



GEOSPATIAL ANALYSIS OF VILLAGE WEAVER (*Ploceus cucullatus*) NESTING SITES IN AKURE SOUTH LOCAL GOVERNMENT AREA, ONDO STATE, NIGERIA

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ABSTRACT: It is imperative to discover the conditions affecting spatial location and distribution of nesting sites of *Ploceus cucullatus* - the most devastating avian pests of grain crops (rice, maize and sorghum) in Southwest Nigeria. This study aimed to determine the spatial distribution of nesting sites of *Ploceus cucullatus*, create a habitat map, determine the relationship between habitat classes, location and number of nesting sites, and determine tree species coupled with the materials used for weaving their nests in Akure South Local Government Area of Ondo State, Southwest Nigeria. Reconnaissance survey and Point-count method were employed to determine the spatial distribution and geospatially analyze the nesting sites of the studied animal respectively. Recent Landsat-8 OLI satellite imagery was subjected to compute the Normalised Difference Vegetation Index, and create a habitat map through supervised classification using maximum likelihood classification method. Spatial analysis tools employed were Direction Geographical Distribution and Geographical Weighted Regression. Total nest population of one thousand one hundred and fifty (1,150) *Ploceus cucullatus* was recorded in the identified seven locations, and FUTA Southgate Axis had the highest population (448). Six tree species were colonized, while eight nesting materials were used. The result indicated that *Ploceus cucullatus* predominantly nested in built-up areas and within elevation more than 300 above sea level against previous studies. This study has demonstrated the usefulness of harnessing geo-information technology in better understanding of the spatial distribution of nesting sites as it relates to a few environmental variables such as topography and land use/cover.

Keywords: Geospatial, Village weaver, nesting sites, settlement

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1. INTRODUCTION

In recent years, the need of incorporating spatial ecology into wildlife management has been highly emphasized which calls for serious attention, even though the analysis of spatial (or geographical) patterns and processes can require time and resources that are typically not available (Clark *et al.* 2000). Conversely, the spatial analysis focuses attention on small-scale factors of habitat and topographic complexity. Global

change is expected to alter the nature and distribution of such habitats, necessitating range movement by many resident species. Village weaver was introduced to many other regions but is mainly resident breeding bird species in much of Sub-Saharan Africa (Lahti 2003). *Ploceus cucullatus* belong to the family ploceidae been the most numerous birds in south-west Nigeria and ninety per cent of village weaver bird colonies are associated with human settlement (Yisau *et al.* 2014). They frequently form large noisy colonies in villages,

towns, hotel grounds and are found in a wide range of open woodlands and human habitation (BirdLife International 2018).

Village Weaverbirds form large foraging flocks and nesting colonies and are often involved in synchronized competitive actions such as displacing other bird species in foraging areas and mobbing intruders near and within colonies (Lahti 2003). Village weaverbird builds elaborate, enclosed nests in often dense colonies and prefers the proximity of human habitation and agriculture (Lahti *et al.* 2002). It nests in often dense colonies in a variety of habitats, places close to a source of water but have been found in abundance near agricultural fields. Their life centres on the breeding colony and the work of building and repairing their nests which is made by weaving blades of grass or other vegetation into a hanging-nest (Serle *et al.* 1990). The global population size has not been quantified, but the species is approaching the thresholds for the population decline criterion of the International Union for Conservation of Nature, IUCN Red List (Birdlife International 2014). The village weaver bird is a native of Africa but has been naturalised on several islands such as Hispaniola, Mauritius and Reunion over a century ago (Lahti *et al.* 2002; Lever 2005).

Rice is the most significant element in the bird's diet when it is available and consistent availability of suitable grains, especially in the brooding season, is suggested to be an important factor limiting the size of village weaver population (Da and Smeets 2002). The bird is absent from arid habitats and in fact, its native range in sub-Saharan Africa coincides with that portion of the continent which receives at least 1mm of rain per day on average (Lahti *et al.* 2002). The rain is important in colony formation and establishing subsequent brooding synchrony within the colony (Hall, 2007). The length of the rainy season determines the length of the village weavers brooding season (Da Camara and Smeets 2002).

