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GEOGRAPHIC INFORMATION SYSTEM APPLICATIONS IN PRIORITIZING KARLAHI FOREST RESERVE AREA FOR CONSERVATION.

Dr Samuel Hyellamada Jerry and Nakama David
Department of Geography Adamawa State University Mubi.
Samjerry455@gmail.com,+2349012000100

Abstract

This study focused on assessing conservation priorities within the Karlahi Forest Reserve of Fufore Local Government in Adamawa State. The main objective was to identify specific areas within the forest reserve that require immediate conservation attention. The research employed remote sensing and GIS techniques to achieve this goal. By overlaying the IDRIS Silva module results, a spatial distribution map was generated, highlighting the cumulative priority areas within and outside the forest. Among the total vegetated area of 26.38 km2 in the Karlahi Forest Reserve, the analysis revealed that 16.16 km2 were classified as high-priority conservation zones. Additionally, 4.59 km2 and 5.63 km2 were identified as medium and low-priority areas, respectively. Considering these findings, it is recommended that conservation efforts incorporate detailed land cover information and regular assessments of species diversity. Furthermore, strict adherence to national and state policies regarding forest reserves and parks is crucial for effective conservation management.

Keywords: Priority, Karlahi, Forest, Reserve, IDRISI Silva, Species diversity

1. Introduction

Forest conservation engagement is intricately linked to the active participation of local communities residing near the forests. This involvement pertains to the management of the forests by these community members. Responsible utilization of forest resources plays a pivotal role in generating income and providing employment opportunities, thereby contributing to the reduction of poverty levels. Additionally, this practice aids in safeguarding biodiversity, protecting the environment, and maintaining the ecological equilibrium of the entire nation (Ranjit, 2012). However, contemporary challenges have made it increasingly arduous for forest-dependent populations to access and utilize local forest resources and their derived products. These challenges stem from factors such as deforestation, logging activities, mounting population pressure, and legal measures like the establishment of state forests, national parks, and wildlife reserves. Unfortunately, these circumstances often lead to unauthorized exploitation of forest resources, ultimately resulting in the degradation of forested areas.

Adekola and Mbalisi in 2015 examined the most effective approach to conserving forest resources in rural communities of Nigeria, focusing on its implications for community education. They found that around 70% of Nigeria's population resides in rural areas, closely connected to nature and dependent on the forest ecosystem for their livelihoods. While existing literature suggests that rural inhabitants might not significantly degrade the forest ecosystem due to their resource utilization within sustainable limits, the degradation of forests is often attributed to unsustainable practices driven by the extraction of resources to meet urban demands. This unsustainable approach leads to excessive use of forest resources, surpassing the ecosystem's capacity and resulting in forest ecosystem destruction. The primary impact of this degradation is borne by rural communities themselves. Therefore, the study underscores the importance of community education as a practical and community-centric method for enhancing environmental awareness and promoting sustainable forest management practices.

1. The main practice leading to deforestation is the systematic felling of trees, resulting in the decline in the forest reserve of the country. Trees

are permanent commodity that cannot be reclaimed when depleted on a large scale; hence, it is appropriate to follow regulatory measures such as controlled and Planned Cutting of Trees. According to Supriya, (2018, 07 13), about 1-2 million sq. meters of wood has been used for various purposes worldwide. Trees are perennial resources, which are endangered due to their continuous exploitation on a large scale. Therefore, felling should be regulated by implementing methods such as clearcutting, selective cutting, and shelter woodcutting (Chand, 2018). The clear-cutting method is suitable for areas where the same types of trees are obtainable over a large area. In that case, trees of the same age group can be cut down in a selected area and then marked for replantation. The forest can be managed in such a way that a timber crop can be harvested indefinitely year after year without being depleted. This technique is called the 'sustained yield' method adopted by many countries of the world.

Despite the significant role the forest plays in the life of humanity, man continues to destroy it through diverse anthropogenic activities such as hunting, bush burning, animal grazing, lumbering, fuel wood extraction, farming, and mining. Disturbances created by these activities influence forest dynamics and tree density as looked open by Samuel, Bashir and Zemba. (2022). It also influences negatively on the forest leading to the destruction of biodiversity and habitat for terrestrial animals. Despite the increasing global awareness of tropical forests, only few reasonable technologies have been developed for the effective certification and subsequent managing of the tropical forests of Nigeria. Furthermore, constant deforestation, degradation and loss of biodiversity have negative repercussions on the livelihoods of most people that are depending on forest resources, as this trend remains unabated for years.

