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Impact of Agriculture and Road Construction on Soil Aggregates in Two Locations of Coastal Plain Sand, Southeastern Nigeria

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ABSTRACT

Background: Understanding how land use affects the stability of soil aggregates and soil organic carbon associated with water stable aggregates in soils within the coastal plain sands is crucial for sustainable management. This study examines how agriculture and road construction influence these factors in two locations of Abia State, Southeastern Nigeria.

Methods: The study was a 2 * 5 factorial experiment; denoting two locations (Umudike and Umuahia) and five land use practices which include Road Construction, Fallow, Grazing, Cultivation and Forest in a randomized complete block design. Soil sampling utilized the Transect method at a depth of 0 - 15 cm. Laboratory analysis on aggregate indices and pertinent soil characteristics were carried out.

Result: Soil texture differed between Umudike (sandy loam) and Umuahia (loamy sand). Umudike soil showed higher water-stable aggregates (WSA), lower CR (clay ratio: 7.19), DR (dispersion ratio: 0.36) clay dispersion index (CDI: 0.41), higher ASC (aggregated silt plus clay: 14.24 g/kg) and aggregated soil organic carbon (ASOC). Both locations are classified as erodible (DR > 15%). The main effect of land use revealed that forest, grazing and fallow enhanced aggregate stability and ASOC compared to cultivation and road construction. The combined effect of location and land use on soil aggregates displayed variability of response, emphasizing the influence of particle size distribution, SOC status including management on aggregate indices. Correlation analysis supported this claim. Therefore, tailored conservation strategies are vital for enhancing structure and ASOC while asphalting with proper drainage is crucial to prevent land degradation.

Key words: Aggregates, Agriculture, Coastal plain sands, Road construction, Soil organic carbon.

INTRODUCTION

Stability of soil aggregate, reflecting particles' adherence and resistance to disintegration, is crucial for carbon stabilization in aggregates (Ran *et al.*, 2021). Soil organic carbon found in microaggregates enhances the formation of macroaggregates and plays a crucial role in the long-term retention of soil organic carbon (Sekaran *et al.,* 2021). Stable aggregates prevent loss of associated carbon linked to soil erosion, maintain soil fertility, plant resilience to moisture fluctuations and mitigate climate change (Menon *et al.,* 2020). Researchers have employed indices such as mean weight diameter (MWD) and colloidal dispersion indices to evaluate stability and predict soil erosion, particularly in tropical soils of Nigeria (Osakwe, 2018).

Coastal plain sand-derived soils as in Abia State are sandy; often exhibit low aggregate stability, clay and organic matter content, making them susceptible to erosion (Uluocha and Uwadiegwu 2015; Chukwu *et al.,* 2023). They added that moderate soil erosion affects around 20% of the area (115,077.9 hectares). Additionally, 27% (60,271.4 hectares) is subject to low erosion and the remaining 33% of the State experiences very low levels of soil erosion. Therefore, regular assessment and evaluation for proper management is imperative. In addition, information on possible variability between soils in the study sites, crucial for site-specific management is lacking. Furthermore, Nigeria's rapid urbanization, infrastructural development and agricultural expansion, while crucial for economic growth and food security, often overlook their impact on soil properties. Consequently, our study aimed to investigate how road construction and agriculture influence coastal plain sand soils in Abia State, southeastern Nigeria and the potential variability in response across locations.

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MATERIALS AND METHODS

Description of study area

The research was conducted between 2018 and 2020 in Umudike and Umuahia between latitude 05°28′N and 05°32′N and longitude 007°28′E and 007°32′E, located in the rainforest agroecology of Abia State, southeastern Nigeria, characterized by a humid tropical climate (Igbozuruike, 1975). The area experiences average annual rainfall of 2176 mm with minimum monthly air temperatures between 20°C and 24°C and maximum temperatures ranging from 28°C to 35°C. The humidity ranges from 51% to 87%. The primary parent material consists of Coastal Plain Sands, along with certain areas featuring alluvial sediments (Amanze *et al*., 2016). The soil type, classified as Ultisols, is sandy, predominantly kaolinite-based with low pH, base status and soil organic carbon (Lekwa and Whiteside 1986).

The land use history, methodology flow chart and location maps are presented in Table 1, Fig 1 and 2 respectively.

Experimental design

The research was designed as a 2×5 factorial experiment in randomized complete block design (RCBD) with three replicates. The numbers are two locations (Umudike and Umuahia) and five land use practices (Fallow land, Arable land, Grazing land, Forest and Road construction). Each location's designated land use areas were subdivided into three blocks and the transect method was used to collect soil samples from 0-15 cm depth. Samples from each block were combined to create 15 composite samples for each location. They were air-dried and passed through 4 mm and 2 mm sieves for laboratory analysis.

