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RELATIONSHIP BETWEEN SOIL AND VEGETATION COVER AT THE SAVANNA VEGETATION OUTLIER IN THE FOREST ZONE OF OKHUESAN ESAN SOUTH EAST LOCAL GOVERNMENT AREA OF EDO STATE

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ABSTRACT

The occurrence of mesic savanna vegetation outlier such as savanna in a forest zone are rare and isolated. One of such is located at Okhuesan Esan South East Local Government Area of Edo State. In the study, the species composition and diversity were recorded and soil analysis was done. The soil component and its properties from the study site was compared with that of a forested region to know if edaphic factor has a impact in the species composition of the area of study. A check list of the plant species was documented and they were catalogued according to their families, habit and life form. Soil samples were collected at a depth of 5–10 cm, 10–20 cm, 20–30 cm, and 30–50 cm. A statistical test was performed on the savanna and a forested site using their soil nutrient composition as a criteria. The t-test was approximately -0.7175 and the p-value was approximately 0.4935, this shows that there is no significant difference between both sites. The result for this survey showed a total of 120 plant species belonging to 51 families and 89 Genera. Fabaceae have the highest number of species 12 followed by poaceae with 11 species, Euphorbiaceae with 9 species, Asteraceae 6 and Apocynaceae 5 species while Amaranthaceae, Commelinaceae and Cyperaceae had 4, 3 and 4 species respectively. Based on the plant habit classification, 40 species (33.3%) were herbs, 11 (9.17%) Grasses, 4 (3.33%) sedge species, 4 (3.33%) vine species, 33 tree species (27.5%) and 27 shrubs (22.5%).

INTRODUCTION

The soil type, which regulates how rainfall is divided into evapotranspiration, drainage, and runoff, has an impact on woody cover as well (Fernandez-Illescas *et al*., 2001). In drier (500 mm/year) and wetter settings, Noy-Meir (1973) argued that an inverse texture effect regulates how woody plants are influenced differently by soil texture. The deeper soil water infiltration caused by coarse-textured soils' better hydraulic conductivity reduces evaporation from the top soil layer. Additionally, runoff generation losses from coarse-textured soils are reduced. Thus, in drier systems, coarse textured soils are advantageous for woody plants. Because coarse-textured soils have a lesser ability to hold water, they also lose more water through drainage to groundwater, which is anticipated to be a more important flux in wetter settings.

According to the inverse texture theory, fine-textured soils are preferred by woody plants in wetter environments. While it has been noted that woody production is lower on clayey soils in drylands (Lane *et al*., 1998; Williams *et al*., 1996), the precise mechanism underlying this is still up for debate. According to Fensham *et al*., (2015), clayey soils makes absorption of water difficult and it also limit plant growth.

However, since "the majority of people in the tropics, over one-fifth of the world's population, live in savannas" and since such studies may help "the long-term survival of so many people, who are already threatened by landscape degradation, drought, famine, and disease," it is worthwhile to make further efforts to understand these contexts. To understand and study environments where grasses and trees co-dominate, as well as the socio-environmental processes that affect such ratios, ecological theories must be modified (Meyer *et al*., 2006). The development of sharp knowledge through research on and around perceived theoretical gaps and contradictions is an attractive prospect for the critical mind in order to better explain environmental change at different spatial scales (Solbrig, 1990). Ground ecological surveys, aerial images, maps, and satellite photography are helpful resources in such projects (Bucini and Lambin, 2002). Construction of theoretical models to explain, assess, and even facilitate the management of savanna environments has become an intriguing subject as a result of this complexity (Siljander, 2009).

Although such distinctions may be "unrealistic," as under different conditions, tree/shrub definitions may overlap, trees may be defined as plants with a distinct bole or trunk exceeding seven to eight meters in height, while shrubs may be shorter, low branched, and with short, "contorted" stems. The formation of low-stemmed, branching trees that pass for shrubs is a result of firewood cutting; a notable example of this is the "stunted" neem trees (*Azadirachta indica*), which predominate in some contexts of the coastal savanna's thicket. A contentious topic in literatures is the link between forest and savanna vegetation and how much one vegetation type has displaced the other [Campbell (1998) and Hopkins (1992)]. Solbrig (1993) and Stott (1994) are extremely pertinent given that Bakkes *et al*. (1997) gives varying prominence to human factors, fire (both natural and human-induced), herbivores, plant available moisture.