Recent studies have shown that deforestation and forest degradation increase continuously (IPCC, 2019; Kyere-Boateng and Marek, 2021 and Samuel, Bashir and Zemba, 2022). Despite extensive studies on forest conservation, many authors in ecology and geography have observed a lack of research integrating Geographic Information Systems (GIS) to create priority conservation maps. Instead, existing studies often treat factors discretely. This gap highlights the need for investigations that employ GIS to develop comprehensive strategies for conserving disturbed forests. Such studies are crucial for establishing the foundation for monitoring reserve conditions.

Given these challenges, the objective of this research is to formulate priority zones within the forest reserve.

2. Study Area

Karlahi Forest Reserve is situated in the Fufore Local Government Area of Adamawa State. It is located between latitudes $8^0 49' 30'' N$ and $9^0 00' N$, of the equator and longitudes $12^0 36' 0'' E$ and $12^0 45' 0'' E$ of the prime meridian with a land area of 122.5 sq. Km (Samuel, 2023). Karlahi Forest Reserve is bounded by the Toja Stream to the North and Beti Stream to the South-to-Southeastern part (Figure 1.1)

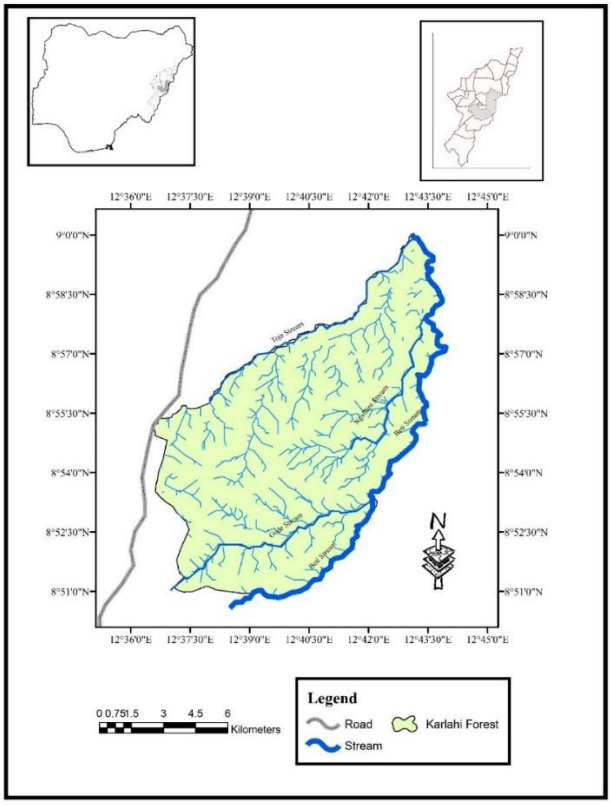

Figure 1.1: Study Area

3. Materials and Methods

3.1 Data Sources

Data used in this study were obtained from primary and secondary sources. Specifically, the data from primary sources, which include field measurement and the Key Informant Interview (KII). The secondary data include information obtained from books, journals, unpublished materials, and Landsat imageries.

1. Field measurement: The data that was obtained from the field which are the number of species found in the study area and the coordinate of the boundary of the forest reserve as in Samuel, 2023 and Samuel, 2023.
2. Key Informant Interview: These includes the people perception of the forest years back (1989-2019), the boundary of the forest and the major drivers that bring change to the forest.
3. Books, journal and News media data on similar problems and various method used in solving such problems elsewhere were obtained which help in shaping this research work.

3.2 Sampling Procedure

The two methods of sampling employed for study were multistage and Systematic Sampling approaches.

3.2.1 Multistage Sampling Approach

Multistage sampling method was used to draw the population element of the study area and this sampling approach was conducted in various level of sampling: Strata, Cluster and Random sampling as stated in Samuel 2023 n his research title: "Spatial Diversity Mapping of Plant Species in Karlahi Forest Reserve", Fufore Local Government Area of Adamawa State.

3.3 Method of Data Collection

For the purposes of this Study, both qualitative and quantitative tools of data collection were used.

3.3.1 Quantitative Data Collection Method

A. Field Measurement

Two methods of filed measurements were employed in Karlahi Forest Reserve and these methods are:

1. **Establishment of quadrants**
   A sample quadrant of 900m^2 were taken within each cluster of 1.5x1.5Km^2 randomly, data on sample units area coordinate and elevation were collected using the Global Position System (GPS) from this 900m^2 quadrants, vegetation species count were carried out to determine the total number of trees within that sample area.
2. **Measurement of Species at Karlahi Forest Reserve**
   Counting and observation of individual tree and shrubs species were sampled from the target population for data collection where data on number of species for each cluster was collected and generalized for the stratum and from these data a species richness, species endemism and species red list were calculated for each stratum as in [10].

