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DETERMINATION OF SOIL ERODIBILITY STATUS UNDER DIFFERENT LAND-USE TYPES USING SOME ERODIBILITY INDICES: A CASE OF YENAGOA AND SOUTHERN IJAW LOCAL GOVERNMENT AREA OF BAYELSA STATE

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Abstract
The research was carried out to determine the effect of different land-use types on the erodibility status of the soils. Two local government areas namely: Southern Ijaw and Yenagoa were considered. Virgin land (VVL) and fallow land (FFL) were found in Southern Ijaw LGA, while the Oil Palm Plantation (OPT) and Plantain Plantation (PPT) were in Yenagoa LGA. Soil samples were taken from three depths (0 – 15, 15-30, and, 30-45cm) in the individual land-use types; with a total of twelve representative samples. The result showed that the soils of the individual land-use type were coarse-textured, with loamy sand to sandy loam to sandy clay loam. The result showed that mean values of Modified clay ratio (6.17% - PPT, 4.73% -OPT, 3% - VVL, 4.70% - FFL) indicated that the soils of the land-use types were erodible (PPT>OPT>FFL>VVL). Also, it was further reiterated in the mean Critical Level of Organic matter (0.78% - PPT, 1.43% - OPT, 1.10% - VVL, and, 0.87% - FFL) with a trend of OPT>VVL>FFL>PPT. Clay Dispersion Index and Clay Flocculation index of the soils of the land use types were above 15%, with a mean of 51.07/57.46% in PPT, 52.35/43.55 in OPT, 50.70/46.27% in VVL, and, 44.58/56.93% in FFL; signifying high erodibility. Bouyoucous Erodibility confirmed the result as erodibility was moderate in the Plantain plantation (3.55), and low in the virgin land (1.83) with the inclination of PPT>OPT>FFL>VVL. It is therefore confirmed that the land-use types had a significant impact on the erodibility of soils, as soils in their natural state are less erodible compared to those under anthropogenic influence. As such, land users are encouraged to practice sustainable soil management such as cover cropping, conservative tillage, bush fallowing, organic manure application, mixed cropping, farming, etc., and should be effected by relevant authorities at the federal, state, and local government level.

Key Words: *Erodibility, Land use, Indices, Bayelsa State*

Introduction

To ensure sustainable and optimal land utilization, there is a developing and essential need for systematic availability of information about soil conditions, their current status, level of deterioration, changes due to land use patterns and management techniques, and appropriate conservation measures (Tellen and Yerima, 2018). Erosion is a major and global issue that has shown great potential for destruction. History in different regions of the world has shown that human activities have exploited soil resources without fractioning soil conservational practices (Karlen and Rice, 2015; Brevik *et al.,* 2015). Worldwide, thirty-three percent of soils have been classified as having either a moderate or high degradation status (FAO and ITPS, 2015). Soil erosion is to blame for over 80% of current agricultural land deterioration around the world As a result, the risk of soil depletion increases, with rapid erosion being a common symptom, putting natural resources and the environment at risk. (Lal, 2016).

In Nigeria, when combined with a violent storm or heavy rain along the stream, soil erosion grows quickly, slurping away arable fields, economic trees, buildings, lives, and the relocation of people and valuable properties worth millions of naira. (Umudu, 2008), and, if unchecked, will result in irreversible deterioration (Chude *et al*., 2020). Soil erosion is a major environmental concern in Nigeria, particularly in the southeastern part of the country (Anambra, Enugu, Abia, Imo, and the Akwa Ibom States in particular.) The Agulu-Nanka-Oko-Ekwulobia gullies (Obi and Okekeogbu, 2017) are well-known in Anambra, with gullies measuring 120m in depth and 2km in width. Across the country, there are 2000 active gully erosion sites (Ume *et al*., 2014).