According to Zimmerer (1994), studies on savanna soils in Zimbabwe are one example where "the way environmental change is conceptualized is crucial" and where the need for additional research that emphasizes "non-linear, multi-directional, punctuated... dynamic and non-equilibrium possibilities for processes of transformation" and an understanding of ecosystem change "in more historical terms" is suggested. Thus, fieldwork is crucial. The understanding that altered surroundings "do not necessarily revert to their previous state when the occurrence of the disturbance ceases" is inherent in this approach.

This research seeks to address a fundamental ecological question: to what extent do soil attributes affect the establishment of savanna vegetation in this specific geographic context? To answer this question, a thorough soil analysis of the savanna and forest soils will be conducted. This analysis will encompass an examination of various edaphic factors like the nutrient content and pH levels. By assessing these factors, we aim to determine if there are significant differences between the two ecosystems, and whether these differences correlate with the presence or absence of savanna vegetation.

A key component of the research involves documenting the plant habit within the study area. This encompasses the identification and quantification of different plant types, including trees, shrubs, vines, grasses, and sedges. This information will contribute to a comprehensive analysis of the structural composition of the ecosystems and provide a foundation for assessing the potential influence of edaphic factors on the distribution of these plant types. The results of this ecological survey will not only contribute to a deeper understanding of the intricate relationships between soil characteristics, plant diversity, and ecosystem establishment but also have broader implications. The findings may offer valuable insights for land-use planning, resource management, and biodiversity conservation in the Okhuessan region and similar ecological settings. Additionally, this research may support sustainable land management practices, benefiting both local communities and the preservation of natural ecosystems. Ultimately, the objective is to shed light on the ecological dynamics of savanna outliers in this specific geographic context, enriching our knowledge of ecosystem functioning and offering practical guidance for informed decision-making in the region and beyond.

MATERIALS AND METHOD

Equipment/apparatus used:

Gps device, camera, weighing scales, Visible spectrophotometer (Vs721G), spoon, stirring stick, pipette, pipette filter, wash bottle, beaker, 50ml, 100ml, measuring cylinder, Desiccator, oven, and petri dishes 100ml and 50ml volumetric flasks, amber glass bottles, a mortar and pestle, and a glass funnel.

Study Location Area

Okhuesan belong to Esan South East Local Government Area, with Ubiaja as the head quarter. It Lies between latitude 6°12′10.49″S and 5°58′15.29″S and between longitude 5°49′46.42″E and 5°52′11.63″E. Uromi is one of the earliest settlements among the present thirty–one kingdom in Ishan (Okoduwa, 2002), and its neighbors are the Kukuruku (Owan/Etsako) in the north, Irrua in the north-west, Ugboha and Ubiaja in the south, Okhuesan on the south-east (Butcher. 1982). Okhuesan is a sma ll village comprising of five quarters they are Eguare, Ichala, Idewan, Ikpeko and Odikeken (Osagie, 2007; Amodu *et al.* 2020), as shown on the map below.

