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*Original research article*

# Vegetation Dynamics and Ecological Potential of the Kehati Forest at UIN Maulana Malik Ibrahim Malang: A Study of Carbon Stock, Water Infiltration, and Bird Diversity

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**Abstract**

*Forests are a renewable resource and support the functioning of an ecosystem. The potential of forests is enormous, both as a habitat for several types of animals, water absorption, and as a location for carbon absorption. This research is a descriptive-quantitative study that evaluates the ecological condition of the Kehati Campus Forest at UIN Maulana Malik Ibrahim Malang through an integrated monitoring approach. The analysis includes estimating vegetation carbon stock, mapping tree distribution using geotagging methods, assessing groundwater infiltration potential, and identifying bird diversity as an ecosystem bioindicator. Data collection was conducted on a 6-hectare plot using a random sampling system. The sampling plots used were 15 plots measuring 20 x 20 m. Vegetation data were collected by measuring tree diameter and height to calculate biomass and carbon storage, while geotagging was employed for spatial mapping of vegetation distribution. Groundwater infiltration potential was projected based on species dominance, whereas bird diversity was assessed using the line transect method. The results indicate that Artocarpus heterophyllus exhibited the highest dominance value and contributed substantially to carbon storage, with a total vegetation carbon stock of 2,341.78 kg. Geotagging successfully visualized stand distribution from seedling to mature tree stages, reflecting the dynamics of natural regeneration. The groundwater infiltration potential was also found to be relatively high, confirming the area's role as a recharge zone. In addition, twelve bird species were recorded, with a Shannon-Wiener diversity index (H' = 2.36), categorized as moderate. These findings underscore the strategic role of the Kehati Campus Forest as a conservation space, carbon sink, water regulator, and biodiversity habitat within the university environment.*

## 1. INTRODUCTION

Vegetation monitoring plays a crucial role in forest management and biodiversity conservation. This monitoring provides long-term data that can describe the dynamics of growth, distribution, and ecological functions of vegetation. The concept of long-term ecological monitoring is essential for detecting changes in vegetation structure and ecosystems over time. By enabling the identification of ecological changes, long-term monitoring supports the adaptive adjustment of conservation strategies. This approach is vital in managing ecosystems sustainably and maintaining environmental stability in the long run. In the context of the Kehati Campus Forest at Universitas Islam Negeri Maulana Malik Ibrahim Malang, vegetation monitoring plays an important role in generating long-term data that describes the dynamics of growth, distribution, and ecological functions of vegetation. This monitoring is not only intended to observe changes in vegetation conditions over time but also to serve as a basis for identifying factors influencing ecosystem stability. By doing so, the results of the monitoring can serve as a primary reference for developing adaptive management strategies. This ensures that the campus forest continues to function optimally as an active green space, an ecosystem buffer, and a natural laboratory for ecological education for both students and the surrounding community. Therefore, vegetation monitoring is essential for illustrating growth dynamics, distribution, and ecological functions, which are key components of ecosystem management and conservation [1]. Long-term observations enable the identification of ecological changes and the adjustment of conservation strategies in an adaptive manner [2].

The monitoring was carried out using an integrated research approach involving various ecological aspects. These activities included the estimation of carbon stock to determine vegetation carbon storage potential, geotagging to spatially map plant distribution, measurement of groundwater absorption potential, and bird diversity surveys. Estimating carbon stock in vegetation is important to assess storage potential and the ecosystem's contribution to climate change mitigation [3]. Allometric methods with carbon calculation coefficients have been widely applied to calculate vegetation carbon stock accurately [4]. Geotagging and spatial mapping facilitate early detection of vegetation changes and deforestation for conservation action [5]. Measuring groundwater absorption potential by vegetation demonstrates the essential role of forests in the local hydrological cycle, contributing to water regulation in surrounding areas [6]. Bird diversity surveys, as ecological indicators, are relevant for evaluating habitat quality and ecological functions of forest areas [7].

The Kehati Campus Forest of UIN Maulana Malik Ibrahim Malang itself holds strategic value, particularly after the implementation of the "Thousand Trees Planting Program," supported by PT British American Tobacco (BAT) Malang. This program not only increased vegetation cover but also strengthened the ecological functions of the area as a carbon sink, water regulator, and habitat for local biodiversity. The tree planting program supported by BAT Malang enhanced vegetation cover, which positively impacted carbon storage, water regulation, and biodiversity habitat improvement. Tree planting also contributed significantly to ecosystem services and environmental buffering on campus.

