PLANT DIVERSITY, STRUCTURE, AND COMPOSITION OF VEGETATION IN KEMAL MULUQ FOREST, LOMBOK ISLAND, INDONESIA

RAHAYU, S. M.[1,2*] – HAKIM, L.[3*] – BATORO, J.[3] – SUKENTI, K.[4]

[1]*Department of Biology, Faculty of Mathematics and Natural Science, Al-Azhar Islamic University, Mataram 83232, Indonesia (e-mail: slamet.mardiyantorahayu84@gmail.com)*

[2]*Doctoral Program in Biology, Faculty of Mathematics and Natural Science, Brawijaya University, Malang 65145, Indonesia (e-mail: slamet.mardiyantorahayu84@gmail.com)*

[3]*Department of Biology, Faculty of Mathematics and Natural Sciences, Brawijaya University, Malang 65145, Indonesia (e-mails: luchman@ub.ac.id; jati_batoro@yahoo.com)*

[4]*Department of Biology, Faculty of Mathematics and Natural Sciences, Mataram University, Mataram 83115, Indonesia (e-mail: kurniasihsukenti@yahoo.com)*

**Corresponding authors*
e-mail: slamet.mardiyantorahayu84@gmail.com; luchman@ub.ac.id

(Received 25th Aug 2023; accepted 30th Oct 2023)

Abstract. Lowland tropical forest needs to be studied for its composition and structure because it has high biodiversity. This forest has experienced a lot of degradation so it is vulnerable to loss of genetic resources. This study aims to analyze plant diversity, structure and composition of vegetation in Kemal Muluq Forest, Lombok Island, Indonesia. The composition of the vegetation in Kemal Muluq Forest consists of 36 families, 58 genera and 62 species. The vegetation structure in Kemal Muluq Forest includes: seedling and understory, sapling, pole, and trees with varying densities. The species with the highest density was *Schleichera oleosa* (Lour.) Oken, followed by *Schoutenia ovata* Korth., and *Streblus asper* Lour. Plants at the seedling and understory levels are included in high diversity. Meanwhile, plants at the sapling, pole, and tree levels have diversity is included in moderate category. Plants at the seedling and understory, sapling, pole, and tree levels have low dominance value. Based on the regression analysis, there is soil temperature and soil pH have a significant influence on the plant diversity index in Kemal Muluq Forest, Lombok Island, Indonesia.
Keywords: *community structure, Shannon–Wiener index, Simpson dominance index, species diversity*

Introduction

Tropical forests cover only 6-7% of the earth's land surface but store two-thirds of terrestrial biodiversity (Lyion-White et al., 2020; Shimamoto et al., 2018). These unique ecosystems are critical for ecosystem services (Lefeuvre, 2022; Nugroho et al., 2022), carbon storage (Almulqu, 2017; Yadav et al., 2022), maintaining local livelihoods and indigenous cultures (Kai et al., 2014), supporting health of people and food security (Asprilla-Perea et al., 2022; Oktavia et al., 2022), and providing recreational opportunities (Newsome and Perera, 2023). Forests also play a role in controlling erosion (Rodrigues et al., 2020), mitigating floods (Asdak, 2023), and mitigating climate change (Duncanson et al., 2023). In the last 20 years, there has been a decrease in forest area on Lombok Island from 156,900 ha (34% of the land area) to 118,365 ha (25.8% of the land area). This shows that there has been land conversion (Kim, 2016), which can lead to decrease in biodiversity.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2203_24392453

Kemal Muluq Forest is a forest with an area of 40 hectares located in Kemal Muluq Hill, Sukadana Village, Pujut District, Central Lombok Regency, West Nusa Tenggara Province, Indonesia. This forest is a lowland tropical forest because it is located at an altitude of < 1000 m above sea level. Liu et al. (2020a) and Tian et al. (2021) stated that vegetation functions as an integral component in soil and atmospheric systems. According to Dubyna et al. (2023) currently the impact of anthropogenic activities on natural vegetation is increasing. Lowland forest needs to be studied for its structure and composition because it has high biodiversity. Lowland forests experience a lot of degradation because they are located close to community settlements so they are vulnerable to loss of genetic resources (Nugraha and Kusmana, 2022). Kemal Muluq Forest is located close to residential areas so it is vulnerable to degradation, illegal logging, land conversion and reduced biodiversity. This is a dilemma in sustainable forest management. Therefore, knowledge of basic ecological information including floristic composition and vegetation structure is needed in the development of sustainable forest management and conservation. Biodiversity measurements provide the basis for developing effective conservation plans. Unfortunately, there is a significant information gap because until now there is no scientific data regarding vegetation in Kemal Muluq Forest. Therefore, this research was conducted with the aim of analyzing plant diversity, structure and composition of vegetation in Kemal Muluq Forest, Lombok Island, Indonesia.

Materials and methods

Study area

This research was conducted on 8-14 November 2022 in Kemal Muluq Forest, Sukadana Village, Pujut District, Central Lombok Regency, West Nusa Tenggara Province, Indonesia (*Fig. 1*) at 08°51’077” - 08°52’153” South and 116° 19’407” - 116° 19’967” East with an altitude of 130-200 meters above sea level. The Central Bureau of Statistics for Central Lombok Regency (2022) stated Pujut is the most expansive district in Central Lombok Regency, has an area 23,355 ha or occupying about 19.33% of the area of Central Lombok Regency. Central Lombok Regency has a tropical climate with a dry summer (The Central Bureau of Statistics for Central Lombok Regency, 2022).

Field survey

Observation of vegetation using a combination of line transect and square plot methods with a total of 27 observation plots. Each plot is 400 m^2 so the total area of the sample plots are 10,800 m^2. Plant species were recorded for each community structure at the sampling location, namely: seedlings and understory (plants at the seedling level and understory up to < 1.5 m height with a sub-plot size of 2×2 m^2), saplings (plants with a height of > 1.5 m to young trees with a stem diameter of < 10 cm with a sub-plot size of 5×5 m^2), poles (plants with a stem diameter of 10-20 cm with a sub-plot size of 10×10 m^2), and trees (plants with a stem diameter of > 20 cm with a sub-plot size of 20×20 m^2) (Kusmana, 2017).