Laboratory analysis

The method of Gee and Bauder (1986) was used to assess the particle size distribution using sodium hexameta phosphate as a dispersing agent. Colloidal stability was determined by substituting water for the dispersing agent and computed as follows:

$$DR = \frac{\%\ clay + \%\ silt\ (H_2O)}{\%\ clay + \%\ silt\ (calgon)}$$

$$CDI = \frac{\%\ clay\ (H_2O)}{\%\ clay\ (calgon)}$$

$$ASC = \%\ clay + \%\ silt\ (calgon) - \%\ clay + \%\ silt\ (H_2O)$$

$$CR = \%\ Sand + \%\ silt / \%\ clay$$

(Bouyoucus, 1951),

DR, Dispersion Ratio, CDI, Clay Dispersion Index and ASC, Aggregated Silt plus Clay.

The method of Kemper and Rosenau (1986) was employed to determine percent water stable aggregates. This process included placing 25 grams of air-dried aggregates larger than 2 mm on the top sieve of a nest containing sieves measuring 2.0 mm, 0.25 mm and 0.053 mm. After pre-soaking in water for 10 minutes, aggregates underwent vertical oscillation 40 times with a 4 cm amplitude. Remaining aggregates on each sieve were oven-dried at 60°C for 24 hours and weighed. The weight of aggregates < 0.053 mm was calculated by subtracting masses collected on specific sieves from original sample weight. The retained aggregates in each sieve size class represented water-stable aggregates (WSA). The MWD was calculated as follows:

$$MWD = \sum_{i=1}^{n} W_i X_i$$

Where,

xi = Represents the average diameter of aggregates within a specific size range, while wi denotes the weight of aggregates in that range as a fraction of the total dry weight of the sample analyzed.

The determination of SOC in bulk soil and water stable aggregates was conducted using the Walkey and Black wet oxidation method, which was modified by Nelson and Sommer in 1982.

Statistical analysis

Data obtained were subjected to statistical analysis using Minitab software, with the Tukey test applied for mean separation at a 5% probability level. Linear correlation analysis between PSD, SOCb and aggregate indices were conducted with SPSS software.

RESULTS AND DISCUSSION

Effect of location and land use on aggregate indices

Soil texture and particle size distribution (PSD)

Table 2 shows the impact of location, land use and their interaction on soil texture and PSD. Soils in Umudike exhibited a sandy loam texture, while Umuahia soils were loamy sand, reflecting a coarser texture in Umuahia. Umudike had higher clay content (138 g/kg) than Umuahia (108 g/kg), while sand content followed the opposite trend. Though texture is mostly inherent, localized leaching, illuviation and pedogenic processes often influence variability (Osakwe *et al.,* 2022; Oguike *et al.*, 2023).

Forest and grazing lands exhibited lower sand and higher clay contents than other land uses, attributed to organic matter inputs and canopy protection against erosion. Cultivated lands showed the highest sand content (854 g/kg) and the lowest clay (93 g/kg) and silt (46 g/kg), likely due to tillage and erosion-consistent with Onwuka (2020). Dinh and Shima (2024) also found bare soils had more sand than forest soils. These interactions underscore cultivation's negative effect on PSD, modulated by location.

Table 1: Land use history.

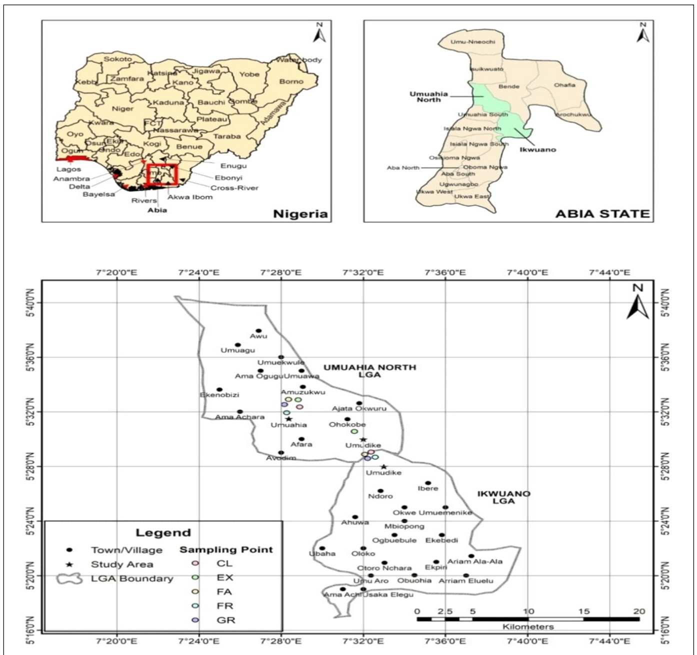
Location	Land use	Land use history
Umudike	Grazing land	MOUA grazing land
	Road grading	Work in progress
	Fallow	Natural fallow >15 Years
	Forest	M OUA forest reserve
	Cultivated	Cassava ,>15 years,
Umuahia	Grazing land	Free range community grazing land.
	Road grading	Work in progress
	Fallow	Natural fallow >15years
	Forest	Abia state forest reserve UM.
	Cultivated	Cassava >15 years

MOUA-Michael Okpara University of Agriculture, Umudike.

