FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 7 No. 6, December, 2023, pp 149 - 156
DOI: https://doi.org/10.33003/fjs-2023-0706-2060

ASSESSMENT OF SEDIMENTS AND GEOMORPHOLOGY OF FRESHWATER BODIES IN NORTHERN GUINEA SAVANNA ZONE, NIGERIA

[1]Kalen Ephraim Audu, *[2]Dahiru Sani, [1]Ibrahim Madu Katsallah Gadzama, [1]Mohammed A. Galadima and [3]Tabita Gaba Sule

[1]Department of Biology, Faculty of Life Sciences, Ahmadu Bello University, Zaria
[2]Department of Veterinary Pharmacology and Toxicology, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria
[3]Department of Biology, Umar Suleiman College of Education Gashu'a

*Corresponding authors' email: mdsani77@gmail.com Phone: +2348064026034

ABSTRACT

Sediments from freshwater bodies of the Northern Guinea Savanna Zone of Nigeria act as reservoirs for mineral and chemical nutrients washed from different sources around the environment. This research aimed at assessing the chemical and macronutrients of the sediments from freshwater bodies and the geomorphology of the area. A global positioning system, Model N9 GARMIN eTrexLegend™, personal navigator® was used to determine the geomorphological features while a polyvinyl chloride tube of 1.0 m long, 25 mm in diameter and 2.0 mm thick was used for sediment collection from a depth of 0-15 cm. The result of the chemical properties of the sediment; pH, organic carbon, organic matter and total nitrogen were found to be higher in dry season whereas phosphorus was high in the rainy season and there was no variation in the macronutrient across the dry and rainy season. Sand had the highest percentage across both seasons for particle distribution. This study revealed that sediments are rich in macronutrients and can be employed for agricultural purposes.

Keywords: Freshwater, Geomorphology, Macronutrients, Sediment

INTRODUCTION

Freshwater bodies of Northern Guinea Savanna Zone of Nigeria is one of the largest water bodies rich in aquatic fauna. The sedimentation of the water bodies is rich in macronutrient due to the anthropogenic activities around the areas (Capra *et al.* 2015). Sediment are component of the aquatic ecosystem found at the bottom of water reservoirs, rivers, streams and lakes which accumulates organic particles and mineral parts of various sizes. Freshwater bottom Sediments are being influenced by the geology of the surrounding environment (Szmeja, 2006). The capacity and depth of rivers, lakes and reservoirs are affected by excessive accumulation of sediments which silt up over time. In the ecosystem, flow of elements is regulated by the bottom sediments (Czamara and Czamara 2008) and their specific properties determine occurrence of particular species of aquatic plants (Szmeja, 2006). Dushyantha *et al.,* (2017) proposed that the lake sediment could possibly be used as a low-grade phosphate fertilizer for direct applications in low intensity farming. Furthermore, Capra *et al.,* (2015) suggested the use of sediment for fertilization. Sediment texture is the measure of the number of particles (clay, sand and silt) found in the sediment component (Melquiades *et al.,* 2014). Physical content of the sediment is influence by the kind of particles in the chemical structure (Zhang *et al.,* 2014). The abundance, composition and diversity of gastropods present in freshwater sediments can act as a powerful indicator for both ecological and hydrological changes (Ervina *et al.,* 2018).

The isolation of freshwater habitat is more transient due to floods, changes in topography as a result of erosion, river capture, minor earth movements, and by climatic changes resulting in break down (Gadzama *et al.* 2015). These geomorphologic aspects elucidate the zoogeography of a few freshwater molluscs species (Gadzama *et al.,* 2015). This study aimed to assess the freshwater sediments for their macronutrient which can possibly be used in agriculture especially for fertilization.

MATERIALS AND METHODS

Study area

Sixteen freshwater bodies spread across the Northern Guinea Savanna Zone of Nigeria were sampled during dry (November/December, 2020) and rainy (July/August 2021) seasons. The study area is within latitudes 7° and 12°N and longitudes 2°4′and 15°E (Fig. 1). The wet season lasts from May to September, while the dry season lasts for around six to seven months, from October/November to March/April. The freshwater bodies fall within two hydrological areas/basins that occur in Nigeria (Niger Kaduna Basin and Lower Niger Basin).