Data analysis

Identification of plants refers to several identification books (Van Steenis, 2008; Setyawati et al., 2015). Scientific name of plant is based on International Plant Names

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2203_24392453

Index (2023). In this study, measurements of abiotic factors were carried out in each sample plot, namely: soil temperature and soil pH. Soil temperature measurements using the ALLA France Soil Thermometer. Soil pH measurements using the Takemura DM-15 Soil Tester. The plant diversity index and dominance index were calculated in this study. The Shannon-Wienner diversity index was utilized for the analysis of plant diversity.

$$H' = - \Sigma \text{ Pi ln Pi} \quad \text{(Eq.1)}$$

where H' = Shannon-Wienner diversity index, Pi = Proportion of the number individuals of a plant species (ni/N), ni = abundance of a plant species, N = total abundance of all plant species. Results of Shannon Wiener diversity index calculation should be categorized below (Odum and Barrett, 2009), there are three levels of biodiversity: high (H' > 3), medium (1 ≤ H' ≤ 3), and low (H' < 1).

Dominance index is analyzed using Simpson's Dominance Index.

$$C = \sum(Pi)^2 \quad \text{(Eq.2)}$$

where C = Simpson dominance index, Pi = Proportion of the number individuals of a plant species (ni/N). According to Odum and Barrett (2009) that the range of Dominance index values (C) is between 0-1. If the Dominance index value (C) is close to 0, it means that there are no dominant species, but if the Dominance index value (C) is close to 1, there are dominant species.

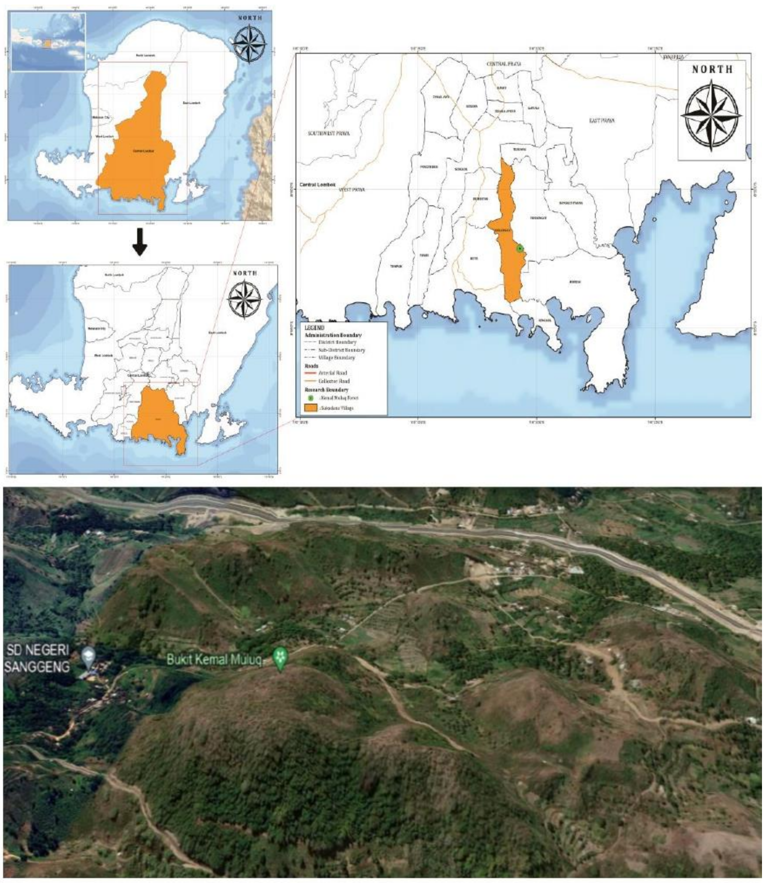

Figure 1. *Map of the study area*

The plants that have been identified are then tabulated including families, vernacular names, and density. The variables of research are categorized into independent and dependent variable. In this research, the independent variables are abiotic factors such as soil pH and soil temperature. The dependent variables are plant diversity index. Influence of independent variable toward dependent variable values is calculated through regression analysis. All of the statistics matters are performed with the assistance of SPSS 26 software.

Results

Based on this research, it can be seen that the vegetation composition in Kemal Muluq Forest consists of 36 families, 58 genera and 62 species, as shown in *Table 1*.