Although the Kehati Campus Forest of Universitas Islam Negeri Maulana Malik Ibrahim Malang has experienced an increase in vegetation cover through tree-planting programs, there is still a lack of comprehensive and continuous monitoring data to evaluate the current condition of the ecosystem. This creates an information gap regarding vegetation growth dynamics, the success rate of planting efforts, and potential changes in biodiversity due to environmental pressures and human activities around the area. Without measurable and well-documented data, potential declines in ecosystem quality such as reduced function as a carbon sink, water regulator, and wildlife habitat are difficult to detect at an early stage. Therefore, this research is important to provide a scientific basis for more adaptive and sustainable management of the Kehati Campus Forest.

## 2. MATERIALS AND METHODS

### Vegetation Analysis and Carbon Stock Estimation

The vegetation analysis method began with the establishment of nested plots: 20 × 20 meters for the tree phase, 10 × 10 meters for the pole phase, 5 × 5 meters for the sapling phase, and 2 × 2 meters for the seedling phase. Based on the total area of 6 hectares, the number of plots used was 15, since 10% of the total area was observed **[8]**. Vegetation was identified through morphological characteristics. The data were then analyzed by calculating density, frequency, dominance, and the importance value index (INP). According to Indriyanto (2024) **[8],** The formulas for density, frequency, dominance, and INP used is:

Density (K):

$$K = \frac{\text{Number of individuals of a species}}{\text{Area of the plot (ha)}}$$

Relative Density (KR):

$$KR = \frac{\text{Density of a species}}{\text{Total density off all species}} \times 100\%$$

Frequency (F):

$$F = \frac{\text{Number of plots in which the species occurs}}{\text{Total number of plots}}$$

Relative Frequency (FR):

$$FR = \frac{\text{Frequency of a specie}}{\text{Total frequency of all species}} \times 100\%$$

Dominance (D):

$$D = \frac{\text{Basal area of a species}}{\text{Area of the plot (ha)}}$$

Relative Dominance (DR):

$$DR = \frac{\text{Dominance of a species}}{\text{Total dominance of all species}} \times 100\%$$

Importance Value Index (INP):

$$INP = KR + FR + DR$$

Vegetation analysis was then followed by carbon sequestration estimation. The formula used is as follows **[9]**:

Biomass:

$0{,}5 \times p \times D^2 \times H$

Carbon Stock:

Biomass x 0,5

In the biomass formula, wood density (ρ) was derived from the Global Wood Density Database, which provides wood density values for plant species worldwide

### Water Infiltration

Water absorption potential was analyzed using quadrat plots measuring 20 × 20 m, where trees were measured for diameter at breast height (DBH) and height to calculate the Importance Value Index (IVI), based on density, frequency, and relative dominance. While we expected plants with higher IVI values to contribute more to water infiltration due to their greater biomass, the relationship between IVI and water absorption was not directly confirmed in our study. Further research is needed to explore this connection, considering factors such as root depth and species-specific water absorption capabilities. Dominance results were analyzed to project species roles in the hydrological cycle of the area **[10]**;**[11]**.

### Geotagging

This study applied a field survey method with a focus on recording tree coordinate points using geotagging techniques. A total of 15 plots measuring 20 × 20 m were placed across three observation blocks, each consisting of five plots. Plot locations were determined using stratified random sampling, and the central coordinates of each plot were recorded using GPS with the WGS84 datum system **[12]**.

The tools used in this study included handheld GPS devices for recording tree coordinates, smartphones with geotagging applications for spatial documentation, diameter tapes for tree measurements, and cameras for geotag photo documentation. In addition, Geographic Information System (GIS) software such as QGIS was used for processing and analyzing spatial data.

Each tree with a trunk diameter ≥ 5 cm was measured and identified by species. Tree positions were recorded using handheld GPS or geotagging applications, with photographic documentation to link species with coordinate points **[13]**. The coordinate data were then processed with QGIS software. Spatial analysis was performed through overlay with plot boundaries and by using the nearest neighbor analysis method to evaluate tree distribution patterns **[14.**

Figure 1. Avocado Area

Figure 2. Jackfruit Area

Figure 3. Longan Area

**Bird Diversity**

This study used an exploratory approach with the line transect observation technique. Four observation transects were established with specific lengths and distances, each surveyed twice in the morning between 06:00–09:00 local time, which is the peak activity period for birds **[15]**. Data collection was conducted through direct observation, supported by cameras for documentation. Transect points were determined with the help of GPS, while bird species identification was based on morphology and vocalizations using Indonesian bird field guides **[16]**.

