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Critical Land Conservation to Save Biodiversity, Case Study: Organic Forest, Megamendung, Bogor, Indonesia

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Abstract. The Muara Karang steam power plant is one of the power plants in Indonesia which is managed by PT PLN Nusantara Power as a state-owned company. In carrying out its business, it has potential impacts on the environment, one of which is on biodiversity. The aim of this research is to analyze the potential of biodiversity resources by conserving critical land in the Organic Forest, Megamendung, Bogor, Indonesia. The method used is a natural forest model scenario including organic farming, reforestation, and sustainable organic farming in a natural rehabilitation process. Rehabilitation is carried out using an agroforestry system, intercropping between forestry and agricultural crops, and fertilization using manure. This planting was carried out by the community as a form of empowerment which succeeded in creating jobs as farmers and participating in managing the forest. As a start, 3,000 tree seeds and intercrops such as edamame, corn, cassava, and taro have been planted. The results of this research in monitoring in 2022, the proportion of tree habitat increased from 40% to 54%, the diversity index (H') of birds increased from 2.17 to 3.22, H' of mammals from 1.76 to 2.05, H' of herpetofauna from 2.08 to 2.82, and H' of arthropods from 3.73 to 3.87.

Keywords. critical land, conservation, agroforestry, biodiversity

1. Introduction

Currently, the world is experiencing a climate change disaster. The impacts of climate change can already be felt such as changes in weather, increased temperatures, extreme natural disasters, and theloss of some biodiversity. It is affected by human activities. To ensure that the environment can stillsupport human interests, environmentally friendly development is needed by involving all people towork together in implementing a living culture that emphasizes environmental sustainability.

Not only human activities, but natural and environmental conditions are also factors that are closely related to the provision of energy sources, both as a source of raw materials and supporting operational activities. Muara Karang Combined Cycle Power Plant which is located in the northern bay area of Jakarta is also affected by this condition. In 2013, the power plant stopped its operational activities due to flooding that submerged the area. The flood phenomenon occurs due to conditions of land cover or use, slopes, water systems, and abnormal land critical levels. This condition causes rainfall to flow downstream and exceed the capacity

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of the river. This makes the company realizes that saving ecosystems and biodiversity must be done immediately.

Forest and Land Rehabilitation according to the Law of the Republic of Indonesia Number 41 of1999 [1], is intended to restore, maintain and improve forest and land functions so that their carrying capacity, productivity, and role in supporting living systems are maintained. One of the activities is tree planting. Planting trees in the upstream area which is the water catchment area is one form of flood disaster mitigation in the downstream area. Forest rehabilitation will restore the role of forests in maintaining water supplies, providing soil protection in a watershed, and minimizing the effects of floods and landslides.

The Puncak area, which is located in Bogor Regency, plays an important role in many areas underit. The entire Puncak area in Bogor Regency is upstream of 4 large watersheds, namely Ciliwung, Cisadane, Kali Bekasi, and Citarum [2]. Ciliwung watershed is one of the largest watersheds flowing through DKI Jakarta. Based on the toposequence, the Ciliwung watershed is divided into three parts,namely upstream, middle and downstream. The Ciliwung Hulu watershed area functions as a bufferzone for the watershed area, if there is a change in the watershed components it will affect all parts of the watershed [3]. Changes in land use with urban development are certainly unavoidable, the impact has significantly increased the frequency and intensity of floods [4].

This study discusses one approach to the conservation of critical land that can be used and the results of the activities. The focus of this study is the changes that have occurred based on the biodiversity index on critical land in the Megamendung Organic Forest area, Bogor since the beginning of the rehabilitation activities in 2019 until 2022, both in terms of flora and fauna diversity. This study gives benefits not only for academics but also for similar business activities, government agencies, or other institutions in efforts to rehabilitate critical land and similar business activities. In the academic field, there is an opportunity to conduct further research in the concept of conservation of critical land, not limited to agroforestry but can develop into the concept of agro- edu-forestry. Government agencies or other institutions can duplicate the rehabilitation model with an agroforestry approach in other areas with similar characteristics. This study shows that to ensure the sustainability of a business, especially a power plant, it is not only limited to the environment adjacent to the business or on the downstream side but must be carried out comprehensively from upstream to downstream.

2. Methodology

The location of the Organic Forest research is in Megamendung Village, Bogor Regency, West JavaProvince. The total planting area is 2 ha. The map of the research location can be seen in Figure 1.