Geographic Information Systems (GIS) are some of the most important of computer-based tools and have rapidly become highly valuable to wildlife managers and researchers. Data incorporated into a GIS usually have (or are given) a spatial reference. This reference links the data to the features they describe in a particular geographic 'space'. A common format of a GIS is a digital, interactive map of an area or location on the Earth's surface, which is linked to a database containing tables or spreadsheets of data (i.e. feature datasets) associated with some or all of the features displayed on the map (e.g. roads, water bodies, patches of vegetation and/or the locations of wildlife). This configuration

enables a relatively quick and easy visual assessment of spatial patterns and relationships in the data, as well as the ability to efficiently edit, update, analyse and create displays of potentially very large quantities of data.

Village weaver bird is the most notorious avian pests of grain crops (rice, maize and sorghum) in South-Western Nigeria (Funmilayo 2005). Thus, there is a need to discover the conditions affecting spatial location and distribution of nesting sites of village weavers, and urgently control the village weavers in the areas found. Understanding the geographical distribution, habitat composition, characteristics and the nesting sites of the village weavers (*Ploceus cucullatus*) within the study area will help to conceptualise and consolidate the ideality of conservation efforts toward the bird species. The geospatial analysis will aid to know the spatial location, habitat mapping, relationship between habitat classes, no of nests and nesting sites altogether with the tree species and the nesting materials used. There is surplus nest formation at sites placed on trees above the height of 10 m with good food opportunities (Nishant 2015). This study aimed to geospatially analyze the nesting sites of village weavers in Akure South Local Government Area in Ondo state by determining the spatial distribution, creation of habitat map, determine the relationship between habitat classes, nesting sites and the number of nesting sites, and determine tree species coupled with the materials used for weaving the nests.

1. MATERIALS AND METHODS

1.1 Study area

The study was carried out in Akure South Local Government Area (Figure 1) situated within latitudes 7° 12' 18"N and longitudes 5° 11' 15.6"E. with a land cover area of 331 km² (UNAAB-IFSERAR 2010). It is one of the eighteen local government areas in Ondo State and located within Akure – the state capital. The area is characterized by two distinct seasons - raining season from April to October, and the dry season from November to March (Ondo 2012). The relative humidity is high (70% - 98%) and the temperature ranges between 27 – 32 °C (Ondo State Agro-climatological and Ecological Monitoring Unit (OSAEMU) 1997).

1.2 Data collection

A reconnaissance survey was carried out at the beginning of the research work to examine the study area; its properties, features and other relevant information needed for the study. Before the commencement of this research work, a repeated visit

was made to the study area to identify the suitable methods to adopt. After which, a field survey was conducted to assess and estimate the nesting sites of the Village weavers in the study area. The study was carried out in seven different locations in Akure South Local Government area (Figure 1) which resulted in fifteen different point count stations. The locations are the only areas where nests of village weavers were seen in the study area during the survey. The varying point count stations were as a result of the distribution of the nesting sites across the different axis. AXIS 1 (FUTA Northgate) had 1 point-count location; AXIS 2 (FUTA Southgate) had six point-count stations; AXIS 3 (Road Block) had three point-count locations, AXIS 4 (Lafe Junction) had one point-count station; AXIS 5 (Idi Ayo street) had one point count station; AXIS 6 (Sabo High School) had one point count station and AXIS 7 (FUTA GNS building) had three point-count stations. It was also observed that at least a village weaver species are found in each nest.

At every site the birds are located, the coordinates were taken with Global Positioning System (GPS) and recorded, the tree species was noted, nests were counted and the materials used for making nests were noted. The numbers of nests found at each location were estimated directly through direct sighting. The height of each tree was measured using hypsometer, and to ensure accuracy, measurement was repeated three times by the same observer. Point-count locations were surveyed between June to July 2016 and observation was carried out every two-day interval between 7:00 - 9:00 hours (GMT +1) when Village Weaverbirds are more active and more accurately enumerated (Funmilayo 2005). Nests on individual colonised trees including those on the floor of the trees were enumerated, and colonised trees were identified. Elevations of the various point-count stations were determined by GPS device. Also, recent Landsat-8 OLI satellite imagery (2016) was acquired, and ground truth information for purposes of

image classification was gathered during the field survey.

