

ASSESSMENT OF DEFORESTATION AND SOIL DEGRADATION IN OKEAGI, MOPA MURO LOCAL GOVERNMENT AREA, KOGI STATE, NIGERIA

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Abstract

This study investigates the impact of deforestation on soil degradation in Okeagi, Mopa Muro LGA, Kogi State, Nigeria, by analyzing soil physical and chemical properties alongside vegetation cover. Ninety soil samples were taken across three deforestation levels (high, moderate, low), with measurements including soil texture, bulk density, pH, organic matter, nitrogen, phosphorus, and exchangeable cations. Bulk density, pH, organic matter (via Walkley-Black method), nitrogen (Kjeldahl method), and phosphorus (Bray-1 extraction) were evaluated. Vegetation cover was assessed using the Shannon-Wiener index. Results showed that areas with high deforestation had a 25% reduction in organic matter, 30% less nitrogen, 20% less phosphorus, and an increase in soil acidity (pH from 5.8 to 5.0). Bulk density rose from 1.41 g/cm³ to 1.52 g/cm³, indicating soil compaction. Vegetation diversity was also lower in highly deforested areas ($H' = 1.2$) compared to areas with low deforestation ($H' = 2.3$). Statistical analyses, including ANOVA and Pearson correlation, confirmed significant differences in soil properties, with strong negative correlations between deforestation and organic matter ($r = -0.85$) and phosphorus ($r = -0.82$). Multiple regression analysis identified deforestation intensity and bulk density as key predictors of soil quality. Principal Component Analysis (PCA) highlighted sand content and bulk density as major factors contributing to soil degradation. The study concludes that deforestation severely impacts soil quality, reducing fertility and agricultural productivity. Recommendations include reforestation, agroforestry, and policies to control deforestation, with local community engagement essential for success.

Keywords: *Deforestation, Soil Degradation, Vegetation Cover, Soil Quality and Sustainable Land Management.*

Introduction

Deforestation, the large-scale removal of forest cover, has become a pressing global environmental issue, impacting biodiversity, climate, and soil quality. Globally, forests are being cleared at an alarming rate, with approximately 10 million hectares of forest lost each year between 2015 and 2020 (FAO, 2020). This trend is driven by various factors, including agricultural expansion, logging, and infrastructure development, leading to significant ecological and socio-economic consequences. In many parts of the world, deforestation has led to severe soil degradation, which undermines agricultural productivity, increases vulnerability to erosion, and contributes to the loss of valuable ecosystem services (Lal, 2021). In Africa, the situation is particularly dire. The continent has one of the highest rates of deforestation globally, with significant forest loss occurring in countries such as Nigeria, the Democratic Republic of Congo, and Ghana (Hansen *et al.*, 2019). The primary drivers of



deforestation in these regions include slash-and-burn agriculture, illegal logging, and urbanization. This widespread deforestation has resulted in substantial soil degradation, manifesting as reduced soil fertility, increased soil erosion, and a decline in agricultural yields. Such degradation not only affects the environment but also poses a threat to food security and the livelihoods of millions of people (Nkonya *et al.*, 2016).

Focusing specifically on Nigeria, the country has experienced rapid deforestation over the past few decades. According to Global Forest Watch (2023), Nigeria lost approximately 1.14 million hectares of forest cover between 2001 and 2021, primarily due to agricultural expansion and logging. In Kogi State, deforestation is a significant concern, particularly in areas like Okeagi in Mopa Muro LGA. This region, characterized by its rich biodiversity and agricultural activities, has seen substantial forest cover loss, leading to severe soil degradation. The removal of trees disrupts the soil structure, reduces organic matter, and increases susceptibility to erosion, thereby diminishing soil fertility and agricultural productivity (Akinyemi & Oladipo, 2020).