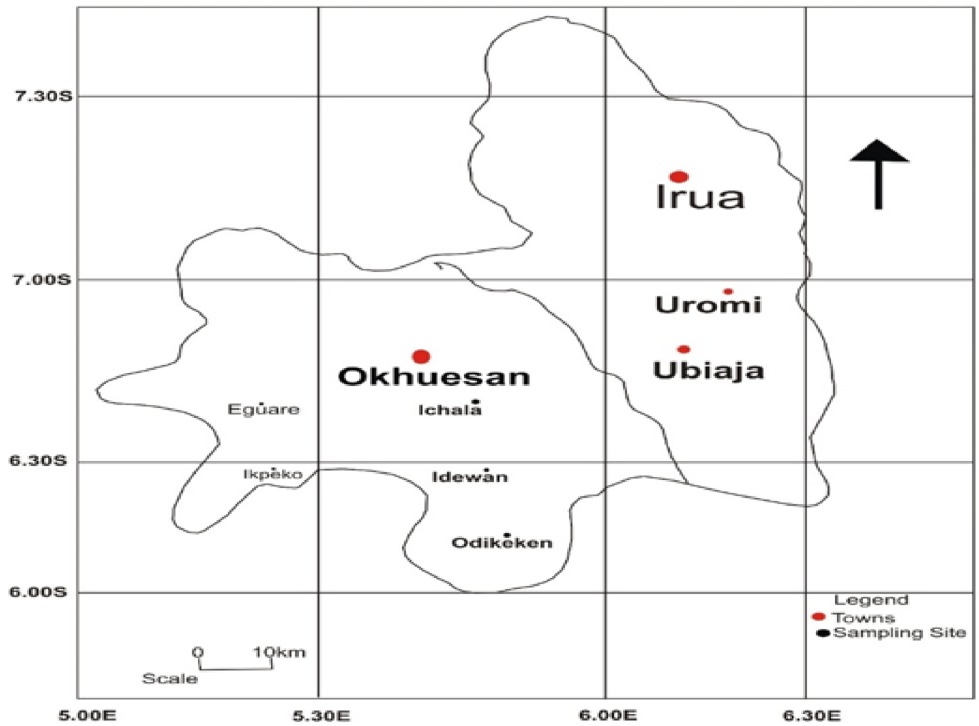

Fig. 1: Map showing the study site among other neighboring local government areas.

Analysis of soil samples

At depths of 5–10 cm, 10–20 cm, 20–30 cm, and 30–50 cm, soil samples were taken. The layer of litter was left out. These were gathered in the plot's Centre using a black polythene bag. After samples had dried in the air, they were sent to the lab for examination.

Soil pH and Electrical conductivity (EC)

After the soil has dried, the sample was sieved with a 2mm sieve, then a 10% soil sample was weighed into an analytical cup, 20ml of distilled water was added, and they were agitated for 5 minutes with a mechanical shaker. The sample was then used to standardize the pH using a set of buffers (4.0, 7.0, 9.2). The Multimeter was used to read the PH and EC.

Potassium and magnesium

A 2 mm mesh sieve was used to easily digest the soil samples after they had been air dried at 25°C for 24 hours 20 mm of the digestion mixture was then added to 1 g of the plant, which had been weighed using an analytical weighing scale. It was dried out by heating it to a temperature of 105°C for an hour (Kakulu and Jacob, 2006). The digested soil sample was filled to the top of a 100 ml volumetric flask with distilled water before being filtered with a Whatman filter paper and allowed to cool for a while. For analysis, the fluid was poured into sampling bottles. A Flame-Atomic Absorption Spectrophotometer was used to assess the concentration of these metals in the soil samples.

Nitrate analysis

A sample of 100 ml of water and 20 g of soil sediment is required. Within 48 hours, the water was analyzed and kept in a refrigerator by cooling to 4°C. Samples that were muddy were filtered. Before examination, every sample of soil and silt was air dried and crushed.

Statistical analysis/Visualization

A t-test was performed to measure the difference between the means of the two groups (savanna soil and forest soil). This information can be used to confirm if there is a statistical difference between both sites.

RESULTS AND DISCUSSIONS

This survey revealed a number of 120 plant species belong to 51 different plant families. The discovery of 51 plant families within the study area suggests that the area supports a wide variety of plant lineages and taxonomic groups.

The diversity of plant species and families within the study area can have important ecological, environmental, and conservation implications. It can serve as a vital resource for researchers, botanists, and ecologists who aim to better understand the region's biodiversity and ecosystem dynamics. Additionally, this information can guide land management and conservation efforts, as it highlights the significance of the study area in terms of plant diversity and species richness. This study agrees with Menaut *et al*., (1995) which showed that woodlands and savanna in Africa were characterized by the increase of the species diversity.

