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Demarcating and Mapping of Karlahi Forest Reserve in Fufore Local Government Area of Adamawa State.

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Abstract: The demarcation and mapping of Karlahi Forest Reserve in Fufore Local Government of Adamawa State was carried out and it was aim at demarcate and mapped out the Karlahi Forest Reserve. This research adopted a Geographic Information System (GIS) methodological approaches that is, the used of GIS in mapping the boundary. Key Informant Observation (KII) was also used to know people perception on the extent of the forest reserve. The result obtain from the Key Informant Interview (KII) shows that, Karlahi Forest Reserve was bounded by natural and cultural features as noted in several document that the forest is bounded by river Toja and Beti (natural) and clear description of the cultural boundary but the forgoing research gives an area of the forest reserve as 122.5 Km^2 and a perimeter of 52.24 km. It is recommended that such studies should be replicated in the various forest reserve within the State that lack a clear spatial boundary.
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Key words: Mapping, Delineation, GIS, Forest Reserve, SRTM, KII

1.1 Introduction

Forest mapping is a critical task because the resulting datasets are fundamental input for a broad range of users and applications, ranging from global environmental change assessment to local forest management planning. Precise, up-to-date, and regularly gathered information on the area covered by trees and shrubs is an important basis for assessing woodland resources and understanding the functionality of forests. The need for consistency and the reduction of manual workload are key reasons for automation in forest mapping. Thus, a high degree of automation in the process of assessing woodland is essential for governmental authorities, international reporting (including the Kyoto protocol), and activities within the Reducing Emissions from Deforestation and Degradation framework, forest disturbance assessments, and biodiversity and restoration programs. Based on mapped woodland, other forest- related parameters (e.g., forest structure, biomass, and carbon storage) are estimated, which are, in turn, needed for resource management by public and private authorities.

Karlahi forest reserve was gazette by the Federal Republic of Nigeria in 1965 yet among all the twelve (12) gazetted and eight (8) proposed forest reserves (Akosin, Tella and Jatau, 2020), the Karlahi forest reserve was found to be the one among the reserve without a well-defined demarcation and documented boundary as there is no published document(s) (books, Journal including topographic map) stating the actual boundary dimensions of the forest. Available sources have always presented the valuable area as a point location, or as an area figure without any proper map to back the figure UNEP-WCMC (2021); Akosin, Tella Jatau (2020) it is in the light of these problems that the researcher seeks to demarcate and mapped out the Karlahi Forest Reserve.

1.2 Location and Extent

Karlahi Forest reserve is situated in 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. Its land area is estimated at about of 105.44 sq Km. Karlahi Forest Reserve is bounded by the Toja Stream to the North and Beti Stream to the South-to-South Eastern part. Relief of the study area lies between the range of 197m and 346m above sea level and characterized by a gentle slope. The area is predominantly constituted by arable and range lands. The area is bounded to the North by a plain with elevations ranging from 197m and 242m above sea level, and to the south by the Varre hill. The dynamics of land use are conditioned by relief areas with high slope, this factor increase the fragility of the system and decrease the possibility of anthropic use, which makes area with low relief (Slope) vulnerable to many agents of deforestation (Karrasch & Hunger, 2017).

Climate of the study area is characterized by humid tropical climate; marked by distinct wet and dry seasons in which the wet season lasts for Six to seven months with annual precipitation values ranging from

656.70mm to 1260.10mm (UBRDA, 2020). The months of July and August has the highest rainfall while the driest months are January, February and December (UBRDA, 2020). The dry season which predominantly occurs from November to May is characterized by high mean evaporation values, mostly from the months of January to March/April with mean monthly values ranging from 115.40mm to 255.76mm (Adebayo and Zemba, 2020) and annual values ranging from 1585mm to 2922.87mm (UBRDA, 2020).