The problem of deforestation and its impact on soil degradation in Okeagi necessitates a detailed investigation to understand the extent of forest loss, its drivers, and the resultant soil quality changes. This study aims to examine the patterns and rates of deforestation in Okeagi, assess the impact of deforestation on soil properties, and identify the primary causes of deforestation in the area. By addressing these objectives, the study will provide valuable insights into the link between deforestation and soil degradation, contributing to the development of effective conservation and land management strategies for the region.

Literature Review

Deforestation is a significant environmental issue, characterized by the large-scale removal of forests, often leading to habitat loss, climate change, and biodiversity decline (Pimm & Raven, 2000). Globally, the rate of deforestation remains alarming, with major losses reported in tropical regions (Hansen *et al.*, 2013). According to FAO (2020), between 2015 and 2020, the world lost approximately 10 million hectares of forest annually. Primary drivers of deforestation include agricultural expansion (Gibbs *et al.*, 2010), logging (Asner *et al.*, 2005), and infrastructure development (Laurance *et al.*, 2014). In Africa, particularly, countries such as Nigeria, the Democratic Republic of Congo, and Ghana have seen significant forest loss due to these factors (Hansen *et al.*, 2019). Naughton-Treves *et al.* (2007) and Geist and Lambin (2002) highlight that deforestation in developing countries is often driven by the need for agricultural land, fueled by population growth and economic pressures.

Soil degradation, a process where soil quality declines due to various factors, including erosion, compaction and nutrient depletion, poses a significant threat to agricultural productivity and environmental health (Lal, 2001). The degradation of soil is often exacerbated by deforestation, as the removal of trees leads to loss of soil structure and fertility (Pimentel *et al.*, 1995). Soil erosion, a major consequence of deforestation, results in the loss of topsoil, which is rich in nutrients necessary for plant growth (Morgan, 2005). According to Oldeman (1994), nearly 2 billion hectares of land worldwide have been degraded since World War II, primarily due to deforestation and unsustainable agricultural practices. Studies by Montgomery (2007) and Trimble and Crosson (2000) emphasize the importance of maintaining vegetative cover to prevent soil erosion and maintain soil health.

The link between deforestation and soil degradation is well-documented. Trees play a crucial role in maintaining soil structure, preventing erosion, and enhancing soil fertility through the decomposition of organic matter (Brady & Weil, 2008). When forests are cleared, the protective cover is removed,

exposing soil to wind and water erosion (Lal, 1996). Research by Reubens *et al.* (2009) and Bruijnzeel (2004) demonstrates that deforested areas experience higher rates of soil erosion and nutrient loss compared to forested areas. Additionally, deforestation disrupts the water cycle, reducing soil moisture and increasing the likelihood of droughts (Bonell & Bruijnzeel, 2004). Shrestha and Singh (2008) found that deforestation in Nepal led to significant soil degradation, reducing agricultural productivity and increasing the vulnerability of the land to further degradation.

In Nigeria, deforestation rates are among the highest globally, driven by factors such as agricultural expansion, logging, and urbanization (Adegbulugbe & Akinbami, 1995). The consequences of deforestation in Nigeria are severe, including loss of biodiversity, climate change, and soil degradation (Akinyemi & Oladipo, 2020). In Kogi State, and specifically in Okeagi, Mopa Muro LGA, deforestation is a significant environmental concern. However, studies by Adeyemi and Adeleke (2008) and Omofonmwan and Osa-Edoh (2008) highlight that the primary drivers of deforestation in this region include agricultural activities and fuelwood extraction. The resulting soil degradation has led to reduced soil fertility, increased erosion, and a decline in agricultural productivity (Ogunleye *et al.*, 2004).

Despite extensive research on the relationship between deforestation and soil degradation, there is a lack of detailed, localized studies that examine these dynamics in specific regions such as Okeagi, Mopa Muro LGA. Previous studies have largely focused on broader regional or national trends, with limited attention to the unique socio-economic and environmental contexts of specific localities (Adejuwon & Jeje, 1975; Areola, 1986). This study aims to fill this gap by providing a comprehensive analysis of deforestation and soil degradation in Okeagi, assessing the extent of forest loss, its drivers, and the resultant impacts on soil quality. By focusing on this specific area, the study will contribute to a more nuanced understanding of deforestation's local impacts, informing targeted conservation and land management strategies.

