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ORIGINAL RESEARCH

Impact of Hydro Potential Hydrogen on River System Quality, in Response to the Aquatic Ecosystem Hydro Index

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ABSTRACT

Quality of aquatic system reflectable on the ecosystem and its hydro environment is of vital consideration for efficient delivery of intended goals of waterbodies for humanity. In response to the aquatic ecosystem hydro index factor, impact of hydro potential hydrogen on river system quality was considerably studied at the study area (Niger river in Asaba, Nigeria). Upon field measurement of the hydro potential hydrogen levels, the general quality assessment prior hydro index factor in the aquatic ecosystem, were deployed in obtaining the hydro potential hydrogen impact using the percentage negative quality effect prior index values at the river system. Conclusively prior obtained results from early, mid - day, late, and average hours, the hydro potential hydrogen levels were high with 7.2, 7.9, 7.6, and 7.5, had very high system quality with hydro index of 88, 88, 88, and 88, as well as recorded low impacts of 12, 12, 12, and 12, respectively. Moreso, it was found that temporary variation in range trend of hydro potential hydrogen occurrence in the river system may be temporarily influence by external variables.

KEYWORDS

Hydro Potential Hydrogen · Hydro Index Factor · River System · Headwater · Tributaries

FULL TEXT

I. Introduction

The power for efficient management of the ecosystem exists in the adequate understanding associative to its observatories. This is especially attainable through appropriate monitoring. In particular, monitoring of the hydro potential hydrogen through appropriate measurements is expected to enhance the capability of managing an aquatic ecosystem. The hydro potential hydrogen measurement is very vital concerning water quality (USGS - WSS, 2019). This is even more explanatory as no quality without status, and no status without measurement. As such, this work intends to measure the hydro potential hydrogen status of the river system, as well as utilized the status in attaining the quality in the system using index factor.

Hydro potential hydrogen refers to the potential hydrogen amount contained in a hydro system. Potential hydrogen concept was ushered into existence in 1909 by Sørensen, Søren Peder Lauritz, a danish chemist who established its relationship to hydrogen ions concentration (Lian *et al*., 2019). NOAA - PMEL (2025) identified positive hydrogen ions (H^+) concentration of aqueous solution to acidity. Alkalinity otherwise base is opposite of acidity. Acids and bases measurements using litmus indicator was accidentally discovered in 1648 by Robert Boyle, while the first potential hydrogen meter commercial designed was in 1936 by Beckman Arnold (Lian *et al*., 2019). Potential hydrogen upon high produces bitter taste, as well as hinders chlorine disinfection effectiveness leading to more chlorine consumption (USGS - WSS, 2019). This affects both humans and other organisms. Low potential hydrogen exposures in river system pose some negative effects. Its exposure causes physiological stressors like excess mucus development which interferes with gaseous and ion exchange, rise in cortisol amount, imbalance in acid - base, gene expression modulation, as well as sodium and chlorine ion passive losses (Hammer, 2020). It also facilitates water corrosion, or encourages metals and dissolvable substances to dissolve (USGS - WSS, 2019). Low potential hydrogen at gills of aquatic animals decreases hemoglobin binding affinity and maximizes its oxygen demand to attain oxygen saturation otherwise bohr effect, and sometimes, may result to inability of oxygen to saturate by the hemoglobin irrespective of oxygen concentration otherwise root effect (Hammer, 2020).

Hydro index factor refers to the obtainable factors that interpret the quality of a hydro system. It simply provides classifiable values with respect to the general quality attributes. It produces water quality information in a simplified format (Darwish *et al*., 2024). It offers avenue of extracting thousands of data relative to environmental records in values of consequential order with respect to water health and quality (Igibah, and Ihimekpen, 2022). Index factor point to hydro parameters which serve as status indicator for hydro properties of river systems. The index rating range from zero to hundred (0 to 100).