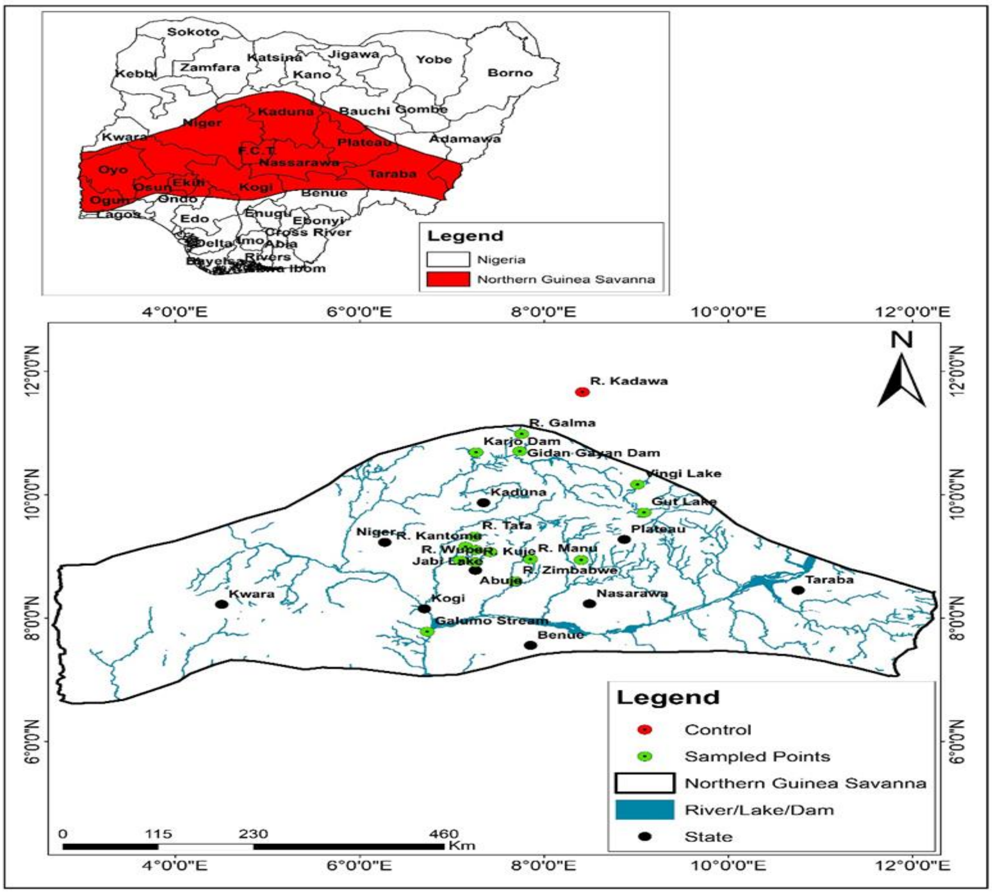

Figure 1: Map of the Study Location
Source: FORMECU, Federal Department of Forestry, Nigeria.

Measurement of geomorphological features

A Global Positioning System was used to pinpoint each sampling site's geographic location, including its longitude, latitude, and elevation. (GPS), Model N9 GARMIN eTrexLegend™, personal navigator®. A three-point scale was used to record observations of the surrounding aquatic vegetation: 1- sparse, little, or no floating vegetation; 2- floating algal mats with macrophytes; and 3- algal mats on dense vegetation along the shores. Environmental observations, such as the nature of the substratum, were also recorded.

Collection of sediment

The sediment samples were collected from all the sampling sites (Fig. 1) using a labelled and pre-treated PVC tube 1.0 m long, 25 mm in diameter, and 2.0 mm thick from a depth of 0-15 cm and transferred into a labelled polythene bag (Kazberuk *et al.,* 2021). Soil pH, Particle size, Basic macronutrients, Available phosphorus, Organic matter, Organic carbon, and Total nitrogen were analyzed in the laboratory at the Department of Soil Science, Ahmadu Bello University, Zaria.

Determination of chemical properties of the sediment

The pH was determined using the pH meter method (pH meter model PHS-3C) in a ratio of 1: 2: 5 soil–water ratio (Gary and Stephen, 2000). The sediment organic carbon was analyzed using Walkley- Black wet oxidation method (Nelson and Sommers, 1982). Bray 1 (Bray and Kurtz, 1945) method was employed to determine the available phosphorus. Total nitrogen was determined by employing the Macro-Kjeldahl method.

Determination of macronutrients in the sediments

Ammonium acetate extraction method at neutral pH 7 was employed to determine potassium, sodium, calcium, and magnesium as described by Jackson, (1973).

Determination of particle size distribution

The conventional Bouyoucos-hydrometer method was used to assess the particle size distribution (Bouyoucos, 1962).

Data analysis

Prior to ANOVA analysis, the data was subjected to normality and homogeneity of variance test using Shapiro-Wilk and Levene's test. The analysis was done by employing Analysis of Variance (ANOVA) with the aid of SPSS software ($p \leq 0.05$). Data were presented in tables as mean ± standard deviation (SD).