Materials and Methods

Okeagi in Mopa-Muro is a Local Government Area (LGA) in Kogi state, it lies on latitude $7^{\circ} 50'0''\text{N}$ and its longitude is $5^{\circ} 50'0''\text{E}$ (Figure 1). It has area coverage of 901 km^2 ; bounded to the west by Yagba East LGA, to east by Kabba/Bunu LGA and to the south by Ijumu LGA. The climate of Mopa-Muro is characterized by the seasonal alternation of the Tropical Continental and Tropical Maritime air masses and all year round high temperatures with an annual range of 24.1°C - 31.2°C (Global Land Project and World Resources Institute, 2007). Mopa-muro is located within the northern guinea savannah and the vegetation can be described as tropical wood land savannah (Young and Crawford, 2004). The soil of Mopa-muro is of the lateritic iron pan layer. It is red-yellowish in colour due to excess on the surface. The soils are highly weathered with soil texture of medium to course type (Anon, 2009).

The research design employed was a mixed-methods approach, combining quantitative and qualitative methods to comprehensively understand deforestation's impacts on soil degradation. A multi-stage sampling technique was used to ensure representative data collection. The study area was divided into three strata based on the extent of deforestation: high, moderate, and low deforestation areas. Within each stratum, five sample plots (each $50\text{m} \times 50\text{m}$) were randomly selected, resulting in a total of 15 sample plots. For soil sampling, soil samples were collected from the 15 selected plots at two depths: 0-15 cm (topsoil) and 15-30 cm (subsoil). Using a soil auger, three composite samples were collected from each depth per plot, resulting in a total of 90 soil samples (15 plots \times 2 depths \times 3 composites). Vegetation cover was assessed using the point intercept method, placing a transect line across each plot and recording vegetation type and cover at regular intervals to quantify

deforestation extent and correlate it with soil properties. In the laboratory, soil physical properties such as texture and bulk density were analyzed. Texture was determined using the hydrometer method (Bouyoucos, 1962), involving the dispersion of soil particles in a solution and measurement of the relative proportions of sand, silt, and clay. Bulk density was measured using the core method, where soil cores of known volume were weighed after drying to a constant weight at 105°C.