2.0 Methodology

2.1 Demarcation of forest Boundary:

The relative forest cultural boundary coordinate of the study area was obtained using Garmin eTrex 30x GPS with an accuracy of 2 meter which the coordinate was used in cultural boundary demarcation and mapping of the forest reserve.

The coordinates of the cultural demarcation of the forest were taken and was used to plot the cultural boundary, while River Toja and Beti serve as natural boundaries at the northern and eastern parts of the forest. There was no natural feature in the western side. Therefore, GPS was used to take the coordinates of points along the cultural boundary line without any specific interval as the terrain makes it difficult to pick coordinate at a specific distance as guided by the Maijiminla of Karlahi and the Chief hunter of Karlahi and The Ministry of Environment and Natural Resource Development staff and was overlaid on SRTM as shown on figure 2.1. The points were later joined together to form the eastern boundary line of the Forest Reserve.

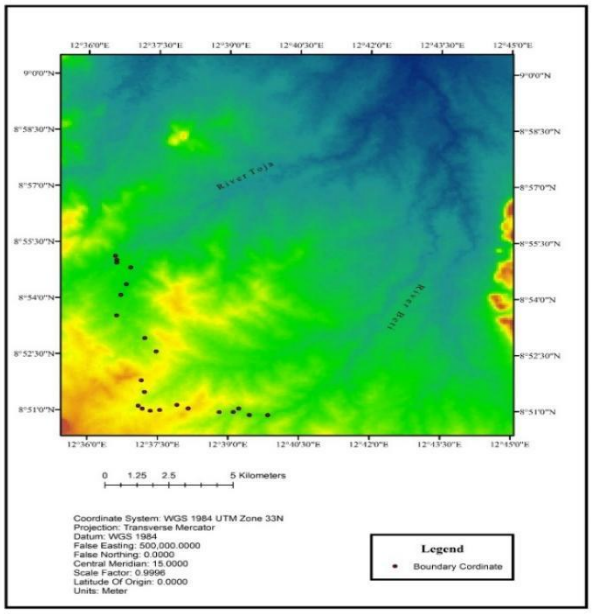

Figure 2.1: Points Showing Boundary
Source: SRTM

Karlahi Forest Reserve Demarcation and Mapping

The steps used in mapping the Karlahi Forest Reserve are:

Generation of the major rivers that bounded the forest which are river Beti and Toja. The location of these two rivers was generated using the terrain pre-processing tab of Arc hydro extension tools of ArcGIS 10.5 that is, using the command of image filling, follow direction and the flow accumulation. This process shows the nature and position of the main rivers and streams within the study areas as shown in figure 2.2.

The output map (Figure 2.2) shows river/streams clearly as major area where water accumulate within the study area, the river was established as the natural boundaries of the forest reserve (Ministry of Environment and Natural Resource Development and the District head of Karlahi). However, River Toja and Beti were only found in the northern and eastern parts of the reserve. Which means the south western part of the reserve has no natural demarcation as shown in Figure 2.3.