Soil organic carbon in aggregates (ASOC) and bulk soil (SOCb)

Fig 3 and 4 reveal that Umudike had higher ASOC in both the 4-2 mm (25.27 g/kg) and 2-0.25 mm (28.95 g/kg) fractions, along with greater bulk SOC (20.67 g/kg) than Umuahia. This supports Yang *et al.* (2022), who emphasized macroaggregates' role in SOC storage. In both locations, the <0.25 mm ASOC was similar, indicating diminishing location effects with decreasing aggregate size, as also noted by Osakwe *et al.* (2024) and Mao *et al.* (2020).

Land use effects showed that road construction eliminated ASOC in the 4-2 mm fraction (0 g/kg), demonstrating the adverse impact of soil disturbance, consistent with Sezgin *et al.* (2019). Grazing areas had the



CL: Cultivated, EX: Road construction, FA: Fallow, FR: Forest, GR:Grazing

Fig 1: Location maps.

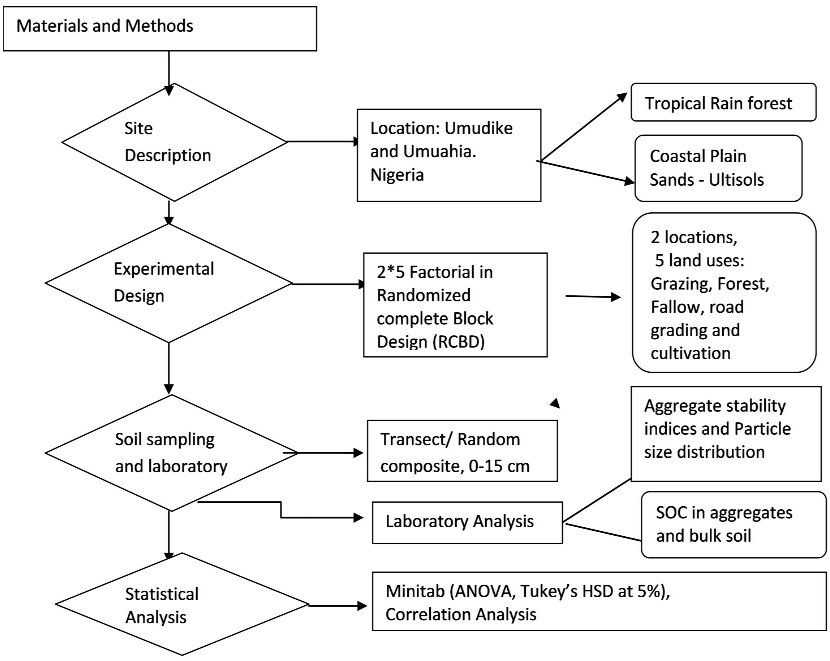


Fig 2: Methodology flow chart.

highest ASOC across all sizes: 25.27 g/kg (4-2 mm), 38.95 g/kg (2-0.25 mm) and 23.56 g/kg (<0.053 mm). Forest soils showed the highest SOCb. These trends suggest that organic matter quality and type-not just quantity-drive ASOC levels. Prabakaran *et al.* (2023) found that vegetation and litter-fall significantly influenced carbon pools across land uses.

SOCb followed the order: forest > grazing > fallow > cultivated > road, confirming findings by Martens *et al.* (2004), who reported that forests and pastures stored 46% and 25% more SOC than cropped soils, respectively, with forest increasing SOC by 29% over pasture. SOC declines in cultivated land stem from crop residue removal, intensive tillage, oxidation and erosion (Mengstie *et al.*, 2020; Osakwe, 2018). Variability in SOC across land uses is also shaped by vegetation, microbial activity, substrate quality and root turnover.

Land use significantly influenced ASOC, aligning with Yi *et al.* (2018). Interaction effects (Table 3) indicated road construction caused significant ASOC loss in macroaggregates at both sites, while grazing, fallow and forest enhanced ASOC. ASOC contributes to soil structural stability, so its decline under road construction likely degrades soil physical properties and ecosystem functions (Ayoubi *et al.*, 2020).

Grazing and forest lands in Umudike showed superior ASOC and SOCb levels, likely due to better management practices (Table 1; Fig 4). These results emphasize the importance of sustainable land use for enhancing SOC and promoting climate resilience.

Table 2: Effect of location and land use on particle size distribution and texture.

Parameter	Sand	Clay	Silt	Texture
		g/kg		
Location				
Umudike	782b	138a	80a	SL
Umuahia	815a	108b	77a	LS
Landuse				
Grazing	774cd	131ab	95a	SL
Road construction	810b	117b	73ab	SL
Fallow	803bc	118b	79ab	SL
Forest	751d	155a	944a	SL
Cultivated	854a	93c	53b	LS
Location*Landuse				
Umudike*Grazing	705e	192a	103a	SL
Umudike*road construction	864ab	70d	66ab	LS
Umudike*fallow	777cd	137bc	86ab	SL
Umudike*forest	744de	177a	79ab	SL
Umudike*cultivated	820bc	114c	66ab	LS
Umuahia*Grazing	844ab	70d	86ab	LS
Umuahia*road construction	757de	164ab	80ab	SL
Umuuahia* fallow	82.91bc	99cd	71ab	LS
Umuahia*forest	759de	132bc	109a	SL
Umuahia* cultivated	888a	72.d	40b	S

SL: (Sandy loam), LS: (Loamy sand).