RESULTS AND DISCUSSION

Geomorphological features of the freshwater bodies

A total of sixteen (16) freshwater bodies in two hydrological areas of the Northern Guinea Savanna Zone of Nigeria, were studied. As shown in Table 1, the water bodies differed in terms of their locations, sizes, elevations, and aquatic flora. The location of the water bodies above sea level varied significantly, with the lowest elevation of 48 m at Galumo Stream (Kogi State) and the highest elevation of 1294 m at Gut Lake (Plateau State). The substratum was primarily composed of boulders, mud, and fine sand. The majority of the water bodies were marked by high levels of human activity.

Chemical properties of the sediment in the dry and rainy season

The results on the chemical properties of the sediment from the study location in dry and rainy seasons are summarized in Table 2. There was a significant ($p < 0.05$) difference when compared with the control having similar variation patterns across the sampling locations. The sediment pH values both for dry and rainy seasons ranged from 6.47 ± 0.09 (GUL) and 8.77 ± 0.09 (GLS) respectively with no significant difference ($p > 0.05$). Organic carbon recorded was highly significant ($p > 0.05$) in WUR (37.41 ± 0.3 g/kg and 37.11 ± 0.01 g/kg) and low in GAR (0.27 ± 0.09 g/kg and 0.20 ± 0.06 g/kg) and MNR (0.20 ± 0.06 g/kg) in dry and rainy seasons respectively. The organic matter content recorded extremely significant difference ($p < 0.05$) in both dry and rainy seasons with the highest (64.73 ± 0.74 g/kg) and 63.99 ± 0.01 g/kg) in WUR and the lowest in GAR (0.36 ± 0.02 g/kg and 0.34 ± 0.0 g/kg) and MNR (0.34 ± 0.0 g/kg) respectively. Similarly, the results for total nitrogen showed that there was a slight significant difference ($p < 0.05$) with the highest (5.84 ± 0.61 g/kg and 0.06 ± 0.0 g/kg) in WUR while GAR and MNR have the lowest (0.06 ± 0.02 g/kg and 0.03 ± 0.00 g/kg) value in dry and rainy season respectively. More so, phosphorus was high in KAR (23.40 ± 0.34 mg/kg and 25.73 ± 0.01 mg/kg) and low in GUL (3.00 ± 0.58 mg/kg and 4.17 ± 0.01 mg/kg) in both seasons respectively.

Macronutrients of the sediment in dry and rainy season

The availability of macronutrients in the sediment for the various locations were recorded and the content of Potassium (K), Sodium (Na), Calcium (Ca) and Magnesium (Mg) varied significantly when compared to the control as presented in Table 3. The highest content of K (0.58 ± 0.04 cmol/kg), Na (0.67 ± 0.02 cmol/kg), Ca (15.67 ± 0.88 cmol/kg) and Mg (4.30 ± 0.06 cmol/kg) was observed in WUR and the lowest content in GWR (0.03 ± 0.00 cmol/kg), GAR (0.13 ± 0.02 cmol/kg) and MHR (2.10 ± 0.58 cmol/kg and 0.40 ± 0.03 cmol/kg) with increase and decrease significant ($p < 0.05$) variation in dry season. Similarly, K, Na, Ca and Mg was high in WUR with mean values of 0.58 ± 0.0 cmol/kg, 0.67 ± 0.02 cmol/kg, 15.67 ± 0.88 cmol/kg and 4.30 ± 0.06 cmol/kg and low in JAL (0.05 ± 0.01 cmol/kg and 0.07 ± 0.01 cmol/kg), GGD (2.00 ± 0.58 cmol/kg) and MHR (0.40 ± 0.03 cmol/kg) respectively.

The study showed a significant increase ($p < 0.05$) in the dry season than in the rainy season with WUR having the highest mean value across all locations (Table 3).

Sediment particle distribution in dry and rainy season

In all the sampling locations WUR revealed the highest (43 % and 55 %) sediment particle for clay and silt respectively while GLS showed the highest (90 %) for sand in the dry season (Table 4). In the rainy season, a similar pattern was observed for WUR (42 % and 54 %) for clay and silt respectively while TAR, GLS, and MNR had 92 % for sand.

The study revealed a high content of sand in both dry and rainy seasons and slight variation in clay and silt respectively (Table 4).