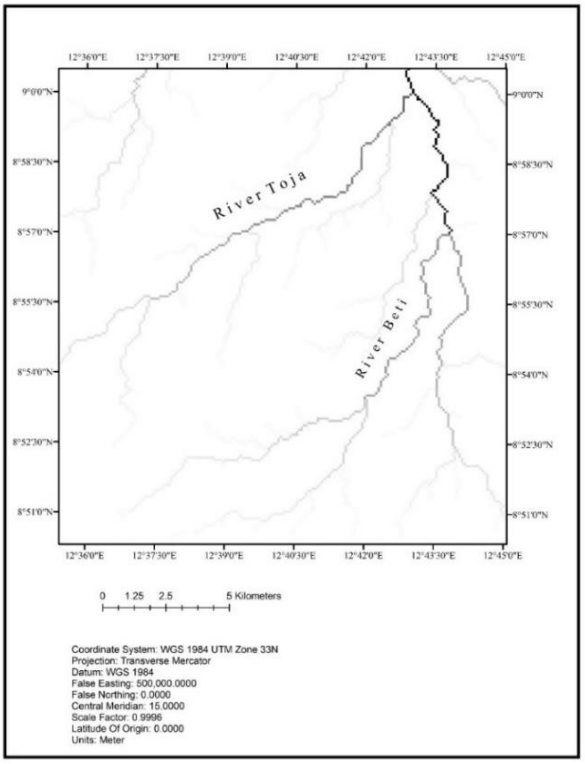

Figure 2.2: Natural Demarcation of Karlahi Forest Reserve
Source: SRTM

To generate the cultural boundary of the forest from the south-western part where river Toja and Beti did not cover, the staff in charge of the forest reserve at the Fufore Local Government area and the representative of the District Head shows the boundary

of the forest reserve.

Geographic Positioning System (GPS) was used by the researcher to obtain the coordinates of the cultural boundary parts and they were immediately recorded in field notebook as shown in table 3.6. the coordinates were entered into Microsoft excel and exported to ArcGIS 10.5 using the text tab delimited formant and was link to the study area map as shown in figure 3.11

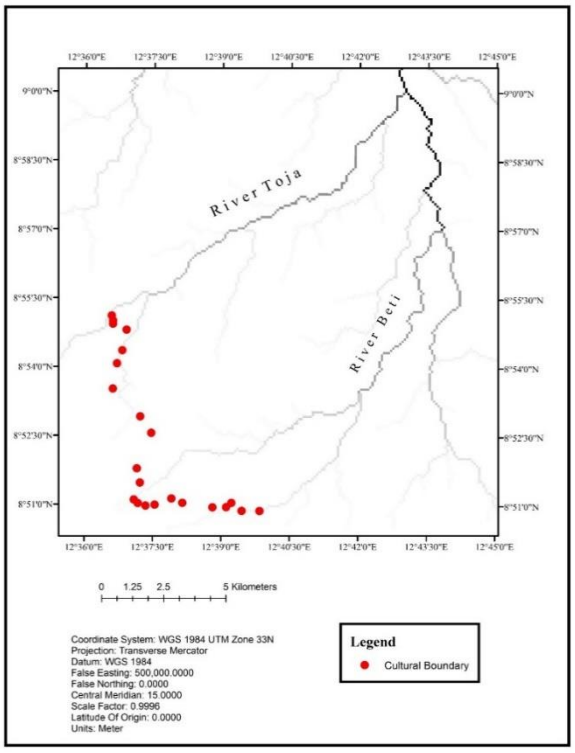

Figure 2.3: Sample Points along the Boundary of Karlahi Forest Reserve,

Source: Researcher 2020

From the sample point of the boundary of Karlahi Forest Reserve and the two major rivers as shown in figure 2.3 were joined with a line to form the forest reserve boundary.

3.0 RESULT AND DISCUSSION

3.1 Demarcation and Boundary Mapping of Karlahi Forest Reserve

3.1.1 The Karlahi Forest Reserve Boundary

The KII carried out on the resource user group and the managers of the forest revealed that the forest reserve is demarcated by natural and cultural boundaries. The natural feature that demarcates the forest reserve demarcate is a river that flow to the Western and Eastern part of the Forest Reserve. The natural feature (River) that demarcates the forest are River Beti and River Toja. River Beti has its source from the verre hills (South) and flows North Eastward with a length of 23.08Km which is 44.18% of the total forest reserve parameter and forms the Eastern boundary of the Karlahi Forest Reserve, this river has two major tributaries: Ngalbini stream and the Gade Stream as shown on Figure 3.1.