2.3 Data analysis

The data on the spatial distribution of Village Weaverbirds and tree species coupled with the materials used for weaving the nests were analysed using descriptive statistics. The imagery was subjected to supervised classification using maximum likelihood classification method in ArcGIS 10.3 software environment. The land use/ land cover classes were grouped into Bare land/ Rock – outcrop, Fallow forest/ riparian forest, Degraded vegetation/ grassland/ Agric land, Open secondary forest/ plantation and Built-up area using a modified United States Geological Service (USGS) Land Classification Scheme. Normalised Difference Vegetation Index (NDVI) was computed to differentiate the vegetated areas from non-vegetated areas.

Spatial analysis was undertaken to determine the relationship between the habitat classes and the number of nests and nesting sites of the Village weaverbirds in the study area. Spatial analysis tools employed were Direction Geographical Distribution to ascertain how dispersed the location of the nesting sites to their elevation and number of nests.

Geographical Weighted Regression (Equation 1) to model spatially varying relationships between the location of the nesting sites and the number of nesting sites with their elevations. The spatial data collected was analysed using ArcGIS 10.3 software.

Number of Nests = $\beta_0 + \beta_1$ (Elevation of Nesting sites)
.....Eq. 1

Where, β_0 = Intercept
 β_1 = Slope

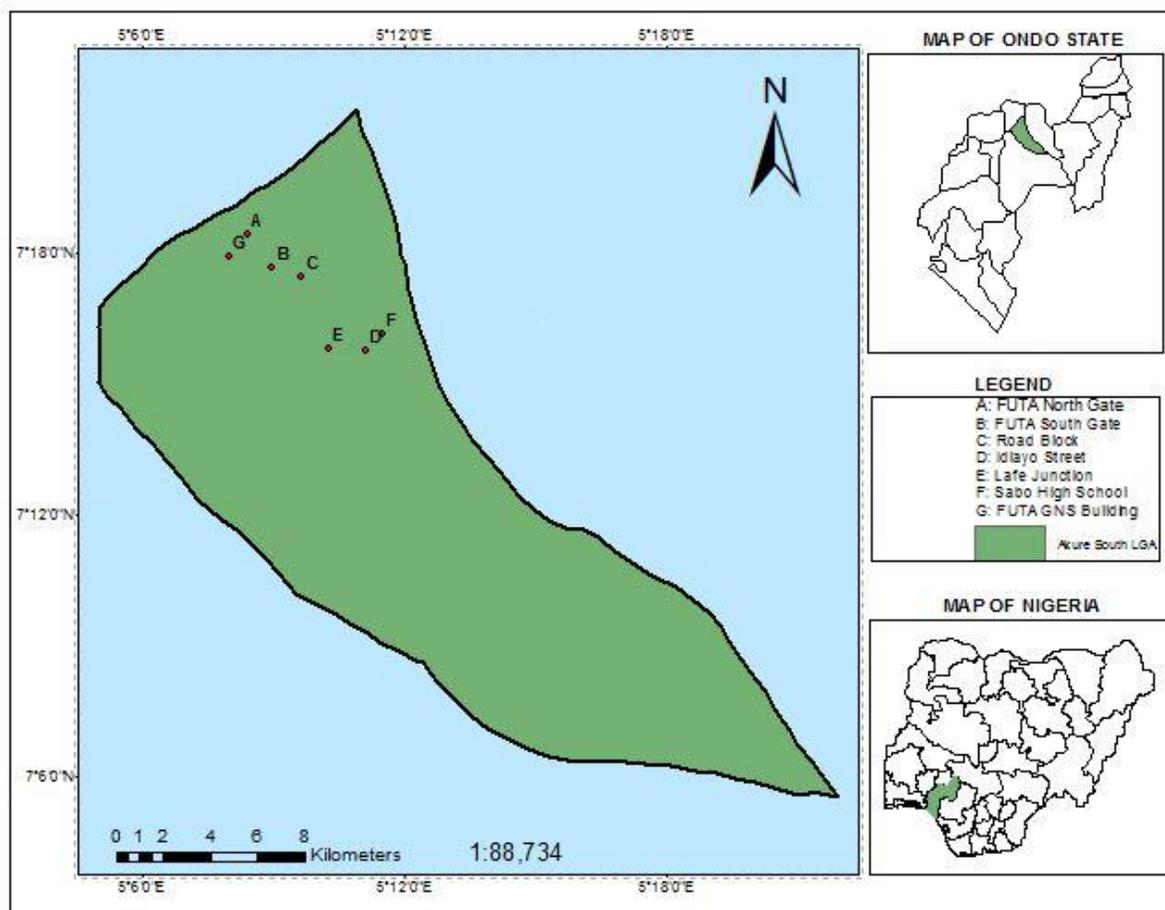


Figure 1: Spatial distribution of Village Weavers' nesting trees at the study sites in Akure South Local Government Area of Ondo State, Nigeria

2. RESULTS AND DISCUSSION

Table 1 presents the spatial (location and coordinates) and non-spatial (number of nests, tree species, nesting materials, elevation and tree height) attributes of Village Weaverbirds' nesting sites in Akure South Local Government Area. The total nest population of Village Weaverbirds encountered in the seven axes was one thousand one hundred and fifty (1,150) nests. At Axis 1, one individual tree stand of *Mangifera indica* was colonised with two hundred (200) nests. Six individual tree stands