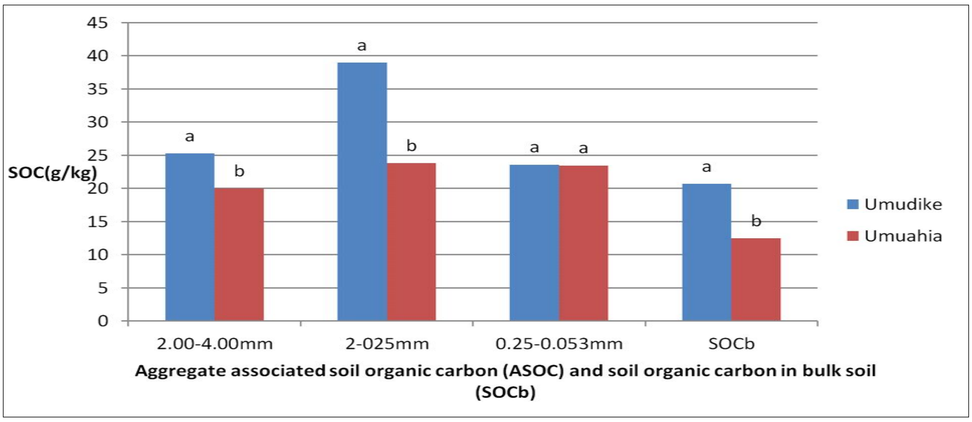


Fig 3: The effect of location on aggregate associated soil organic carbon and soil organic carbon in bulk soil.

Aggregate size distribution (ASD) and mean weight diameter (MWD)

Table 4 shows that Umudike soils had a higher proportion of water-stable aggregates (WSA) in all size fractions. Despite this, no significant location effect was observed on MWD. Greater WSA in Umudike is likely due to its higher clay and SOC content (Tables 2 and 3), which promote aggregation. Li *et al.* (2023) reported that fine particles and SOC support aggregate formation. Umudike also had a higher proportion of microaggregates (33%) than Umuahia, linked to its finer texture. Similar findings were reported by Gao *et al.* (2024) and Wu *et al.* (2024) for Mollisols and silty loam soils.

Land use effects on ASD were as follows:

- **4.00–2.00 mm:** Grazing = Forest > Fallow > Road > Cultivated
- **2.00–0.25 mm:** Grazing > Fallow > Forest > Road = Cultivated
- **0.25–0.053 mm:** Road = Cultivated > Fallow > Forest > Grazing
- **<0.053 mm:** Road = Cultivated > Fallow = Forest = Grazing

Grazing, forest and fallow lands retained larger aggregates better than road and cultivated lands. Higher WSA in the smallest fractions under road and cultivation implies greater breakdown and weaker structure. MWD values were higher in forest, grazing and fallow, supporting Nwite (2015), who observed improved aggregation in these systems.

Interaction effects revealed that macroaggregation was lowest at Umuahia's road construction sites (4.53%) and in Umudike's cultivated lands (6.41%), showing severe degradation. Grazing and forest lands recorded the highest macroaggregation (42.08-44.31%). Road construction and cultivation caused up to 88% decline in macroaggregates, consistent with Osakwe *et al.* (2024) in southeastern Nigerian Ultisols.

Enhanced macroaggregation implies not only reduced compaction (Obalum and Obi 2014) but also improves root penetration, erosion control and nutrient cycling (Zhang

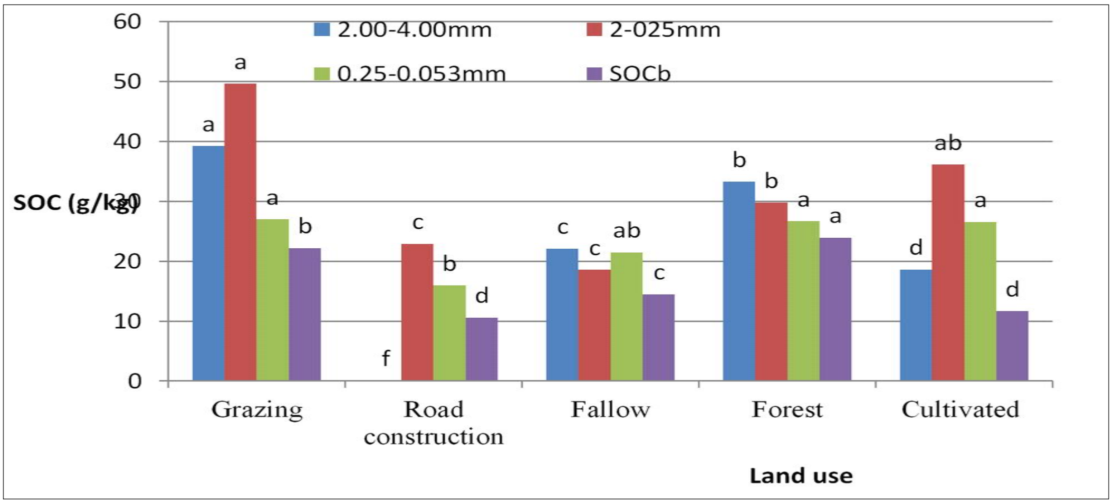


Fig 4: Effect of land use on aggregate associated soil organic carbon and soil organic carbon in bulk soil.