Table 1: Geomorphological Features of the Freshwater Bodies

Water Body	Code	River Basin	Coordinates	Elevation (meters)	Area/Size (ha/km)	Vegetation	Predominant substrate type	Anthropogenic Activity
River Kadawa (Control)	KDWC	Hadejia	N11º40′01.6″ E008º25′15.7″	488	5.97	1	Fine mud	High
GidanGayan Reservoir	GGD	Niger	N10º42′31.4″ E007º44′21.5″	658	9.45	1	Fine sand with mud patches	High
Kargo Reservoir	KAD	Kaduna	N10º48′12.2″ E007º35′02.2″	637	40.68	1	Fine sand with mud patches	Low
River Galma	GAR	Kaduna	N11º4′32.5″ E007º44′21.5″	606	71.21	1	Fine sand with mud patches	Intermediate
River Tafa	TAR	Niger	N09º19′26.1″ E007º14′56.6″	506	42.61	2	Intermediates sand with fine mud	Low
River Kantoma	KAR	Niger	N09º10′15.4″ E007º11′45.3″	398	39.33	3	Large rocks, intermediate sand	High
River Gwazunu	GWR	Niger	N09º10′10.0″ E007º11′54.3″	420	36.02	2	Large rocks, intermediate sand	Intermediate
Galumo Stream	GLS	Niger	N07º46′54.3″ E006º44′07.2″	48	39.27	1	Small rocks, intermediate sand	Low
River Wupa	WUR	Niger	N08º56′08.5″ E007º05′34.3″	213	19.64	1	Fine mud	Low
River Gai	GKR	Niger	N08º54′30.6″ E007º15′33.2″	272	17.13	1	Fine sand with mud	High
Jabi Lake	JAL	Niger	N09º04′20.1″ E007º25′00.6″	449	115.95	3	Fine sand with mud	Low
River Zimbabwe	ZBR	Niger	N08º54′55.6″ E007º41′57.11″	255	111.25	2	Small rocks, intermediate sand	High
River Manu	MNR	Niger	N08º51′16.0″ E007º53′05.9″	277	42.42	2	Small rocks, intermediate sand	High
River Madahills	MHR	Niger	N08º56′37.2″ E008º24′20.3″	431	3.29	3	Large rocks, intermediate sand	High
Gut Lake	GUL	Lower Benue	N09º50′23.5″ E008º54′35.3″	1294	26.8	1	Fine mud	Low
Yingi Lake	YGL	Lower Benue	N09º51′30.9″ E008º53′34.8″	1202	3.34	2	Intermediate sand with fine mud	High

KEY: 1- sparse, little or no floating vegetation. 2- floating algal mats with macrophytes. 3- algal mats on dense vegetation along the shore.

Table 2: Chemical Properties of the Sediment in Dry and Rainy Season

LOCATION	DRY SEASON					RAINY SEASON				
	pH (1:1)	**O.C (g/kg)**	**O.M (g/kg)**	**TN (g/kg)**	**P (mg/kg)**	**pH (1:1)**	**O.C (g/kg)**	**O.M (g/kg)**	**TN (g/kg)**	**P (mg/kg)**
CONTROL	7.53±0.34[a]	5.50±0.31[a]	8.95±0.01[a]	0.65±0.00[a]	3.64±0.58[a]	7.20±0.06[a]	5.20±0.06[a]	8.95±0.01[a]	0.65±0.0[a]	5.64±0.01[a]
GGD	7.57±0.32[a]	0.58±0.01[b]	1.05±0.03[b]	0.08±0.01[b]	6.02±0.88[b]	7.23±0.03[a]	0.58±0.01[b]	1.02±0.01[b]	0.08±0.00[b]	7.35±0.01[a]
KAD	6.93±0.34[a]	15.18±0.31[b]	26.40±0.55[b]	3.67±0.47[b]	9.23±0.64[b]	6.60±0.06[a]	14.90±0.05[b]	25.83±0.04[b]	1.87±0.09[b]	10.23±0.07[b]
GAR	6.97±0.09[a]	0.27±0.09[b]	0.36±0.02[b]	0.06±0.02[b]	11.18±0.56[b]	6.90±0.06[a]	0.20±0.06[b]	0.34±0.0[b]	0.04±0.00[b]	12.18±0.04[b]
TAR	7.03±0.24[a]	5.24±0.09[a]	8.97±0.02[a]	0.72±0.04[a]	5.20±0.55[b]	6.80±0.06[a]	5.20±0.01[a]	8.95±0.01[a]	0.65±0.01[a]	7.20±0.06[a]
KAR	7.43±0.29[a]	8.03±0.04[b]	14.04±0.26[b]	2.00±0.58[b]	23.40±0.34[b]	7.10±0.06[a]	8.02±0.04[b]	13.78±0.01[b]	1.00±0.00[a]	25.73±0.01[b]
GWR	7.67±0.09[a]	0.83±0.04[b]	1.67±0.31[b]	0.21±0.00[b]	7.19±0.75[b]	7.60±0.06[a]	0.79±0.01[b]	1.36±0.01[b]	0.11±0.01[b]	9.19±0.61[b]
GLS	8.77±0.09[a]	0.82±0.06[b]	1.93±0.28[b]	0.33±0.06[b]	6.00±0.58[b]	8.50±0.06[a]	0.80±0.06[b]	1.38±0.00[b]	0.12±0.01[b]	9.27±0.64[b]
WUR	8.23±0.15[a]	37.41±0.3[b]	64.73±0.74[b]	5.84±0.61[b]	17.00±0.58[b]	8.10±0.06[a]	37.11±0.01[b]	63.99±0.01[b]	4.64±0.01[b]	19.85±0.01[b]
GKR	7.27±0.09[a]	16.76±0.4[b]	29.03±0.55[b]	2.72±0.42[b]	5.66±0.34[b]	7.20±0.06[a]	16.36±0.01[b]	28.17±0.03[b]	2.05±0.01[b]	8.33±0.01[b]
JAL	7.30±0.17[a]	4.89±0.05[a]	8.68±0.41[a]	0.50±0.06[b]	3.98±0.30[a]	7.17±0.09[a]	4.83±0.04[a]	8.27±0.01[a]	0.50±0.06[b]	7.32±0.06[b]