of *Pinus caribaea* were colonised with four hundred and forty-eight (448) nests at Axis 2. Three and one individual tree stands of *Cassia fistula* were colonised with fifty-eight (58) and one hundred and thirty (130) nests at Axes 3 and 4 respectively. One individual tree stand of *Ficus spp* was colonised with one hundred and twenty (120) nests at Axis 5. One and two individual tree stands of *Prunus dulcis* and *Leucaena leucocephala* were colonised with seven (7) and one hundred and eighty-eight (188) at Axes 6 and 7

respectively. The nesting materials found at the sites was eight in number - grasses, mango leaf, pine leaf, raffia palm, palm fronds, bamboo leaf, maize leaf, coconut fronds.

In this study, the tree species colonised by the village weavers amounts to six (6) which are; *Mangifera indica*, *Cassia fistula*, *Ficus spp*, *Pinus caribaea*, *Prunus dulcis*, *Leucaena leucocephala* and a grass species - *Pennisetum purpureum*. But, village weavers preferred *Pinus caribaea* and *Cassia fistula* when compared to the study undertaken by Yisau *et al.* (2014) at Ogun State, Nigeria. They observed that twelve (12) different species of trees - *Terminalia catappa*, *Mangifera indica*, *Gliricidia sepium*, *Spondias mombim*, *Cassia spp*, *Hura crepitans*, *Pinus caribaea*, *Azadirachta indica*, *Gmelina arborea*, *Elaeis guineensis*, *Psidium guajava* and *Bambusa vulgaris* – were colonised by the Village Weaverbirds. A few variances in the trees species colonized by the village weavers could be attributed to the availability and

dominance of the trees species in the environment. This aligned with the assertion of Efenakpo *et al.* (2017) that the village weavers preferred to colonize the most available trees species in the University of Port Harcourt, Nigeria. However, it can be deduced from our observation and the studies of Yisau *et al.* (2014) that the village weavers colonise mostly pine trees, mango trees and cassia trees. The most commonly used materials are grasses, palm fronds, bamboo leaves, raffia palm, coconut fronds, maize (*Zea mays*), rice (*Oryza sativa*), grasses, tree leaves and sedges (Barlow *et al.* 1997).