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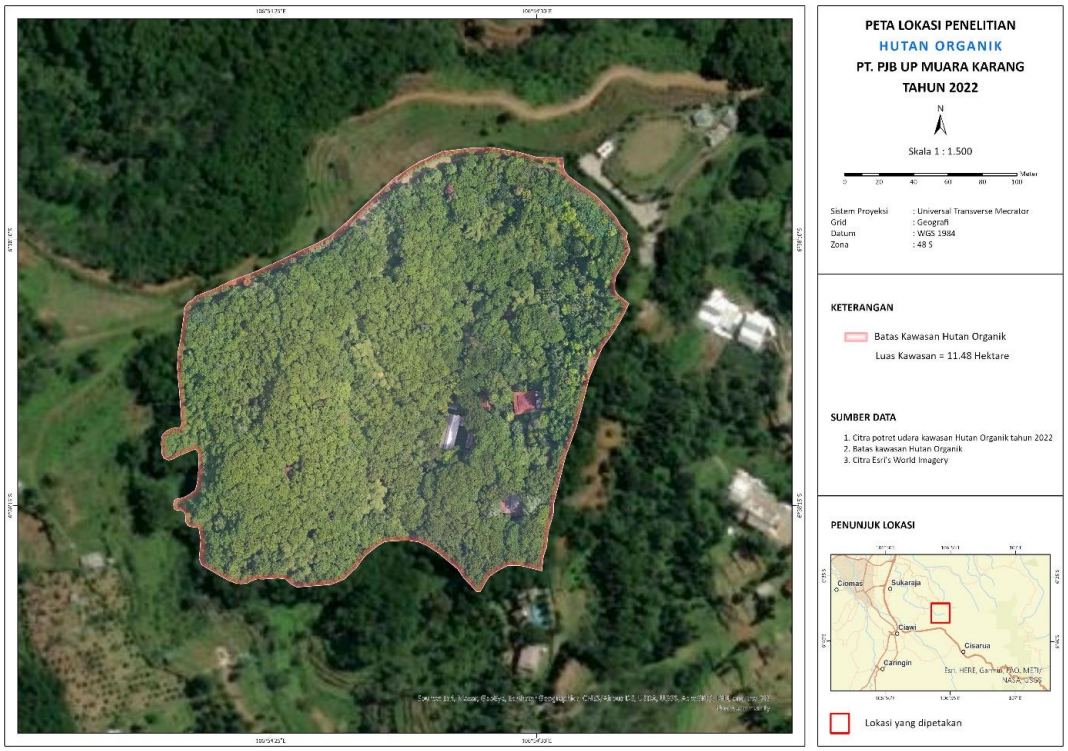

Figure 1. Map of Research Locations for Organic Forest Areas

2.1 Data Collection

Monitoring the diversity of flora and fauna is carried out to determine the dynamics that occur in Organic Forests every year. The monitoring data used are the results of monitoring for the period 2019 – 2022. Details of the types of monitoring data and methods of data collection can be seen in Table 1.

Table 1. Types and Methods of Data Collection

No	Aspect	Parameters and Variabels	Method	Source
1.	Land survey andland capability	Characteristic of soil	Semi-detailed mapping survey at1:50,000 scale, delineated land map units, and land map unit classification	Primary and secondary data
2.	Area mapping	Area typology studies,spatial analysis, and aerial portrait images	*Desktop study, field verification,and spatial data processing*	Primary data

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3.	Area potential	- Diversity of flora	- Explore - Vegetation analysis - Non-destructive and censussampling methods - Direct measurement of growthcharacteristics (height, diameter, percent life, vitality)	Primary data
		Diversity of fauna - Mammals - Bird - Herpetofauna - Arthropod	- *Rapid Assessment* & *Lifetrapping* - *Point transect* & MacKinnon - VES method - Line transect method	

2.2 Data Processing

2.2.1 Diversity of Flora

To determine the value of plant diversity, several parameters were used, including species richness calculated using the Margalef Wealth Index and species diversity using the Shannon-Wiener Diversity Index, with the formula:

- Indicies of Species Richness (R)

$$R = \frac{(s-1)}{\ln(N)}$$

Note
R = Indicies of Species RichnessS = Species per habitat
N = Individu per habitat

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A value of R < 3.5 indicates a low species richness, a value of 3.5 < R < 5.0 indicates a moderatespecies richness, and R > 5.0 indicates a high species richness [5]

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- Indicies of Diversity

$$H' = -\sum_i \left(\frac{n_i}{N}\right) \ln \left(\frac{n_i}{N}\right)$$

Note:
H’ = Shannon Indicies of Diversity
n_i = Importance value indices per habitat
N = Total of importance value indicies

If the value of H' < 2 then the value of species diversity is in the low category, if the value of 2 < H' < 3 then it is in the medium category, and if the value of H' > 3 then the value is classified as high [5].

Table 2. Shannon – Wiener Diversity Index Value Classification

Index value Shannon-Wiener	Category
> 3	High diversity, high distribution of the number of individuals per species, and high community stability
1 – 3	Moderate diversity, moderate distribution of the number of individuals per species and moderate community stability
< 1	Low diversity, low distribution of the number of individuals per species, and low community stability

3. Result and Discussion

Initially, the Organic Forest area was included in the critical land category [7]. Arid land conditions with a soil pH between 2,5 – 4, lack of macroorganisms and trees (70% of the land is not overgrown with trees), and with a slope between 15^0 - 80^0 make the land very vulnerable to erosion and land damage the topographicalal condition of the Organic Forest area is hilly with an altitude of 700-800 meters above sea level. The results of the analysis using satellite imagery in the study area, it is known that the slope in this area ranges from 41% - 60% where based on the classification of the slope class is included in the steep to very steep class [8]. Slope and slope length are the two topographic properties that most influence surface flow and erosion. Erosion will get bigger with steeper slopes [9].

The planting area in the Organic Forest consists of two blocks of land that have an area of about ± 1 ha each with a sloping contour area. The span of the two areas is formed by terraced land that extends parallel to the contour where the width of the planting field ranges from 1–3 m and there are 1–2 lanes of tree planting. Based on monitoring in 2022, block 1 planting found that grass is quite high covering this area, some of which are groups of Elephant Grass species that are used as areas for sheep feed cultivation. Meanwhile, in block 2, the condition of the area is covered by grass but not as high as in block 1. Grass in the field is usually harvested periodically as goat feed.