B. Data Processing and Analysis

1. Data Processing

Area prioritization in conservation is done with reference to definite values, which are vegetation class, species richness, endemism, and endangered species. The criteria were developed in IDRIS Silva for individual stratum that were converted to constrain as shown in Figure 2, were it shows the individual criterial considered for the conservation priority and were over laid to categorize conservation priority sites within the study area. Vegetation classes were collected from the Landsat image classified map of 2019 of the study area the species richness was collected from the field and the endemism and endangered species (red list) in each sample site were obtained from the species richness.

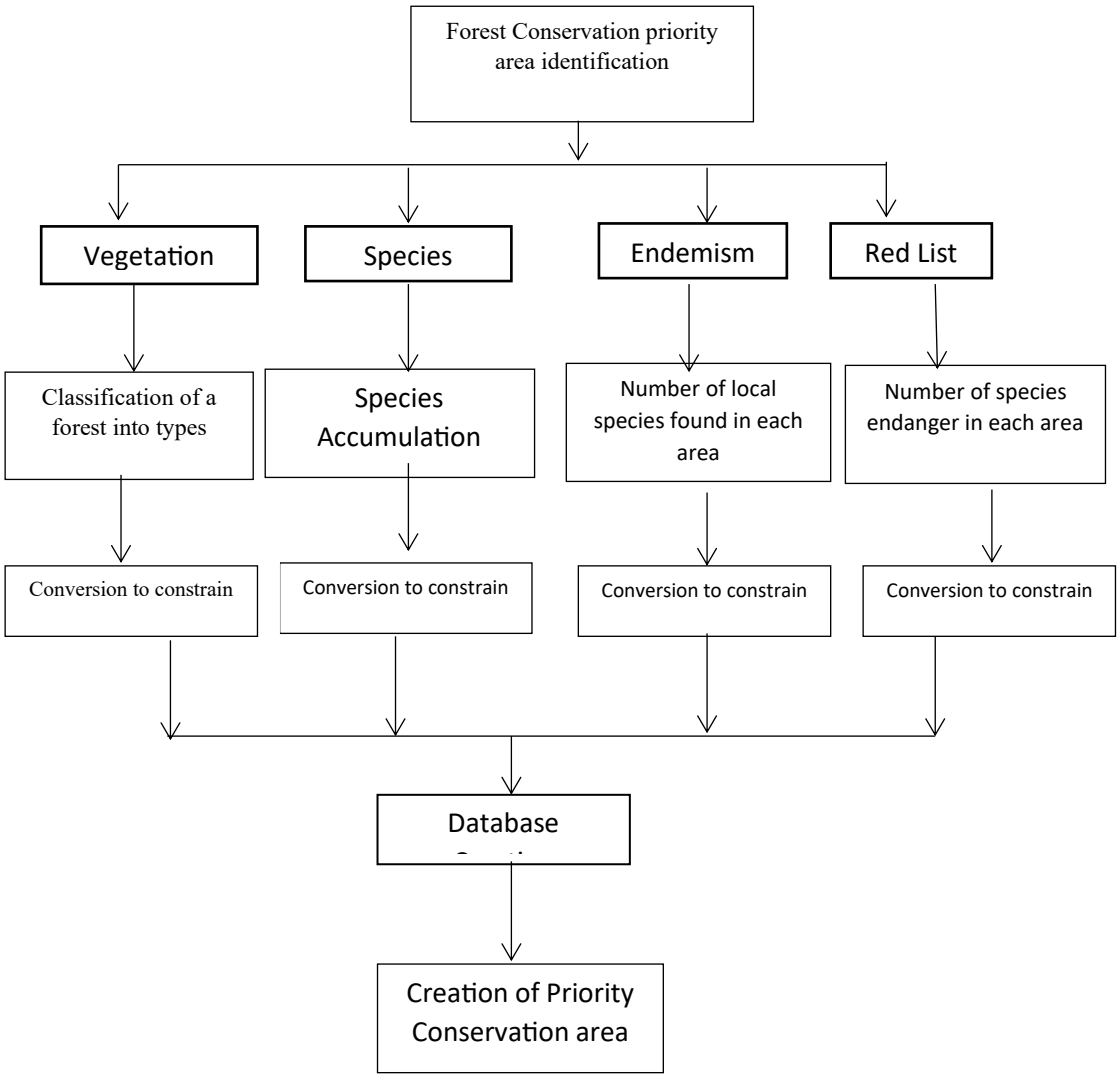

Figure 2: Conceptual Model of conservation priority
Source: Researcher 2023

2. Data Analysis

1. The species count in each stratum were used to calculate the species richness index which show accumulation of species within a stratum, number of local species found in the strata and endanger species found in each stratum. These criterial that were calculated using the number of species count from the study area were converted to constraint that is attaching it to a number, which was used in calculating the conservation priority areas within the forest ecosystem.
2. An overlay module of Idrisi was used to creates a conservation priority composite map by combining the geometry and attributes of the input data sets of the constrain map as illustrated in the formular as shown in equation (2) below.