River Toja originates from Verre hills which forms the North-western boundary of the forest, the river covers a length of 16.22Km which is 31.05% of the parameter of the forest reserve and flows Northward from the western side of the forest, connecting the River Beti at Wuro Babawa and is the second major river which flow from the North-eastern part of the forest as shown on Figure 3.1. The southern boundaries of the forest were culturally demarcated (KII, 2020) through relative cultural boundary coordinate which delineate the southern boundary using the Geographic Information System (GIS) method following the identified path as guided by the village head, resource users and staff of the Ministry of Environment and Natural Resource Development to identify the relative cultural boundary of the Forest Reserve using the boundary path coordinates as shown in Figure 3.1

Settled within and immediately outside the Karlahi Forest Reserve are houses which are mostly farm house which depend largely on the forest for their livelihood. Settlements found within the forest reserve are Sandre, Toza with some newly established farm with an estimate of about 15 years. While, Wuro Babawo, Bagare and Tashau settlement were found close to the forest reserve as shown on figure 3.1.

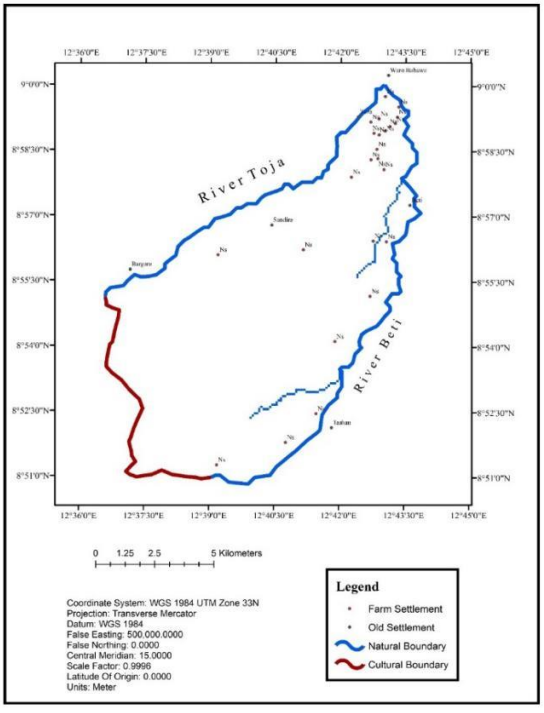

Figure 3.1: Settlement Distribution in Karlahi Forest Reserve

Source: Researcher 2020

Old settlement found within the forest are Beti and Sandire settlement. The newly found settlements adopted the name Beti (Maijiminla, 2020) and are settlement with only few houses which can be term farm settlement and are mainly occupied by Fulani people (Majority is five to seven houses) as shown on plate 3.1.

Most newly establish settlement are found on farmland area, hence the need to engage in farming activities, which often results to extensive cutting down of tress for building houses, furniture, firewood extraction and cultivation of crops as shown on plate 3.2. The farming activities which result to degradation of this forest area is a common practice in larger villages such as the Wuro-Babawa, Toza, Chigari, Beti and Karlahi.

Plate 3.1: Settlement/Farmland within the Karlahi Forest Reserve in Fufore L.G.A (Lat 8.88 log 12.70)
Source: Researcher, 2020

Karlahi Forest Reserve from figure 4.1 was found to cover a total land area of 122.5Km^2 and a parameter of 52.24406 km. This finding contradicts the areal figures earlier estimated by Akosim, Tella and Jatau (1999 and 2020) in their research work title *Vegetation and Forest Resources* in which they published the area of the Karlahi Forest Reserve as 105.44 Km^2 and the spatial location of the forest reserve was only stated as a point feature. VYMaps (2021) in their publication looked at Karlahi forest reserve as a point and the area of the forest reserve was not stated. Therefore, these findings can be on the grounds that document on the demarcation of the forest reserve as well as its area cover by the forest was not stated.

Finding on size of Karlahi Forest Reserve in this research shows a huge variation in the published size of the forest in earlier studies, this variation is in size and shape in relation with the published area which is 105.44 Km^2 and 122.5 on the current research with a variation of 17.64Km^2.