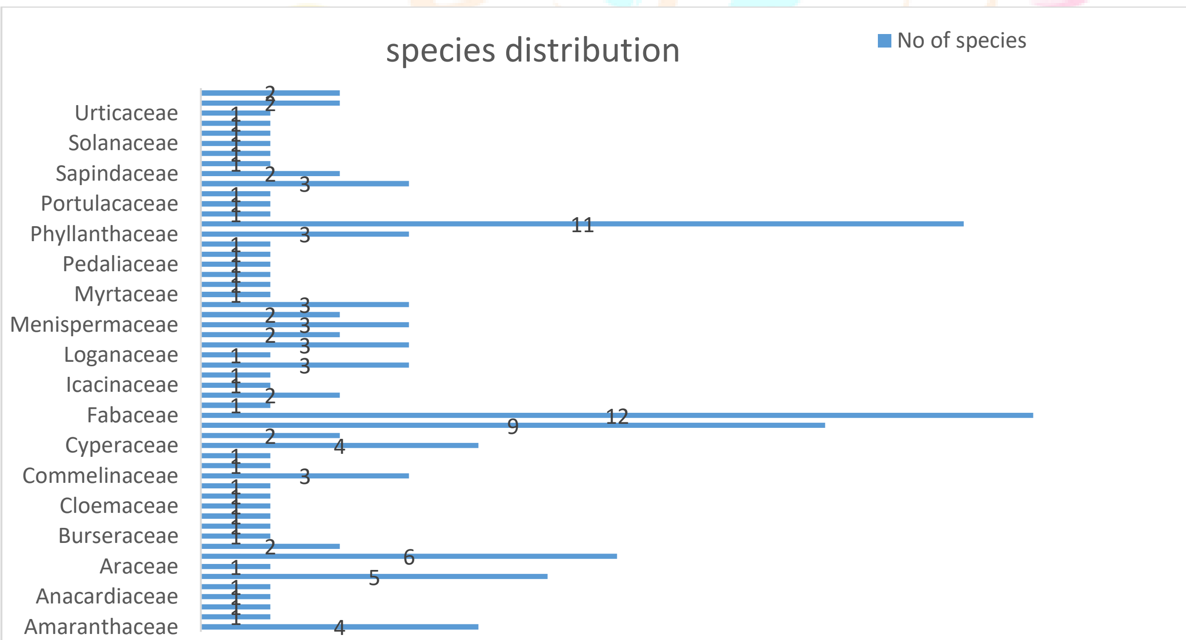

Fig 2: Plant families in the study area

Diverse range of plant families was observed in the study area, each contributing to the overall botanical richness of the region. Among the identified plant families, the Fabaceae family stands out with the highest number of species, having a total of 12 different species. This observation is in close agreement with the findings of Asase and Oteng-Yeboah (2007) and Asase *et al*., (2009) that Leguminosae and Combretaceae were dominant tree families in Guinea savanna vegetation. Lawson (1986) also listed most these families among those identified as common in the forest vegetation of West Africa. Fabaceae is the most diverse plant family in the world with a wide distribution of sort, registering 770 genera and 19,500 species and considered the third largest family of angiosperms in species numbers after Asteraceae and Orchcidaceae in the global context (Beech *et al*., 2017; Azani *et al*., 2017) which agrees with this study as 12 species was recorded (see table 2).

Following closely behind, the Poaceae family is the second most prominent, with 11 species. Other notable families contributing significantly to the plant diversity of the area include Euphorbiaceae with 9 species, Apocynaceae and Asteraceae, both presenting 5 and 6 species respectively.

The diversity in the number of species among these plant families highlights the varied ecological roles and adaptations within the study area.