Bayelsa State is located in the Niger-Delta area, which is heavily influenced by its geographical characteristics. Because of its distinctive topography, which is crisscrossed by a variety of river distributaries, and its location on the Atlantic coast, the region is particularly susceptible to flooding, sea-level rise, and coastal flooding. About 65% of the region's population relies on the environment for survival, while the remaining 35% rely on remittances (Onakuse and Eamon, 2007). The atmosphere in the Niger Delta has shifted in recent years. The state of the physical environment has been compounded by worldwide climatic changes. Coastal floods, sea-level rise, and saltwater invasions are all too typical in today's towns. As a result, habitats have been altered, biodiversity has been lost, and water and land have been polluted, which are the people's most valuable assets. Hundreds of thousands of people, mainly the impoverished as well as those who rely on subsistence like fishing and crop farming, are affected in local communities. (Week and Wizor, 2020).

In Bayelsa State, the Obogoro community in Yenagoa Local Government Area is currently being ravaged by erosion whenever there is a heavy downpour of rain or the rising river level. This phenomenon has caused unquantifiable distress to the residents alongside the loss of properties worth millions of naira. The cause of the erosion has not been ascertained as proper analysis has not been carried out in the area. The residents of the area are mainly farmers and their farmlands were not spared, posing threat to food security in the area. This current degradation across the area and state will result in increased diversion and pressure on forest soils, therefore causing a rapid decline in the fertility of the soils (The Punch, 2021).

Similarly, the Ogbia communities, residing along the Kolo Creek and Ayama River have in the local Press media expressed concern over the erosion and flooding that have repeatedly occurred in the area claiming farmlands and nearby markets (Egirani, 2002). Land use can determine its effect on the soil. Land-use systems and changes are complicated processes controlled by anthropogenic activities which can cause ecological, social, and economic detriments if not properly guided (Agarwal *et al*., 2000). The soil is an abundantly essential natural resource that sustains biological life and provides products such as food, feed, fibre, and fuel. It also regulates carbon storage, water quality, and the impact of floods (Ritter and Eng, 2012). Indiscriminate land use can lead to degradation of soil properties and therefore occurrence such as erosion. Changes in land-use patterns have negative consequences on soil properties such as permeability, texture, and aggregate stability (Emadi *et al*., 2009). These changes are relevant because they determine the rate of soil erosion (Lambin and Geist, 2008). Researchers have shown that change in land use from forest to croplands may result in clay and silt increase and sand decrease (Martinez-Mena *et al*., 2009).

Erosion is the detachment and displacement of the surface soil by rainfall impact such as raindrops and runoff causes other degradation features, such as soil crusting, compaction, reduction of soil nutrients such as organic carbon, organic matter, Calcium, Magnesium, etc, salinization, contamination, and eventual pollution. This negatively affects the use of land, especially for agriculture. This was further confirmed by ELD (2015) as the annual soil loss amounting from arable lands is 75 billion tonnes and costs approximately \$400 billion annually in agricultural production worldwide.

Soil erodibility is defined as the susceptibility of soil to be detached and transported by water or wind, and it is related to the inherent properties of the soil, therefore making it the main factor for predicting soil erosion (Kulikov *et al*., 2017). The study, therefore, aims to reveal the current erodibility status of soils of the different land-use types, to curb the degradation process and proffer possible conservational and sustainable measures.

Methodology

The research was carried out in Bayelsa State. Bayelsa lies within 4° 39' 50.5080" N, 6° 2' 13.1532" E and is situated in the southern part of the Niger Delta of Nigeria. The wet season is warm and overcast, the dry season is hot and mostly cloudy, and it is oppressive year-round. Over the year, the temperature typically varies from 71°F to 87°F and is rarely below 63°F or above 90°F. The annual rainfall of the study area is 2000 – 4500mm, spread over 8 to 10 months of the year and bimodal, peaking in June and September. The relative humidity averages 80% all over the state and the natural vegetation zone is tropical rainforest.

The different land-use types are sited in two Local Government Areas in the State namely: Southern Ijaw and Yenagoa. Four land-use types were considered: Virgin

Land (4°59′35″ N 6°07′21″ E), Oil Palm Plantation (also called Bayelsa Palm) (4°58′50″ N 6°06′15″ E), plantain Plantation (4°59′45″ N 6°22′20″ E), and Fallow Land (4°53′06″ N 6°09′26″ E).