Axis 2 had the highest number of nests with 448 nests, while Axis 3 had the lowest number of nests with 7 nests. The elevation of the nesting sites ranged from 316 to 407 above sea level (asl). Sabo High school had the highest elevation value (407 asl), while FUTA Northgate had the least elevation value (316 asl). The height of the tree species that were colonised as nesting sites ranged between 4.40m and 13.0m. Figure 2 and Table 2 show the pictorial and attributes of the Normalised Difference Vegetation Index of Akure South Local Government Area respectively. The non-vegetated areas occupied the highest land cover mass of 180km² (54.38%), while the vegetated areas occupied the least land cover mass of 151km² (45.62%). Figure 3 and Table 3 present the land use/land cover classification map and spatial attributes of land use/land cover classes of the study area. Bareland had the least land use/land cover classes of 10.30 km² (3.10%) while the open secondary forest/plantations had the highest land use/ land cover of 150.37 km² (32.30%). Figure 4 and Table 4 presents the Directional Geographic Distribution as it relates to elevation and number of nests of the study area. The geographic direction of the number nesting sites is 133° i.e. at 90°, the distribution tends downwards in the same direction with the elevation at 128°.

However, it was observed that the number of the observed colony of a village weaver during the study fell within the range of about 100 – 500 nests built on one or a few trees which correlated to submissions of Barlow *et al.* (1997). In colonies that were associated with human settlements, nests are usually located at least 4m from the ground level but nests may be located very close to the ground surface in undisturbed colonies situated in a bush along roadsides or on farmlands and

nests may be built on any moderately tall 9-20m tree. At FUTA South gate, a bamboo stand used as nesting materials was sited some meters away from the nesting site while other materials are found very close to the trees.

Spatial distribution of village weaverbirds' nesting sites could be a reflection of land use and land cover in the study area as provided by the avenue trees for the birds. This assertion aligned to the view of Fernandez-Juricic (2000), who opined that the distributions of some birds are enhanced by improved wooded roadsides for movement and other activities. Also, Inah *et al.* (1999) emphasized that the emanating effects of urban sprawl at Abeokuta city in Nigeria on the roosting sites and abundance of *Ploceus cucullatus*, resulting to the low richness of the preferred nesting trees. In contrary, the highest nest population of birds from the study area could be attributed to the availability of many human settlements and more point-count stations as confirmed by Yisau *et al.* (2014). NDVI and land use/land cover results depicted a positive association between the Village Weavers' nesting sites selection and non-vegetated area (most especially the built-up area/settlements). The land use/land cover and remotely-sensed NDVI data justified that the nesting sites fell within built-up areas and related to the productivity of habitat resources respectively.

Moreover, habitat association models are tools used in conservation (Bamford *et al.* 2009). Habitat selection theory and model suggested that birds choose nesting sites to maximize their survival and fitness based on some the variables such as topography, land use/cover (Chalfoun and Schmidt 2012; Meyer *et al.* 2015). Bamford *et al.* (2009) found that topography and soil types predicted weavers nest occurrence within any location. Also, Murn and Anderson (2008) stated that food availability in the area around the nest may influence site selection. It can be seen from the result that using the directional geographical distribution, the direction of nesting sites tends with the elevation. The site elevation of the colonized trees contributed to the spatial distribution and number of species' nests. However, this finding negated the opinion of Cheke (1987) that Village weaverbirds have much tendency to thrive in locations not usually above 300m above sea level.

Table 1: Spatial and non-spatial attributes of Village Weaverbirds' nesting sites in Akure South Local Government Area

