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# A SURVEY OF AQUATIC MACROPHYTES IN THE AKASSA AXIS OF THE RIVER NUN, NIGER DELTA, NIGERIA

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## ABSTRACT

An ecological study was conducted to measure the diversity of aquatic macrophytes and nutrient levels of the River Nun estuary around Akassa, Niger Delta, Nigeria. This was done to ascertain the current ecological status of the estuary and gauge the ecological health of the water body as a result of anthropogenic additions into the water body. Macrophye and Subsurface samples were collected from three sampling points on the estuary. Macrophyte samples were identified using standard keys while water samples were investigated for pH, Salinity, Nitrates, Phosphates, and Sulphates. Result from the study reveals the presence of 17 species of aquatic macrophytes from 8 families. All nutrient parameters were within the permissible levels. There is no significant difference ($P>0.05$) in pH, salinity and sulphate between stations. There is a significant difference ($P<0.05$) in nitrate and phosphate between stations. The diversity of macrophytes was also uniformly high in all stations. The preponderance of macrophytes in this study agrees with the aphorism that marine ecosystems contain a high diversity of living organisms. The River Nun is therefore not under any immediate ecological threat.

**Contribution/Originality:** Due to environmental pollution and the resultant impact on aquatic ecosystems, there is a critical need to monitor aquatic biota especially macrophytes. Sadly, there is a dearth of information on the changing composition and distribution of macrophytes in River-nun at the Akassa axis. This study is therefore novel as it provides a connect between measurable pollution parameters and macrophyte composition and abundance. This may provide a justification for pollution prevention and control.

## 1. INTRODUCTION

Macrophytes are aquatic plants that grow in or near water environment and are either emergent, submerged, or floating vegetation. They form a critical mass of the aquatic ecosystem providing habitat, nesting sites and even food for other aquatic organisms in the food chain. They also provide a regulatory framework in the maintenance of nutrient levels, accumulation of toxins and regulation of gaseous exchange [1].

Aquatic plants are widely distributed in the aquatic environment because of their special adaptive features mostly aided by their morphology. The most common adaptation is the presence of lightweight internal packing cells called aerenchyma, found in floating leaves and finely dissected leaves [2]. However, other factors may also control their distribution and abundance. These are nutrients, disturbance from waves, grazing, and salinity of the aquatic environment [3]. Therefore, a few aquatic plants are able survive in brackish, saline, and salt water [2]. Furthermore, some are able to tolerate certain nutrient levels whereas others are unable to withstand nutrient spikes. Understandably, anthropogenic activities around river catchments contribute greatly to the nutrient dynamics of receiving water bodies. The unrestricted use of fertilizers and other agrochemical find easy entry into water bodies through runoff and direct discharges.

As the River Nun around Akassa axis is prone to diverse activities around its catchment, there is a need to gauge its nutrient levels and assess its macrophyte inventory. This will provide a snap-shot of the ecosystem stability and aquatic health.

## 2. MATERIALS AND METHODS

### *2.1. Description of Study Area*

The study area is the River Nun Estuary, which is situated around Akassa kingdom in Brass Local Government Area of Bayelsa State, Nigeria. Several creeks, inlets, and canals are connected to this estuary, which serve as navigational routes and drains in the area. It is also connected to other estuaries through these channels. The Brass River estuary is situated towards the east while the Sangana River estuary is situated towards the west of the River Nun estuary. The Atlantic Ocean is connected to the River Nun estuary from the south. Akassa kingdom comprise of 21 major towns and several fishing settlements with a population of over 280,000 people. It occupies an area of 120km² and is situated on both sides of the River Nun estuary.

Figure 1 illustrates the different sampling point on River Nun in the Akassa axis.


**Figure 1.** Map of the study area, showing the Nun River Estuary.

*2.2. Designation of Sampling Stations*

Three sampling stations were chosen in the River Nun estuary for the nutrient and biodiversity study of the aquatic macrophytes.

*2.2.1. Sampling Station 1 (Mouth of Buoama creek)*

This sampling station is around Buoama creek and is located on a latitude of N4$^0$20'59.6472" and a longitude of E6$^0$2'48.3036". This sampling station is characterized by mangrove vegetation and a relatively short intertidal zone. The vegetation consists mainly of red mangroves, Nypa palm, and other plant species.