Table 3: The interaction of location and land use on ASOC and SOCb.

Parameter (g/kg)		ASOC		SOCb
Aggregate size(mm)	2.00-4.00	2-025	0.25-0.053	
Location*Landuse				
Umudike*Grazing	38.31a	66.95a	29.93a	28.93a
Umudike*road construction	0f	37.27b	26.30ab	14.36d
Umudike*fallow	23.97c	17.87bc	15.67bc	16.89c
Umudike*forest	39.40a	34.44bc	23.87ab	29.06a
Umudike*cultivated	24.66bc	38.20b	22.04ab	14.10d
Umuahia*Grazing	40.12a	32.26bc	24.01ab	15.36cd
Umuahia* road construction	0f	8.43d	5.54c	6.78g
Umuahia* fallow	20.14d	19.23bc	27.16ab	12.04e
Umuahia*forest	27.08b	25.04bc	29.43a	18.82b
Umuahia* cultivated	12.55e	33.99bc	31.06a	9.18f

ASOC - Aggregated associated carbon, SOCb- Soil organic carbon in bulk soil.

et al., 2012). These findings underline the need for land management practices that improve soil aggregation.

Microaggregate stability indices

Table 5 shows that Umudike had better microaggregate stability, with lower clay ratio (CR: 7.1), clay dispersion index (CDI: 0.41), dispersion ratio (DR: 0.35) and higher aggregated silt + clay (ASC: 14.24 g/kg) than Umuahia. These values suggest Umuahia soils are more erosion-prone. Umudike's higher clay and lower sand content explain this stability. However, both sites are highly erodible (DR > 15%, Middleton, 1930).

Table 4: Effect of location and land use on aggregate size distribution (ASD).

Aggregate sizes (mm)	4-2	2-0.25	0.25- 0.053	<0.053	
Parameter	ASD (%)				MWD(mm)
Location					
Umudike	33.11a	25.04a	12.58a	15.36a	1.25a
Umuahia	26.15b	22.19b	11.32b	9.70b	1.15a
Landuse					
Grazing	43.14a	29.21a	3.31d	4.28c	1.63a
Road construction	19.06c	17.48c	19.02a	13.99b	0.79b
Fallow	31.87b	31.54a	12.46b	11.62b	1.32a
Forest	43.19a	23.49b	6.99c	12.81b	1.57a
Cultivated land	10.89d	16.37c	17.98a	19.96a	0.70b
Location*landuse					
Umudike*grazing	44.06a	37.53a	1.93e	3.87d	1.75a
Umudike*road construction	4.53d	16.12cd	18.81abc	22.65a	0.33c
Umudike*fallow	31.45b	33.91ab	15.82bc	9.31bc	1.35ab
Umuahia*forest	44.31a	18.13cd	4.93de	20.89a	1.55a
Umudike*cultivated	6.41d	19.52cd	21.42a	20.09a	0.78bc
Umuahia*Grazing	42.21a	20.90c	4.68de	4.69cd	1.51a
Umuahia*road construction	33.59b	18.85cd	19.23ab	5.83cd	1.24ab
Umuahia* fallow	32.30b	29.17b	9.09d	13.94b	1.31ab
Umuahia*forest	42.08a	28.84b	9.05d	4.73cd	1.60a
Umuahia* cultivated	15.37c	13.19d	14.54c	19.82a	0.62c

Table 5: Effect of location and land use on microaggregate stability indices.

Parameter	ASC (g/kg)	CR	CDI	DR
Location				
Umudike	14.24a	7.19b	0.41b	0.36b
Umuahia	11.29b	9.36a	0.55a	0.41a
Landuse				
Grazing	15.59a	8.64bc	0.49c	0.32cd
Road construction	11.64b	9.16ab	0.57b	0.41b
Fallow	11.67b	7.74c	0.39d	0.39bc
Forest	18.05a	5.60d	0.30e	0.26d
Cultivated land	6.88c	10.24a	0.65a	0.54a
Location*landuse				
Umudike*grazing	22.52a	4.17e	0.26d	0.22e
Umudike*road construction	5.95ef	13.11a	0.82a	0.55b
Umudike*fallow	13.23cd	6.29cde	0.26d	0.39cd
Umudike*forest	19.23ab	4.68de	0.21d	0.23e
Umudike*cultivated land	10.29de	7.71bc	0.51b	0.42c
Umuahiae*Grazing	8.67def	13.11a	0.72a	0.42c
Umuahia* road construction	17.33bc	5.21de	0.32cd	0.27e
Umuahia* fallow	10.11def	9.19b	0.52b	0.39cd
Umuahia*forest	16.87bc	6.51cd	0.40c	0.27de
Umuahia* cultivated	3.47f	12.77b	0.80a	0.67a

ASC, Aggregated Silt + Clay, CR, Clay ratio, CDI, clay dispersion index, MWD, Mean weight diameter.