Location	Coordinates	No of Nests	Tree Species	Nesting materials	Elevation (m) asl	*Tree Height (m)
FUTA Northgate	N 07.3635° E 004.1277°	200	<i>Mangifera indica</i>	Raffia palm, palm fronds, grasses	316	11.40 ± 0.00
FUTA Southgate	N 07.2943° E005.1493°	448	<i>Pinus caribaea</i>	Pine, bamboo, grasses	372	22.34 ± 9.33
Road block	N 07.2905° E005.1606°	58	<i>Cassia fistula</i>	Cassia leaves, palm fronds	372	11.00 ± 1.40
Lafe Junction	N 07. 2632° E 005.1709°	130	<i>Cassia fistula</i>	Grasses, palm fronds	372	4.40 ± 0.00
Idi Ayo street	N 07.2629° E 005.1850°	120	<i>Ficus spp</i>	Grasses, palm fronds	351	4.60 ± 0.00
Sabo high school	N 07.2690° E 005.1912°	7	<i>Prunus dulcis</i>	Grasses, raffia palm	407	7.40 ± 0.00
FUTA GNS Building	N 07.2985° E 005.133°	188	<i>Leucaena leucocephala</i>	Grasses, raffia palm	338	5.70 ± 0.00

*Mean ± Standard error at 95% confidence limit

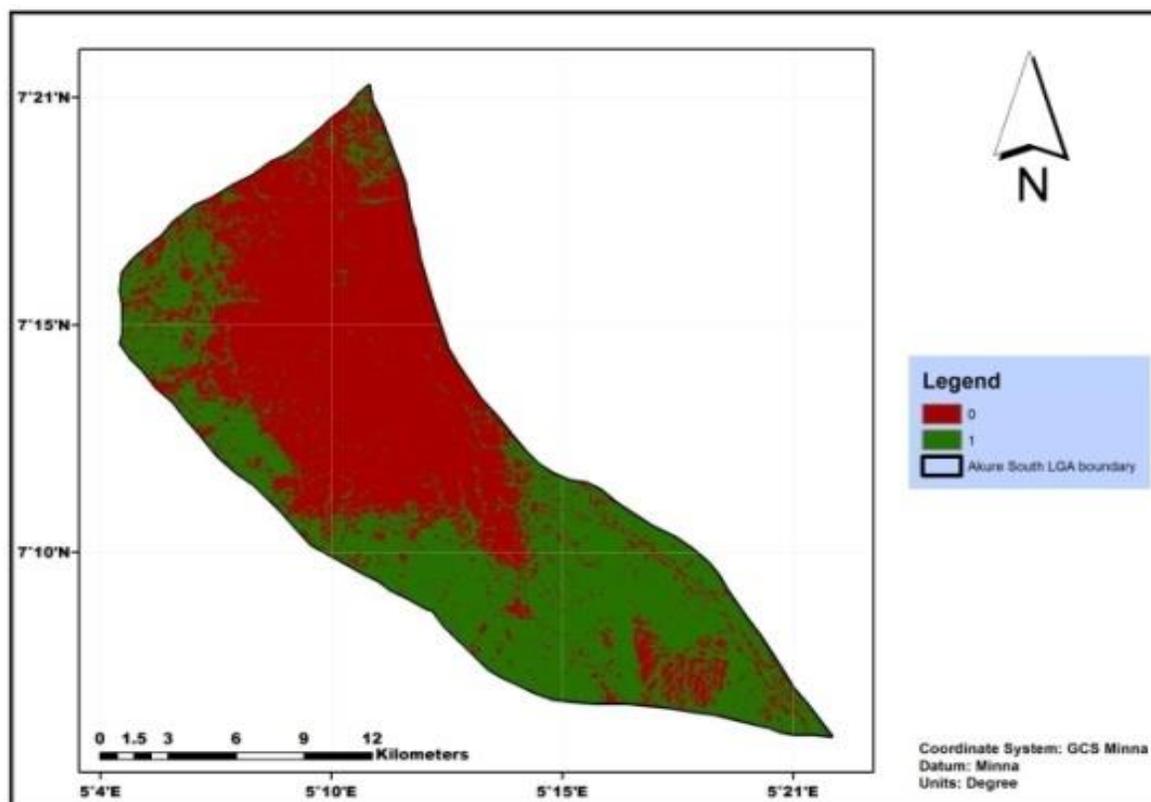


Figure 2: Normalised Difference Vegetation Index (NDVI) of Akure South Local Government Area of Ondo State, Nigeria

Table 2: Normalised Difference Vegetation Index of Akure South Local Government Area