ZBR	6.88±0.06^{a}	2.26±0.07^{b}	4.05±0.27^{b}	0.34±0.04^{b}	7.63±0.61^{b}	6.82±0.02^{a}	2.19±0.01^{b}	3.78±0.01^{b}	0.27±0.00^{b}	8.63±0.04^{b}
MNR	7.23±0.09^{a}	0.27±0.09^{b}	0.53±0.03^{b}	0.06±0.02^{b}	6.20±0.76^{b}	7.13±0.03^{a}	0.20±0.06^{b}	0.34±0.0^{b}	0.03±0.00^{b}	7.60±0.06^{b}
MHR	7.07±0.09^{a}	0.80±0.06^{b}	1.69±0.31^{b}	0.16±0.02^{b}	5.25±0.68^{b}	6.99±0.02^{a}	0.77±0.03^{b}	1.38±0.01^{b}	0.13±0.01^{b}	6.37±0.01^{a}
GUL	6.47±0.09^{a}	2.79±0.00^{b}	5.33±0.39^{b}	0.45±0.06^{b}	3.00±0.58^{a}	6.40±0.06^{a}	2.79±0.00^{b}	4.81±0.01^{b}	0.35±0.01^{a}	4.17±0.01^{a}
YGL	6.77±0.15^{a}	2.63±0.24^{b}	5.38±0.69^{b}	0.50±0.06^{a}	6.60±0.12^{b}	6.90±0.06^{a}	2.39±0.01^{b}	4.13±0.01^{b}	0.30±0.06^{b}	7.60±0.12^{b}
P-value	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000

Means with different superscript letters within same column are statistically significant at $p < 0.05$.

Key: pH- Hydrgen ion concentration; O.C- Organic Carbon; O.M- Organic Matter; TN- Total Nitrogen; P- Phosphorus

R. Kadawa (KDWC)– Control, Gidan Gayan Reservoir- GGD, Kargo Reservoir- KAD, R. Galma GAR, R. Tafa- TAR, R. Kantoma- KAR, R. Gwazunu- GWR, Galumo Stream- GLS, R. Wupa-WUR, R. Gai- GKR, Jabi Lake- JAL, R. Zimbabwe- ZBR, R. Manu- MNR, R. Madahills- MHR, Gut Lake- GUL, Yingi Lake- YGL.