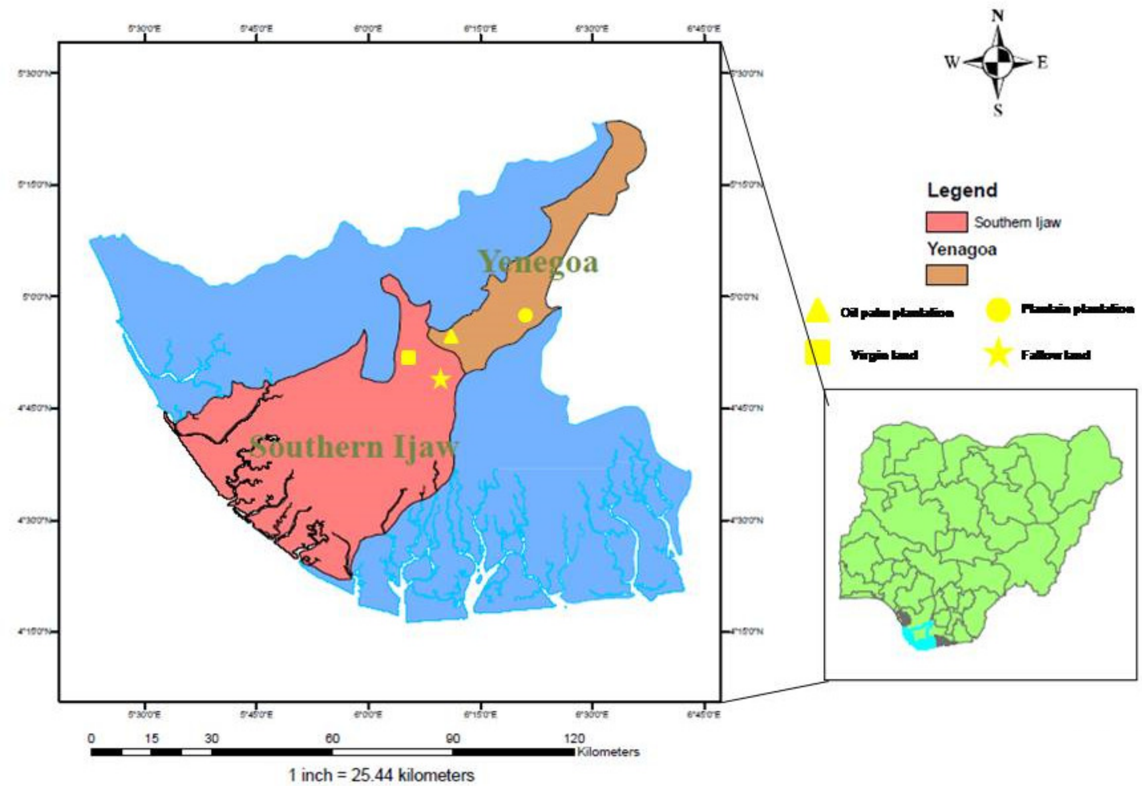

Fig 1: Map of Bayelsa State showing the two Local Government Areas housing the land use types and the sampling points (Designed using ArcGIS 10.4)

Soil Sampling

A random sampling method was implored to collect soil samples from three depths: 0-15, 15-30, and 30-45cm respectively using a hand auger in the four respective land-use types. Waterlogged areas, ant, and termite mounds were avoided to reduce sampling errors. A total number of 12 representative samples were collected, labeled, air-dried, and prepared for some physical and chemical analysis. Only disturbed soil samples were air-dried, undisturbed samples in cores were properly covered at both ends for bulk density and saturated hydraulic conductivity determination.

Soil texture was analyzed using the modified hydrometer method (Gee and Or, 2002). Soil pH and Electrical Conductivity (EC) were measured using a digital hand pH meter and EC meter respectively, in a 1:2.5 soil/water suspension. Total organic carbon was analyzed using the wet dichromate oxidation method of Walkley and Black, 1934. Organic matter was computed by multiplying the value of the organic carbon by a value of 2.0, as determined by I
W. Pribyl (2010).