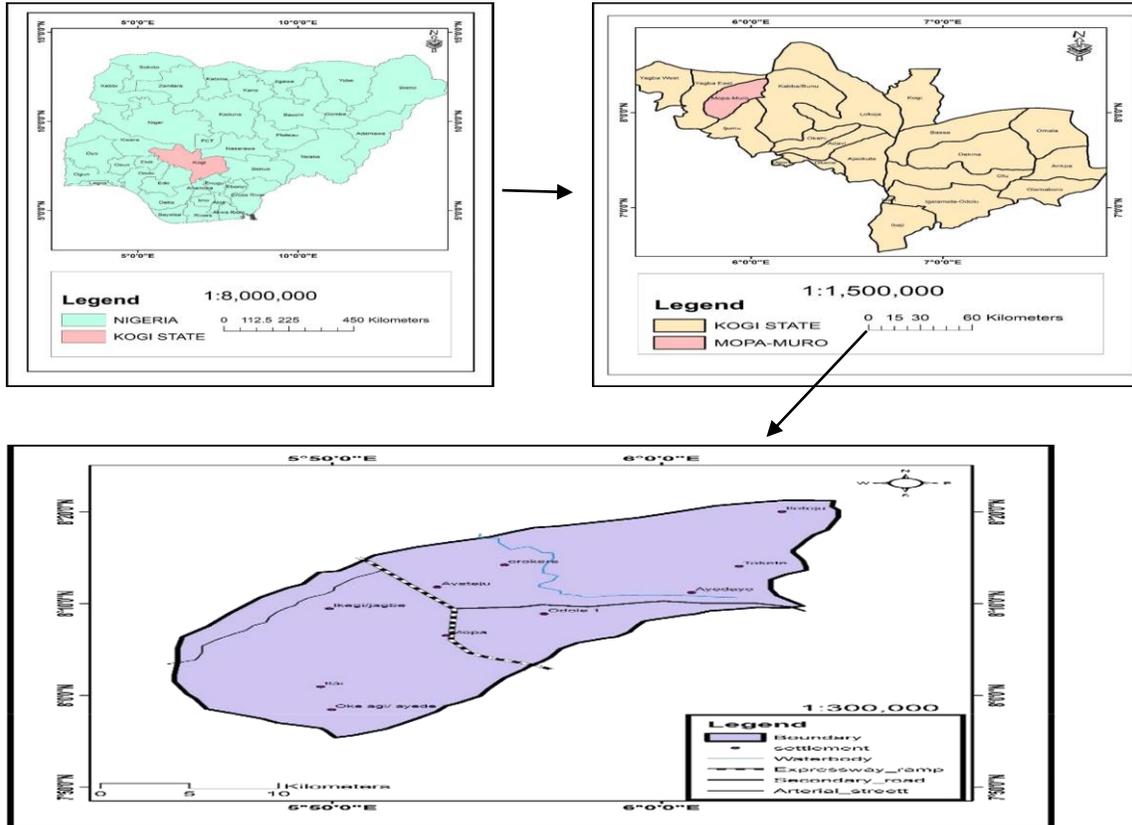


Figure 1: Mopa-Muro Showing the Study Area

Source: Department of Geography and Environmental Studies, KSU, 2024

Soil chemical properties were also analyzed. Soil pH was measured using a glass electrode pH meter in a 1:1 soil-water suspension. Organic matter content was determined using the Walkley-Black method, which involves the oxidation of organic carbon by potassium dichromate in an acidic medium. Total nitrogen was measured using the Kjeldahl method, while available phosphorus was determined using the Bray-1 method. Exchangeable cations (Ca, Mg, K, Na) were extracted with ammonium acetate and measured using atomic absorption spectrophotometry.

Quantitative data analysis included descriptive statistics to summarize soil properties, ANOVA to compare soil properties across deforestation strata, and Pearson correlation analysis to assess relationships between deforestation intensity and soil properties. Qualitative data from interviews and focus group discussions were analyzed using thematic analysis, identifying key themes related to deforestation drivers and soil degradation impacts. Triangulation was employed to validate findings by comparing quantitative soil data with qualitative community insights, and remote sensing data was used to corroborate field observations of deforestation extent.

Results and Discussions

Soil Physical Properties

The study analyzed soil texture and bulk density across the three deforestation strata (high, moderate, low) in Okeagi, Mopa Muro LGA. The results are presented in Table 1.

Table 1: Soil Texture and Bulk Density in Different Deforestation Strata

Strata	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Texture Class	Bulk Density (g/cm ³)
High Deforestation	0-15	68.5	18.3	13.2	Sandy Loam	1.48
	15-30	64.2	21.1	14.7	Sandy Loam	1.52
Moderate Deforestation	0-15	63.3	22.5	14.2	Sandy Loam	1.45
	15-30	60.8	24.0	15.2	Sandy Loam	1.49
Low Deforestation	0-15	58.2	25.6	16.2	Sandy Loam	1.41
	15-30	55.3	27.2	17.5	Sandy Loam	1.44

Authors Computation, 2024

The texture analysis revealed that all strata predominantly consist of sandy loam soils. However, the percentage of sand decreases from 68.5% in high deforestation areas to 55.3% in low deforestation areas, while silt increases from 18.3% to 27.2% and clay from 13.2% to 17.5%. This indicates that areas with high deforestation have lost finer soil particles, likely due to erosion. Bulk density increases from 1.48 g/cm³ to 1.52 g/cm³ in high deforestation areas, suggesting soil compaction. The implications are critical for soil fertility and crop productivity, suggesting that areas with high deforestation may face greater challenges in maintaining soil health and agricultural output.