The increase in the area of land cover in organic forests greatly affects the forest’s functional system. With the increase in land cover, it can be interpreted as a preventive measure

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against forest destruction and degradation [10]. The land cover change also contributes to total GHG emissions [11], due to the increase in carbon stock which affects GHG absorption [12].

3.1 Land Survey and Land Capability

Surveys and land mapping in the Organic Forest area were carried out on a semi-detailed mapping survey on a scale of 1: 50.000 with determining factors for slope, type of land use, and type of soil. The determination of the point of observation must represent an area that is considered homogeneous in a single expanse. In this study, the number of field check points was 3 observation points by taking samples at a depth of 0-100 cm which was then composted at each observation point.

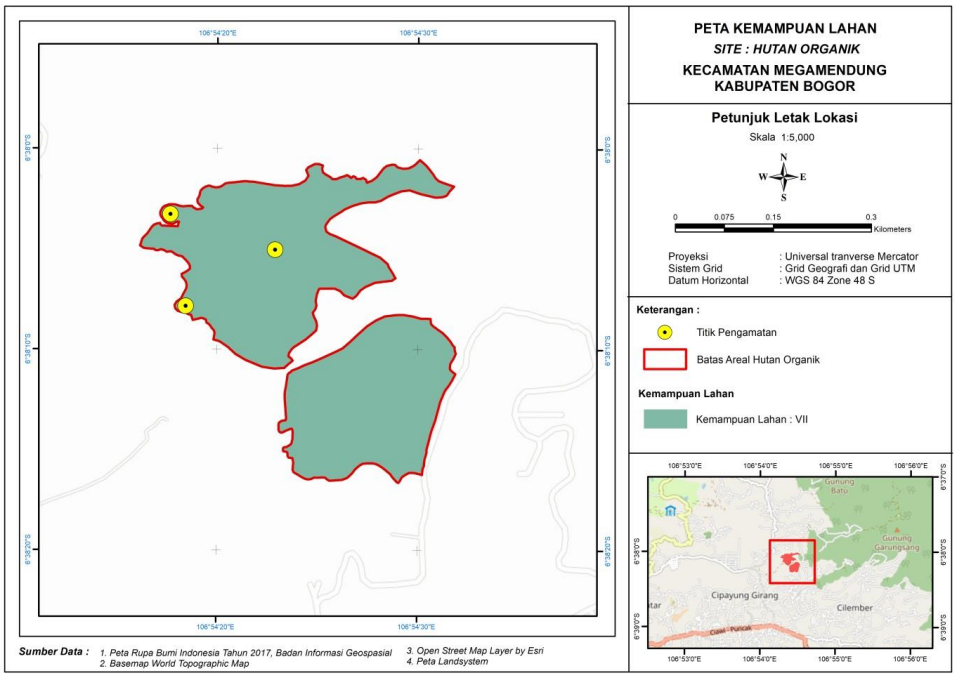

Figure 2. Slope Map of Organic Forest Area

Soil texture is a relative ratio between the fractions of sand, dust, and clay. Soil texture classification according to USDA, sand fraction measuring 2 mm – 0.05 mm, dust fraction measuring 0.05 mm – 0.002 mm, and clay fraction <0.002 mm [13]. Soil texture can be assessed qualitatively and quantitatively. Qualitative methods are commonly used by soil surveyors in establishing soil texture classes in the field. Quantitative determination of the texture of a soil sample is carried out through a mechanical analysis process carried out in the laboratory. The results of laboratory analysis of 3 soil fractions are further classified according to the classification of the Soil Research Center using the texture triangle of the USDA system [14] and the results were obtained that the soil in the Organic Forest area is dominated by the texture class of clay clay.

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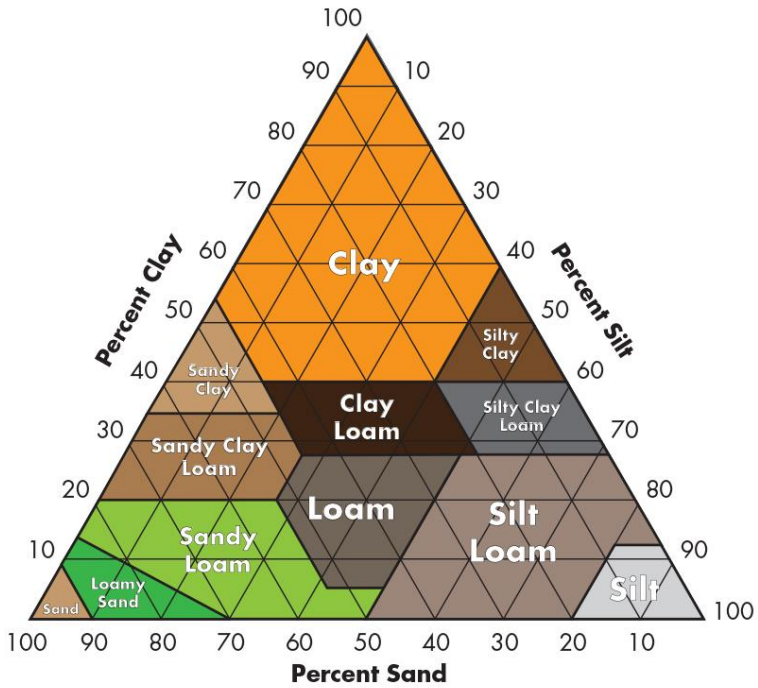

Figure 3. USDA Soil Texture Triangle [15]