Bulk Density (BD) was acquired using the gravimetric soil core method as described by Blake and Hartage (1986). The Total Porosity (PT) was obtained from the values of Bulk Density and Particle Density (PD).

Total Porosity = $1 - \frac{BD}{PD}$ (1)

Where Particle Density was assumed to be 2.65 gcm^{-3}. The default value of 2.65 g/cm^3 is used as a 'rule of thumb' based on the average bulk density of rock with no pore space (Fasinmirin and Olorunfemi, 2011)

Erodibility Indices

Clay ratio (CR) and Modified Clay Ratio (MCR). The clay ratio is the estimation of the amount of binding agent clay that tightly binds the soil particles, hard to detach the particle by the external forces in the presence of a higher amount of clay particles Bouyoucos, (1935). The minimum amount requirement of clay for any kind of interpretation is 10% (Bryan, 1968).

CR and MCR are inversely related to soil erodibility. Earlier studies stated the correlations among soil properties which reveals that modified clay ratio is also another index for erodibility (Tarafdar and Ray, 2005). The clay ratio and modified clay ratio were obtained by the Eqs. (2) and (3) as shown below:

Clay Ration (CR) = $\frac{(\%\text{sand} + \%\text{silt})}{\%\text{clay}}$ (2)

Modified Clay Ratio (MCR) = $\frac{(\%\text{sand} + \%\text{silt})}{\%\text{clay}} + \%\text{OM}$ (3)

Critical Level of Soil Organic Matter (CLOM)

The critical level of organic matter (CLOM) is also an indicator of erosion susceptibility. It is related to soil aggregate formation capability which offers resistance to soil erosion. If the value of CLOM is less than 5%, it is indicated that soil loses its structure and becomes highly susceptible to erosion. Soil is said to be moderately susceptible to erosion if the value lies between 5 and 7%. CLOM value of more than 9% indicates that soil is stable and offers more resistance to erosion23.

CLOM = $\frac{\text{Organic Matter}}{Clay + Silt}$ (4)

The new and advanced Bouyoucos (1962) erodibility index was also used to analyze the erodibility status

$EI_{ROM} = \frac{\% SAND + \% SILT}{2\ (\% CLAY)}$ (5)

Table 1: 'ROM' Scale with regards to soil erodibility category (Roslan and Mazidah, 2002)

Rom Scale	Soil Erodibility Category
< 1.5	Low
1.5 ~ 4.0	Moderate
4.0 ~ 8.0	High
8.0 ~ 12.0	Very high
> 12.0	Critical

The clay-dispersion indices were calculated as follows:

Clay dispersion ratio (CDR) = $\left\{\frac{(\%\text{ silt} + \%\text{ clay (H2O)}}{(\%\text{ silt} + \%\text{ clay (calgon)}}\right\}$ x100 (6)

Clay dispersion index (CDI) = $\left\{\frac{\%\text{ clay (H2O)}}{[\%\text{ clay (Calgon)}}\right\}$ x 100 (7)

$$\text{Clay flocculation index (CFI)} = \left\{\frac{[\%\ \text{clay (Calgon)}] - [\%\ \text{clay (H2O)}]}{[\%\ \text{clay (Calgon)}]}\right\} \times 100 \qquad (8)$$

The greater the CDR and CDI value, the more susceptibility of the soil to erode, while the higher the CFI, the better aggregated the soils are. Soils with a Clay Dispersion Ratio greater than 15% are erodible, and with less than 15% are not erodible.

Duncan Multiple Range Test at 5% level of significance was used to separate the means.