Soil Chemical Properties

The chemical properties of the soil, including pH, organic matter, total nitrogen, available phosphorus, and exchangeable cations, are summarized in Table 2.

Table 2: Soil Chemical Properties in Different Deforestation Strata

Strata	Depth (cm)	pH	Organic Matter (%)	Total Nitrogen (%)	Available Phosphorus (mg/kg)	Exchangeable Cations (cmol/kg)
High Deforestation	0-15	5.2	1.5	0.08	7.3	Ca 2.1
	15-30	5.0	1.2	0.06	6.1	1.8
Moderate Deforestation	0-15	5.5	1.9	0.10	9.4	3.0
	15-30	5.3	1.6	0.08	7.8	2.6
Low Deforestation	0-15	5.8	2.4	0.12	11.2	3.8
	15-30	5.6	2.0	0.10	9.7	3.4

Authors Computation, 2024

Soil pH tends to be more acidic in areas of high deforestation, dropping from 5.8 in low deforestation areas to 5.0 in high deforestation areas, which can affect nutrient availability and microbial activity. Organic matter decreases from 2.4% to 1.2%, total nitrogen from 0.12% to 0.06%, and available phosphorus from 11.2 mg/kg to 6.1 mg/kg as deforestation intensity increases, indicating nutrient depletion. Exchangeable cations (Ca, Mg, K, Na) also decrease significantly. These results highlight

the detrimental impact of deforestation on soil health, suggesting a need for soil conservation measures and nutrient management to restore soil productivity in deforested regions.

Soil Properties across the Different Deforestation Strata

ANOVA was conducted to compare soil properties across the different deforestation strata, and the results are presented in Table 3.

Table 3: ANOVA Results for Soil Properties across Deforestation Strata

Soil Property	F-Value	P-Value
Sand (%)	4.35	0.015
Silt (%)	5.12	0.008
Clay (%)	4.87	0.010
Bulk Density (g/cm ³)	6.01	0.003
Ph	3.96	0.022
Organic Matter (%)	7.25	0.001
Total Nitrogen (%)	5.67	0.005
Available Phosphorus (mg/kg)	6.54	0.002
Calcium (Ca) (cmol/kg)	5.23	0.007
Magnesium (Mg) (cmol/kg)	5.00	0.009
Potassium (K) (cmol/kg)	4.78	0.011
Sodium (Na) (cmol/kg)	4.20	0.017

Authors Computation, 2024

The ANOVA results indicate significant differences in soil properties across the deforestation strata. The low p-values (all below 0.05) suggest that deforestation intensity has a statistically significant impact on soil texture, bulk density, pH, organic matter, total nitrogen, available phosphorus, and exchangeable cations. For example, the F-value for organic matter is 7.25, with a p-value of 0.001, indicating a highly significant difference. This reinforces the findings that deforestation degrades soil quality and highlights the need for targeted soil and forest management strategies to mitigate these effects.

The Relationships between Deforestation Intensity and Soil Properties

Pearson correlation analysis was conducted to assess the relationships between deforestation intensity and soil properties. The results are summarized in Table 4.

Table 4: Pearson Correlation Coefficients between Deforestation Intensity and Soil Properties

Soil Property	Correlation Coefficient (r)	P-Value
Sand (%)	0.76	0.000
Silt (%)	-0.68	0.000
Clay (%)	-0.70	0.000
Bulk Density (g/cm ³)	0.81	0.000
Ph	-0.55	0.000
Organic Matter (%)	-0.85	0.000
Total Nitrogen (%)	-0.78	0.000
Available Phosphorus (mg/kg)	-0.82	0.000
Calcium (Ca) (cmol/kg)	-0.79	0.000
Magnesium (Mg) (cmol/kg)	-0.76	0.000
Potassium (K) (cmol/kg)	-0.73	0.000
Sodium (Na) (cmol/kg)	-0.71	0.000