River system refers to the network of flow primarily involving a main river and its associated tributaries. In a river system, the flow gathered from the headwater and the tributaries faces menders (geographically bending curvatures), floodplains (floodable plain lands) in or outflows, wetlands (soak able lands) impacts due groundwater table intake or outtakes, propel the water through the river mouth (water exit point or river end) at the delta (where river change to ocean) to the ocean or sea. They are featured with landscape crossage by open spatial water network that fuel runoff concentration and higher ground discharge of water and substance accompanied load (Birk, 2022).

A typical example of a river system is presented in figure 4 below:

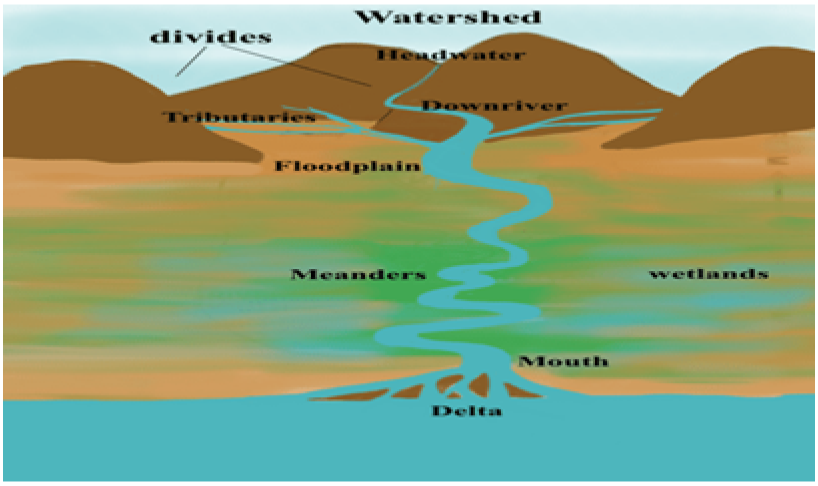

Figure 1: River system (Wordpress, 2015).

Headwater is the beginning part of a river system network. They form about 80% of the river total coverage length, and are very sensitive to the river landscape environment due to their attributive little volume of water and size (Suring, 2020). Their small sized environment enable them provide habitational refuge to young species and selected species, against the predatory large size species (Richardson, 2020). They also respond to rainfall inputs to the river system. Headwater catchments serve as sinks, containing particulates and preventing obstructions in river transportation (Hilton *et al*., 2025).

Tributaries are recharging waterbodies to a connected major waterbody that conveys the water to the seas or ocean or another bigger waterbody. They feed in water to the main waterbody otherwise parent waterbody (Thames, 2023). They are generally referred to as affluent, and cannot convey water directly to the ocean (NGS, 2023). They contribute additional water, sediments, and nutrients to the larger waterbodies they flow into (Atlas, 2025).

II. Materials

The Otu - Ogwu river section of the Niger River system, at Asaba in Delta State of Nigeria, West Africa, was the main material utilizably as the study area for this work. The exact river system spot terrene and descriptive location of the area of study (Otu - Ogwu River Niger in Asaba, Nigeria) is presented in figure 2 below;

Figure 2: River system spot terrene of the study area and map location

Other materials include the portable membrane hydro potential hydrogen - meter with probe, computerized mobile digital set, satellite sensing software, *etc*.

III. Methods

The portable hydro meter was used in field measurements for the acquisition of the hydro potential hydrogen levels. The hydro quality index was deployed as the general Index factor of the aquatic ecosystem, used for general quality assessment. The percentage impact of the hydro potential hydrogen on the river system quality was further deduced from the percentage negative quality effect prior index value.