Result and Discussion

Table 2 shows some physical and chemical properties of the soils of the different land-use as these factors such as soil texture, organic matter, bulk density, etc play an important role in determining the resilience of soils to erosion. In the plantain plantation**,** the soils were dominated by the sand fraction, followed by the clay and silt fraction of the soil. Loamy sand dominated the first two depths of 0-15cm and 15-30cm, with sandy loam at the 30-45cm depth. The pH of the soils was highly acidic at the 0-15cm depth and consistently acidic (4.7) at the other two depths. Organic carbon and organic matter were very low, with a range of 4-11 g/cm and 8 – 22 g/cm. The higher organic carbon and matter were found at the surface soils (0-15cm). The bulk density of the soil was lowest at the surface soils (0-15cm) and significantly increased with increasing depth, with a range of 1.22 – 1.41 g/cm^3. Texture ranged from loamy sand – to sandy loam. The bulk density increased with an increase in the clay content of the soil, and a reduction in the sand fraction, therefore indicating illuviation (Agbai, 2022). Porosity was inversely proportional to bulk density, recording 54% at the 0-15cm depth and declined with increasing bulk density. In the oil palm plantation, pH use was also very acidic, with a range of 4.3-4.5. Organic Carbon and Organic Carbon were higher at the 0-15cm depth but decreased drastically at the lower depths. The three depths were mainly sandy loam showing no significant difference amongst them. Bulk density was lowest (1.22g/cm^3) at the 0-15cm depth and highest (1.33g/cm^3) at the 30-15cm depth. Porosity ranged from 50-54%.

The regular soil cultivation in the plantain and oil palm plantation resulted in rapid decomposition of organic carbon, which could have an impact on other soil activities that rely on organic carbon and organic matter (Akpan-Ebe, 2017); and it should be noted that low soil organic carbon and organic carbon could result to destruction of the soil structure, thereby decreasing soil aggregation and resilience to erosion (Bamikole *et al*., 2020). The loamy sand texture could be attributed to the parent material as it is an inherent kaolinitic property (Oguike and Mbagwu, 2009) that does not change easily (Kiflu and Beyene, 2013). Also, the frequent application of fertilizer and cultivation of the land caused a drastic reduction in pH thereby making the soils highly acidic (Muche *et al*., 2015). The higher bulk density values in both land-use types correlated with the results of Bamikole *et al*. (2020), showing that cultivated registered higher disturbances mainly from human and machine factors.

In the virgin land, pH was consistent (4.7) through the respective depths. Organic carbon and organic carbon were moderately low (29 and 58g/kg) at the surface (0-15cm) and reduced with increasing depths. Sandy loam described the texture of the 0-15cm depth, which afterward became sandy clay loam through the other two depths, indicating a significant increase in clay and reduction in sand ratio. Bulk density ranged from 1.24 – 1.36 g/cm^3), while porosity ranged from 49-53%. The higher organic matter content found in the virgin land could be attributed to the reduced or absence of crops cultivation and exposure to direct sunlight which could lead to rapid degradation of the organic residues and mineralization. In the fallow land, the pH ranged from 4.5-4.6 (moderately acidic) through the depths. Organic Carbon and Organic Matter were low, with the higher values (17 and 34g/kg) at the 0-15cm depth, which reduced thereafter. Loamy sand significantly dominated the three depths indicating a higher sand ratio in the soil. Bulk density ranged from 1.20 – 1.30g/cm^3 while porosity ranged from51-55% (Table 2).

Based on the classification of Adepetu *et al*. (2014), the pH of the soils in the virgin land and Fallow land were moderately acidic (Table 2). This could be due to the acidic nature of the highly weathered and leached soil. Surprisingly, the soil organic carbon and organic matter registered a different proportion as against the report of Alcantara *et al*. (2016), that soil organic carbon and matter were higher under natural forest compared with cropped land and fallow land respectively. This could be due to closed canopies formed in the oil palm and plantain plantation, including high decomposing and mineralized litter. The findings of Weil and Brady (2016) confirm that soils with high bulk densities will have reduced infiltration of water, thereby causing runoff and eventually erosion. This concurs with the bulk densities of the different land use of the study, summarily predicting imminent erosion.