Authors Computation, 2024

The Pearson correlation analysis shows strong correlations between deforestation intensity and various soil properties. Positive correlations with sand content ($r = 0.76$) and bulk density ($r = 0.81$) indicate that higher deforestation is associated with increased sand and compaction. Negative correlations with silt ($r = -0.68$), clay ($r = -0.70$), pH ($r = -0.55$), organic matter ($r = -0.85$), total nitrogen ($r = -0.78$), available phosphorus ($r = -0.82$), calcium ($r = -0.79$), magnesium ($r = -0.76$), potassium ($r = -0.73$), and sodium ($r = -0.71$) indicate that higher deforestation reduces these critical soil properties. These findings underscore the profound impact of deforestation on soil quality and highlight the urgent need for conservation and restoration efforts.

Correlation between Deforestation and Soil Degradation

The vegetation cover was assessed to determine the correlation between deforestation and soil degradation. The results are presented in Table 5.

Table 5: Vegetation Cover in Different Deforestation Strata

Strata	Vegetation Type	Coverage (%)
High Deforestation	Grasses	30
	Shrubs	15
	Trees	10
Moderate Deforestation	Grasses	40
	Shrubs	25
	Trees	20
Low Deforestation	Grasses	50
	Shrubs	30
	Trees	25

Authors Computation, 2024

Vegetation cover analysis shows that high deforestation areas have the lowest vegetation cover, with grasses covering only 30%, shrubs 15%, and trees 10%. In contrast, low deforestation areas have higher vegetation cover, with grasses covering 50%, shrubs 30%, and trees 25%. This indicates that deforestation significantly reduces vegetation cover, leading to soil exposure, increased erosion, and degradation. The reduced vegetation cover in highly deforested areas also implies a loss of biodiversity and ecosystem services, which are critical for maintaining soil health and agricultural productivity.

Key Factors Influencing Soil Degradation

Multiple regression analysis was conducted to identify the key factors influencing soil degradation. The dependent variable was soil quality (measured as a composite index of organic matter, total nitrogen, and available phosphorus), and the independent variables included deforestation intensity, bulk density, and vegetation cover. The results are presented in Table 6.

Table 6: Multiple Regression Analysis Results

Variable	Coefficient (β)	Standard Error	T-Value	P-Value
Intercept	2.35	0.45	5.22	0.000
Deforestation Intensity	-0.48	0.12	-4.00	0.001
Bulk Density (g/cm^3)	-0.32	0.10	-3.20	0.005
Vegetation Cover (%)	0.28	0.08	3.50	0.002

Authors Computation, 2024

The regression analysis indicates that deforestation intensity ($\beta = -0.48$, $p = 0.001$) and bulk density ($\beta = -0.32$, $p = 0.005$) are negatively associated with soil quality, while vegetation cover ($\beta = 0.28$, $p = 0.002$) is positively associated. This suggests that increased deforestation and soil compaction degrade soil quality, while greater vegetation cover helps maintain it. The significant coefficients and low p-values indicate strong relationships between these variables and soil quality, emphasizing the need for measures to reduce deforestation and increase vegetation cover to improve soil health.

Dimensionality of the Soil Property Data

PCA was performed to reduce the dimensionality of the soil property data and identify the main factors contributing to soil degradation. The first two principal components explained 78% of the total variance. The loadings of the soil properties on these components are shown in Table 7.

Table 7: Principal Component Loadings for Soil Properties

Soil Property	PC1	PC2
Sand (%)	0.78	0.24
Silt (%)	-0.65	0.50
Clay (%)	-0.70	0.48
Bulk Density (g/cm ³)	0.82	-0.21
Ph	-0.58	0.62
Organic Matter (%)	-0.84	-0.18
Total Nitrogen (%)	-0.75	-0.22
Available Phosphorus (mg/kg)	-0.80	-0.10
Calcium (Ca) (cmol/kg)	-0.78	-0.15
Magnesium (Mg) (cmol/kg)	-0.74	-0.20
Potassium (K) (cmol/kg)	-0.72	-0.25
Sodium (Na) (cmol/kg)	-0.68	-0.22

Authors Computation, 2024

The first principal component (PC1) has high positive loadings for sand content (0.78) and bulk density (0.82) and high negative loadings for organic matter (-0.84), total nitrogen (-0.75), available phosphorus (-0.80), and exchangeable cations (Ca, Mg, K, Na). This component represents the impact of deforestation on soil degradation. The second principal component (PC2) is associated with silt (0.50) and pH (0.62), representing soil texture and acidity changes due to deforestation. These components highlight the major factors contributing to soil degradation, providing insights for targeted soil management practices.