Habitat type	Area cover (Sq Km)	Area proportion (%)
Non-vegetation	180	54.38
Vegetation	151	45.62
Total area cover	331	100.00

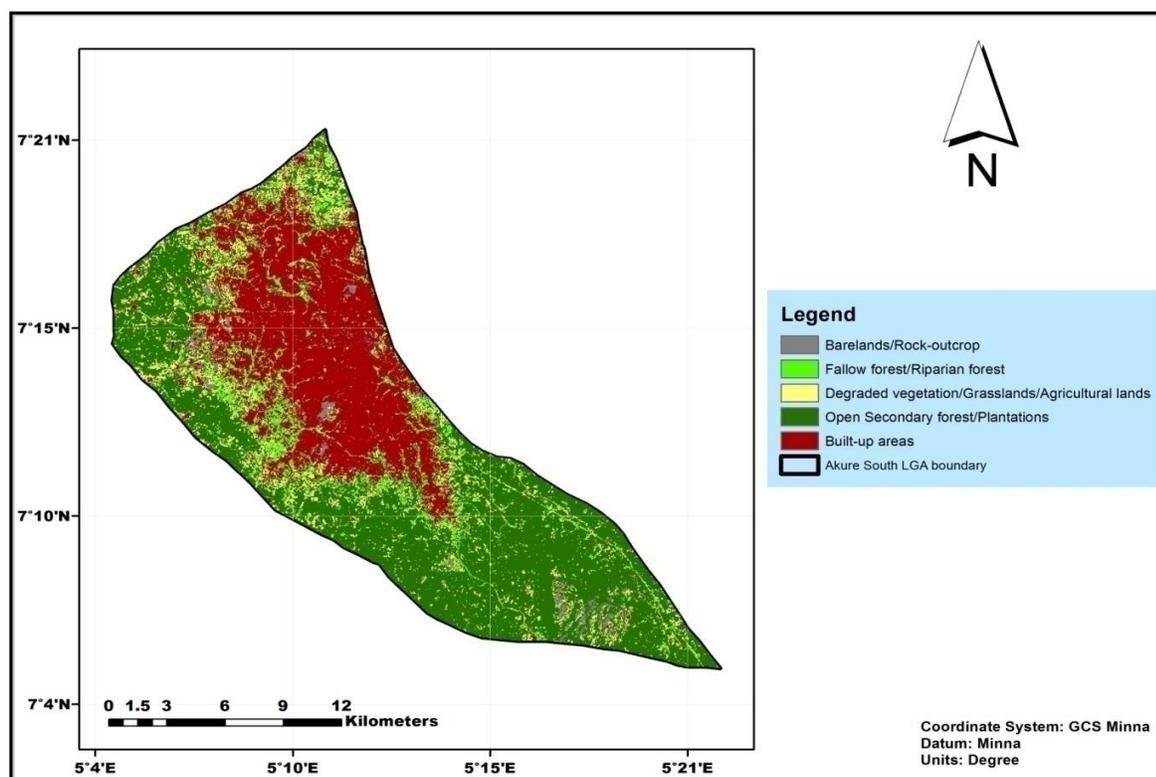


Figure 3: Land use/ land cover classification map of the study area

Table 3: Spatial attributes of Land use/land cover classes

Land use/cover classes	Area covered (km ²)	Area proportion (%)
Bareland/Rock-outcrop	10.30	3.10
Fallow forest/Riparian forest	28.69	8.70
Degraded vegetation/Grasslands/Agricultural lands	34.53	10.40
Open Secondary forest/Plantations	150.37	45.50
Built-up areas	106.88	32.30
Total area cover	330.77	100.00