Table 1: Soil chemical characteristics of the forest and savanna area, including soil PH, Electrical conductivity (EC), Nitrate, Magnesium and potassium

S/N	Parameters	Unit	Test Method	Forest Soil	Savannah Soil
1	pH (1:1, Soil-Water ratio)	_	ASTM D4972	6.17	5.80
2	Electrical conductivity	µs/cm	USEPA 9050A	94	48
3	Nitrate	mg/kg	ASTMD3867	2.73	1.89
4	Magnesium	mg/kg	ASTM D511	106.81	83.76
5	Potassium	mg/kg	ASTM D4192	82.43	54.98

Key:

ASTM D4972: The degree of acidity or alkalinity in soils suspended in water and a 0.01 molar calcium chloride solution is determined by this approach, which entails measuring the soil's pH using a potentiometer.

USEPA 9050A: The specific conductance of drinking, ground, surface, and saline water as well as home and industrial waste is measured using this technique.

ASTMD3867: This is a typical test procedure for nitrite-nitrate concentrations between 0.05 and 1.0 mg per nitrogen.

ASTM D511: This is how calcium and magnesium levels in water are often tested using intricate metric titration and atomic absorption spectrometric techniques.

ASTM D4192: Atomic absorption spectrophotometer standard test procedure for potassium in water. The measurement of potassium is covered by this technique. This test method's applicability range is 0.20 to 4.0 mg/L.

In the test result recorded above (Table 1), showed that the forested soil has the highest value from the parameters recorded than that gotten from the savanna (study site).

The pH of the savanna soil is 5.80, indicating that it is slightly acidic. This level of acidity may affect the types of plants that can thrive in this soil, as some plants prefer slightly acidic conditions, while others may require more neutral or alkaline soils. The pH of the forest soil is 6.17, which is slightly more alkaline compared to the savanna soil. It still falls within a range suitable for various types of plants.

The electrical conductivity of the savanna soil is 48. This value suggests a moderate level of salt content in the soil. High salt content can impact plant growth, so it's important to consider when choosing crops for cultivation. The electrical conductivity of the forest soil is 94, which is higher than that of the savanna soil. This suggests a potentially higher salt content in the soil, which can influence plant selection and suitability.

The nitrate content in the savanna soil is 1.89. Nitrate is a crucial nutrient for plant growth, and this value indicates a moderate but potentially suitable level for plant growth. Proper nitrogen nutrition is essential for plant health. The nitrate content in the forest soil is 2.73. This indicates a higher level of available nitrogen for plant growth compared to the savanna soil.

The magnesium content in the savanna soil is 83.76, which is a relatively high concentration. This is beneficial for plant growth because magnesium is an essential secondary nutrient. The magnesium content in the forest soil is 106.81, which is relatively high and beneficial for plant growth.

The potassium content in the savanna soil is 54.98. This represents a moderate level of potassium, which is another important nutrient for plant growth. Most plants should grow well with this level, although specific crops may require additional potassium supplementation. The potassium content in the forest soil is 82.43, representing a moderate to high level of potassium. Most plants should thrive in such conditions, although specific crop requirements may need to be considered.

Odu and Vine (1968) and Sys (1976) estimated C/N ratios of 10 to 12.7 for savanna soils in the Northern Guinean and Sudanian Zones. In Mato Grosso, savanna soils had a mean C/N ratio of 11.2 according to Askew *et al*. (1970). In 1954, Frankart discovered C/N ratios of 13.7 and 9.0. Tree growth in semi-arid savannah habitats is often influenced by moisture, soil properties, landscape position, and species-specific growth requirements (Akpo & Grouzis, 1996). Leguminous trees are conserved and managed on farms as a result of their importance in maintaining the nitrogen balance of agro-ecosystems, according to Feler & Bandurski (1979) and Felker (1980). In the savanna outlier, there appears to be evidence to support the idea that the soil is not the only factor affecting the vegetation, meaning that the vegetation also affects the soil. Regarding soil nutrient levels, the presence of tree litter may be the determining factor. It would be beneficial to do more research to measure microbial activity. It's also vital to remember that toxicity testing wasn't conducted for this study. On the savanna outlier, it is unknown whether prior pesticide use had an impact on the current vegetation patterns.