$$Priority\ Area = SR + SE + RL + FT \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Note

SR: Species Richness,

SE: Species Endemism,

RL: Species Red List and

FT: Forest type

4. Result and Discussion

4.1 Prioritization of Karlahi Forest Reserve Area for Conservation

The four factors that were considered as prioritization factors of forest conservation in this study are: Species Richness, Species Endemism, Species Red List and the Vegetation Types within the Karlahi Forest Reserve which were converted to constrain as shown in Table 1 and Figure 3, 4, 5 and 6

Table 1: Constrain of Conservation Prioritization

	zone 1	zone 2	zone 3	zone 4
Factor	Constrain			
Species Richness	0.19	0.27	0.29	0.26
Species Endemism	0.17	0.25	0.31	0.27
Species Red List	0.23	0.24	0.24	0.29
Forest type	Woodland=0.67 and Shrubs= 0.33			

Source: Researcher 2021

Table 1 and Figure 3 to 6 shows the zonal/spatial distribution of the factors in form of constrain. Zone 3 has the highest value of species richness and species endemism, both of which depend on the number of plant species found in the individual zones. However, this is not the case with the species red list, which depends on the need for such species at a given time. As a result, there is an overexploitation of individual species, leading to zone three having the highest red list va lue.

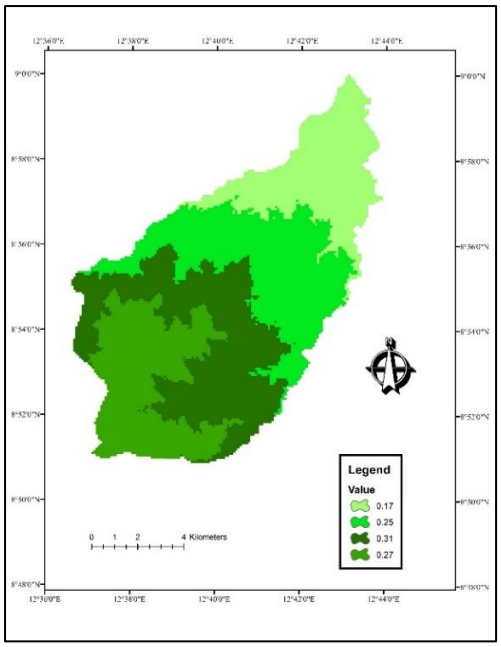

Figure 3: Spatial Distribution of Species Richness in form of constraints.