The results of the analysis include slope data, soil physicochemical properties data, and land capabilityevaluation in the period 2021 and 2022, as follows:

Table 3. Soil Physic-Chemical Parameters 2021 [16]

Observation Code	Soil Texture Grade and Class (%)				pH Value and Soil Class		Soil Class based on C/N Ratio	
	Sand	Ash	Clay	Class	pH H_2	Class	C/N Ratio	Class
HO-1	15	24	61	Dusty clay	5,24	Acid	12	Moderate
HO-2	26	26	48	Sandy clay	5,38	Acid	10	Moderate
HO-3	25	30	45	Dusty clas	5,26	Acid	11	Moderate

Table 4. Soil Physic-Chemical Parameters 2022 [17]

Observation Code	Soil Texture Grade and Class (%)				pH Value and Soil Class		Soil Class based on C/N Ratio	
	Sand	Ash	Clay	Class	pH H_2	Class	C/N Ratio	Class
HO-1	20	29	51	Loam	5,37	Acid	14	Moderate
HO-2	24	17	59	Clay loam	5,44	Acid	14	Moderate

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HO-3	18	22	60	Clay loam	5,21	Acid	13	Moderate

Based on the measurement results, the soil structure in the organic forest area is an angular lump with a rough size (20-50 mm) and a moderate developmental level. This shows that the soil structure in organic forests is relatively good due to the formation of soil aggregates. The application of organic matter, plant remains, and planting trees with wide canopies can form soil aggregates to be more stable and protect them from rainwater that can damage soil aggregates. The more stable a soil aggregate is, the lower the sensitivity to erosion (soil erodibility) [18]. Compared with the results of testing soil characteristics between 2021 and 2022, planting results in the Organic Forest area can improve soil structure. Soils with a steady aggregate structure can be a good place for plant growth as they provide good pore space for roots and good infiltration. This can affect the availability of water for plants and the soil is not easily flooded.

The land capability in the Megamendung Organic Forest area is included in the land capability class VII, where the recommendation for land use is limited to nature reserves, forests, and limited grazing. The most influential limiting factors in Organic Forest areas are slope and climate because these two factors are natural and difficult to overcome. With these limitations,an appropriate rehabilitation method is needed so that the application of land use can run optimally. Soils belonging to the category of class VII lands that have deep soil solum and are not sensitive to erosion if used for agricultural crops should be made bench terraces supported by vegetative means for soil conservation other than fertilization. The degree of effectiveness of soil conservation depends on the carrying capacity of the land (site-specific, soil properties, type, and climate).

PT PLN Nusantara Power UP Muara Karang understands very well that a certain approach is needed in carrying out critical land rehabilitation activities in Organic Forests. The involvement of the surrounding community to have the same role is very much needed to support the success of this activity.Therefore, the agroforestry approach is the most appropriate because, in the agroforestry system, there are interactions between components both ecologically and economically. Ecologically, agroforestry functions as a life support system that can control erosion, provide oxygen, spring water, and a source of biodiversity. In addition, economically, agroforestry can improve people's welfare because it produces various food sources derived from crops and MPTs (multipurpose tree species). The high variety of products that can be produced by agroforestry land is expected to change the mindset of people who view forests only as wood producers so that the existence of forests can be maintained [19].

Agroforestry that integrates tree crops (annual) and shrubs with other businesses (seasonal crops, livestock, or fish) in one field can create additional sources of income, spread labor use throughout the year and increase the productivity of other businesses, and can also protect soil, water, and wildlife [20].The sustainability of the land use system depends on the flexibility of the land use in a changing environment. The existence of a high diversity of resources at the farm level will support the flexibilityof land use [21]. Thus, agroforestry is a land use system that supports sustainable agriculture, because, in addition to having a real and diverse production contribution, it also functions conservatively on the environment and social conditions, thereby ensuring a wider economy and higher food security [22].