*2.2.2. Sampling Station 2 (Erewei- kongho)*

This station has a mixture nipa palm and native mangrove vegetation. Its Global Positioning System coordinates are N4$^0$20'35.0628" and E6$^0$3'0.738". The soil is sandy at the high intertidal zone and the mid intertidal zone in some areas and clayey at some parts of the mid intertidal zone and the the low and intertidal zone. The intertital zone has a steep topography.

*2.2.3. Sampling Station 3 (Ogbokiri)*

Sampling station 3 is at Ogbokiri. The station is situated on a mud flat at Ogbokiri, Akassa and its Global Positioning System coordinates are N4$^0$19'46.8048" and E6$^0$3'49.3596". It has a vegetation that is dominated by the black mangroves.

*2.3. Field Sampling*

Plant and Water samples were collected from three sampling stations of the River Nun estuary for identification and analysis respectively. The plant samples were collected by simple hand picking for floating macrophytes and cutting with a knife for deep rooted plants on the shoreline. Plant samples were identified using appropriate taxonomic keys. Sub-surface water samples were collected at depths of 2-5cm by simply dipping empty plastic containers into the water and allowing it to fill.

*2.4. Laboratory Analysis*

*2.4.1. Determination of pH*

The pH meter was used for the determination of the pH of the water sample. The meter was calibrated (standardized) with two (2) buffers of pH 4 and pH 9. The electrode was then thoroughly rinsed in distilled water and then dipped into the water sample. A steady pH read out is recorded as the pH of the water sample.

*2.4.2. Determination of Nitrate*

Into a 20ml volumetric flask, one tablet of Nitrites and one tablet Nitrates were crushed and added. This was shaken to aid the dissolution of the tablets to flocculate the mixture for 3- 4 times. 10ml of the supernatant was transferred into a 10ml flask, one tablet of Nitricol was crushed and added and shaken for proper mixing. This was left to stand for 10mm, for color, development. The spectrophotometer, Jenway 6300® was switched on and the wavelength was set at 570nm. The % transmittance was taken and the concentration $NO^{3-}$ was obtained directly in mg/l on the chart.

*2.4.3. Determination of Sulphate*

100ml sample was placed into a 250ml conical flask. 5ml of conditioning reagent was added and mixed properly. A spatula full of Barium chloride was added and stirred with a magnetic stirrer. The spectrophotometer was set 425nm wave length. Absorbance values were taken and read off from the calibration curve which has been previously done using standard sulphate solutions.

### *2.4.4. Determination of Salinity*

The salinity of the water sample was measured with the salinity meter. The probe of the meter was dipped into the water sample using a handheld meter and the readings obtained.

### *2.4.5. Determination of Phosphate*

This test is to check the amount of tri-sodium phosphate which is used as an inhibitor to test residual water hardness in incoming water and circulating heated water in boilers. Fill the test tube with 5 ml of test water and add 4 drops of reagents with a dropper.

### *2.5. Statistical Analysis*

Means and standard deviation were calculated for the physicochemical parameters for all the sample stations. Analysis of Variance (ANOVA) was employ to determine the variability between means of the measured parameters. Turkey Honestly Significant Difference Post Analysis test was also employed to separate means where significant differences exist (P<0.05). Version 20 of Statistical Package for Social Sciences software was used to aid statistical analysis.

## 3. RESULTS AND DISCUSSION

### *3.1. Result*

### *3.1.1. Physico-Chemistry of the Water Samples*

The results of the analysis of the water samples of the river nun estuary are presented in Tables 1 and 2 and Figure 2. The mean values of the physico-chemistry ranged from 7.867 to 8.033, 15.84mg/l to 16.7mg/l, 0.923mg/l to 1.62mg/l, 2.197mg/l to 10.68mg/l, and 0.103mg/l to 0.179mg/l for pH, Salinity, Nitrate, Phosphate, and Sulphate, respectively. The highest mean value of pH (8.033) was recorded in sampling station 3 while the lowest value (7.867) was recorded in sampling station 1. Salinity was highest in sampling station 3 (16.7mg/l) and least in sampling station 1 (16.097mg/l). Nitrate were high in sampling station 3 (1.62mg/l) than stations 1 and 2 which had 1.217mg/l and 0.923mg/l respectively. Also, Phosphate were higher in sampling station 3 (10.68mg/l) than stations 1 and 2 which had 2.197mg/l and 7.47mg/l, respectively. Furthermore, the mean Sulphate value of sampling station 3 (0.179mg/l) was higher than those of stations 1 and 2 which had 0.139mg/l and 0.103mg/l, respectively.