Statistical analysis

The t-statistic is approximately -0.7175 and the p-value is approximately 0.4935. The t-statistic measures the difference between the means of the two groups (savanna soil and forest soil). In this case, the negative value indicates that the mean of the savanna soil is slightly lower than that of the forest soil, but the magnitude of the difference is not very large. The p-value is a critical indicator of the statistical significance of the observed difference. In this case, the p-value is approximately 0.4935. This p-value suggests that there is not enough evidence to reject the null hypothesis. In other words, the difference in the means of the two groups is not statistically significant at a typical significance level of 0.05.

based on the t-test results, there is no statistically significant difference between the soil parameters of the savanna soil and the forest soil. The p-value, which is well above the typical significance level of 0.05, indicates that the observed differences in means could likely be due to random variation rather than a meaningful distinction between the two soil types. Therefore, we can conclude that the soil parameters, as measured in this study, are not significantly different between the two sites.

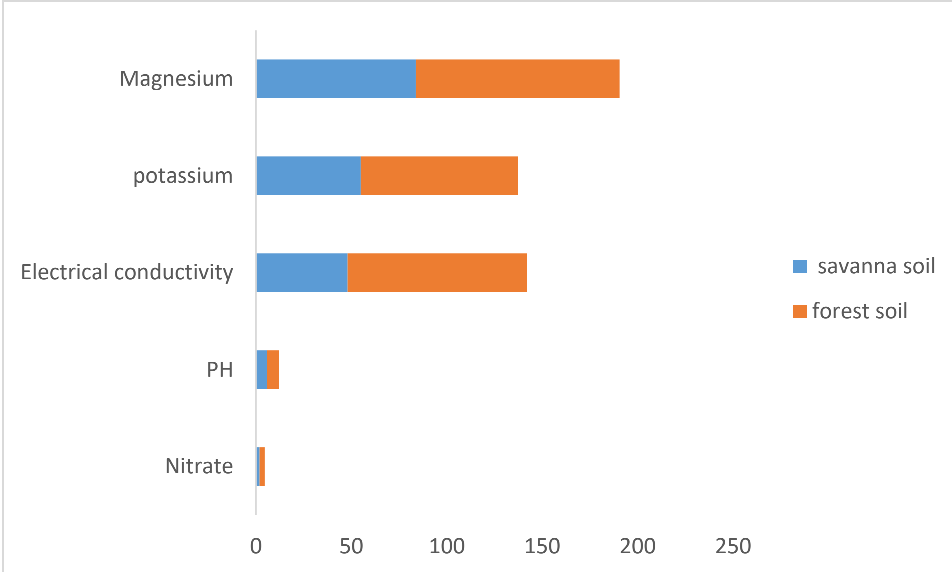

Fig 3: A chat showing the soil nutrient and their variation in forested and savanna soil.