Source: Researcher 2021

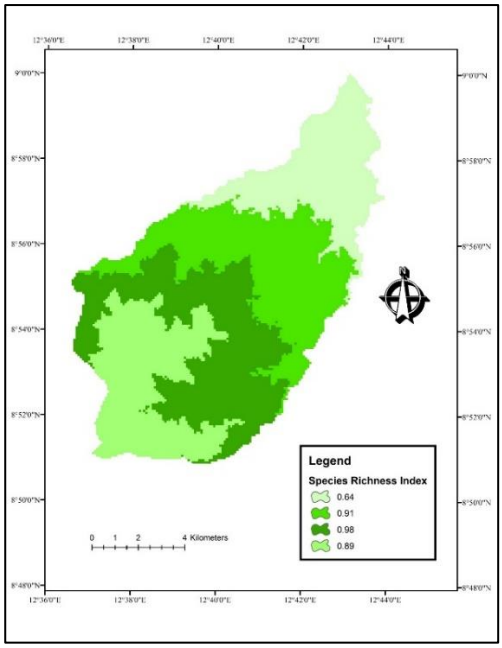

Figure 4: Spatial Distribution of Species Endemism in form of constraints

Source: Researcher 2021

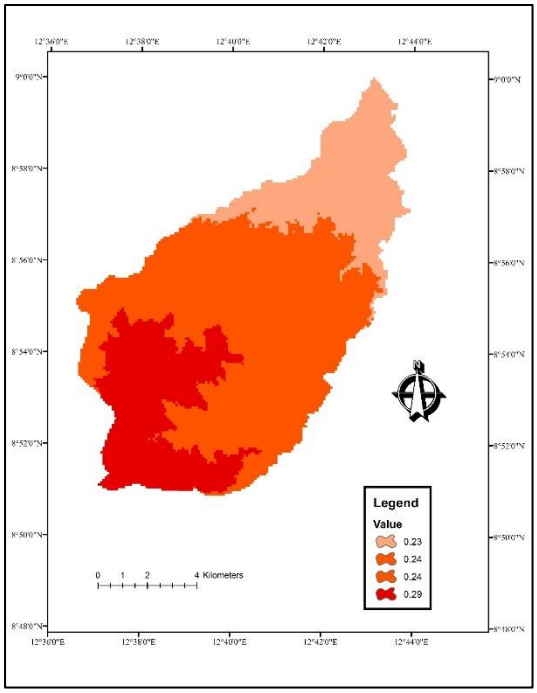

Figure 5: Spatial Distribution of Species Red List in form of constraints

Source: Researcher 2021

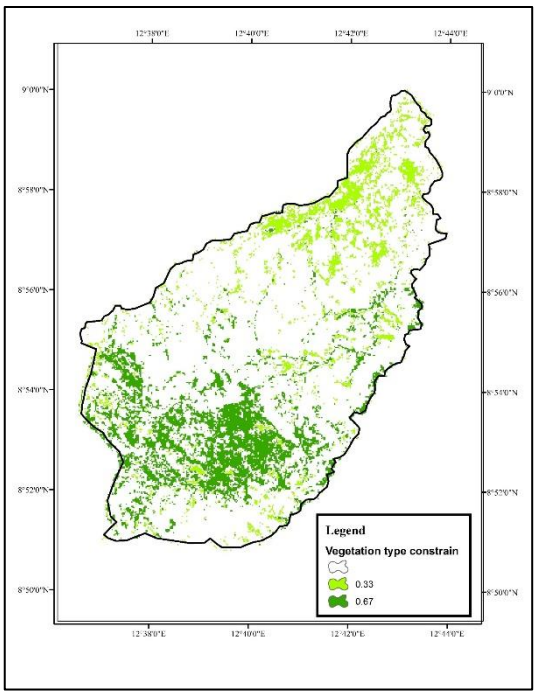

Figure 6: Spatial Distribution of Vegetation Types in form of constrain.

Source: Researcher 2021

The result of the overlay module shows a spatial distribution of the cumulative results of species richness, species endemism, species red list and the vegetation types in

each zone of the study area as shown on Figure 7.