Table 1. *Plant species in Kemal Muluq Forest*

Family	Species	Vernacular name	Conservation status	Density (individual/ha)			
				SU	S	P	T
Acanthaceae	*Ruellia tuberosa* L.	Pengempokan	NE	93			
Amaranthaceae	*Amaranthus spinosus* L.	Lembain dui	NE	278			
Anacardiaceae	*Toxicodendron radicans* (L.) Kuntze	Ogem	LC	93			
Annonaceae	*Asimina triloba* (L.) Dunal	Buah paw-paw	LC	93			
Annonaceae	*Uvaria grandiflora* Roxb. ex Hornem.	Unknown	NE	93	15		
Apocynaceae	*Asclepias curassavica* L.	Kumbang mas, Kapas cinde	NE	93			
Apocynaceae	*Calotropis gigantea* (L.) Dryand.	Rembige	NE	185			
Apocynaceae	*Cynanchum acutum* L.	Pupak	LC	93			
Apocynaceae	*Rauvolfia serpentina* (L.) Benth. ex Kurz	Pule pandak	NE	370			
Araceae	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	Gawok	LC	1759			
Araliaceae	*Hedera colchica* (K. Koch) K. Koch	Unknown	LC	93			
Asteraceae	*Chromolaena odorata* (L.) R. M. King & H.Rob.	Daun pki	NE	5000			
Asteraceae	*Porophyllum ruderale* (Jacq.) Cass.	Pupak	NE	556			
Boraginaceae	*Cordia monoica* Roxb.	Lolon kendal	LC	2870			
Boraginaceae	*Ehretia microphylla* Lam.	Hokianti	NE	93			
Calycanthaceae	*Calycanthus floridus* L.	Unknown	NE	93			
Capparaceae	*Capparis micracantha* DC.	Sene	NE	185			
Caryophyllaceae	*Saponaria officinalis* L.	Kembang sengeh	LC	1389			
Clusiaceae	*Gardenia thunbergia* Thunb.	Bengal trumpet	NE	2870			
Convolvulaceae	*Ipomoea cairica* (L.) Sweet	Ubi kates	LC	1389			
Cornaceae	*Nyssa javanica* (Blume) Wangerin	Lolon Tupelo	NE	2222			
Dioscoreaceae	*Dioscorea alata* L.	Uwi	NE	3796			
Dioscoreaceae	*Dioscorea hispida* Dennst.	Gadung	NE	741			
Ebenaceae	*Diospyros macrophylla* Blume	Ajang	NE	370			
Ericaceae	*Vaccinium varingaefolium* (Bl.) Miq.	Cantigi	NE	278			
Fabaceae	*Abrus precatorius* L.	Saga rambat	NE	3056			

APPLIED ECOLOGY AND ENVIRONMENTAL RESEARCH 22(3):2439-2453.
http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2203_24392453

Fabaceae	*Adenanthera pavonina* L.	Lolon saga	LC	278	44		
Fabaceae	*Amorpha fruticosa* L.	Kembang indigo	NE	185			
Fabaceae	*Crotalaria pallida* Aiton	Orok-orok	NE	556			
Fabaceae	*Senna alata* (L.) Roxb.	Ketepeng cine	LC	278	133		
Fabaceae	*Senna obtusifolia* (L.) H.S.Irwin & Barneby	Ketepeng	LC	185			
Fabaceae	*Styphnolobium japonicum* (L.) Schott	Lolon pagoda	NE	93		4	
Fabaceae	*Tamarindus indica* L.	Bagek	LC	278	59		
Loganiaceae	*Spigelia anthelmia* L.	Kemangi cine	NE	3333			
Lamiaceae	*Lamium galeobdolon* (L.) L.	Malaikat kuning	NE	1389			
Lamiaceae	*Salvia hispanica* L	Pupak	NE	463			
Lauraceae	*Lindera benzoin* (L.) Blume	Merica jamaika liah	LC	185			
Malpighiaceae	*Malpighia coccigera* L.	Kelingkit taiwan	NE	2778			
Malvaceae	*Grewia koordersiana* Burret	Ringe	LC	93			
Malvaceae	*Schoutenia ovata* Korth.	Kukun	NE	7870	859	281	69
Moraceae	*Antiaris toxicaria* Lesch.	Lolon ipuh	LC	93			
Moraceae	*Ficus racemosa* L.	Ara	LC	370			3
Moraceae	*Morus rubra* L.	Murbei Beak, Bluberi gunung	LC	2222	207		
Moraceae	*Streblus asper* Lour.	Perek	LC	6111	593	152	38
Phyllanthaceae	*Antidesma bunius* (L.) Spreng	Bone	LC	93			1
Phyllanthaceae	*Phyllanthus pulcher* Wall. ex Müll.Arg.	Unknown	NE	2870			
Poaceae	*Bambusa vulgaris* Schrad.	Treng aur	NE	93	207		
Poaceae	*Microstegium vimineum* (Trin.) A.Camus	Pupak	NE	93			
Polygonaceae	*Fallopia convolvulus* (L.) A.Love	Pupak	NE	93			
Rhamnaceae	*Ziziphus jujuba* Mill.	Gol cine	LC	93			
Salicaceae	*Flacourtia indica* (Burm.f.) Merr.	Unknown	LC	93	15		
Salicaceae	*Flacourtia jangomas* (Lour.) Raeusch.	Kerukup	NE	648	59	22	
Salicaceae	*Flacourtia rukam* Zoll. & Moritzi	Rukam	NE	93			
Sapindaceae	*Cardiospermum halicacabum* L.	Perie gunung	LC	278			
Sapindaceae	*Dodonaea viscosa* (L.) Jacq.	Kesek	LC	93			
Sapindaceae	*Schleichera oleosa* (Lour.) Oken	Kesambik	LC	8148	933	207	62
Smilacaceae	*Smilax rotundifolia* L.	Unknown	NE	1204			
Taccaceae	*Tacca leontopetaloides* (L.) Kuntze	Taka	LC	2870			
Verbenaceae	*Lantana camara* L.	Tembelekan	NE	4444	193		
Verbenaceae	*Stachytarpheta jamaicensis* (L.) Vahl	Pecut kuda	LC	93			
Vitaceae	*Vitis vinifera* L.	Anggur	LC	93			
Zingiberaceae	*Hedychium coronarium* J.Koenig	Gandasuli	DD	185			
Shannon Wiener Diversity Index (H’)				3.275	1.905	1.206	1.162
H’ Category				H	M	M	M
Simpson Dominance Index (C)				0.052	1.191	0.328	0.336
C Category				L	L	L	L

Density: SU = seedling and understory, S: sapling, P: pole, T: tree
Category: H = high, M = moderate, L = Low
Conservation status: NE = not evaluated, DD = data deficient, LC = least concern

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2203_24392453

Family with the highest number of species in Kemal Muluq Forest is Fabaceae, as shown in *Figure 2*. Michaels (2015) states that Fabaceae is a family consisting of 19,000 plant species and is widely distributed throughout the world. There are 8 species of Fabaceae found in Kemal Muluq Forest, namely: *Abrus precatorius* L., *Adenanthera pavonina* L., *Amorpha fruticosa* L., *Crotalaria pallida* Aiton, *Senna alata* (L.) Roxb., *Senna obtusifolia* (L.) H.S.Irwin & Barneby, *Styphnolobium japonicum* (L.) Schott, and *Tamarindus indica* L.