**Table 1.** The results Physico- chemistry of the water of the Nun River estuary.

| Sample code | pH | Salinity | Nitrates | Phosphates | Sulphates |
|---|---|---|---|---|---|
| ST 1 | $7.867\pm0.611^{b}$ | $16.097\pm0.386^{a}$ | $1.217\pm0.225^{b}$ | $2.197\pm0.015^{a}$ | $0.139\pm0.009^{c}$ |
| ST 2 | $8.033\pm0.45^{b}$ | $15.84\pm0.14^{a}$ | $0.923\pm0.30^{a}$ | $7.47\pm0.19^{c}$ | $0.103\pm0.004^{c}$ |
| ST3 | $8.033\pm0.15^{b}$ | $16.7\pm0.31^{a}$ | $1.62\pm0.035^{b}$ | $10.68\pm3.7^{b}$ | $0.179\pm0.0525^{c}$ |

Data is expressed as Mean ± SD; Different superscript letters along the row indicate significant difference (P>0.05).

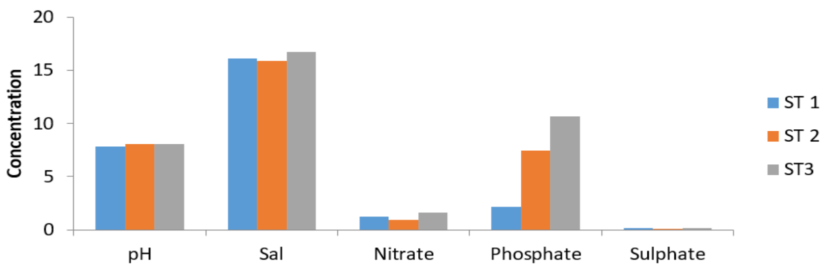


**Figure 2.** Concentration of nutrients in the three sampling stations.

### *3.1.2. Aquatic Macrophytes*

The checklist of the aquatic macrophytes that were identified in the River Nun estuary around Akassa kingdom is presented in Table 2. 17 species of aquatic macrophytes from 8 families were identified.

**Table 2.** Checklist of aquatic macrophytes of the river nun estuary.

| Family | Name | Common Name | ST. 1 | ST. 2 | ST. 3 |
|---|---|---|---|---|---|
| Avicenniaceae | Avicennia germinans | (Black mangroves) | + | + | + |
| | Avicennia marina | | + | + | + |
| Combrataceae | Laguncularia racemosa | (White mangrove) | + | + | + |
| Rhizophoracea | Rhizophora mangle | (Red mangroves) | + | + | + |
| | Rhizophora racemosa | | + | + | + |
| | Rhizophora stylosa | (Stilted mangrove) | + | + | + |
| | Rhizophora mucronata | (Loop- root mangrove) | + | + | + |
| | Rhizophora africana | | + | + | + |
| | Ceriops tagal | | + | + | + |
| Acanthaceae | Avicennia germinans | (Black mangrove) | + | + | + |
| Arecaceae | Nypa fruticans | (Nipa palm or mangrove palm) | + | + | + |
| | Calamus sp | (Rattan palm) | + | + | + |
| Pontederiaceae | Eichhornia crassipes | (Water hyacinth) | + | + | + |
| Pteridaceae | Acrostichum speciosum | (Mangrove fern) | + | + | + |
| | Acrostichum aureum | (Golden leather fern) | + | + | + |
| Poaceae | Spartina alterniflora | (salt mash cord grass) | + | + | + |
| | Sporobolus alterniflora | (salt- water cord grass) | + | + | + |

**Note:** + = Presence of macrophyte -- = Absence of macrophyte.

Table 3 presents safe or suitable ranges of nutrient levels and physicochemical parameters in water for optimum functioning and survival of aquatic organisms as stipulated by international bodies. These bodies are the World Health Organization (WHO), United States Environmental Protection Agency (USEPA), Central Pollution Control Board (CPCB), Indian Council of Medical Research (ICMR) and Water Quality Standard for Classifying Surface Water Sources (BIS or ISI).