IV. Results

The obtained results are presented in tables 1 to 4, and figures 3 and 4 below:

Table 1: The results from the early hours

SN	Month	Hydro Potential Hydrogen Level	Level Classification	Hydro Quality Index, (HQI)	River System Quality	Impact Rate (%)	Impact Level
1	January	6.8	Low	88	Very High	12	Low
2	February	6.6	Low	88	Very High	12	Low
3	March	6.7	Low	88	Very High	12	Low
4	April	8.1	High	88	Very High	12	Low
5	May	7.3	High	88	Very High	12	Low
6	June	7.3	High	88	Very High	12	Low
7	July	6.6	Low	88	Very High	12	Low
8	August	6.8	Low	88	Very High	12	Low
9	September	6.6	Low	88	Very High	12	Low
10	October	8.1	High	88	Very High	12	Low
11	November	8.2	High	88	Very High	12	Low
12	December	7.4	High	88	Very High	12	Low
Total	-	86.5	-	1,056	-	144	-
Average	-	7.2	High	88	Very High	12	Low

Table 2: The results from the mid-day hours

SN	Month	Hydro Potential Hydrogen Level	Level Classification	Hydro Quality Index, (HQI)	River System Quality	Impact Rate (%)	Impact Level
1	January	7.6	High	88	Very High	12	Low
2	February	7.2	High	88	Very High	12	Low
3	March	7.2	High	88	Very High	12	Low
4	April	8.5	High	88	Very High	12	Low
5	May	7.9	High	88	Very High	12	Low
6	June	8.4	High	88	Very High	12	Low
7	July	8.4	High	88	Very High	12	Low
8	August	7.1	High	88	Very High	12	Low
9	September	6.8	Low	88	Very High	12	Low
10	October	8.4	High	88	Very High	12	Low
11	November	8.5	High	88	Very High	12	Low
12	December	8.6	Very High	84	Very High	16	Low
Total	-	94.6	-	1,052	-	148	-
Average	-	7.9	High	88	Very High	12	Low

Table 3: The results from the late hours

SN	Month	Hydro Potential Hydrogen Level	Level Classification	Hydro Quality Index (HQI)	River System Quality	Impact Rate (%)	Impact Level
1	January	7.3	High	88	Very High	12	Low
2	February	6.7	Low	88	Very High	12	Low
3	March	6.8	Low	88	Very High	12	Low
4	April	8.3	High	88	Very High	12	Low
5	May	7.7	High	88	Very High	12	Low
6	June	8.1	High	88	Very High	12	Low
7	July	7.2	High	88	Very High	12	Low
8	August	6.8	Low	88	Very High	12	Low
9	September	6.8	Low	88	Very High	12	Low
10	October	8.5	High	88	Very High	12	Low
11	November	8.5	High	88	Very High	12	Low
12	December	8.4	High	88	Very High	12	Low
Total	-	91.1	-	1,056	-	144	-
Average	-	7.6	High	88	Very High	12	Low

Table 4: The results from the average

SN	Month	Hydro Potential Hydrogen Level	Level Classification	Hydro Quality Index, HQI	River System Quality	Impact Rate (%)	Impact Level
1	January	7.2	High	88	Very High	12	Low
2	February	6.8	Low	88	Very High	12	Low
3	March	6.9	Low	88	Very High	12	Low
4	April	8.3	High	88	Very High	12	Low
5	May	7.6	High	88	Very High	12	Low
6	June	7.9	High	88	Very High	12	Low
7	July	7.4	High	88	Very High	12	Low
8	August	6.9	Low	88	Very High	12	Low
9	September	6.7	Low	88	Very High	12	Low
10	October	8.3	High	88	Very High	12	Low
11	November	8.4	High	88	Very High	12	Low
12	December	8.1	High	88	Very High	12	Low
Total	-	90.5	-	1,056	-	144	-
Average	-	7.5	High	88	Very High	12	Low

The chart of the early hours, mid-day hours, late hours, and average hydro potential hydrogen are presented in figure 3 below;