Table 3: Macronutrient of the Sediment in Dry and Rainy Season

LOCATION	DRY SEASON				RAINY SEASON			
	K	**Na**	**Ca (cmol/Kg)**	**Mg**	**K**	**Na (cmol/Kg)**	**Ca**	**Mg**
CONTROL	0.21±0.06^{a}	0.40±0.06^{a}	6.70±0.32^{a}	1.76±0.03^{a}	0.27±0.01^{a}	0.33±0.03^{a}	6.40±0.12^{a}	1.73±0.01^{a}
GGD	0.28±0.21^{a}	0.20±0.06^{b}	4.00±0.58^{b}	0.60±0.03^{b}	0.08±0.01^{b}	0.13±0.03^{b}	2.00±0.58^{b}	0.57±0.01^{b}
KAD	0.17±0.03^{a}	0.23±0.04^{b}	7.00±0.58^{a}	1.27±0.03^{a}	0.24±0.01^{a}	0.19±0.01^{b}	4.00±0.58^{b}	1.20±0.06^{a}
GAR	0.23±0.13^{a}	0.13±0.02^{b}	3.33±0.61^{b}	0.63±0.07^{b}	0.13±0.03^{b}	0.12±0.01^{b}	2.20±0.06^{b}	1.20±0.42^{a}
TAR	0.21±0.07^{a}	0.37±0.02^{a}	5.07±0.23^{a}	1.30±0.06^{a}	0.34±0.01^{b}	0.36±0.00^{a}	4.83±0.09^{a}	1.33±0.04^{a}
KAR	0.13±0.02^{a}	0.17±0.01^{b}	4.23±0.62^{a}	1.20±0.06^{a}	0.14±0.01^{a}	0.16±0.01^{b}	3.47±0.29^{b}	0.93±0.01^{b}
GWR	0.01±0.00^{a}	0.14±0.02^{b}	3.93±0.23^{b}	1.40±0.06^{a}	0.10±0.00^{b}	0.13±0.01^{b}	3.40±0.06^{b}	0.92±0.01^{b}
GLS	0.03±0.00^{a}	0.20±0.06^{b}	6.00±0.58^{a}	2.05±0.02^{a}	0.08±0.01^{b}	0.13±0.03^{b}	4.00±0.58^{b}	1.08±0.01^{a}
WUR	0.58±0.04^{b}	0.67±0.02^{b}	15.67±0.88^{b}	4.30±0.06^{b}	0.58±0.04^{a}	0.67±0.02^{b}	15.67±0.88^{b}	4.30±0.06^{b}
GKR	0.22±0.02^{a}	0.37±0.04^{a}	10.00±0.58^{b}	3.45±0.01^{b}	0.22±0.02^{a}	0.37±0.04^{a}	10.00±0.58^{b}	3.45±0.01^{b}
JAL	0.05±0.01^{b}	0.07±0.01^{b}	4.00±0.58^{b}	2.10±0.06^{a}	0.05±0.01^{b}	0.07±0.01^{b}	4.00±0.58^{b}	2.10±0.06^{b}
ZBR	0.11±0.00^{b}	0.30±0.06^{a}	3.67±0.33^{b}	0.70±0.06^{b}	0.11±0.00^{b}	0.30±0.06^{a}	3.67±0.33^{b}	0.70±0.06^{b}
MNR	0.06±0.00^{b}	0.21±0.05^{b}	3.67±0.88^{b}	0.60±0.03^{b}	0.06±0.00^{b}	0.21±0.05^{b}	3.67±0.88^{b}	0.60±0.03^{b}
MHR	0.06±0.01^{b}	0.19±0.03^{b}	2.10±0.58^{b}	0.40±0.03^{b}	0.06±0.01^{b}	0.19±0.03^{b}	2.10±0.58^{b}	0.40±0.03^{b}
GUL	0.10±0.01^{b}	0.20±0.06^{b}	2.57±0.34^{b}	0.53±0.03^{b}	0.10±0.01^{b}	0.20±0.06^{b}	2.57±0.34^{b}	0.53±0.03^{b}
YGL	0.27±0.04^{a}	0.40±0.04^{a}	4.00±0.29^{b}	0.83±0.04^{b}	0.43±0.01^{b}	0.32±0.01^{a}	3.05±0.03^{b}	0.81±0.01^{b}
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Means with different superscript letters within same column are statistically significant at $p < 0.05$.

Key: K- Potassium, Na- Sodium, Ca- Calcium, Mg- Magnesium**.**

R. Kadawa (KDWC)– Control, Gidan Gayan Reservoir- GGD, Kargo Reservoir- KAD, R. Galma GAR, R. Tafa- TAR, R. Kantoma- KAR, R. Gwazunu- GWR, Galumo Stream- GLS, R. Wupa-WUR, R. Gai- GKR, Jabi Lake- JAL, R. Zimbabwe- ZBR, R. Manu- MNR, R. Madahills- MHR, Gut Lake- GUL, Yingi Lake- YGL.

Table 4: Sediment Particle Distribution in Dry and Rainy Season

LOCATION	DRY SEASON				RAINY SEASON			
	Clay %	Silt %	Sand %	Textural class	Clay %	Silt %	Sand %	Textural class
CONTROL	18	25	57	Sandy loam	16	24	60	Sandy loam
GGD	23	27	50	Sandy clay loam	22	26	52	Sandy clay loam
KAD	17	16	67	Sandy loam	16	14	70	Sandy loam
GAR	17	21	62	Sandy loam	16	20	64	Sandy loam
TAR	9	4	87	Sand	6	2	92	Sand
KAR	15	15	70	Sandy loam	14	14	72	Sandy loam
GWR	9	4	87	Sand	8	2	90	Sand
GLS	7	3	90	Sand	6	2	92	Sand
WUR	43	55	3	Silty clay	42	54	4	Silty clay
GKR	24	26	50	Sandy clay loam	22	24	54	Sandy clay loam
JAL	9	7	84	Loamy sand	8	6	86	Loamy sand
ZBR	10	6	84	Loamy sand	8	4	88	Loamy sand
MNR	7	4	89	Sand	6	2	92	Sand
MHR	7	4	89	Sand	6	2	92	Sand
GUL	9	9	82	Loamy sand	8	8	84	Loamy sand
YGL	19	19	62	Sandy loam	18	18	64	Sandy loam
Mean	15.19±2.35	15.32±3.43	69.56±5.71		15.19±2.35	15.32±3.43	69.56±5.71	

Key: R. Kadawa (KDWC)– Control, Gidan Gayan Reservoir- GGD, Kargo Reservoir- KAD, R. Galma GAR, R. Tafa- TAR, R. Kantoma- KAR, R. Gwazunu- GWR, Galumo Stream- GLS, R. Wupa- WUR, R. Gai- GKR, Jabi Lake- JAL, R. Zimbabwe- ZBR, R. Manu- MNR, R. Madahills- MHR, Gut Lake- GUL, Yingi Lake- YGL.