Table 6: Correlation of aggregate stability indices, aggregate soil organic carbon (ASOC) with particle size distribution and SOC in bulk soil (SOCb).

Location	Umudike				Umuahia			
Parameter	Sand	Silt	Clay	SOCb	Sand	Silt	Clay	SOCb
CR	0.94**	-0.45ns	-0.96**	-0.76**	0.90**	-0.39ns	-0.96**	0.07ns
CDI	0.88**	-0.43ns	-0.91**	-0.71**	0.92**	-0.46ns	-0.94**	0.012ns
DR	0.94**	-0.56*	-0.94**	-0.87**	0.93**	.-0.78**	.-0.56**	-0.26ns
ASC	-0.98**	0.96**	0.65*	0.88**	-0.98**	0.71**	0.86**	0.18ns
MWD	-0.91**	0.43ns	0.93**	0.85**	-0.27	-0.004	0.51ns	0.85**
WSA1	-0.89**	0.35ns	0.94**	0.89**	-0.60*	0.75**	0.31ns	0.65**
WSA2	-0.64*	0.55*	0.63*	0.31ns	0.49ns	0.63*	0.24ns	0.60*
WSA3	-0.83**	-0.34ns	-0.88**	-0.97**	-0.25	0.52*	-0.27ns	-0.79**
WSA4	-0.90**	0.50ns	0.91**	-0.37ns	-0.58*	0.78**	0.24ns	-0.42ns
ASOC1	-0.93**	0.47ns	0.95**	0.83**	0.35ns	0.35ns	-0.56*	0.83**
ASOC2	-0.40ns	0.20ns	0.36ns	0.48ns	0.61*	-0.18ns	.-0.65**	0.32ns
ASOC3	-0.09ns	-.10	0.14ns	0.35ns	0.51ns	-0.10ns	-0.62*	0.56*

CR: Clay ratio, CDI: Clay dispersion index, DR: Dispersion ratio, ASC: Aggregated Silt + Clay, MWD: Mean weight diameter, WSA: Water stable aggregates, WSA1: 4-2mm. WSA2: 2-0.25mm, WSA3: 0.25-0.053 mm, WSA4: < 0.053mm, ASOC1, SOC in WSA1, ASOC2, SOC in WSA2, ASOC3, SOC in WSA3, *, significant (p=0.05), **, significant (p=0.01), ns, non significant.

Land use impacted microaggregate stability. Forest soils showed the lowest CR (5.6), CDI (0.30) and DR (0.26), whereas cultivated and road-graded lands had the highest CR (10.24 and 9.1 respectively). Cultivated soils also had the highest CDI and DR (0.65 and 0.54 respectively). This agrees with Osakwe (2021), who reported reduced microaggregate stability due to tillage. Elevated dispersion indices indicate susceptibility to soil structure loss and increased erosion.

Interaction effects revealed that road construction increased CR in Umudike, while CDI rose under grazing (Umuahia) and cultivation (Umudike). Grazing at Umuahia (community-managed) showed higher dispersion than Umudike (better-managed pasture), demonstrating management's role. ASC was lowest under road construction in Umudike but highest in Umuahia due to clay increase with depth, showing location influence.

Despite grazing and forest soils' superior microaggregate stability, coastal plain sands remain inherently erodible, as indicated by CR values (5.6-10.54; Bouyoucos, 1935) and DR >15% (Middleton, 1930).

Correlation analysis

Table 6 presents significant correlations among PSD, SOCb, aggregate indices and ASOC, consistent with Yi *et al.* (2018) and Hoang (2024). Sand content correlated positively with dispersion (r = 0.88** - 0.94**) and negatively with aggregation (-0.58 to -0.91). Sand also negatively correlated with ASOC in all size classes, indicating reduced carbon storage. Clay content, in contrast, promoted macroaggregation and reduced dispersion.

Silt content decreased DR and increased ASC and WSA, especially in Umuahia, due to its coarser texture. Li *et al.* (2023) also found positive clay and negative sand correlations with aggregate stability.

SOCb was strongly correlated with ASC, MWD, WSA1 and ASOC1 in Umudike (r = 0.71 - 0.96) and with MWD, WSA1, WSA2 and ASOC1 in Umuahia (r = 0.56 - 0.85), suggesting SOC's key role in macroaggregation. SOCb negatively correlated with dispersion indices only in Umudike (r = -0.83 to -0.89), indicating site-specific dynamics. Negative correlations between SOCb and WSA3 and ASOC3 suggest macroaggregates are the main carbon storage zones, corroborating Yudina *et al.* (2022).