Table 2: Some relevant Physical and Chemical properties of the study area

LAND-USE	Depth	pH	Org. C	Org.M	Sand	Clay	Silt	Soil Texture	Bulk Density (BD)	Porosity
			g/kg						g/cm^3	%
Plantain Plantation (4^{0}59’45”N 6^{0}22’20” E)										
PPT	0-15	4.4a	11c	22c	853.4c	91.4a	55.2c	loamy sand	1.22a	54c
PPT	15-30	4.7b	7b	14b	813.4b	138.6b	48b	loamy sand	1.38b	48b
PPT	30-45	4.7b	4a	8a	793.4a	162.5c	44.1a	sandy loam	1.41c	47a
Oil Palm Plantation (4^{0}58’50”N 6^{0}06’15” E)										
OPT	0-15	4.5a	36c	72c	773.4c	11.52a	115.2a	sandy loam	1.22a	54c
OPT	15-30	4.5a	11b	22b	723.4b	156.4b	120.2b	sandy loam	1.30a	51b
OPT	30-45	4.3a	5a	10a	713.4a	167.4c	119.2b	sandy loam	1.33a	50a
Virgin land (4^{0}59’35”N 6^{0}07’21” E)										
VVL	0-15	4.7a	29c	58c	693.4c	191.4a	115.2c	sandy loam	1.24a	53c
VVL	15-30	4.7a	22b	44b	683.4b	211.4b	105.2b	sandy clay loam	1.36b	49a
VVL	30-45	4.7a	14a	28a	653.4a	247.4c	99.2a	sandy clay loam	1.3b	51b
Fallow land (4^{0}53’06”N 6^{0}09’26” E)										
FFL	0-15	4.5a	17c	34c	733.4c	141.4a	125.2b	sandy loam	1.26a	52a
FFL	15-30	4.5a	11b	22b	723.4b	151.4b	125.2b	sandy loam	1.20a	55c
FFL	30-45	4.6a	7a	14a	703.4a	176.4c	120.2a	sandy loam	1.30a	51a

Mean value(s) with the same letters(s) in the column are not significantly different from one another at a 5% level of probability in each location. PPT-Plantain plantation, OPT-Oil Palm Plantation, VVL-Virgin land, FFL, Fallow land

Erodibility Status of the Soils of the Different Land-Use Types

Clay Ratio (CR) and Modified Clay Ratio (MCR): The result in Table 3 shows that the ability of the soils to erode was higher in the surface soils and reduced with depth increment. The CR of 10.77, 13.67, and 12.60% showed that PPT, OPT, and FFL were highly susceptible to erosion, compared to VVL with a lower susceptibility level (8.17). The erodibility susceptibility according to the land-use type is VVL<FFL<PPT<OPT. The result further confirms that soils with a low clay ratio and higher sand fraction were prone to erosion as the coarse nature of the soils makes them easily transported by wind or water. The higher percentage of clay found in the virgin land provided the required bonding forces of cohesion, leading to the formation of a more stable aggregation, making them less susceptible to erosion. The result as stated in Table 3 showed that the lower clay ratio in the oil palm and plantain plantation reduced the ability of the soil particles to bind and form well structure aggregates. This will eventually lead to easy dispersion and transportation of the soil particles, and hence erosion. This is in line with Donald et al. (2020), who discovered that soils with higher clay content have lower erodibility. As a result, low-clay soils are more susceptible to erosion, have fewer binding forces, and have poor cohesiveness.

Critical Level of Soil Organic Matter (CLOM): CLOM values ranged from 0.4-

1.5 in PPT, 0.3-3.2 in OPT, 0.8 – 19 in VVL, and 0.5-1.3% in FFL. The average values of 0.78, 1.43, 1.10, and 0.87% in the PPT, OPT, VVL, and FFL indicate that the soils of the four land-use are highly susceptible to erosion. The level of vulnerability as depicted by the CLOM is OPT<VVL<FFL<PPT. The susceptibility of the soils reiterates the importance of organic matter as a binding agent and promoter of a conducive environment for organisms that facilitate aggregation.

Clay Dispersion Ratio and Clay Dispersion Index: The results in Table 3 shows that all the land-use types were highly erodible as their CDR and CDI were significantly higher than 15%. The CDR levels are OPT>PPT>VVL>FFL, while that of CDI is PPT>FFL>VVL>OPT. The detrimental effect caused by low clay content in the soil and higher sand content was noticed as the soils were dispersed under external stress, similar to the field process. It means the soils of the individual land-use will easily disperse at the onset of rainfall, flood, or wind.