The data were analyzed using the Shannon-Wiener diversity index (H'), calculated with the formula: $H' = -\sum(p_i \ln p_i)$ **[17]**. Interpretation of H' values followed the categories of low, medium, and high diversity **[18]**, and the results were presented in tables and graphs.

## 3. RESULTS

**Geotagging**

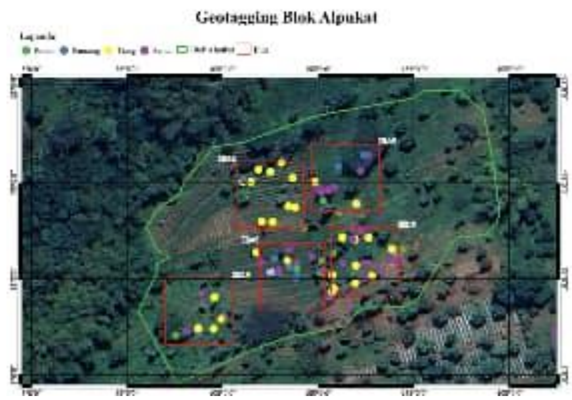


Figure 4. Geotagging Map of Plants in the Avocado Area

The geotagging map of the Avocado Area illustrates the distribution of trees, poles, saplings, and seedlings located in the Kehati Campus Forest of UIN Maulana Malik Ibrahim Malang. In this map, trees are marked with green dots, saplings with blue dots, poles with yellow dots, and seedlings with purple dots. The Avocado Block boundary is shown with a green line, while the research area is divided into five plots (Plots 1–5), each marked with red boxes.


Figure 5. Geotagging Map of Plants in the Jackfruit Area

The geotagging map of the Jackfruit Area represents the distribution of trees, poles, saplings, and seedlings within the Kehati Campus Forest of UIN Maulana Malik Ibrahim Malang. Green dots indicate trees, blue dots indicate saplings, yellow dots indicate poles, and purple dots indicate seedlings. The block boundary is outlined in red, featuring six observation plots (Plots 6–10) marked with red boxes; these sample plots were selected using a random sampling method

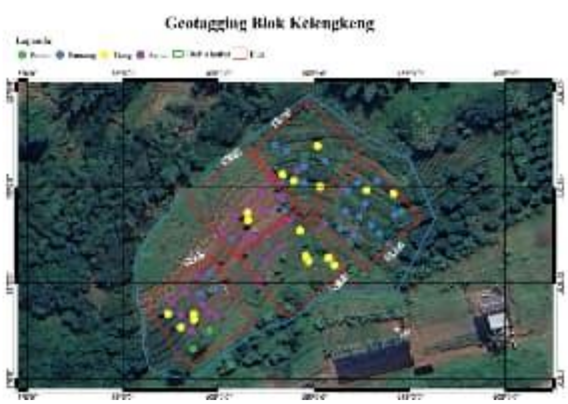


Figure 6. Geotagging Map of Plants in the Longan Area

The geotagging map of the Longan Area shows the distribution of trees, poles, saplings, and seedlings in the Kehati Campus Forest of UIN Maulana Malik Ibrahim Malang. Trees are represented with green dots, saplings with blue dots, poles with yellow dots, and seedlings with purple dots. The block boundary is outlined in red, featuring six observation plots (Plots 11–15) marked with red boxes these sample plots were selected using a random sampling method.

**Vegetation Analysis and Carbon Stock Estimation**

Table 3.1. Observation Results of Trees, Poles, Sapling and Seedling

| No | Spesies Name | Number of Individual |
|---|---|---|
| 1. | *Tectona grandis* | 14 |
| 2. | *Dimocarpus longan* | 68 |
| 3. | *Artocarpus heterophyllus* | 121 |
| 4. | *Albizia chinensis* | 1 |
| 5. | *Ochroma pyramidale* | 1 |
| 6. | *Ceiba pentandra* | 2 |
| 7. | *Senna multijuga* | 3 |
| 8. | *Syzygium aqueum* | 5 |
| 9. | *Mangifera indica* | 20 |
| 10. | *Persea americana* | 21 |
| 11. | *Annona muricata* | 3 |

The vegetation analysis identified six tree species in the research area: *Tectona grandis* (teak), *Dimocarpus longan* (longan), *Artocarpus heterophyllus* (jackfruit), *Albizia chinensis* (sengon), *Ochroma pyramidale* (balsa), and *Ceiba pentandra* (kapok). Among these, *Artocarpus heterophyllus* recorded the highest number of individuals, totaling 121. Conversely, *Albizia chinensis* and *Ochroma pyramidale* were represented by only one individual each.