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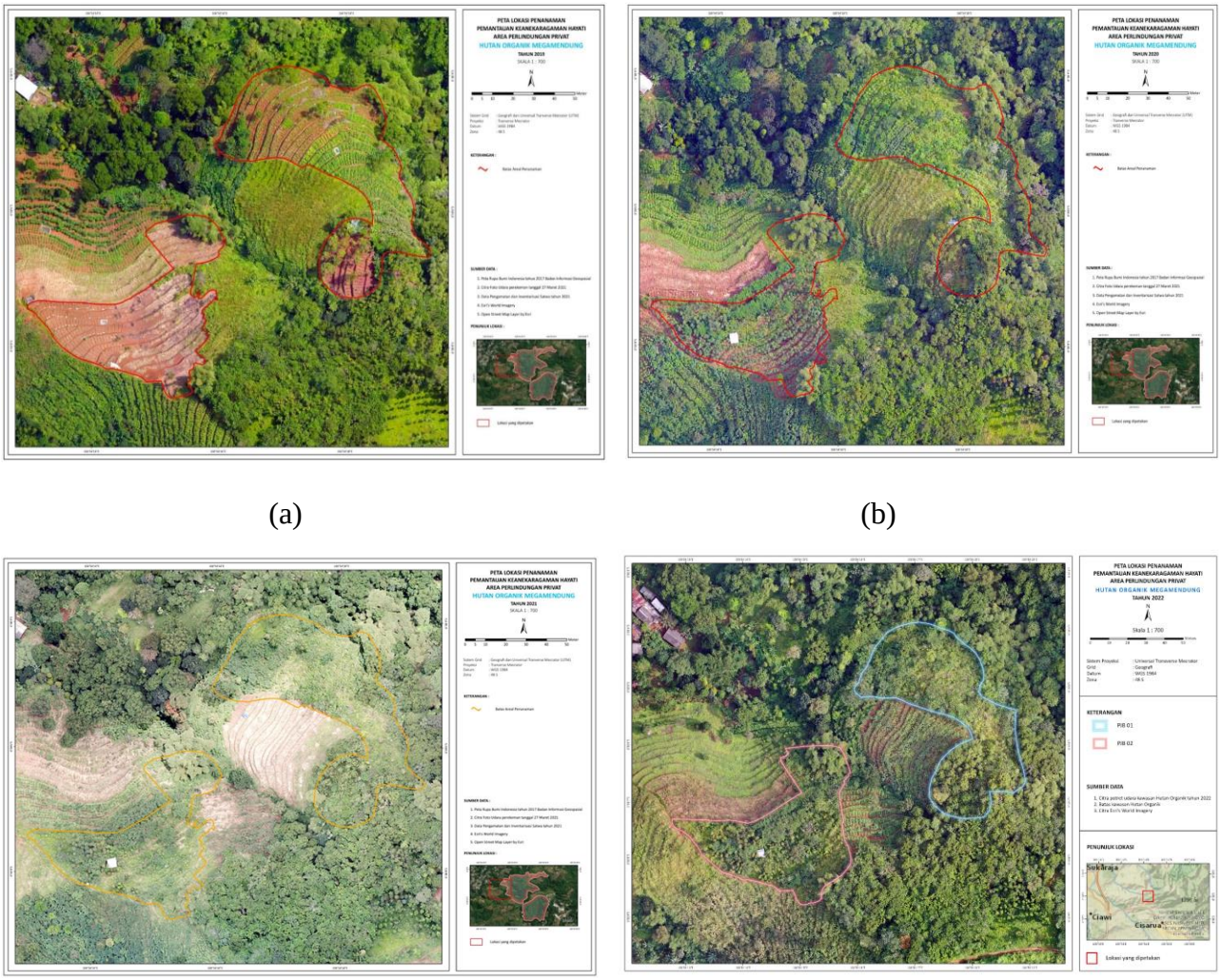
3.2 Land Cover

Based on the results of monitoring during the 2019-2022 period, there are changes in land cover in the conservation area. The following is a map of planting block land cover from 2019 to 2022 presented in the following images.



(a) (b)

(c) (d)

Figure 3. Land Cover Map (a) Year 2019 ; (b) Year 2020 ; (c) Year 2021 ; (d) Year 2022

3.3 Diversity of Flora

The richness of plant species can be known by conducting a detailed observation survey on the entire area to be studied. If the study area is relatively narrow, it is possible to conduct a thorough census observation of all areas or cover of the study land. If the study area is too large and includes various types of ecosystems and land cover, then observations can be made at points that are considered to have the highest diversity or activities are carried out gradually and continuously.

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The implementation of plant observations is carried out by following the cruising path that has been determined on the survey plan map, especially in areas that are the main points of observation. Data collection of plant species is carried out by identifying directly in the field by observing and recording morphology and then be documented.

The development of the Organic Forest area during the period 2019 – 2022 shows that the rehabilitationof critical land using the agroforestry method has increased land productivity. The potential for successcan be seen in several areas that have become forests, both in terms of composition, structure, microclimate, and protection function. Based on the results of the monitoring inventory in 2022, there were 129 plant species belonging to 53 families. Planted vegetation in Organic Forests is very varied with an increase in tree habitus of 69 species (54% of the total area). The Megamendung Organic Forestplanting block is dominated by African Timber trees (*Maesopsis eminii*), which were found to be 770 trees. Other habitus found in this area are shrubs of 12 types (9.4% of the total area), grasses of 8 types (6.3% of the total area), spikes of 5 types (3.9% of the total area), 4 types of shrubs (3.1% of the total area), 3 types of palms (2.3% of the total area), 2 types of shrubs (1.6% of the total area), and bamboo 1 type (0.8% of the total area).

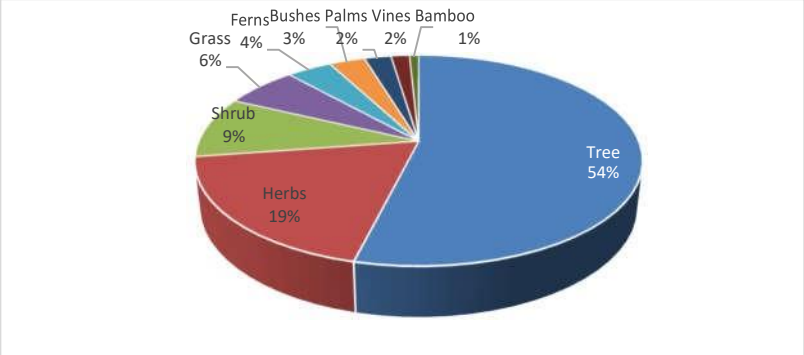

Figure 4. Habitus Proportion

The success of the agroforestry system in this area is related to the combination of forestry plant species, plantation crops, and agricultural crops that grow in this area. With the presence of agriculturalplants around forestry plants, forestry plants will be well maintained. With the selection of the right types of agricultural crops, the results of land productivity will increase, and land maintenance will alsobe more intensive. The application of agroforestry is very helpful for the success of the rehabilitation program in the form of maintenance of woody plants (rehabilitation plants) is greatly helped by the presence of agricultural plants because by caring for agricultural plants, rehabilitation plants are also maintained and their water and nutritional needs are met; maintenance costs can be reduced by using organic fertilizers derived from goat manure produced from farms in agroforestry locations; land productivity increases and farmers' welfare increases, crop yields are in the form of carrots, kapulagi, coffee, ginger, turmeric, tomatoes, chilies, mustard greens, chives, vetiver; and forest sustainability is maintained because the mindset of "forest as a wood producer" shifts to the forest as a source of food so that people will take better care of the forest.