Clay Flocculation Index (CFI): The mean Clay aggregation of PPT, OPT, VVL, and FFL was 5.92, 2.82, 5.00, and 2.02. The aggregation inclination is PPT>VVL>OPT>FFL. The low CFI indicates that the soils were weakly aggregated and will break upon external force.

Bouyoucous Erodibility Index: From Table 2, the erodibility category of the plantain plantation (PPT) ranged from moderate (2.58) to high (4.97), with an average status of moderately erodible (3.55). In the oil palm plantation (OPT), the erodibility category ranged from 2.49 – 3.98 indicating moderate to high erodibility, with a mean of 3.06 indicating moderate erodibility. In the virgin land (VVL), the soil erodibility category ranged from low (1.5) to moderate erodibility (2.11), while in the fallow land, the erodibility category as determined by the Bouyoucous index ranged from 2.33 to 3.04 which was moderately erodible (Table 1). The Bouyoucous Erodibility Indexshows that forest land with less human activities and degeneration of soil properties have lower susceptibility compared to soils that have been disturbed

The result showed that the different land-use types had a significant effect on the erodibility of the soils. This was proven as the values of the indices were significantly different amongst the land-use types. The following shows the patterns followed: MCR and CR – PPT>OPT/FFL >VVL; CLOM – PPT/FFL<VVL<OPT; CDR – OPT>PPT>VVL/FFL; CDI – PPT>FFL>VVL>OPT; CFI – PPT>VVL>OPT>FFL; EI_{ROM} PPT>OPT>FFL>VVL. (Table 3). The CDI and CDR showed an inverse relationship following that while the values of CDR and CDI were high, the CFI values were low; indicating that flocculation and aggregation have opposite influences on the soil; this was reiterated in the result of Osujieke *et al*. (2018).

Table 3: Determination of the erodibility status of the study areas using some erodibility indices

LAND USE	DEPTH	MCR	CR	CLOM	CDR	CDI	CFI	EIROM
		%						
PPT	0-15	8.0c	15.4c	1.5b	51.7b	62.25b	3.96a	4.97c
	15-30	5.6b	9.3b	0.8a	40.62a	42.2a	6.53b	3.11b
	30-45	4.9a	7.6a	0.4a	60.89c	67.93c	7.28c	2.58a
	Mean	6.17c	10.77c	0.78a	51.07c	57.46d	5.92d	3.55d
OPT	0-15	4.8a	17.3c	3.2c	53.75b	41.83b	3.29c	3.98c
	15-30	4.7a	12.3b	0.8b	49.16a	38.87a	2.31a	2.70b
	30-45	4.7a	11.4a	0.3a	54.15c	49.94c	2.87b	2.49a
	Mean	4.73b	13.67b	1.43c	52.35d	43.55a	2.82b	3.06c
VVL	0-15	3.2b	9.6c	1.9c	37.76a	25.39a	3.98a	2.11b
	15-30	3.1b	8.2b	1.4b	49.21b	44.7b	5.02b	1.87a
	30-45	2.7a	6.7a	0.8a	65.14c	68.71c	5.99c	1.50a
	Mean	3.00a	8.17a	1.10b	50.70b	46.27b	5.00c	1.83a
FFL	0-15	4.9b	14.0c	1.3b	35.93a	40.02a	1.14a	3.04c
	15-30	4.9b	13.0b	0.8a	45.48b	60.43b	1.73b	2.80b
	30-45	4.3a	10.8a	0.5a	52.32c	70.35c	3.18c	2.33a
	Mean	4.70b	12.60b	0.87a	44.58a	56.93c	2.02a	2.72b

Mean value(s) with the same letters(s) in the column are not significantly different from one another at a 5% level of probability in each location. PPT-Plantain plantation, OPT-Oil Palm Plantation, VVL-Virgin land, FFL, Fallow land

The mean values of the indices (Fig 2) revealed that high dispersive power indicated by the CDR and CDI was highest in the oil palm plantation and plantain plantation owing to the critical level of organic matter (Critical Level of Organic Matter) and clay (Modified Clay Ration and Clay Ration). Also, the relative ratio of the soil texture (EIrom) showed both land use (Oil palm and plantain plantation) to be at higher erodibility status compared to the virgin land and fallow land.