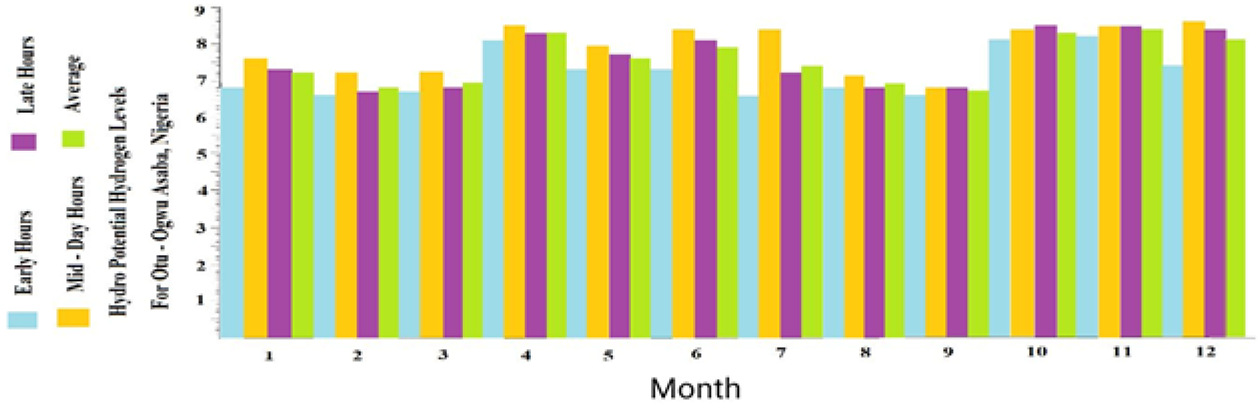

Figure 3: Early hours, mid-day hours, late hours, and average hydro potential hydrogen

The chart of the early hours, mid-day hours, late hours, and average hydro quality index and impact due to hydro potential hydrogen are presented in figure 4 below;

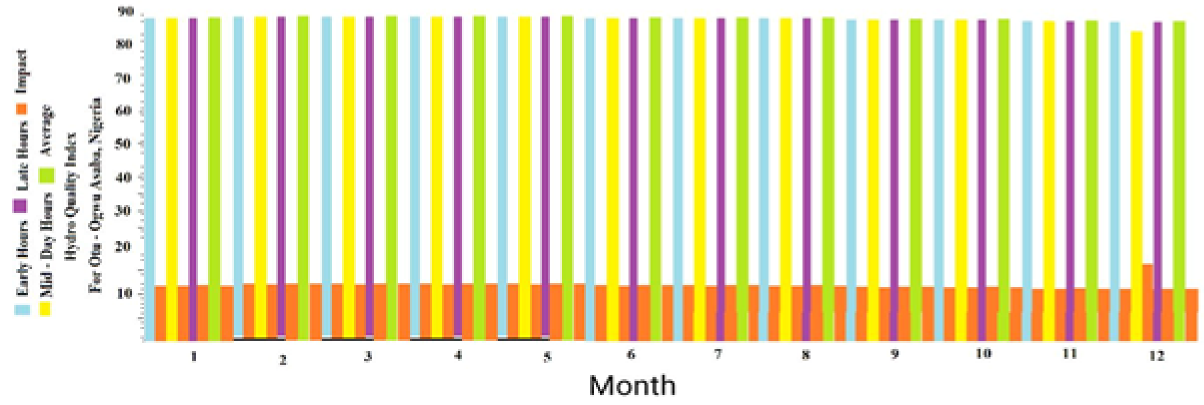

Figure 4: Early hours, mid-day hours, late hours, and average hydro quality index and impact due to hydro potential hydrogen

V. Discussion

The hydro potential hydrogen rose to 8.6 with quality index of 84% (still good) in the month of December. It however on average resulted to 8.1 with 88%. This pointed on high stable trend in occurrence of hydro potential hydrogen, in the river system. The trend can be seen in figure 4 above, where almost all results obtained were of similar range. The slight alteration resulting from the December however did not last long before returning to the trend. It was considered as a temporary variation from the main trend, probably influenced by external variable.

VI. Conclusion

Conclusively prior obtained results from early, mid - day, late, and average hours, the hydro potential hydrogen levels were high with 7.2, 7.9, 7.6, and 7.5, had very high system quality with hydro index of 88, 88, 88, and 88, as well as recorded low impacts of 12, 12, 12, and 12, respectively. Conclusively moreso, it was found that, temporary variation in range trend of hydro potential hydrogen occurrence in the river system may be temporarily influence by external variables.

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