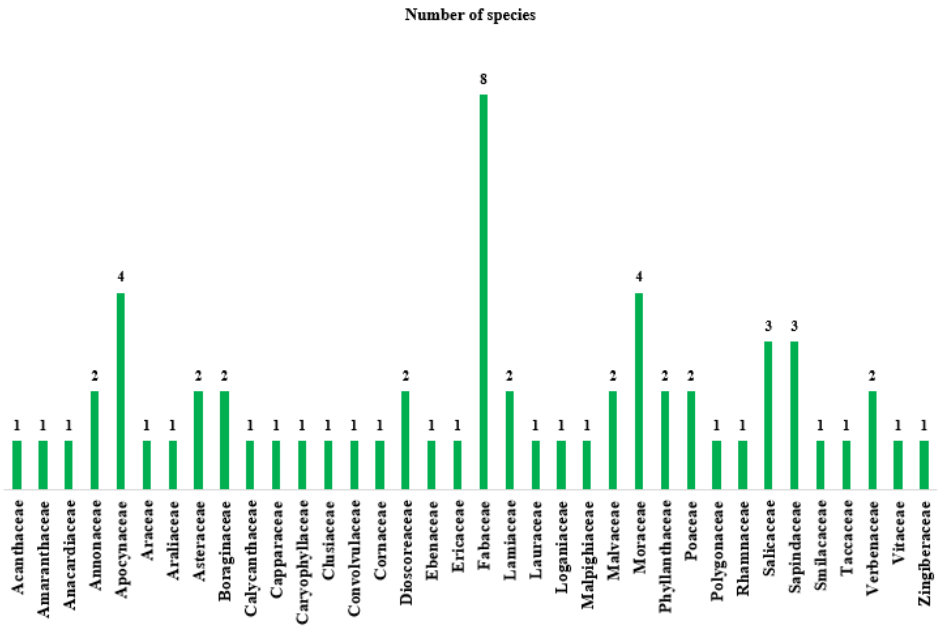

Figure 2. *Number of species of each plant family in Kemal Muluq Forest*

The vegetation structure in Kemal Muluq Forest includes: seedling and understory, sapling, pole, and trees with varying densities. The highest plant density was at the seedling and understory levels, followed by sapling, pole, and tree, as shown in *Figure 3*. Plants in Kemal Muluq Forest were identified as 62 species at the seedling and understory level, 12 species at the sapling level, 5 species at the pole level, and 5 species at the tree level. Not all species can be found at all growth levels. This is thought to be because the Kemal Muluq Forest is no longer natural due to forest disturbance in the form of illegal logging of tress, poles and saplings because the forest location is easily accessible. Based on IUCN Red List (2023), the plants in Kemal Muluq Forest are divided into three categories, namely: Not Evaluated, Data Deficient, and Least Concern, as shown in *Table 1*. There is 1 species identified as Data Deficient, 27 species as Not Evaluated, and 34 species as Least Concern.

Species with the highest percentage density in Kemal Muluq Forest is *Schleichera oleosa* (Lour.) Oken, followed by *Schoutenia ovata* Korth., and *Streblus asper* Lour. The ten plant species with the highest densities can be seen in *Figure 4*. This is in accordance with the results of research by Sutomo and van Etten (2023) that these three species are abundant in dry tropical forests.

Based on research, it is known that soil temperature ranges from 27-30°C and soil pH ranges from 6.4-6.5. It can be said that soil temperature and soil pH at the research site are appropriate for plant growth.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2203_24392453

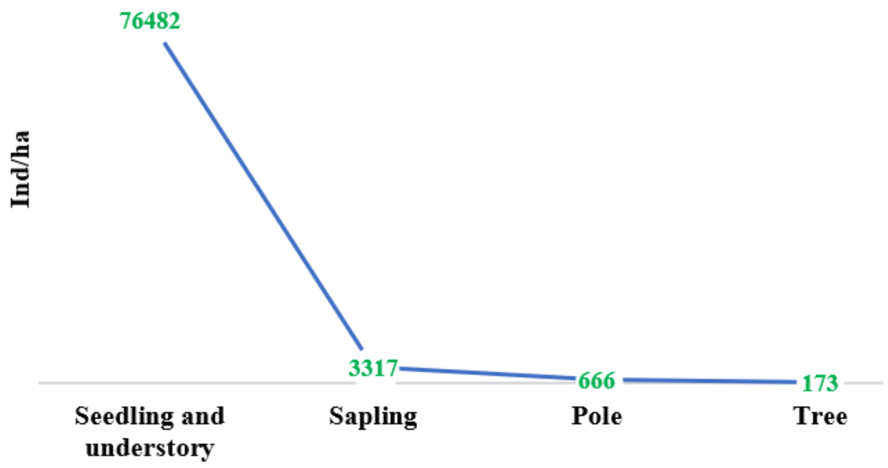

Figure 3. *Plant density of seedling and understory, sapling, pole, and tree in Kemal Muluq Forest*