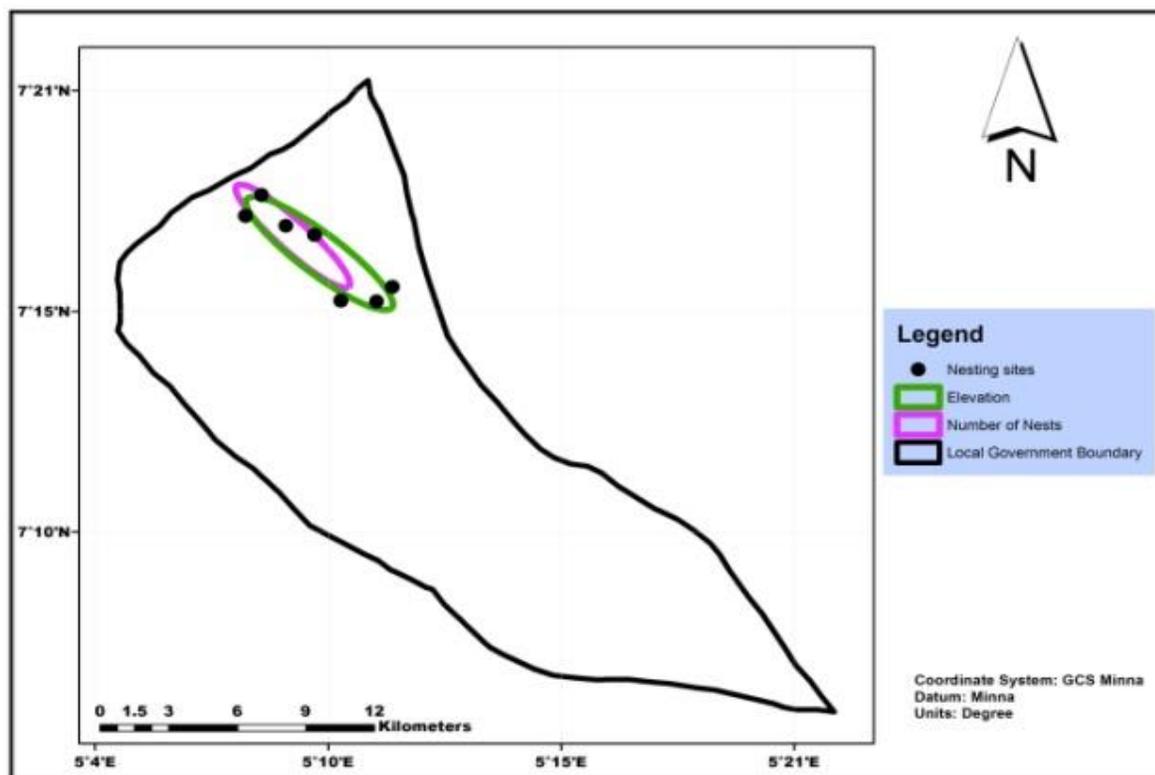


Figure 4: Directional Geographic Distribution in relation to Elevation and number of nests in the study area

Table 4: Directional Geographic Distribution in relation to elevation and number of nests

Variable	Center X	Center Y	X std Dist	Y std Dist	Rotation (°)
Number of Nests	737686.05	806261.46	3366.45	684.01	133.31
Elevation	738884.84	803472.06	4016.62	918.09	128.26

3. CONCLUSION AND RECOMMENDATIONS

1. It can be concluded that six tree species (*Mangifera indica*, *Cassia fistula*, *Ficus spp*, *Pinus caribaea*, *Prunus dulcis*, *Leuceana leucocephala*) were colonized in Akure South Local Government Area of Ondo State, Southwest Nigeria.
2. Eight nesting materials (grasses, mango leaf, pine leaf, raffia palm, palm fronds, bamboo leaf, maize leaf, coconut fronds) were used on the colonized trees.
3. *Ploceus cucullatus* predominantly nested in built-up areas as confirmed by the NDVI and land use/land cover maps of the study area.
4. This species colonized the trees with the height ranging between 4.40m and 13.0m and were sighted within elevation more than 300 above sea level against previous studies.
5. However, it is recommended that a comprehensive habitat association models are developed to integrate the habitat and micro-climatic

characteristics with the spatial distribution and abundance of *Ploceus cucullatus*. These robust models will be useful as tools in the conservation and management of the species within an urbanized area.

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