CONCLUSION

Agricultural and road construction activities reduced aggregate stability and ASOC, while grazing, forest and fallow lands improved them. Pedogenic and management factors influenced location-specific outcomes. Macroaggregates were primary SOC storage zones, not microaggregates. Road construction in Umuahia enhanced microaggregate stability due to deeper clay accumulation, contrasting with increased dispersion in Umudike. Well-managed pastures in Umudike improved ASOC levels.

Correlation analysis highlighted the importance of particle size and SOC in stabilizing aggregates and enhancing ASOC. Conservation measures should be tailored to specific soil characteristics and road construction should consider soil properties to mitigate degradation, especially in the erosion-prone coastal plain sands of southeastern Nigeria.

Correlation analysis highlighted the importance of particle size distribution and bulk SOC in promoting aggregate stability and ASOC. It is recommended that conservation measures be tailored to each location's soil characteristics. Additionally, customizing road construction projects according to specific soil properties will help mitigate soil degradation in the highly erodible coastal plain sands of southeastern Nigeria.

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Conflict of interest

The authors declare that they have no conflict of interest.

REFERENCES

Amanze, C.T., Oguike, P.C., Lekwa, G. (2016). Characterization and classification of soils at mbara achara ubowalla, emekuku in owerri north LGA, Imo State. *Nigeria Journal of Soil and Environmental Research.* **14(1):** 245-255.

Ayoubi, S., Mirbagheri, Z., Mohammad, R. (2020). Soil organic carbon, physical fractions and aggregate stability influenced by land use in humid region of Northern Iran. *International Agro Physics*. **34(3):** 343-353.

Bouyoucos, G.H. (1951). Method of determining particle sizes by the soil hydrometer. *Agronomy Journal.* **43:** 434 - 438

Bouyoucos, G.J. (1935). The clay ratio as a criterion of susceptibility of soils to erosion. *Agronomy Journal*. **27(9):** 738-741

Chukwu, E.D., Udoh, B.T., Afangide, A.I., Osisi, A.F. (2023). Evaluation of soil quality under oil palm cultivation in a coastal plain sands area of Akwa Ibom State Nigeria. *Soil Security*. **10.**

Dinh, K.H.T. and Shima, K. (2024). Soil properties variation valued in relation to land use and management practices in Vietnam. *Indian Journal of Agricultural Research.* **58(4):** 634-641. doi: 10.18805/IJARe.AF-818.

Gao, Y., Zhang, X., Li, Y., Xu, Y. and Zhang, S. (2024). Dynamic change of soil aggregate stability and infiltration properties during crop growth under four tillage measures in Mollisols region of northeast China. *Frontiers in Earth Science.* **12:** 1357467. https://doi.org/10.3389/feart.2024.1357467.

Gee, G.N. and Bauder, J.W. (1986). Particle Size Distribution. In: Klute, A., Ed., Methods of Soil Analysis Part 1. Physical and Mineralogical Methods, 2nd Edition, Agronomy Society of America/Soil Science Society of America, Madison, Wisconsin. 383-411.

Hoang, T.V.H. (2024). Land use practices effects on soil organic carbon and nitrogen in north-central vietnam. *Agricultural Science Digest*. doi: 10.18805/ag.DF-623.

Igbozuruike, M.U. (1975). Vegetation types In: Nigeria in maps: Eastern States. Ethiope Publishing House, Benin City.pp. 30-32.

Kemper, W.D. and Rosenau, R.C. (1986). Aggregate Stability and Size Distribution (2nd ed.). in:klute, Editor, Methods of Soil Analysis. part 1. Physical and Mineralilogical Methods 1, Soil Science Society of America, Madison, Wisconsin, USA. 425-442.

Lekwa, G. and Whiteside, E.P. (1986). Coastal plain sands of southeastern nigeria: Morphology, soil classification and genetic relationships. *Soil Science Society of American Journal*. **50:** 154-160.

Li, Y., Ma, Z., Liu, Y., Cui, Z., Mo, Q., Zhang, C., Sheng, H., Wang, W., Zhang, Y. (2023). Variation in soil aggregate stability due to land use changes from alpine grassland in a high-altitude watershed. *Land.* **12:** 393.

Mao, X., Van Zwieten, L., Zhang, M., Qui, Z. (2020). Soil parent material controls organic carbon stock and retention patters in subtropical china. *Journal of Soils and Sediments*. **20:** 1-3.

Martens, D., Reedy, T., Lewis, D. (2004). Soil organic carbon content and composition of 130 year crop, pasture and forest land use managements. *Global Change Biology*. **10:** 65-78.

Mengstie, F.E., Soromessa, T., Ayele, G. (2020). Effect of changes in land-use management practices on soil physicochemical properties in kabe Watershed, Ethiopia. Air, *Soil and Water Research*. **13:** 1-16.

Menon, M., Mawodza, T., Rabbani, A., Blaud, A., Lair, G.J., Babaei, M., Banwart, S. (2020). Pore system characteristics of soil aggregates and their relevance to aggregate stability. *Geoderma*. **366:** 114259.