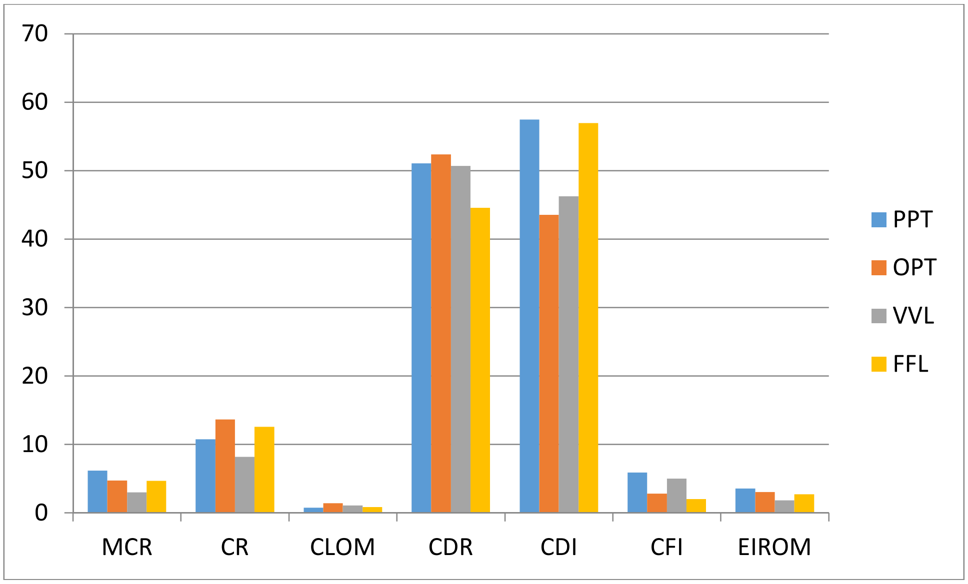

Fig 2: Mean erodibility status of the individual land use type

Conclusion

The research revealed that the soils of the different land-use types were mainly coarse natured with little clay ratio, with sandy loam in the fallow land and oil palm plantation, loamy sand in the plantain plantation, and sandy loam to sandy clay loam in the virgin land. These textures significantly contributed to the erodible state of the soils. Organic matter was low through the different land-use types, with the highest found in the virgin land and the lowest in the plantain plantation. From the erodibility indices considered, the results showed that land-use types affected the erodibility status of the soils. Although the erodibility indices indicated that all the soils in the land-use types are prone to erosion, the land-use with higher organic matter and clay content (in this case the virgin land) will drastically resist the tendency of the soils to erode, as the organic matter and clay will improve the soil structure through stronger aggregate stability. Consequently, conversion of natural/native forest for agricultural use can lead to land degradation in form of erosion, especially when they are not utilized conservatively. It is therefore recommended that soils in their natural state be left untouched or utilized using conservative and ameliorative practices such as cover cropping, conservative tillage, terracing, bush fallowing, organic manure application, mixed cropping, farming, etc.

The Federal, State, and Local Government of Nigeria alongside other agencies like the Nigerian Institute of Soil Science (NISS), National Emergency Management Agency (NEMA), etc should formulate and implement policies that will control the destructive use of land such as over dredging of waterways, overgrazing by herders, causing exposure of the land to the direct impact of rainfall. Also, subsistent farmers and wood loggers in Nigeria who build camps in the forest should be enlightened on the dangers of indiscriminate felling of trees which reduce the protective canopy formed by these trees; clearing and exposure of the soil.

In the case of non-implementation or noncompliance, the effect on land will affect the populace by reducing land for agricultural practices, thereby causing food scarcity and insecurity.

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