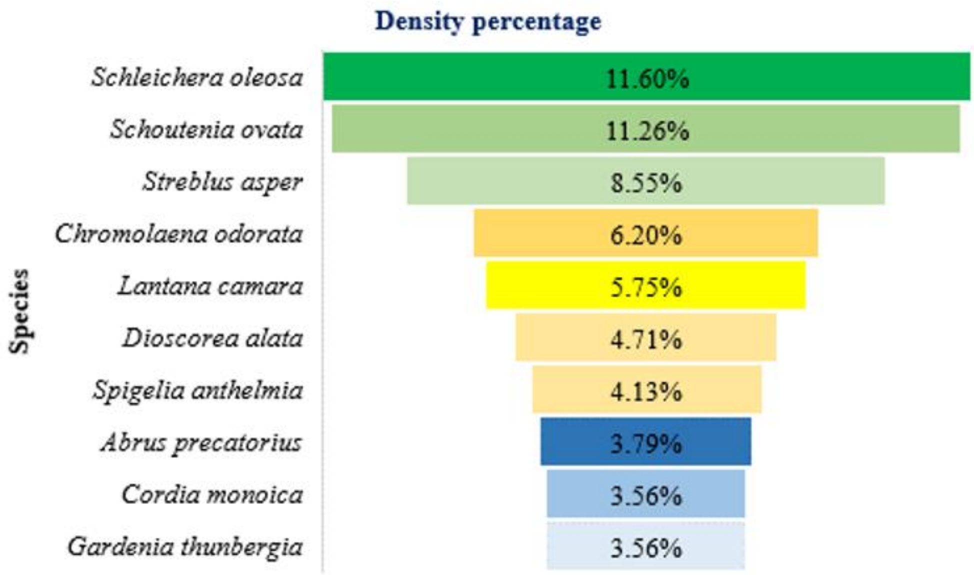

Figure 4. *The ten plant species with the highest densities in Kemal Muluq Forest*

Environmental factors such as soil affect plant diversity (Dong et al., 2019). The test results for the coefficient of determination in testing the influence of soil temperature and soil pH on the plant diversity index (*Table 2*) obtained an R Square value of 0.804, which means that the magnitude of the influence on the plant diversity index can be explained by 80.4% by soil temperature and soil pH, while the rest of the influence is explained by other factors outside the study.

Table 2. *Determination coefficient test result*

Model summary				
Model	**R**	**R square**	**Adjusted R square**	**Std. error of the estimate**
1	0.897[a]	0.804	0.788	0.146929

[a]Predictors: (constant), soil pH, soil temperature

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2203_24392453

The results of the simultaneous effect test in testing the effect of soil temperature and soil pH on the plant diversity index (*Table 3*) obtained an F count of 49.200 and a significance value (p) of 0.000 ($p < 0.05$) so that it was stated that there was a significant influence between soil temperature and soil pH on the plant diversity index, meaning that changes that occur in soil temperature and soil pH will have a significant effect on changes that occur in the plant diversity index. This is in accordance with the statement of Liu et al. (2020b) that soil pH is a limiting factor for plant diversity.

Table 3. *Simultaneous influence test result*

ANOVA[a]						
Model		**Sum of squares**	**df**	**Mean square**	**F**	**Sig.**
1	Regression	2.124	2	1.062	49.200	0.000[b]
	Residual	0.518	24	0.022		
	Total	2.642	26			

[a]Dependent variable: plant diversity index
[b]Predictors: (constant), soil pH, soil temperature

Discussion

Scientific documentation of forest vegetation in an area provides basic information to guide conservation strategies and design policies for biodiversity management regulations (Haq et al., 2023). Floristic diversity is a crucial component of ecosystems (Hua et al., 2022). In this research, 62 plant species were found in the Kemal Muluq Forest. The richness of plant species in this study is in line with research by Lleno et al. (2023) and Moeljono (2020). There are 54 plant species in lowland tropical forests in Prosperidad, Agusan del Sur, Philippines (Lleno et al., 2023). The vegetation in the lowland tropical forest of Samares, Biak Numfor Regency, Papua, Indonesia consists of 29 species (Moeljono et al., 2020). The differences in species richness of each area are caused by differences in topography and soil conditions. Turner (2001) states that these factors influence species richness in lowland tropical forests.

Family with the highest number of species in Kemal Muluq Forest is Fabaceae. The most common Fabaceae family plant found in Kemal Muluq Forest is *Abrus precatorius* L. Gogte (2016) stated that *Abrus precatorius* L. is a vine with many branches. This plant is widespread in the tropics in various habitats such as village bushes and forests (Rashid et al., 2018). This plant has compound leaves and flowers complete with pod-shaped fruit containing 6 seeds (Hassan et al., 2021). The most common Fabaceae species found at the sapling level is *Senna alata* (L.) Roxb. Garvita et al. (2023) stated that *Senna alata* (L.) Roxb. is a shrub or small tree. This plant is widespread in tropical and humid areas (Oladeji et al., 2020). Even though it only has a limited lifespan, this plant can colonize and develop quickly (Legaspi and Maramba-Lazarte, 2020). This is because in each fruit pod, 50-70 seeds will be released (Angelina et al., 2021). These seeds then germinate and grow into new individuals in large numbers.

Vegetation structure in Kemal Muluq Forest includes: seedling and understory, sapling, pole, and trees. *Figure 3* shows that the plant structure in the Kemal Muluq Forest forms an inverted J-curve pattern. This means that Kemal Muluq Forest is in good condition and has good regeneration. Deng et al. (2023) states that understory vegetation contributes most of the diversity of plants. It provides various ecosystem

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2203_24392453

functions and services, such as productivity, nutrient cycling, decomposition of organic matter and regeneration of the ecosystem itself (Deng et al., 2023). The juvenile stage of plant life is represented by seedlings and saplings, and their presence can indicate future forest regeneration.