Table 3.2. Importance Value Index (IVI) Calculation for Tree Stage

| No. | Spesies Name | RD (%) | RF (%) | RDo (%) | IVI (%) |
|---|---|---|---|---|---|
| 1. | *Tectona grandis* | 4,34 | 16,66 | 2,35 | 23,37 |
| 2. | *Dimocarpus longan* | 10,87 | 16,66 | 5,83 | 33,37 |
| 3. | *Artocarpus heterophyllus* | 76,08 | 41,66 | 43,41 | 16,17 |
| 4. | *Albizia chinensis* | 2,17 | 8,33 | 5,68 | 16,19 |
| 5. | *Ochroma* | 2, | 8, | 6, | 16, |

| | | | | | |
|---|---|---|---|---|---|
| | *pyramidale* | 17 | 33 | 17 | 68 |
| 6. | *Ceiba pentandra* | 4, 34 | 8, 33 | 36,52 | 49, 21 |

The phytoplankton species and quantities Analysis in the Welang River, Gunung Baung, at three observation stations (ST 1, ST 2, and ST 3) showed a diverse composition of three main classes: Chlorophyceae (green algae), Cyanophyceae (blue-green algae), and Chrysophyceae (golden algae/diatoms). These phytoplankton communities serve as important indicators of water quality and river ecosystem productivity.

The Chlorophyceae class is represented by four species: *Closterium striolatum*, *Scenedesmus dimorphus*, *Stigeoclonium* sp, and *Spirogyra ionia*. The total abundance of this class tends to be dominant at Station 3, followed by Station 2, and is lowest at Station 1. *Closterium striolatum* was not found at ST 1 (-) but had a similar number of cells (63 cells/L) at ST 2 and ST 3. The genus Closterium is known as a freshwater indicator [22], often found in clear waters [23], although tolerant to different organic levels [24] *Scenedesmus dimorphus* was found at ST 1 and ST 3 in equal numbers (126 cells/L), and was not detected at ST 2 (-). Scenedesmus is a common genus and is often abundant in nutrient-rich (eutrophicated) waters. *Stigeoclonium* sp had the highest abundance at ST 1 (189 cells/L), followed by ST 3 (126 cells/L), and was not found at ST 2 (-).

Table 1. Structure of Phytoplankton

| No. | Species | Cell Unit | | |
|---|---|---|---|---|
| | | ST 1 | ST 2 | ST 3 |
| | Chlorophyceae | | | |
| 1 | *Closterium striolatum* | - | 63 | 63 |
| 2 | *Scenedesmus dimorphus* | 126 | - | 126 |
| 3 | *Stigeoclonium* sp. | 189 | - | 126 |
| 4 | *Spirogyra ionia* | - | 189 | 252 |
| | Cyanophyceae | | | |
| 5 | *Chroococcus* sp. | 126 | - | 189 |
| 6 | *Merismopedia convoluta* | 63 | 126 | - |
| 7 | *Oscillatoria* sp. | 189 | 189 | 126 |
| | Crysophyceae | | | |
| 8 | *Navicula* sp. | - | 126 | - |
| 9 | *Neidium* sp. | 126 | - | - |
| 10 | *Surirella robusta* | - | - | 189 |
| 11 | *Pleurosigma* sp. | 126 | 189 | - |

Analysis of the tree phase showed that *Artocarpus heterophyllus* had the highest Importance Value Index (IVI) at 161.17, supported by a relative density (RD) of 76.08%, relative frequency (RF) of 41.66%, and relative dominance (RDo) of 43.41%.

Based on the vegetation analysis for the tree phase, *Albizia chinensis* recorded the lowest Importance Value Index (IVI) of 16.9, which resulted from a relative density of 2.17% and a relative frequency of 8.33%. Despite its low frequency, the species maintained a relative dominance of 5.8%, suggesting that the few individuals present possess relatively large stem diameters that contribute to the overall basal area.

Table 3.3. Importance Value Index (IVI) Calculation for Pole Stage

| **No.** | **Spesies Name** | **RD (%)** | **RF (%)** | **RDo (%)** | **IVI (%)** |
|---|---|---|---|---|---|
| 1. | *Tectona grandis* | 10, 63 | 16, 66 | 10, 21 | 37, 52 |
| 2. | *Dimocarpus longan* | 28, 72 | 37,5 | 30, 53 | 96, 76 |
| 3. | *Artocarpus heterophyllus* | 57, 44 | 37,5 | 56, 53 | 151,48 |
| 4. | *Syzygium aqueum* | 1, 06 | 4,16 | 0,67 | 5,91 |
| 5. | *Senna multijuga* | 2, 12 | 4,16 | 2,02 | 8,32 |

In the pole phase, *Artocarpus heterophyllus* again showed the highest IVI value at 151.48, influenced by a relative density of 57.44%, relative frequency of 37.5%, and relative dominance of 56.53%. The lowest IVI in this phase was recorded for *Syzygium aqueum* (water apple), at 5.91, with low relative density (1.06%), frequency (4.16%), and dominance (0.67%).