Middleton, H.E. (1930). Properties of soils which influence soil erosion. Tech. Bull. no. 178.Washington, DC: USDA.

Nelson, D.W. and Sommers, L.E. (1982). Total Carbon, Organic Carbon and Organic Matter. In: Page, A.L., R. H. Miller and D.R. Keeney (eds) Methods of Soil analysis, Part 2. American Society of Agronomy Madison, WI pp 539-579.

Nwite, J.N. (2015). Assessment of soil structural stability under different land uses using some predictive indices in Abakaliki, Southeastern Nigeria. *Current Agricultural Research*. **3(1).**

Obalum, S.E. and Obi, M.E. (2014). Measured and estimated total porosity along structure-stability gradient of coarse-textured tropical soils with low clay activity. *Environmental Earth Sciences*. **72(6):** 953-1963.

Oguike, P.C., Onwuka, B.M.O., Balum, S.E. (2023). Soil organic carbon control of water transmission properties of coarse textured soils under contrasting land use types in tropical rain forest. *International Journal of Hydrology, Science and Technology*. **16(1):** 95-106.

Onwuka, M.I., Ejikeme, A.L., Uzoma, O., Oguike, P.C. (2020). Land -use change effects on soil quality at umudike Area, Abia State, South-East Nigeria. *Nigerian Agricultural Journal*. **51(1):** 109-118.

Osakwe, Uju C., Ogunleye Kayode, S., Igwe, Charles, A., Babalola, Temitope, S. (2021). Land use effect on microaggregate stability of waterstable aggregates in Southeastern NIgeria. *Journal of erosion and Environment Dgradation*. **6(1):** 1-10.

Osakwe, U.C., Omoju, O., Oluleye, A.K., Odetola, K.A. (2024). Impact of road construction and Agriculture on soil aggregate stability and aggregate-soil organic carbon: Ultisols of derived savannah. *Indian Journal of Ecology.* **51(2):** 446-452.

Osakwe, U.C.,Quadri, S.A., Aladeokin, M.T., Adeyoriju, W., Ilo, S. (2022). Effect of different land use on selected soil physical properties. *Journal of Science of Agriculture, Food Technology and the Environment.* **20:** 87-109.

Osakwe, U.C. (2018). Effect of land use on aggregate properties and soil erodibility (K Factor) in selected soils of Enugu State, Southeastern Nigeria. *International journal of Agriculture and Rural Development*. **21(1):** 3476- 3400.

Prabakaran, S., Kaleeswari, R.K., Backiyavathy, M.R., Backiyavathy, R., Jagadeeswaran, R., Selvi, R., Bama, S.S. (2023). Soil carbon stock and carbon pool indices under major land use systems of Mayiladuthurai District, Cauvery Delta Zone, India. *Agricultural Science Digest*. doi: 10.18805/ag.D-5786.

Ran, Y., Ma, M., Liu, Y., Zhou, Y., Sun, X., Wu, S., Huang, P. (2021). Hydrological stress regimes regulate effects of binding agents on soil aggregate stability in the riparian zones. *Catena*. **196:** 104815.

Sekaran, S., Laxmisagara, S., Sandeep, K. (2021). Soil aggregates, aggregate-associated carbon and nitrogen and water retention as influenced by short and long-term no-till systems. *Soil and Tillage Research*. 208.

Sezgin, H., Selçuk, G., Uğur, K., Hakan, K. (2019). Impact of forest road construction on topsoil erosion and hydro-physical soil properties in a semi-arid mountainous ecosystem in Turkey. *Polish Journal of Environmental Studies*. **28(1):** 113-121.

Uluocha, N.O. and Uwadiegwu, I. (2015). Mapping gully erosion in Abia State, Nigeria using Geographic Information Systems (GIS) and remote sensing techniques. *Journal of Soil Science and Environmental Management*. **6(10):** 284-300.

Wu, J., Teng, B., Zhong, Y., Duan, X., Gong, L., Guo, W., Qi, P., Haider, F.U. and Cai, L. (2024). Enhancing soil aggregate stability and organic carbon in Northwestern China through straw, biochar and nitrogen supplementation. *Agronomy*. **14(5):** 899. https://doi.org/10.3390/agronomy14050899.

Yang, X., Shao, M., Li, T., Gan, M., Chen, M., Li, Z. (2022). Soil macroaggregates determine soil organic carbon in the natural grasslands of the Loess Plateau, *Catena*. 21.

Yi, L., Wnenzi, L., Lianha, W., Chuang, L. (2018). Soil aggregate associated organic dynamics subjected to different types of land use: Evidence from 13C natural abundance. *Ecological Engineering*. **122:** 295-302.

Yudina, A.V., Klyueva, V.V., Romanenko, K.A., Fomin, D.S. (2022). Micro-within macro: How micro-aggregation shapes the soil pore space and water-stability. *Geoderma*. **415:** 115771.

Zhang, B., Peng, X., Zhao, Q., Zhao, P. (2012). Relationship between soil aggregates and organic carbon fractions under different land uses in mid-subtropical China. *Soil and Tillage Research*. **121:** 88-94.