Three plant species with the highest percentage density in Kemal Muluq Forest is *Schleichera oleosa* (Lour.) Oken, *Schoutenia ovata* Korth., and *Streblus asper* Lour. Karthikeyan et al. (2023) stated *Schleichera oleosa* (Lour.) Oken belongs to Sapindaceae family and is widely distributed in the Himalayas, India, Nepal, and Sri Lanka. This tropical plant is also distributed in the Southeast Asian region (Kundu and Chaturvedi, 2019) and is found in many lowland forests in Indonesia (Yadav et al., 2016). This plant flowers in January-February and bears fruit in March-April. Each fruit contains 1-2 seeds which can then germinate and grow into new individuals. New individuals can also grow from root suckers (adventitious shoots that develop from roots) (Saha et al., 2010). *Schleichera oleosa* (Lour.) Oken has a high photosynthetic rate because it contains a lot of chlorophyll so it plays an important role as an oxygen-producing plant for the surrounding area (Ikkonen et al., 2018; Rahmah and Rahmawati, 2021). *Schoutenia ovata* Korth. has a small tree habitus with distribution in Southeast Asia (Indonesia, Malaysia, Thailand, Cambodia, Vietnam) to Australia. The habitat of this plant is hot lowlands. This plant can grow on less fertile soil and is resistant to shade (Sujarwo and Keim, 2017). This plant is commonly found in lowland forests (Kartawinata et al., 2022). *Streblus asper* Lour. is a small tree in the Moraceae family which is found in many tropical countries (Sivamaruthi et al., 2022) and is native to Southeast Asia (Oraon and Mondal, 2022; Prasansuklab et al., 2018). The round fruit is yellow and contains seeds as a breeding tool. *Schleichera oleosa* (Lour.) Oken, *Schoutenia ovata* Korth., and *Streblus asper* Lour can be found at the seedling, sapling, pole, and tree levels in the Kemal Muluq Forest. This indicates good regeneration in the three species. Therefore, the seedling level can grow into sapling then pole and tree.

Species diversity is used to measure community stability, namely: the ability of a community to maintain itself stable despite disturbances to its components. Or it can be said that the diversity index is used to measure community abundance based on the number of species and the number of individuals of each species in a location. The more the number of species, the more diverse the community. The diversity index is strongly influenced by the number of individuals and the number of species. If the number of species found is more and the number of individuals in each species is evenly distributed, the diversity index will be higher. Based on the analysis of the Shannon-Wiener diversity index, the seedlings and understory plants in Kemal Muluq Forest are included in high diversity (*Table 1*). High diversity values indicate a high level of species distribution and high community stability. The high diversity of plant species helps forests maintain ecological balance. The plants at the sapling, pole and tree levels in Kemal Muluq Forest have a diversity value that is included in moderate category (*Table 1*). This means that the ecological pressure in Kemal Muluq Forest on plants in sapling, pole, and tree level are moderate. There are differences in term of value categories of plant diversity at the seedling and understory level with plants at the sapling, pole, and tree levels. This is because at the time of growth from the seedling level to the next higher level (saplings, poles, and trees), plants experience a lot of disturbances and ecological pressures. Sanjaya et al. (2022) stated that tree diversity can be used as an indicator of forest health because it is sensitive to change, an indicator of ecological systems, and spatial, temporal, and trophic heterogeneity. Tree diversity is

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2203_24392453

critical to the stability of forest ecosystems, services, and tropical biodiversity (Lleno et al., 2023). Species diversity in ecosystem is not high due to limitations of certain environmental factors (An et al., 2023). Species diversity in an area is also influenced by substrate factors (soil), abundance of food sources, interspecies and intraspecies competition, disturbances, and conditions from the surrounding environment so that species that have high tolerance will increase in population while species that have low tolerance will decrease population.

Dominance index range between 0-1. Dominance index categories according to Ludwig and Reynold (1988), to be specific: low dominance ($0 < C \leq 0.5$), moderate dominance ($0.5 < C \leq 0.75$), and high dominance ($0.75 < C \leq 1{,}0$). Based on the analysis of the Simpson dominance index, plants at the seedling and understory levels, saplings, poles, and trees in Kemal Muluq Forest have a dominance value that is included in the low category, as shown in *Table 1*. This means that there are no species that are extreme dominates other species.

In Kemal Muluq Forest, among the species identified as Least Concern, there is an endemic species which is the identity flora of West Nusa Tenggara, namely: Diospyros macrophylla Blume. This plant is found in the seedling and understory levels. The population in wild areas such as forests is decreasing. This happens because of illegal logging and slow growth. *D. macrophylla* Blume is a woody plant with a height of 10-46 m. The stem has a diameter of up to 60 cm. The lower stem does not branch up to a height of 9-30 m. The bark is brown to dark red with white wood. This plant has a single, oblong leaf with a sharp tip, 7-35 cm long and 3-19 cm wide. The flowers are yellowish white and smell good. The round fruit is pink to yellowish orange. The skin of the fruit has smooth reddish hair with yellowish white flesh. Inside the fruit there are brown seeds. This plant is often used for its wood because it has strong wood qualities and beautiful wood grain patterns. Therefore, the wood of this plant has high economic value.

The success rate of individual plants to survive is influenced by abiotic factors, including: soil temperature and soil pH. The ability of soil as a medium for growing vegetation plays a role in determining the quality of vegetation habitat. The soil is a significant heat store. Numerous biological processes are catalyzed by soil temperature. The moisture, aeration, and availability of plant nutrients that are necessary for plant growth are all affected by soil temperature (Onwuka, 2018). The temperature for plant growth goes from 15-40°C. Plant growth slows down at temperatures above 40°C and below 15°C. Temperature plays a role in activating biochemical and physiological reactions in plants (Wiraatmaja, 2017). The biogeochemical processes of soil are significantly influenced by the soil pH. As a result, soil pH is referred to as the “master soil variable” because it has a significant impact on a wide range of biological, chemical, and physical properties as well as processes that influence plant growth and biomass yield (Neina, 2019). Soil pH influences the availability of soil nutrients, soil microbial activity, and plant growth and development (Zhang et al., 2019). The entire chemistry of plant nutrient colloidal solutions is controlled by the concentration of hydrogen ions, which is what determines the soil’s pH (Msimbira and Smith, 2020). Soil pH affects the ability of the soil to provide nutrients for plants. Thus, the pH of the soil is one indicator of soil fertility. In the pH range of 6-7, plant nutrients are most readily available (Hutasuhut, 2020).