In the future, Organic Forests will be aimed at becoming a unit of complex ecosystems towards Sustainable Forests with a combination of staple plants and plants that grow naturally. The concept of Sustainable Forest aims to ensure the sustainability of the ecological function of forests and ensure the socioeconomic function of culture for local communities [23]. The

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main group of trees recorded in the planting program covering an area of ± 2 ha consists of 47 types, a very diverse number of types within the scope of an area. This diversity shows that the Organic Forest not only holds planting but also pays attention to the diversity of types planted. The diversity of this species is of course very instrumental in the conservation of diversity. Species diversity is a very useful vegetation parameter to know the state of succession or stability of the community. The more stable the state of the community generally has a high diversity of plant species [24].

Tree planting in the Organic Forest area is planted on a terraced ridge parallel to the contour in the hope that the tree root system will be able to strengthen the terraced cliffs, so that they can withstand erosion or landslides. The number of main trees on the land is 2,691 individuals, which is the largest proportion of woody trees within the planting area. This shows good conditions because it means that this main tree can survive and continue to regenerate which of course this planting has a high planting success rate which means that the land already has a land cover that is close to the forest and has a high diversity of species.

In addition, in monitoring the planting of Organic Forests, diameter and height of increment of plants are used to determine the development of their growth. The increment of the plants is defined as the increase in the volume of a tree or erect per certain unit of time [25]. The increment of the plants can also be used to express the increase in stand value or the increase in the diameter or height of a tree every year [26]. In the Organic Forest planting area, The increment of the plant calculations are devoted to the dominant species only and only in the class of seedlings and stakes because the types used are quite diverse and some types have only a few individuals. Based on the calculation of the average diameter, the types that have the best growth speed are Gmelina, African Wood, and Petai with successive values of 2.56 cm, 2.34 cm, and 2.27 cm. As for the average high increment of the plants, the types that have the best high addition speed are Salam, Gmelina ,and Eucalypts with a successive increment values of 1.56 m, 1.44 m, and 1.41 m.

3.4 Diversity of Fauna

Type or species is the basis of organizational units in ecology and as an evolutionary unit that can be measured easily in the field. Species are important for ecological evaluation and evolutionary patterns and have processes that are generally considered the most suitable units for the purposes of natural area management and conservation [27]. Species richness is the simplest measure of biodiversity because it only takes into account the difference in the number of species in a particular area. Species richness is denoted in the equation as S. Species richness has been known to be the best substitute for other, more complicated biodiversity measures for direct measurement. In addition, species richness also has a positive relationship with various sizes. The diversity index is a mathematical measure of species diversity in a community. The diversity index provides better information about the composition of the community compared to the richness of modestly calculated species (such as the number of species present) and has taken into account the relative abundance of different species. The diversity index blends species richness and evenness into a single value.

The Organic Forest Area was originally an open and critical land area that was started to be planted by the Organic Forest Foundation in 2001. This habitat is adjacent to a community-owned plantation area in Megamendung District, Bogor Regency with commodities in the form of vegetables and fruits. The forest areas closest to this area are the Telaga Warna Nature

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Reserve Area and the Gunung Gede-Pangrango National Park Area. Habitat types in the Organic Forest area are secondary forests, plantations, open land, and plantation forests.

The results of monitoring in organic forests show a high level of fauna species diversity index (Table 5), where the inventory results for mammal fauna are 11 species, bird fauna 41 species, herpetofauna fauna as many as 23 species, and Arthropoda fauna as many as 66 species. The index of fauna species diversity in the Organic Forest area is H'=2.0522. The evenness index value (E) of mammal species in Organic Forest E= 0.8913 tends to increase and is close to 1. This indicates that the symptom of dominance by one particular mammal species does not occur (not significant) in the Organic Forest area.

3.4.1 Mammals

The presence of mammals in an area is important because of its role in ecosystem sustainability. The role of mammals includes soil fertilisers, flower pollinators, seed harvesters, and biological pest control [28]. Mammals are animals that are sensitive to environmental changes. Based on the results of the inventory, there are at least 10 types of mammals in this area including coconut squirrel (Callosciurus notatus), kekes squirrel (Tupaia javanica), codot krawar (Cynopterus brachyotis), kalong (Pteropus vampyrus), ferret (Paradoxurus hermaphroditus), riul rat (Rattus norvegicus), shrub rat (Rattus tiomanicus), long-tailed monkey (Macaca fascicularis), wild boar (Sus scrofa) and garangan (Herpestes javanicus).