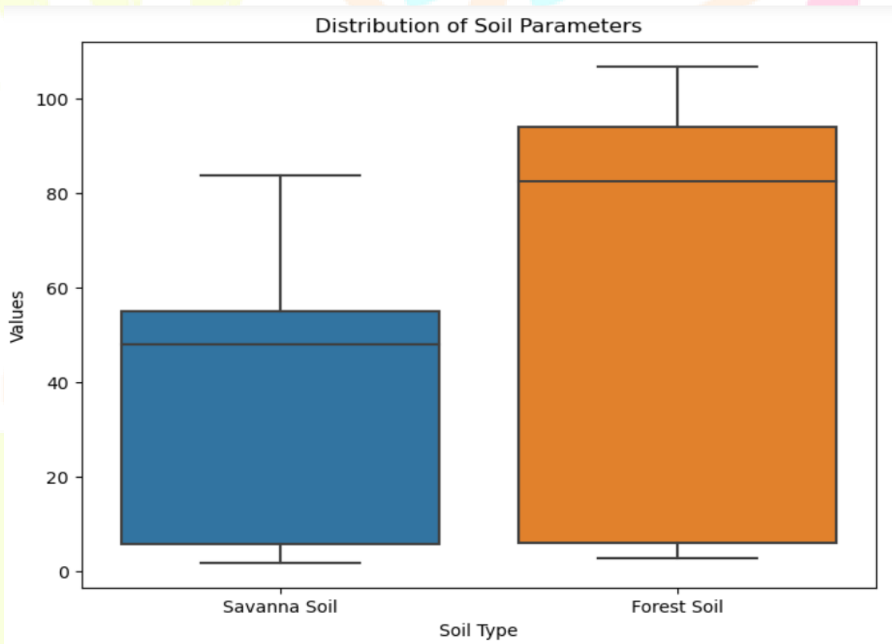

Fig. 4: Distribution of soil parameters using box plot

Table 2: Plant growth form and number of species with relative abundance

Growth form/Habit	No of species	Relative (%)
Herb	40	33.3%
Trees	33	27.5%
Shrub	27	22.5%
Grass	11	9.17%
Sedge	4	3.33%
Vine	4	3.33%
Climber	1	0.83%
Total	120	100%

Plant species in the study area categorized based on their growth forms, revealing the following distribution:

Herbs were the most dominant growth form, with 40 species. This category includes a wide range of non-woody plants, often with a relatively short lifespan, suggesting their adaptation to the environmental conditions of the study area.

Trees were also well represented, with 33 species. Trees are characterized by their woody stems and long life spans, indicating their importance in shaping the local ecosystem. Shrubs, comprising 27 different species, added to the structural and ecological diversity of the area. Shrubs are woody plants with relatively low height. We identified 11 grass species, indicating their significance in the ecosystem. Grasses often play a critical role in open landscapes and various ecological functions.

Sedges were represented by 4 species, which can be associated with wetland and riparian habitats, highlighting the importance of such environments in the study area. Vines, with 4 species, provide climbing or trailing plants, impacting the local vegetation structure and providing habitat and food sources for wildlife.

This distribution of plant species across different growth forms showcases the ecological complexity and diversity of the study area, guiding informed decisions related to conservation, land management, and the study of local ecosystems.

CONCLUSION

The ecological survey conducted on a savanna outlier in Okuessan, Esan Southeast Local Government in Edo State, Nigeria, has yielded valuable insights into the rich biodiversity and ecological characteristics of this unique ecosystem. This study was a comprehensive examination of soil composition in the region, providing a deeper understanding of the natural environment and its ecological dynamics. One of the primary objectives of this survey was to document the plant species found in the area and categorize them according to their taxonomic names, habit, and life form. The results of the study revealed an astonishing diversity of plant life, with a total of 114 plant species belonging to 51 families and 89 Genera. This finding underscores the ecological significance of the savanna outlier, highlighting its role as a habitat for a wide range of plant species.

In addition to cataloging plant species, the survey also delved into the composition of the soil in various layers, ranging from 5 to 50 cm in depth. The findings in this regard provide crucial information about the soil's characteristics, which is vital for understanding the ecosystem's overall health and productivity. Based on the plant habit classification, the study revealed that herbs constituted the most significant proportion, accounting for 42 species (34.4%). Trees and shrubs were also well-represented, with 33 tree species and 26 shrubs identified. Grasses and sedges contributed to the diversity with 11 (9.6%) and 4 (3.2%) species, respectively, while 4 (2.4%) vine species added to the ecosystem's complexity. In the ecological survey conducted on the savanna outlier in Okuessan, Esan Southeast Local Government in Edo State, Nigeria, it is essential to acknowledge that while the study provided valuable insights into the plant species and soil composition, it did not encompass all ecological parameters that influence the dynamics of this ecosystem.

One crucial aspect not considered during the study is the assessment of climatic conditions. Climatic factors, including temperature, rainfall patterns, and seasonal variations, play a significant role in shaping the structure and function of savanna ecosystems. Understanding the influence of climate on plant phenology, water availability, and fire susceptibility is paramount in comprehending the ecological dynamics of the region. Moreover, knowledge of climatic conditions is fundamental for making predictions about the ecosystem's response to climate change and variability.

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