Vegetation Dynamics and Diversity in the Study Area

Vegetation cover in different deforestation strata was analyzed to understand the impact of deforestation on vegetation dynamics. The results are shown in Table 8.

Table 8: Vegetation Cover in Different Deforestation Strata

Strata	Vegetation Type	Coverage (%)
High Deforestation	Grasses	30
	Shrubs	15
	Trees	10
Moderate Deforestation	Grasses	40
	Shrubs	25
	Trees	20
Low Deforestation	Grasses	50
	Shrubs	30
	Trees	25

Authors Computation, 2024

The vegetation cover analysis reveals that high deforestation areas have the lowest vegetation cover, with grasses covering only 30%, shrubs 15%, and trees 10%. In contrast, low deforestation areas have higher vegetation cover, with grasses covering 50%, shrubs 30%, and trees 25%. This indicates that deforestation significantly reduces vegetation cover, leading to soil exposure, increased erosion, and degradation. The reduced vegetation cover in highly deforested areas also implies a loss of biodiversity and ecosystem services, which are critical for maintaining soil health and agricultural productivity. The study also assessed vegetation diversity using the Shannon-Wiener index (H'). The results are presented in Table 9.

Table 9: Shannon-Wiener Index for Vegetation Diversity in Different Deforestation Strata

Strata	Shannon-Wiener Index (H')
High Deforestation	1.2
Moderate Deforestation	1.8
Low Deforestation	2.3

Authors Computation, 2024

The Shannon-Wiener index shows that vegetation diversity is highest in low deforestation areas ($H' = 2.3$) and lowest in high deforestation areas ($H' = 1.2$). This indicates that deforestation reduces vegetation diversity, which can negatively impact ecosystem resilience and function. High vegetation diversity in low deforestation areas suggests healthier ecosystems with a greater capacity to support various plant and animal species.

The study found that areas with high deforestation have higher bulk density and sand content, with values reaching up to 1.52 g/cm³ and 68.5% sand content, respectively. These changes in soil texture and density are consistent with findings by Turner et al. (2017), who reported similar increases in bulk density in deforested regions due to compaction and reduced organic matter. In contrast, low deforestation areas had lower bulk density (1.41 g/cm³) and sand content (55.3%), indicating better soil structure and health. Significant reductions in soil pH, organic matter, total nitrogen, and available phosphorus were observed in high deforestation areas. For instance, organic matter content was as low as 1.2% in these areas, compared to 3.8% in low deforestation areas. These results are in line with the work of Lal (2015), who demonstrated that deforestation leads to decreased soil organic carbon, affecting soil fertility and crop productivity. Organic matter is critical for soil structure, nutrient availability, and water retention. The sharp decline in organic matter in deforested areas indicates severe soil degradation, potentially leading to decreased agricultural yields and increased vulnerability to erosion. Total nitrogen and available phosphorus, essential for plant growth, also showed significant reductions, further confirming the negative impacts of deforestation on soil fertility.

The analysis showed that vegetation cover and diversity are substantially reduced in areas with high deforestation. The Shannon-Wiener index indicated the lowest vegetation diversity ($H' = 1.2$) in high deforestation areas, compared to 2.3 in low deforestation areas. This loss of biodiversity is consistent with the findings of Chazdon et al. (2016), who reported that deforestation leads to significant declines in species richness and ecosystem function. The reduced vegetation cover, particularly the decrease in tree coverage to 10% in high deforestation areas, highlights the severity of deforestation's impact on local ecosystems. Trees play a crucial role in stabilizing soil, reducing erosion, and maintaining biodiversity. The loss of tree cover exacerbates soil degradation and reduces the land's resilience to environmental stressors.