Table 5. Diversity of Mammals in Periode 2019 – 2022 [17]

Parameters	2019	2020	2021	2022
Total of Kinds	8	11	10	11
Number of Individuals	18	20	23	29
Diversity Index (H')	1.76	2.01	1.90	2.05
Evennes Index (E)	0.48 (moderate)	0.67 (moderate)	0.97 (high)	0.89 (high)
Richness Index (R)	2.01 (moderate)	2.67 (high)	1.91 (moderate)	2.67 (high)

3.4.2 Birds

A bird community is a group of individuals of several different types of birds living together in the same time and space [29]. Birds have a variety of functions and important roles in the ecosystem. The ecological function of birds is as seed dispersers and natural pollinators for plants which greatly helps farmers in the cultivation of food crops [30]. The richness of bird species in an ecosystem, related to habitat types and the presence of certain types of plants, will give an idea in assessing and explaining changes in habitat quality [31]. A good habitat will be able to provide various resources needed by various types of birds, both as feed providers, perches or resting places, providers of nesting materials, to become nesting locations. From that function and role, the diversity of birds of an ecosystem can be one of the good bio-indicators to assess the quality of the ecosystem and see the environmental changes that occur. As an effective bio-indicator, birds also have several advantages, such as a high level of species diversity, their presence capable of occupying various types of habitats, easy to find and monitor, and relatively easy to identify up to the species level.

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Based on the results of bird monitoring in 2022 in the Organic Forest area, there were 41 species from 22 families with a total of 140 individuals. This number is relatively high, due to the presence of diverse habitat types, including secondary forests, fields, parks, and lakes. The birds found in the Organic Forest area are dominated by insectivorous bird species characterized by seven species of Cuculidae recorded, including the reed lathe (Centropus bengalensis), the large lathe (Centropus sinensis), the Kadalan birah (Phaenicophaeus curvirostris), the striated Wiwik (Cacomantis sonneratii), the gray Wiwik (Cacomantis merulinus), the jungle Wiwik (Cacomantis variolosus), and the black Kedasi (Surniculus lugubris).

Based on the results of observations, it is known that the analysis of the bird species diversity index found in the Organic Forest area shows that the level of bird species diversity is relatively high. The diversity of bird species is influenced by the diversity of habitat types [32]. The diversity of bird species is influenced by the structure and diversity of vegetation species. In principle, the greater the index value, it shows a community that is increasingly diverse and not dominated by only a few species. The more compound the habitat tends to be the higher the diversity of bird species. Bird species diversity tends to be low in physically controlled ecosystems and tends to be high in biologically regulated ecosystems.

Table 6. Diversity of Birds in Periode 2019 – 2022 [17]

Parameters	2019	2020	2021	2022
Total of Kinds	19	24	38	41
Number of Individuals	40	43	133	140
Diversity Index (H')	2.17	2.69	3.27	3.29
Evennes Index (E)	0.46 (moderate)	0.56 (moderate)	0.89 (moderate)	0.86 (moderate)
Richness Index (R)	7.36 (high)	4.82 (moderate)	7.56 (high)	8.09 (high)

3.4.3 Herpetofauna

Herpetofauna consists of groups of animals from the class of amphibians and reptiles grouped by the ability of the body that requires heat from the environment or belongs to ectothermic vertebrates as well as similar observation and survey methods [33]. Herpetofauna has a role in ecosystems as part of the food chain as well as bioindicators of habitat destruction [34]. In terms of ecology, herpetofauna plays a role in maintaining the balance of ecosystems on the food chain as predators or prey. Herpetofauna has an important role because this species is spread across 5 habitats, namely terrestrial, aquatic, semiaquatic, arboreal, and fossorial so it has a role in the study of ecological links. In addition, the decline in the population of herpetofauna species in their habitat can signal a change in environmental quality at the location or can be an early warning of environmental changes.

Organic Forest Area is a secondary forest that has various types of habitats suitable for herpetofauna such as lakes, streams, and waterholes. The condition of the observation site is a small river flow around which is dominated by dense stands of trees, grass, and shrubs. Based on the results of observations, 23 types of 11 families consisting of 5 families of amphibian class and 6 families of reptile class were found. The most common types of the herpetofauna from the amphibian class are the Javan Percil (Microhyla achatina) of the family Microhylidae

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and the Green Fly-frog (Rhacophorus reinwardtii) of the family Rhacophoridae. In addition, there are 2 types of snakes found in Organic Forests, namely the Mine Snake (Dendrelaphis pictus) from the family Colubridae and the Snail Snake (Pareas carinatus) from the family Pareidae.

The results of the herpetofauna species diversity index analysis in the Organic Forest area show that the herpetofauna species diversity index is relatively moderate. The medium diversity index shows sufficient productivity, moderate ecological pressure as well, and ecosystem conditions are quite balanced. The results of the herpetofauna evenness index in the Organic Forest area are included in the medium to high category.

Table 7. Diversity of Herpetofauna in Periode 2019 – 2022 [17]

Parameters	2019	2020	2021	2022
Total of Kinds	15	12	18	23
Number of Individuals	38	43	105	163
Diversity Index (H')	2.19	1.87	2.57	2.82
Evennes Index (E)	0.90 (moderate)	0.49 (moderate)	0.89 (high)	0.90 (high)
Richness Index (R)	3.08 (low)	2.92 (low)	3.65 (low)	4.36 (moderate)

3.4.4 Arthropoda

Insects are one of the most dominant animal groups on earth, which can be found in soil, water (fresh, brackish and a small part of seawater) as well as air [35]. The role of insects in the ecosystem of a habitat is as herbivores, carnivores, and detrivores in the food web. Insect monitoring in this study focused more on the order Lepidoptera (Moth and Butterfly) and the order Odonata (Dragonfly and Needle Dragonfly).