Soil pH has been demonstrated in several studies to have a significant effect on plant diversity and the combination of acidic soils and low temperature conditions limits the

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2203_24392453

distribution of many tropical species (Jiang et al., 2016). In this study, differences in plant diversity showed a decrease in the Shannon-Wienner diversity index. The highest diversity index was for seedling and understory plants, followed by sapling, pole and tree. Kettle and Koh (2014) stated that the decline in plant diversity was caused by various natural (abiotic and biotic) and anthropogenic factors, including habitat fragmentation and deforestation.

Conclusion

The composition of the vegetation in Kemal Muluq Forest consists of 36 families, 58 genera and 62 species. The vegetation structure in Kemal Muluq Forest includes: seedling and understory, sapling, pole, and trees with varying densities. The species with the highest density was *Schleichera oleosa* (Lour.) Oken, followed by *Schoutenia ovata* Korth., and *Streblus asper* Lour. Plants at the seedling and understory levels are included in high diversity. Meanwhile, plants at the sapling, pole, and tree levels have diversity which is included in the moderate category. Plants at the seedling and understory, sapling, pole, and tree levels have a low dominance value. Based on the regression analysis, there is a significant influence between soil temperature and soil pH on the plant diversity index in Kemal Muluq Forest, Lombok Island, Indonesia.

Acknowledgments. The authors would like to thank Center for Higher Education Funding (Balai Pendanaan Pendidikan Tinggi, BPPT), The Ministry of Education, Culture, Research, and Technology of The Republic of Indonesia and *Lembaga Pengelola Dana Pendidikan*, LPDP which have provided Indonesia Education Scholarship (*Beasiswa Pendidikan Indonesia*, BPI). We would also like to thank all informants, institutions, and all of them who participated in and supported this research.

REFERENCES

[1] Almulqu, A. A. (2017): Dynamic growth model simulation for carbon stock management in dry forest. – Biosystems Diversity 25(3): 249-254. https://doi.org/10.15421/011738.

[2] An, Y. P., Li, Y. X., Chen, J. R., Wang, Z. B., Yang, X. L. (2023): Characteristics and diversity of main shrub communities in Southeast Tibet. – Applied Ecology and Environmental Research 21(3): 2265-2275. http://dx.doi.org/10.15666/aeer/2103_22652275.

[3] Angelina, M., Mardhiyah, A., Dewi, M. T., Fajriah, S., Muthiah, N., Ekapratiwi, Y., Dewijanti, I. D., Sukirno, Jamilah, Hartati, S. (2021): Physicochemical and phytochemical standardization, and antibacterial evaluation of Cassia alata leaves from different locations in Indonesia. – Pharmacia 68(4): 947-956. https://doi.org/10.3897/pharmacia.68.e76835.

[4] Asdak, C. (2023): Sustainable Forest Management from hydrology and climate change mitigation perspectives. – Jurnal Ilmu Kehutanan 17(1): 1-10. https://doi.org/10.22146/jik.v17i1.6904.

[5] Asprilla-Perea, J., Diaz-Puente, J. M., Martin-Fernandez, S. (2022): Estimating the potential of wild foods for nutrition and food security planning in tropical areas: experimentation with a method in Northwestern Colombia. – Ambio 51: 955-971. https://doi.org/10.1007/s13280-021-01624-9.

[6] Deng, J., Fang, S., Fang, X., Jin, Y., Kuang, Y., Lin, F., Liu, J., Ma, J., Nie, Y., Ouyang, S., Ren, J., Tie, L., Tang, S., Tan, X., Wang, X., Fan, Z., Wang, Q-W., Wang, H., Liu, C.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2203_24392453

(2023): Forest understory vegetation study: current status and future trends. – Forestry Research 3: 6. https://doi.org/10.48130/FR-2023-0006.

[7] Dong, S., Sha, W., Su, X., Zhang, Y., Li, S., Gao, X., Liu, S., Shi, J., Liu, Q., Hao, Y. (2019): The impacts of geographic, soil and climatic factors on plant diversity, biomass and their relationships of the alpine dry ecosystems: cases from the Aerjin Mountain Nature Reserve, China. – Ecological Engineering 127: 170-177. https://doi.org/10.1016/j.ecoleng.2018.10.027.

[8] Dubyna, D. V., Vakarenko, L. P., Ustymenko, P. M., Davidov, D. A., Dziuba, T. P., Baranovski, B. A., Karmyzova, L. A., Kulik, A. F., Zhykharieva, A. V. (2023): Rare steppe plant communities in Ukraine: status, threats and their minimization. – Biosystems Diversity 31(2): 209-216. https://doi.org/10.15421/012322.

[9] Duncanson, L., Liang, M., Leitold, V., Armston, J., Moorthy, S. M. K., Dubayah, R., Costedoat, S., Enquist, B. J., Fatoyinbo, L., Goetz, S. J., Gonzalez-Roglich, M., Merow, C., Roehrdanz, P. R., Tabor, K., Zvoleff, A. (2023): The effectiveness of global protected areas for climate change mitigation. – Nature Communications 14: 2908. https://doi.org/10.1038/s41467-023-38073-9.

[10] Garvita, R. V., Ismaini, L., Damayanti, F., Lailaty, I. Q., Surya, M. I., Harto, Nudin. (2023): A study on seed germination of *Senna alata* (L.) (ketepeng). – IOP Conf. Series: Earth and Environmental Science 1192: 012016. https://doi.org/10.1088/1755-1315/1192/1/012016.

[11] Gogte, V. V. M. (2016): Ayurvedic Pharmacology and Therapeutic Uses of Medicinal Plants Dravyagunavignyan. – Chaukhambha Publications, Mumbai.

