal turbidity and water quality index was 2NTU and 78% on average, as well as in late hours, 3NTU and 78% at mid-day hours, and 1NTU and 78% at early hours. And, the maximum turbidity and water quality index were 6NTU with 72% on average, 7NTU with 72% at late hours, 11NTU with 66% at mid-day hours, and 2NTU with 78% at early hours. It was summararily found that turbidity impact on water quality index in an inverse order of the higher turbidity value, the lower water quality index value.

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