Table 3.4. Importance Value Index (IVI) Calculation for Sapling Stage

| No. | Nama Spesies | RD (%) | RF (%) | IVI (%) |
|---|---|---|---|---|
| 1. | *Persea americana* | 5,26 | 5,88 | 11, 14 |
| 2. | *Tectona grandis* | 5,26 | 11,76 | 17, 02 |
| 3. | *Dimocarpus longan* | 52,63 | 29,41 | 82, 04 |
| 4. | *Artocarpus heterophyllus* | 13,15 | 23,52 | 36, 68 |
| 5. | *Mangifera indica* | 2,63 | 5,88 | 8,51 |
| 6. | *Syzygium aqueum* | 10,52 | 11,76 | 22, 29 |
| 7. | *Annona muricata* | 7,89 | 5,88 | 13, 77 |
| 8. | *Senna multijuga* | 2,63 | 5,88 | 8,51 |

In the sapling phase, *Dimocarpus longan* recorded the highest IVI value at 82.04, supported by a relative density of 52.63% and relative frequency of 29.41%. The lowest IVI values in this phase were found for *Mangifera indica* (mango) and *Senna multijuga*, each with a score of 8.51, derived from low density (2.63%) and frequency (5.88%).

Table 3.5. Importance Value Index (IVI) Calculation for Seedling Stage Table 3.5. Importance Value Index (IVI) Calculation for Seedling Stage

| No. | Nama Spesies | RD (%) | RF (%) | IVI (%) |
|---|---|---|---|---|
| 1. | Persea americana | 23,45 | 25 | 48, 45 |
| 2. | Dimocarpus longan | 19,75 | 31,25 | 51 |
| 3. | Artocarpus heterophyllus | 33,33 | 25 | 58, 33 |
| 4. | Mangifera indica | 23,45 | 18,75 | 42, 20 |

Table 3.6. Biomass Potential and Carbon Stock

| No | Species Name | Biomassa (Kg) | Carbon Reserves (Kg) |
|---|---|---|---|
| 1. | *Tectona grandis* | 636,12 | 318,06 |
| 2. | *Dimocarpus longan* | 1939,16 | 969,58 |
| 3. | *Artocarpus heterophyllus* | 4683,56 | 2341,78 |
| 4. | *Albizia chinensis* | 588,86 | 279,43 |
| 5. | *Ochroma pyramidale* | 256,46 | 128,23 |
| 6. | *Ceiba pentandra* | 2833,22 | 1416,61 |
| 7. | *Senna multijuga* | 65,09 | 32,54 |
| 8. | *Syzygium aqueum* | 11,49 | 5,74 |

The biomass potential and carbon stock data in Table 3.6 were calculated based on vegetation at the tree and pole growth stages. The highest biomass value was recorded in *Artocarpus heterophyllus* at 4683.56 kg, with a carbon stock of 2341.78 kg. Conversely, the lowest biomass value was found in *Syzygium aqueum*, at 11.49 kg, with a carbon stock of 5.74 kg

**Bird Diversity**

Table 3.7. Results of Bird Observation

| No | Species | Replicate 1 | | | | Replicate 2 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Track 1 | Track 2 | Track 3 | Track 4 | Track 1 | Track 2 | Track 3 | Track 4 |
| 1 | *Cacomantis sepulcralis* | 3 | 1 | 0 | 1 | 3 | 2 | 3 | 2 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2 | *Cacomantis merulinus* | 1 | 0 | 1 | 3 | 2 | 0 | 0 | 4 |
| 3 | *Lonchura punctulata* | 3 | 0 | 0 | 2 | 10 | 3 | 0 | 6 |
| 4 | *Pycnonotus goiavier* | 4 | 2 | 0 | 3 | 4 | 2 | 4 | 6 |
| 5 | *Geopelia striata* | 2 | 1 | 5 | 2 | 3 | 2 | 0 | 2 |
| 6 | *Pycnonotus aurigaster* | 2 | 7 | 1 | 10 | 5 | 6 | 6 | 4 |
| 7 | *Apus nipalensis* | 5 | 0 | 0 | 4 | 0 | 0 | 4 | 5 |
| 8 | *Streptopelia chinensis* | 6 | 3 | 2 | 0 | 4 | 2 | 2 | 2 |
| 9 | Passer montanus | 8 | 0 | 0 | 7 | 6 | 0 | 8 | 6 |
| 10 | *Lonchura leucogastroides* | 6 | 0 | 0 | 9 | 5 | 0 | 0 | 8 |
| 11 | *Turnix suscitator* | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 4 |
| 12 | *Lalage nigra* | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 4 |