Based on the findings, insects in the Organic Forest obtained lepidoptera results as many as 52 species belonging to 9 families with a total of 284 individuals, and odonata as many as 14 species belonging to 7 families with a total of 170 individuals. There are many water sources such as springs, swamps, embung and puddles as well as several different vegetation covers, making many types of insects, especially butterflies and dragonflies, can live in the Organic Forest area. Butterflies from the family Nymphalidae are the most common species found in the Organic Forest area, numbering 20 species. The existence of the family Nymphalidae is very much due to the large availability of feed sources in its diverse habitat. Vegetation condition in the Organic Forest area are very diverse providing diverse habitats for insects, one of which is butterflies from the family Nymphalidae. The most common type of dragonfly found in Organic Forests is Agriocnemis rubescens of the family coenagrionidae. This species is mostly found in groups near water sources and can often be seen perched around dry twigs and grass near lakes and shrubs.

Organic Forest is a unique habitat for insects with several clean water sources and diverse vegetation canopy shades so that many types of insects can be found in this location. Physical factors such as temperature, humidity and intensity of sunlight can adversely affect the presence of insects. The high diversity of plant species also supports the presence of insects in the Organic Forest, especially butterflies whose lives are very dependent on the host plant and its feed.

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Table 8. Diversity of Arthropoda in Organic Forests Period 2019 - 2022 [17]

Parameters	2019	2020	2021	2022
Total of Kinds	49	54	59	66
Number of Individuals	8234	10566	23894	133
Diversity Index (H')	3.73	3.79	3.69	3.87
Evennes Index (E)	0.93 (high)	0.97 (high)	0.90 (high)	0.92 (high)
Richness Index (R)	7.27 (high)	7.76 (high)	8.53 (high)	10.62 (high)

From Table 5 – Table 8, it can be seen that there is an increase in the diversity index from 2019 to 2022. The mammal diversity index increased from 1.76 to 2.05, the bird diversity index increased from 2.17 to 3.29, the herpetofauna diversity index increased from 2.19 to 2.82, and the arthropod diversity index increased from 3.73 to 3.87. The index value between 2 – 3 indicates moderate diversity which shows significant productivity, moderate ecological pressure, and balanced ecosystem conditions. The index value > 3 indicates high diversity which shows high productivity and good ecosystem stability.

3.4.5 Animal Protection Status List

Based on the results of monitoring, the types of wild animals found in Organic Forest habitats are quite diverse, ranging from animals typical of residential areas, animals typical of plantations, and animals typical of forested areas. The highest number of individuals living in the Organic Forest area are Herpetofauna (Reptiles and Amphibians). This is affected by the condition of Organic Forest which is a secondary forest with various habitats such as lakes, streams, and water puddles. From the results of monitoring, it is found that there are faunas that are protected according to the IUCN. This is an indication that Organic Forest is the right ecosystem for fauna.

Table 9. Animal Protection Status List 2022 [36]

No	Animal	Latin Name	IUCN	CITES	P.106/2018
		Mammals			
1	Long-tailed Macaque	*Macaca fascicularis*	LC	App II	Unprotected
2	Large Flying-fox	*Pteropus vampyrus*	NT	App II	Unprotected
3	Horsfield's Treeshrew	*Tupaia javanica*	LC	App II	Unprotected
4	Common Palm Civet	*Paradoxurus hermaphroditus*	LC	App III	Unprotected
5	Javan Mongoose	*Herpestes javanicus*	LC	App III	Unprotected
		Bird			
1	Black Eagle	*Ictinaetus malaiensis*	LC	App II	Protected
2	Crested Serpent-eagle	*Spilornis cheela*	LC	App II	Protected

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		Herpetofauna			
1	Reinwardti's Frog	*Rhacophorus reinwardtii*	NT	-	-
		Arthropod			
1	Common Bushbrown	*Mycalesis janardana*	LC	-	Unprotected
2	*Vestalis luctuosa*	*Vestalis luctuosa*	LC	-	Unprotected
3	Tropical Bluetail	*Ischnura senegalensis*	LC	-	Unprotected
4	*Euphaea variegata*	*Euphaea variegata*	LC	-	Unprotected
5	*Coeliccia membranipes*	*Coeliccia membranipes*	LC	-	Unprotected

Information:

- *Threat status based on IUCN Redlist 2018, accessed from [www.iucnredlist.org]*
- *International trade status based on a checklist issued by CITES, accessed from [www.cites.org]*
- *The protection status of Indonesia Government based on Regulation of Ministry of Environment and ForestryNo. P.106/2018*
- *(*) = endemic*

4. Conclusion

This study aims to determine whether critical land conservation measures using agroforestry methods can be used to improve and increase biodiversity on critical land by taking the Bogor Megamendung Organic Forest as a case study. By using the parameters of the biodiversity index based on the results ofmonitoring in the period 2019 – 2022, it can be known the changes that occur in the Organic Forest area.Based on the results of this monitoring, the proportion of tree habitus increased from 40% to 54%, the diversity index (H') of birds increased from 2.17 to 3.22, the H' of mammals increased from 1.76 to 2.05, the H' of herpetofauna increased from 2.08 to 2.82, and the H' of arthropod from 3.73 to 3.87. This shows that the conservation of critical land with the agroforestry method is successful.

This study has benefits such as opening up opportunities for other academics to conduct further research in the concept of conservation of critical land not limited to agroforestry but can develop into the concept of agro-edu-forestry. Another benefit is the duplication of the rehabilitation model with an agroforestry approach in other areas with similar characteristics.

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