Discussion

Geomorphological conditions are key players that contribute to the composition of sediments. Some species of freshwater molluscs may have their zoogeography explained by the geomorphologic features of an isolated freshwater habitat (Kohl, 2006; Gadzama *et al.,* 2015). There was variation in the elevation of the freshwater bodies. Gadzama *et al.,* (2015) reported that the tributaries to these depressions have helped to ensure the availability of water midway through the dry season or for most of the year and therefore served as reservoirs for different macro and microelements. The substratum is an important conditioner for the distribution of minerals in the isolated water environment. They were predominantly fine sand with mud that accelerates water retention, especially during desiccation while some locations were rocky. High anthropogenic activities were observed during the study period which include; fishing, washing, mining, dumping of refuse, watering points for animals, bathing, and channelling of water for irrigation leading to water pollution.

Anthropogenic and environmental variables can have an impact on sediment, which is a crucial component of aquatic habitats. Both harmful compounds and a variety of aquatic life can be found in sediment. (Javed *et al.,* 2018). There was no significant variation in the composition of sediment collected between dry and rainy seasons from the freshwater bodies studied. The chemical properties of the sediment; pH, organic carbon, organic matter, and total nitrogen were found to be higher in the dry season whereas phosphorus was high in the rainy season this could be due to increased photosynthesis and evaporation of water, the presence of bicarbonates in sediment and the presence of phosphorus fixing species (Davidson *et al.,* 2004; Wachinski, 2017). The type of soil used for agriculture in the catchment area, the industries operating there, and other factors all affect the chemical makeup of the sediment. (Zhang *et al.,* 2020). Augustyniak *et al.,* (2020) showed that the main factor which differentiated the sediment of the analysed Polish lakes is its hydrological regime. There was no variation in the macronutrient across dry and rainy season. In a related study, Iordache et al., (2020) reported high content of Ca, Mg, Na, K, Mn, Zn, Fe (1629.3, 1378.4, 51.61, 1190.8, 323.61, 54.9 and 16961 mg/kg respectively) in soil. The high content of Ca could be attributed to the texture of the soil in the area which is mainly of the Silty-clay, rich in carbonates. Ogbonna *et al*., (2018) also reported higher content of Ca (12.04 ± 0.08 cmol/kg), Mg (380 ± 1.13 cmol/kg), K (471 ± 4.24 cmol/kg), N (1.46 ± 0.10 cmol/kg), and P (6.53 ± 0.49 cmol/kg) in soil during dry season which is attributed to the fact that macro elements are easily leached, transported or washed away by runoff in wet season. The textural class was found to be Sandy loam, Sandy clay loam, Sand, Silty clay and Loamy sand. Sand had the highest percentage across the both seasons. According to Chima (2007), vegetation change may have played a role in the variations in particle size distribution, even though soil texture is an inherent feature.

CONCLUSIONS

The geomorphological features as the key players as they contribute to the composition of sediments. With the increase in agriculture in Nigeria, the result from this research suggest that sediments can be used for fertilization as they are rich in macronutrients. These results contribute to the macronutrient cycling in freshwater bodies, ecosystem status and eutrophication.

Declarations

All authors have read, understood, and have complied as applicable with the statement on "Ethical responsibilities of Authors"

ACKNOWLEDGEMENTS

The authors will like to thank the technical staff of Faculty of Life Sciences, Ahmadu Bello University, Zaria for their expertise in carrying out this research.

REFERENCES

Augustyniak, R., Grochowska, J., Łopata, M., Parszuto, K., Tandyrak, R. (2020). Characteristics of Bottom Sediments in Polish Lakes with Different Trophic Status. In Polish River Basins and Lakes—Part I; Korzeniewska, E., Harnisz, M., (*Eds*); *the* Handbook of Environmental Chemistry; *Springer International Publishing*: Berlin, Germany, 86, 139-157.

Bouyoucos, G. J. (1962). Hydrometer method improved for making particle size analysis of soil. *Agronomy Journal*, 54, 465–466.

Bray, R. H., and Kurtz, L. T. (1945). Determination of total, organic and available phosphorus in soils. *Soil Science*, 59:39.

Capra, G. F., Grilli, E., Macci, C.,Vacca, S., Masciandaro, G., Ceccanti, B., Bondi, G., Duras, M. G., Dessena, M.A., Merras, G., Gaviano, C., and Buondonno, A. (2015). Lake-dredged material (LDM) in pedotechnique for the restoration of Mediterranean soils affected by erosion/entisolization processes. *Journal of Soils and Sediments*, 15, 32-46.