Based on the observations conducted in the Kehati Campus Forest of UIN Maulana Malik Ibrahim Malang (Campus III), a number of bird species with varying abundances were recorded. The data show that several species, such as *Pycnonotus goiavier* (yellow-vented bulbul), *Lonchura punctulata* (scaly-breasted munia), and *Cacomantis sepulcralis* (rusty-breasted cuckoo), dominated the bird community with relatively high numbers of individuals.

Table 3.8. Diversity Index Table

| **No** | **Species** | **n** | **Pi (ni/N)** | **LnPi** | **Pi.Ln Pi** |
|---|---|---|---|---|---|
| 1 | *Cacomantis sepulcralis* | 15 | 0,06 | -2,81 | -0,17 |
| 2 | *Cacomantis merulinus* | 11 | 0,04 | -3,12 | -0,14 |
| 3 | *Lonchura punctulata* | 24 | 0,10 | -2,34 | -0,23 |
| 4 | *Pycnonotus goiavier* | 25 | 0,10 | -2,30 | -0,23 |
| 5 | *Geopelia striata* | 17 | 0,07 | -2,68 | -0,18 |
| 6 | *Pycnonotus aurigaster* | 41 | 0,16 | -1,80 | -0,30 |
| 7 | *Apus nipalensis* | 18 | 0,07 | -2,63 | -0,19 |
| 8 | *Streptopelia chinensis* | 21 | 0,08 | -2,47 | -0,21 |
| 9 | *Passer montanus* | 35 | 0,14 | -1,96 | -0,28 |
| 10 | *Lonchura leucogastroides* | 28 | 0,11 | -2,19 | -0,25 |
| 11 | *Turnix suscitator* | 7 | 0,03 | -3,57 | -0,10 |
| 12 | *Lalage nigra* | 7 | 0,03 | -3,57 | -0,10 |
| | Total | 249 | | | H'= 2,36 |

Based on the observations, a total of 12 bird species with 249 individuals were recorded. The Shannon-Wiener diversity index (H') obtained was 2.36. Dominance was observed in species such as *Pycnonotus aurigaster* (sooty-headed bulbul, 41 individuals), *Passer montanus* (Eurasian tree sparrow, 35 individuals), and *Lonchura leucogastroides* (white-bellied munia, 28 individuals).

## 4. Discussion

The vegetation distribution in each plot demonstrates varied stand structure compositions, ranging from the early regeneration stage (seedlings) to mature trees. The distribution patterns indicate that some plots are dominated by poles and seedlings, suggesting good regeneration potential, while other plots exhibit a more even tree distribution. This geotagging map facilitates structural vegetation analysis and supports ecosystem management using spatial data **[19]**.

The distribution patterns show variations in stand structure, where some plots are dominated by poles and trees, while others display higher concentrations of seedlings and saplings. This reflects the multilayered dynamics of natural vegetation regeneration. The presence of a significant number of trees in several plots also suggests relatively stable ecosystem conditions. This map is important for analyzing structural vegetation diversity and provides a scientific basis for sustainable conservation and management of the Jackfruit Block **[20]**.

Spatially the vegetation distribution reveals heterogeneous stand structures, with higher concentrations of saplings and poles in most plots, indicating continuous regeneration processes. Some plots also show abundant seedlings, which can be an indicator of the habitat's natural productivity. The limited distribution of trees suggests later stages of growth that are still in recovery. These geotagging results are expected to support ecological studies, conservation, and sustainable management strategies for the Longan Block **[21]**.

The vegetation analysis identified six tree species in the research area: *Tectona grandis* (teak), *Dimocarpus longan* (longan), *Artocarpus heterophyllus* (jackfruit), *Albizia chinensis* (sengon), *Ochroma pyramidale* (balsa), and *Ceiba pentandra* (kapok). Among these, *Artocarpus heterophyllus* recorded the highest number of individuals, totaling 121. This species is often found in large numbers in agroforestry systems and tropical forests due to its adaptability to diverse environmental conditions **[22]**. Conversely, *Albizia chinensis* and *Ochroma pyramidale* were represented by only one individual each, suggesting their very limited distribution and relatively minor contribution to the tree community in the study area. Competition among tree species for resources such as light, water, and root space likely restricts the abundance of some species, allowing only certain ones to dominate. Natural and anthropogenic disturbances also contribute to limiting species distribution across certain plots **[23]**.