**Table 3.** Permissible limits of drinking water quality.

| Parameters | USEPA | WHO | ISI | ICMR | CPCB |
|---|---|---|---|---|---|
| pH (mg/l) | 6.5 – 8.5 | 6.5 – 8.5 | 6.5 – 8.5 | 6.5 – 9.2 | 6.5 – 8.5 |
| NITRATE (mg/l) | - | - | 45 | 100 | 100 |
| SULFATE (mg/l) | - | - | 150 | 400 | 400 |
| CONDUCTIVITY (mg/l) | - | - | - | - | 2000 |
| ALKALINITY (mg/l) | - | - | - | - | 600 |
| TOTAL HARDNESS (mg/l) | - | 500 | 300 | 600 | 600 |

**Note:** International Permissible safe limits and range of nutrients in water.
**Source:** Kumar and Puri [4].

## *3.2. Discussion*

### *3.2.1. Physico-Chemical Parameters*

pH, Salinity, Nitrate, Phosphate, and Sulphate were analyzed in the overlay water samples. The mean values of the physico-chemistry ranged from 7.867 to 8.03, 15.84mg/l to 16.7mg/l, 0.923mg/l to 1.62mg/l, 2.197mg/l to 10.68mg/lmg/l, and 0.103mg/l to 0.179mg/l for pH, Salinity, Nitrate, Phosphate, and Sulphate, respectively. The highest mean value of pH (8.033) was recorded in sampling station 3 while the lowest value (7.867) was recorded in sampling station 1. Salinity was highest in sampling station 3 (16.7mg/l) and least in sampling station 1 (16.097mg/l). Nitrates were high in sampling station 3 (1.62mg/l) than stations 1 and 2 which had 1.217mg/l and 0.923mg/l, respectively. Also, Phosphates were higher in sampling station 3 (10.68mg/l) than stations 1 and 2 which had 2.197mg/l and 7.47mg/l, respectively. Furthermore, the mean Sulphate value of sampling station 3 (0.179mg/l) was higher than those of stations 1 and 2 which had 0.139mg/l and 0.103mg/l, respectively.

Hydrogen concentration (pH) is the standard measurement of how acidic or alkaline a solution is. It is measured on a scale from 0 to 14. pH of 7 is neutral. pH less than 7 is acidic while pH greater than 7 is basic. Hydrogen ion concentration (pH) ranged from 7.86 to 8.03 from the 3 stations sampled. This value is within the permissible limit by national and intentional standards for water quality. The pH values obtained for this study are within the limits to support aquatic life as suggested by Deekae, et al. [5] for optimum fish, shrimp and other aquatic organisms. Statistical analysis of this study shows that there were no significant variation between the pH values of the stations ($P>0.05$). The pH range observed is suitable for aquatic macrophyte to thrive. Station 1 pH was slightly lower when compared with values of stations 2 and 3.

The salinity of Nun River Nun estuary ranged from 15.84 to 16.09mg/l. Salinity was higher in station 1 and station 2, compared to station 2. Moderate salinity value is an indicator that the river is an estuary comprising of both salt water and freshwater. There was no significant difference among the sample location ($P>0.05$). Moderate salinity ranges greatly influenced the distribution of aquatic macrophytes in this study as water hyacinth for instance cannot survive in Rivers of very high salinity regimes.

Nitrate in surface water is an important factor for water quality assessment. The presence of nitrates in lotic systems depends mostly upon the activity of nitrifying bacteria, stream currents and catchment characteristics. Nitrate concentration ranged from 0.92mg/l to 1.62 mg/l from the sampled locations. Nitrate was higher in stations 3 and 1 than in station 2. There was a slight significant difference among the sampled locations ($P<0.05$). High concentrations of nitrate can be attributed mainly to anthropogenic activities such as runoff water from agricultural lands, discharge of household and municipal sewage from the market place and other effluents' containing nitrogen. Comparison of nitrate values with international and national standards shows, it is below the permissible limit of 50mg/l. High values of Nitrate always suggest or indicate eutrophication in receiving waters.