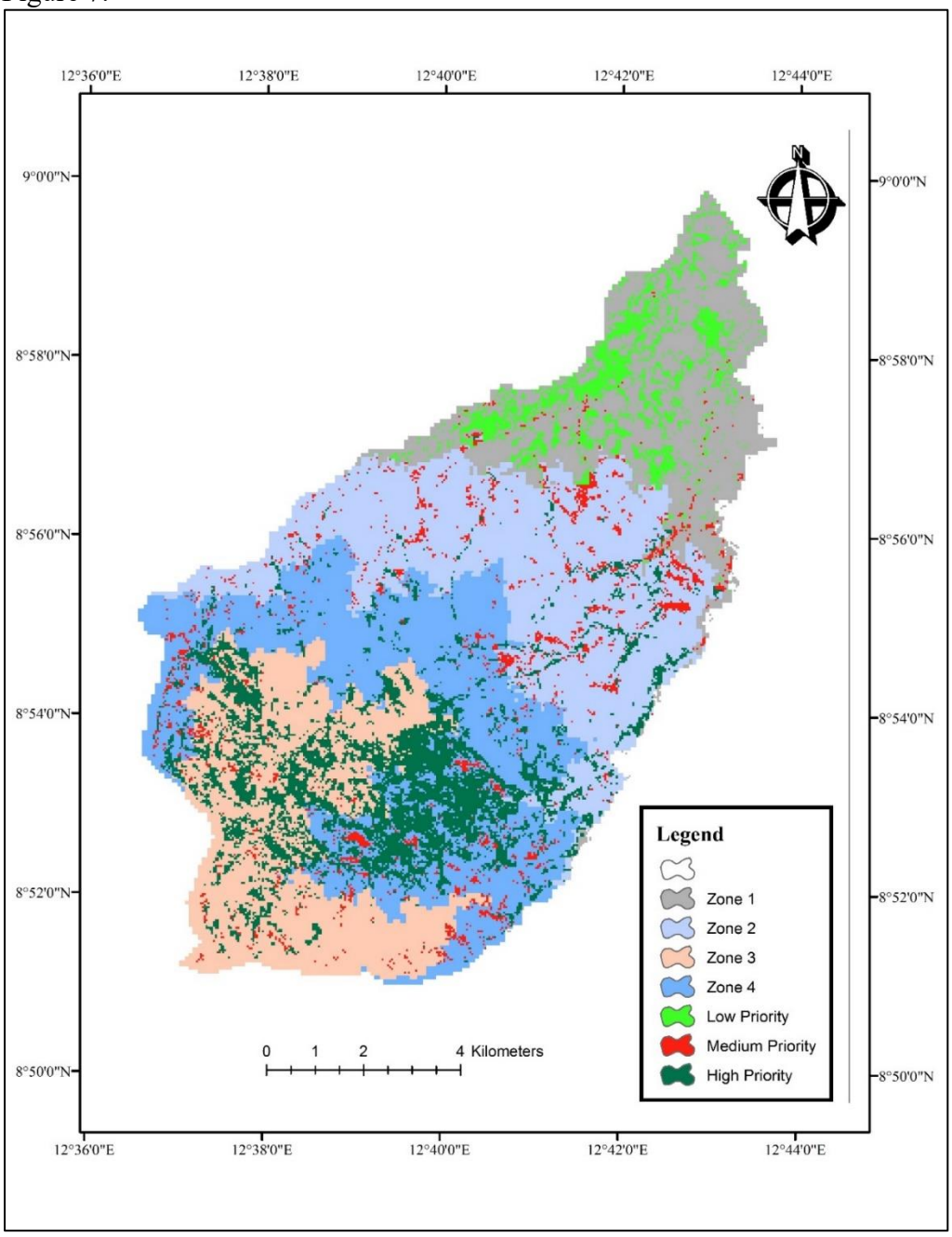

Figure 7: Conservation Priority within Karlahi Forest Reserve
Source: Researcher, 2021

Figure 7. Illustrates the spatial distribution of conservation priority zones within the delineated Karlahi Forest Reserve. The figure reveals that zone three encompasses a larger area covered by high-priority conservation areas, while zone one comprises the highest proportion of low-priority areas. Table 2 further supports these findings.

Table 2: Zonal Distribution of Conservation Priority \

Sq. Km	zon1	zone2	zone3	zone4
Low	4.06	1.57	0.00	0.00
Medium	0.39	2.07	1.55	0.58
High	0.00	1.90	7.77	6.49

Source: Researcher 2021

Table 2 shows that out of the total land area covered by vegetation within Karlahi Forest Reserve, of 26.38 km^2 (addition of all the values in the four columns in Table 5.5), 61.24% were high priority areas in terms of priority ranking. Zone 3 had the highest area considered as high priority second by zone 4 and zone 2.

The lower relief of the Karlahi Forest Reserve is significantly impacted by extensive agricultural activities, leading to the widespread clearance of woodlands and shrubs. Consequently, the area becomes deforested, resulting in the limited availability of shrub species. As the degraded vegetation in the zone attempts to regenerate, the area is characterized by low priority value.

5. Conclusion

The conservation priority analysis reveals that zone 3 exhibits the highest species richness and species endemism. The number of species present in each zone determines these factors. Additionally, the species red list represents the number of trees and shrubs that are most exploited within each individual zone. Zone 4, characterized by extensive logging activities, has the highest number of endangered species with an index of 1.12. Following closely are zone 3 and zone 2 with indices of 0.94 each. The red-listed species that are commonly found in these zones include *Pterocarpus Erinaceus, Ziziphus Spina-Christi, Balanites Aegyptiaca, Vitellaria Paradoxa, Anogeissus Leiocarpus, Banhinia Thonningii, Parkia Biglobosa, and Detarium Microcarpum* (Samuel, 2023).

6. Recommendations

Prioritize research on patch density and the dynamics of patch direction within the forest reserve, as this knowledge is vital for effective conservation and management strategies.

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