Analysis of the tree phase showed that *Artocarpus heterophyllus* had the highest Importance Value Index (IVI) at 161.17, supported by a relative density (RD) of 76.08%, relative frequency (RF) of 41.66%, and relative dominance (RDo) of 43.41%. This indicates that jackfruit plays a dominant role in the studied vegetation community. According to De Freitas et al. (2017) **[24]**, high dominance and frequency of jackfruit populations are signs of strength and stability within the community, as reflected by its high IVI value, which not only represents individual abundance but also wide distribution and large stem sizes contributing significantly to stand structure.

Based on the vegetation analysis for the tree phase, *Albizia chinensis* recorded the lowest Importance Value Index (IVI) of 16.9, which resulted from a relative density of 2.17% and a relative frequency of 8.33%. These figures indicate that the species is characterized by individual rarity and a restricted spatial distribution within the study area. Despite its low frequency, the species maintained a relative dominance of 5.8%, suggesting that the few individuals present possess relatively large stem diameters that contribute to the overall basal area. Ultimately, this low IVI reflects the species' limited adaptability to the local environment and lower competitiveness for resources, positioning A. chinensis as a subordinate member of the vegetation community with minimal influence on the overall stand structure. **[25]**.

In the pole phase, *Artocarpus heterophyllus* again showed the highest IVI value at 151.48, influenced by a relative density of 57.44%, relative frequency of 37.5%, and relative dominance of 56.53%. This demonstrates the species' dominance not only in terms of individual numbers but also in distribution and structural contribution. According to Asigbaase et al. (2019) **[26]**, high IVI values indicate ecological dominance and substantial contribution to forest stand structure. The lowest IVI in this phase was recorded for *Syzygium aqueum* (water apple), at 5.91, with low relative density (1.06%), frequency (4.16%), and dominance (0.67%). This suggests that *S. aqueum* contributes minimally to the vegetation community, likely due to competitive pressure from more dominant species and limited adaptability at this growth stage **[27]**.

In the sapling phase, *Dimocarpus longan* recorded the highest IVI value at 82.04, supported by a relative density of 52.63% and relative frequency of 29.41%. This demonstrates the dominant role of longan within the community. According to Juliarti et al. (2022) **[28]**, *D. longan* thrives due to its strong root system and tree structure, enabling it to adapt well to its habitat. The lowest IVI values in this phase were found for *Mangifera indica* (mango) and *Senna multijuga*, each with a score of 8.51, derived from low density (2.63%) and frequency (5.88%). These results indicate their limited presence and minor role in the vegetation community **[29]**.

In the seedling phase, *Artocarpus heterophyllus* recorded the highest IVI value at 58.33, supported by a relative density of 33.33% and relative frequency of 25%. This indicates the species' dominant role in early regeneration stages. According to Samsoedin & Heriyanto (2010) **[30]**, jackfruit contributes significantly to community structure in early forest regeneration, demonstrating its ability to persist and grow well at this stage, thereby ensuring population continuity. The lowest IVI was found in *Mangifera indica*, with a value of 42.20, attributed to lower relative density (23.45%) and frequency (18.75%). This reflects mango's limited role in the community, likely influenced by light availability constraints, which may hinder growth and cause stagnation during sapling and pole phases **[31]**.

The biomass potential and carbon stock data in Table 3.6 were calculated based on vegetation at the tree and pole growth stages. The highest biomass value was recorded in *Artocarpus heterophyllus* at 4683.56 kg, with a carbon stock of 2341.78 kg. This is related to the species' large diameter (30.87 cm) and height (8 m). According to Isah et al. (2025) **[32]**, high biomass is associated with tree size, crown structure, and wood density, all of which allow substantial carbon storage. The larger the basal area, the greater the carbon storage potential **[33]**. Conversely, the lowest biomass value was found in *Syzygium aqueum*, at 11.49 kg, with a carbon stock of 5.74 kg. This is due to its small individual size (10.82 cm in diameter and 3 m in height) and lower wood density compared to other species **[34]**.

The species Pycnonotus goiavier, Lonchura punctulata, and Cacomantis sepulcralis are native birds of Java commonly found in various types of habitats. These species can be found in primary forests, agroforestry areas, and agricultural lands **[35]**. The high abundance of these bird species is related to the availability of food sources, stratified vegetation structure, and suitable habitat conditions surrounding the forest area **[36]**.