Phosphate is the first limiting nutrient for plants in freshwater which regulates the phytoplankton production in presence of nitrogen. It is available in the form of phosphate in natural waters and generally occurs in low to moderate concentration. Agriculture runoff containing phosphate fertilizers as well as the waste water containing detergents etc. tend to increase $PO_4^{3-}$ pollution in water. High phosphate values were observed in this study. Phosphate content of the river water varied from 2.19mg/l to 10.68mg/1. The observation of this study is in conformity with previous works. Phosphate was higher in station 3 than in station 1 & 2. Comparing the values obtained with standards indicates the concentration were above the permissible limits of 0.1 were above the permissible limits of 0.1mg/l suggesting that the River Nun is polluted by phosphate compounds. There is a slight significant difference among the selected sampled stations ($P<0.05$).

Sulphate values ranged from 0.10mg/l to 17mg/1. Sulphate was higher in station 3 than in station 2 and 1. There is no significant difference among the study locations. The absence of significant variation suggest that the water is polluted frequently by waste materials, and in comparison to standards, shows sulphate concentration were below the safe limit of 100mg/l.

The interplay between macrophytes and water quality variables, represent a fundamental quality variable and represent a fundamental characteristics of river systems which is important for river flow and ecological functioning.

#### *3.2.2. Aquatic Macrophytes*

Seventeen (17) species of aquatic macrophytes in Eight (8) families were identified in the Nun River Estuary, Niger Delta and they include *Avicennia germinans* (Black mangroves) and *Avicennia marina* in Family Avicenniaceae, *Laguncularia racemosa* (White mangrove) in Family Combrataceae, Rhizophora mangle (Red mangroves), *Rhizophora racemosa*, *Rhizophora africana*, *Rhizophora mucronata* (Loop- root mangrove), *Rhizophora stylosa* (Stilted mangrove) and *Ceriops taga* in Family Rhizophoraceae, *Nypa fruticans* (Nipa palm or mangrove palm) and *Calamus sp.* (Rattan palm) in Family Arecaceae, *Acrosticum speciosum* (Mangrove fern) and *Acrostichum aureum* (Golden leather fern) in Family Pteridaceae, *Eichhornia crassipes* (Water hyacinth) in Family Pontederiaceae, and *Spartina altemiflora* or *Sporobolus alterniflora* (salt mash cord grass or salt water cord grass) in Family Poaceae.

The water hyacinth (*Eichhomta crassipes*) of the family Potenderaceae, though known as a freshwater aquatic macrophyte, was also found in the River Nun estuary. These occasionally stray into the estuary, and are especially abundant during the rainy season. When it strays into the estuary during the rainy season, the plant is able to survive for a long period of time because of the dilution of the salinity of the estuary by increased precipitation (rains). However, the plant is unable to survive in the estuary for long during the dry season when the salinity or the water of the estuary is very high. During the dry season the dying plants (water hyacinths) are seen in isolation and not as dense floating mats.

The aquatic macrophytes that were found in this estuary are influenced mainly by the physic-chemistry of the water (especially, salinity) and the physico-chemical properties of the sediments.

Estuarine aquatic macrophytes serve as food to fish, offers shelter to fish, serve as spawning ground, provide food and shelter to water fowls, improve aesthetic values, and provide materials for curative therapy for ethno-botanist. They also have a negative value or impeding navigation in the water.

## 4. CONCLUSION

The dynamics in the macrophytes diversity in relation to the physico-chemical parameters of the River Nun in the Niger Delta is due to the industrial and human activities. In this study, the amount of macrophytes in the river compares favourable with that found in rivers of similar characteristics. Generally, the abundance and diversity of macrophytes is governed and controlled by physico-chemistry of the river. The physicochemistry of this river are within permissible limits. Therefore to maintain this balance, there should be a regulatory frame work to protect the river from anthropogenic inputs from sewage, industrial and agricultural sources into the river.

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**Authors' Contributions:** All authors contributed equally to the conception and design of the study.

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