Chima, U. D. (2007). Effects of tropical rainforest modification on soil quality of Omo biosphere reserve in Ogun State, Nigeria. (Master of Forestry Dissertation, University of Agriculture, Abeokuta, Ogun state, Nigeria).

Czamara, A., and Czamara, W. (2008). Heavy metal in the Mściwojów Reservoir ecological system. Infrastruktura i Ekologia Terenów Wiejskich 9, 283–296.

Davidson, E. A., de Carvalho, C. J. R., Vieira, I. C. G., Figueiredo, R. D., Moutinho, P., Ishida, F.Y., dos Santos, M.T.P., Guerrero, J. B., Kalif, K., and Saba, R.T. (2004). Nitrogen and phosphorus imitation of biomass growth in a tropical secondary forest. *Ecological Applications*, 14(4), 150 - 163.

Dushyantha, N., Panagoda, H. Jayawardena, C. L., Ratnayake, A. S., Premasiri, H. M. R., Ratnayake, N. P. (2017). Nutrient characteristics of lake sediments around Eppawala Phosphate Deposit, Sri Lanka. *Journal of Geological Society of Sri Lanka*, 18, 33–42.

Ervina, I., Lisiard, D., Kalvin, P., and Felix, R. (2018). The Analysis of Phytoplankton Abundance Using Weibull Distribution (A Case Study in the Coastal Area of East Yapen in the Regency of Yapen Islands, Papua). *Journal of Education and Learning*, 7:3.

Gadzama, I. M. K., Ezealor, A. U., Aken'Ova, T., and Balarabe, M. L. (2015). Aspects of the Geomorphology and Limnology of some mollusc-inhabited freshwater bodies in northern Nigeria. IOSR *Journal of Environmental Science Toxicology and Food Technology*, 9 (11), 20-29.

Gary, W. V. and Stephen J. D. (2000). "Environmental Chemistry a global perspective" Oxford University Press, Inc., New York.

Iordache, M., Sandru, C., Miricioiu, M., Nechita, C., Ionete, R.E., and Botoran, O. R. (2020). Influence of anthropogenic activity to the macronutrient loading in water and soil-Case study of industrial area. *Smart Energy Sustainable Environment*, 23(2), 81-92.

Jackson, M. L. (1973). Soil chemical analysis. Prentice Hall India Private Limited. New Delhi, 498.

Javed, T., Ahmad, N., and Mashiatullah, A. (2018). Heavy Metals contamination and ecological risk assessment in surface sediments of Namal Lake, Pakistan Pol. *Journal of Environmental Studies,* 27(2), 675–688.

Kazberuk,W., Szulc,W. and Rutkowska, B. (2021). Use Bottom Sediment to Agriculture—Effect on Plant and Heavy Metal Content in Soil. *Agronomy*, 11, 1077.

Kohl, M. (2006). Freshwater molluscan shells. Kong 1(2), 123-129.

Melquiades, F. L., González-Borrero, P. P., Dos Santos, F. R., De Deus, W. E. D., Kalwa, M. and Quináia, S. P. (2014). Method for Sediment Texture Characterization Using Spectroscopy Techniques and Multivariate Analysis. *Revista Virtual de Quimica*, 6 (6), 1687-1701.

Nelson, D. W., and Sommers, L. E. (1982). Total Carbon, Organic Carbon and Organic Matter. In: Page AL, Miller RH, Keeny DR (Eds.). Methods of Soil Analysis. Part 2. Chemical and Microbiological Properties. *American Agronomy,* 539-579.

Ogbonna, P. C., 1nzegbule, E. E., and Okorie, P. E. (2018). Seasonal Variation of Soil Chemical Characteristics at Akwuke Long Wall Underground Mined Site. *Nigeria Journal of Applied Science and Environmental Management*, 22(8), 1303 –1310.

Szmeja, J. (2006). Przewodnik do badań roślinności wodnej, *Gdańsk: Wydawnictwo Uniwersytetu Gdańskiego*, 1–407.

Wachinski, A. M. (2017). Environmental ion exchange: Principles and design (2nd edition) *CRC* Press. Pp. 76.

Zhang, C., Yu, Z., Zeng, G., Jiang, M., Yang, Z., Cui, F., Zhu, M., Shen, L. and Hu, L. (2014). Effect of sediment geochemical properties on heavy metal bioavailability. *Environment International*, 73, 270–281.

Zhang, Y., Zhang, X., Bi. Z., Yu. Y., Shi, P., Ren, L., and Shan, Z. (2020). The impact of land use changes and erosion process on heavy metal distribution in the hilly area of the Loess Plateau. China. *Science of the Total Environment,* 718, 137305.