The boundary of the forest reserve is bounded by natural and cultural features, the natural features are river Beti and Toja which is centrally to the cartographer's map of 1965 as shown on figure 4.2 where river Toja is within the forest reserve and river Beti is outside the forest reserve. However, from the KII the managers of the forest observed that the forest is naturally been bounded by the two river and a cultural feature along the mountain ranges. This attribute shows the Karlahi forest reserve map was created out of assumption as the coordinate on the map do not correspond or align with the boundary of Fufore Local Government Area as such the map created 1965 (Figure 4.3) is inaccurate, hence obliterating the Karlahi Forest Reserve in all the topographic maps. Looking at the Mapeo Sheet 218 were Karlahi Forest Reserve is located one can notice that there is no forest Reserve being represented as Karlahi Forest Reserve (Figure 3.2) but other Forest Reserve were represented in most sheet such as the Gurin Forest Reserve in sheet 197, Bagale and others.

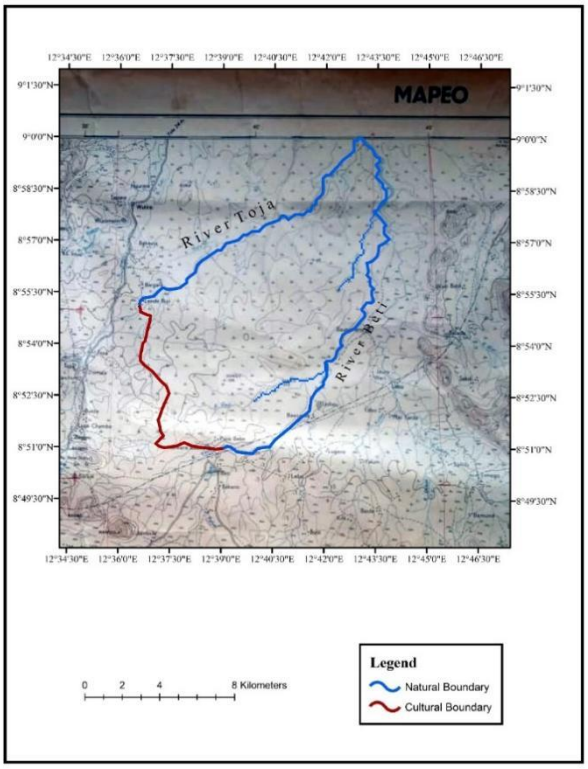

Figure 3.2: Karlahi Forest Reserve Boundary on Topographic Map
Source: Researcher, 2021

Karlahi Forest Reserve is second largest forest reserve in Adamawa State sequel Wuro-De Forest Reserve located in Song Local Government Area which cover a total area of 226.20 Km^2 as the largest in Adamawa state, then by Gurin Forest Reserve in Fufore Local Government of the State with 165.45 Km^2 which is adjacent to Karlahi Forest Reserve which as the third

Forest Reserve in Adamawa State with 122.5 Km^2 (REF).

Conclusion and Recommendations

The delineation of the Karlahi Forest Reserve displays the area to be bounded by natural and cultural features as noted in several document that the forest is bounded by river Toja and Beti (natural) and clear description of the cultural boundary but the forgoing research gives an area of 122.5 Km^2 with a perimeter of 52.24 km which served as a based area for feature studies.

Recommendations

i. A more Scientific Method of Mapping is recommended.
ii. Finding from the research reveals that communities around the Karlahi Forest Reserve did not know their role in the forest reserve conservation as stated in national policies of efforts at combating desertification in Nigeria, and in line with this policy, the Ministry of Environment and Natural Resource Development needs to do an awareness campaign on the role of local community in forest reserve management and introduce program that can improve or empower the local communities within and outside the forest reserve which can help to improve the conservation management and settlement encroachment into the forest.
iii. A detailed species audit is recommended within the Karlahi Forest Reserve which will help in determining the dynamics of species within the forest.

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