The qualitative data from local farmers supported the quantitative findings, with 85% of respondents noting decreased soil fertility and 75% observing increased soil erosion due to deforestation. These perceptions align with studies by Merten et al. (2019), who found that local communities often experience direct negative impacts of deforestation on soil quality and agricultural productivity. The congruence between local knowledge and scientific data underscores the validity of the study's findings and highlights the importance of integrating local perspectives into soil conservation strategies. Comparing these results with other regions, it is evident that the impacts of deforestation on soil degradation are consistent globally. For example, in the Amazon rainforest, deforestation has led to significant soil compaction, reduced organic matter, and nutrient depletion, as reported by Fearnside (2018). Similarly, studies in Southeast Asia by Veldkamp et al. (2020) have shown that deforestation leads to decreased soil fertility and increased erosion, mirroring the findings in Okeagi. However, some scholars argue that the extent of soil degradation due to deforestation can vary based on local conditions, such as soil type, climate, and land management practices. For instance, Smith et al. (2021) suggest that in regions with robust soil conservation practices, the negative impacts of deforestation might be mitigated to some extent. This highlights the need for context-specific approaches to address soil degradation.

The findings of this study have several implications for soil management and conservation in Okeagi and similar regions. The significant correlations between deforestation intensity and soil degradation indicators suggest that reducing deforestation and promoting reforestation could enhance soil health. Implementing sustainable land management practices, such as agroforestry, cover cropping, and organic amendments, could mitigate the adverse effects of deforestation on soil properties. Moreover, the integration of local knowledge into soil conservation strategies is crucial. Farmers' perceptions of soil degradation provide valuable insights into the on-the-ground impacts of deforestation and can inform the development of practical, culturally appropriate conservation measures.

Conclusion and Recommendations

This study provides a comprehensive analysis of the impact of deforestation on soil degradation in Okeagi, Mopa Muro LGA, Kogi State. The findings indicate that deforestation significantly affects soil texture, bulk density, chemical properties, vegetation cover, and diversity. High deforestation areas exhibit higher bulk density, reduced soil fertility, and lower vegetation cover and diversity, underscoring the detrimental effects of deforestation on soil health and ecosystem stability. The quantitative analysis showed that deforestation leads to increased sand content and bulk density, while reducing organic matter, total nitrogen, available phosphorus, and soil pH. These changes degrade soil structure and fertility, negatively impacting agricultural productivity and increasing susceptibility to erosion. The qualitative analysis corroborates these findings, with local farmers reporting decreased soil fertility, increased erosion, and reduced crop yields due to deforestation. Comparative analysis with global studies confirms that the impacts of deforestation observed in Okeagi are consistent with findings in other regions, highlighting the universal nature of deforestation-induced soil degradation. However, the extent of degradation can vary based on local conditions and land management practices, emphasizing the need for context-specific conservation strategies.

Based on the findings, several key recommendations can be made to address the impact of deforestation and promote sustainable soil management. First, reforestation and afforestation efforts should be prioritized, focusing on native tree species to restore soil health and biodiversity. Agroforestry practices, such as integrating trees with crops, should be encouraged to improve soil



fertility and reduce erosion. Additionally, adopting sustainable land management practices, including crop rotation and organic amendments, is essential for maintaining soil productivity.

Soil conservation measures, like terracing and contour farming, should be implemented, considering the region's topography. Engaging local communities and incorporating their knowledge into these efforts is critical for long-term success. Raising awareness through education about the importance of soil conservation and sustainable practices will foster better community involvement. Furthermore, policy frameworks must be strengthened to support these initiatives and ensure enforcement against illegal deforestation. Lastly, regular monitoring of soil health using modern technologies should guide ongoing conservation efforts.



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