Meanwhile, there were also species recorded with low numbers of individuals. The presence of species with limited abundance may reflect certain ecological traits, such as habitat specialization or high mobility, which makes them rarely detected during observations **[37]**. Nevertheless, the presence of species with varying abundances indicates that the Kehati Campus Forest still supports a bird community with a fairly good level of diversity. This finding aligns with the function of the campus forest as a biodiversity conservation area and an ecological buffer for the local ecosystem.

From an ecological perspective, the dominance of certain species with relatively high abundance indicates a tendency for uneven distribution. However, the presence of many other species, even with low abundance, still contributes to the stability of the bird community **[38]**. Birds are also recognized as important bioindicators for assessing ecosystem quality. The diversity that remains in this area indicates that environmental conditions are relatively good and capable of providing the basic needs of wildlife **[38]**.

Based on the observations, a total of 12 bird species with 249 individuals were recorded. The Shannon-Wiener diversity index (H') obtained was 2.36. According to the criteria described by Krebs (1989) **[18]**, H' values in the range of $1 \leq H' \leq 3$ are categorized as medium diversity, while $H' < 1$ indicates low diversity, and $H' > 3$ indicates high diversity. Therefore, the calculation results show that the bird diversity in this area falls within the medium category.

Dominance was observed in species such as *Pycnonotus aurigaster* (sooty-headed bulbul, 41 individuals), *Passer montanus* (Eurasian tree sparrow, 35 individuals), and *Lonchura leucogastroides* (white-bellied munia, 28 individuals). This dominance indicates that these species have higher adaptability to the environmental conditions around the campus, particularly in mosaic habitats consisting of natural vegetation, shrubs, and open spaces. Conversely, species with relatively low numbers of individuals, such as *Turnix suscitator* (barred buttonquail) and *Lalage nigra* (pied triller), with only seven individuals each, reflect their rarity or dependence on more specific habitats.

Environmental factors such as food availability, vegetation structure, and the level of anthropogenic disturbance play an important role in shaping bird diversity patterns **[37]**. For example, seed-eating species such as *Lonchura punctulata* and *Geopelia striata* indicate sufficient availability of seed resources, while insectivorous species such as *Cacomantis sepulcralis* demonstrate the stability of the food chain in the area. The presence of various guilds (granivores, insectivores, and frugivores) indicates that the Kehati Campus Forest has significant ecological value in supporting bird life with diverse ecological strategies.

Ecologically, this moderate level of biodiversity indicates that the Kehati Forest area functions as a habitat that supports biodiversity on campus. However, pressure from human activities remains a factor that needs to be considered. Efforts to conserve natural vegetation, increase tree planting that supports frugivorous birds, and reduce anthropogenic disturbances are essential to maintain and increase bird diversity in the area **[39]**.

## 5. Conclusion

Based on the research findings, the Kehati Campus Forest of the State Islamic University of Maulana Malik Ibrahim Malang serves significant ecological functions, particularly as a carbon sink and a supporter of biodiversity. Vegetation structure analysis revealed that *Artocarpus heterophyllus* is the dominant species with the highest Importance Value Index (IVI). This species makes a substantial contribution to biomass accumulation and carbon storage, thereby playing a vital role in local climate change mitigation. Meanwhile, species with lower IVI values, such as *Syzygium aqueum* and *Ochroma pyramidale*, although limited in distribution and competitiveness, still contribute to maintaining ecosystem stability.

Vegetation mapping using geotagging demonstrated the spatial distribution across various growth strata, ranging from seedlings to mature trees, within three observation blocks. These findings indicate layered and continuous natural regeneration, which serves as an indicator of ecosystem sustainability. Furthermore, the presence of established vegetation supports the area's function as a catchment zone, contributing to the maintenance of hydrological conditions within the campus environment.

Avifaunal observations recorded 12 bird species with a total of 249 individuals. The

Shannon-Wiener diversity index ($H' = 2.36$) indicates a moderate level of diversity. The dominance of adaptive species, such as *Pycnonotus aurigaster* and *Passer montanus*, reflects a favorable habitat carrying capacity, although anthropogenic pressures remain a factor of concern. The variation in guild composition highlights the ecosystem's role in sustaining the availability of food resources and habitat space.

Overall, this study emphasizes the importance of the Kehati Campus Forest as a conservation area, an ecological buffer, and an environmental education site. Therefore, adaptive and sustainable management strategies are required to ensure the preservation of the forest and to maximize its ecological, scientific, and social benefits for both the academic community and the surrounding society.

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