[12] Haq, S. M., Khoja, A. A., Lone, F. A., Waheed, M., Bussmann, R. W., Mahmoud, E. A., Elansary, H. O. (2023): Floristic composition, life history traits and phytogeographic distribution of forest vegetation in the Western Himalaya. – Frontiers in Forest and Global Change 6: 1169085. https://doi.org/10.3389/ffgc.2023.1169085.

[13] Hassan, M. A., Rahman, M. O., Afroz, S. (2021): A new variety of *Abrus Precatorius* L. (Fabaceae) from Bangladesh. – Bangladesh Journal of Plant Taxonomy 28(2): 289-294. https://doi.org/10.3329/bjpt.v28i2.57127.

[14] Hua, F., Bruijnzeel, L. A., Meli, P., Martin, P. A., Zhang, J., Nakagawa, S., Miao, X., Wang, W., Mc Evoy, C., Pena-Arancibia, J. L., Brancalion, P. H. S., Smith, P., Edwards, D. P., Balmford, A. (2022): The biodiversity and ecosystem service contributions and trade-offs of forest restoration approaches. – Science 376: 839-844. https://doi.org/10.1126/science.abl4649.

[15] Hutasuhut, M. A. (2020): Plant Ecology. – State Islamic University of North Sumatera, Medan.

[16] Ikkonen, E. N., Shibaeva, T. G., Titov, A. F. (2018): Influence of daily short-term temperature drops on respiration to photosynthesis ratio in chilling-sensitive plants. – Russian Journal of Plant Physiology 65(1): 78-83. https://doi.org/10.1134/S1021443718010041.

[17] International Plant Names Index. (2023): International Plant Names Index. – https://www.ipni.org/ (accessed on 14 August 2023).

[18] IUCN Red List. 2023.The IUCN Red List of Threatened Species. International Union for Conservation of Nature and Natural Resources. – http://www.iucnredlist.org.

[19] Jiang, Y., Zang, R., Letcher, S. G., Ding, Y., Huang, Y., Lu, X., Huang, J., Liu, W., Zhang, Z. (2016): Associations between plant composition/diversity and the abiotic environment across six vegetation types in a biodiversity hotspot of Hainan Island, China. – Plant Soil 403: 21-35. https://doi.org/10.1007/s11104-015-2723-y.

[20] Kai, Z., Woan, T. S., Jie, L., Goodale, E., Kitajima, K., Bagchi, R., Harrison, R. D. (2014): Shifting baselines on a tropical forest frontier: extirpations drive declines in local ecological knowledge. – PLoS ONE 9(1): e86598. https://doi.org/10.1371/journal.pone.0086598.

[21] Kartawinata, K., Roemantyo, Keim, A. P., Sujarwo, W. (2022): Natural Vegetation and Ethnobotany of Bali. – BRIN Publishing, Jakarta.

[22] Karthikeyan, M., Raju, S. K., Karthikeyan, R., Arivanantham, S., Kumar, S., Sekar, P. (2023): A review on phytochemistry and pharmacological activities of S*chleichera oleosa* (Lour.) Oken. – World Journal of Advanced Research and Reviews 17(01): 1101-1107. https://doi.org/10.30574/wjarr.2023.17.1.0024.

[23] Kettle, C. J., Koh, L. P. (2014): Global Forest Fragmentation. – CABI, Wallingford.

[24] Kim, C. (2016): Land use classification and land use change analysis using satellite images in Lombok Island, Indonesia. – Forest Science and Technology 12(4): 183-191. https://doi.org/10.1080/21580103.2016.1147498.

[25] Kundu, M., Chaturvedi, N. (2019): Preliminary studies on seed dormancy of *Schleichera oleosa* (Lour.) Merr. – Tropical Plant Research 6(1): 133-138. https://doi.org/10.22271/tpr.2019.v6.i1.019.

[26] Kusmana, C. (2017): Survey Methods and Vegetation Data Interpretation. – IPB Press, Bogor.

[27] Lefeuvre, N. B., Keller, N., Plagnat-Cantoreggi, P., Godoong, E., Dray, A., Philipson, C. D. (2022): The value of logged tropical forests: a study of ecosystem services in Sabah, Borneo. – Environmental Science and Policy 128: 56-67. https://doi.org/10.1016/j.envsci.2021.11.003.

[28] Legaspi, C. L. B., Maramba-Lazarte, C. C. (2020): The Phytochemical content and the in vitro antifungal properties of *Senna alata* (Linn.) Roxb.: a review. – Acta Medica Philippina 54(1): 86-93. https://doi.org/10.47895/amp.v54i1.1111.

[29] Liu, H., Chen, Q., Liu, X., Xu, Z., Dai, Y., Liu, Y., Chen, Y. (2020a): Variation patterns of plant composition/diversity in *Dacrydium pectinatum* communities and their driving factors in a biodiversity hotspot on Hainan Island, China. – Global Ecology and Conservation 22: e01034. https://doi.org/10.1016/j.gecco.2020.e01034.

[30] Liu, L., Gudmundsson, L., Hauser, M., Qin, D., Li, S., Seneviratne, S. I. (2020b): Soil moisture dominates dryness stress on ecosystem production globally. – Nature 11: 4892. https://doi.org/10.1038/s41467-020-18631-1.

[31] Lleno, J. V., Ligalig, R. J., Sarmiento, R. T., Along, A. A. (2023): Tree diversity, composition, and stand structure of lowland tropical forest in Prosperidad, Agusan del Sur. Philippines. – Journal of Survey in Fisheries Sciences 10(1S): 4810-4830.

[32] Ludwig, J. A., Reynolds, J. F. (1988): Statical Ecology: A Primer Methods and Computing. – John Wiley and Sons, New York.

[33] Lyons-White, J., Pollard, E. H., Catalano, A. S., Knight, A. T. (2020): Rethinking zero deforestation beyond 2020 to more equitably and effectively conserve tropical forests. – One Earth 3(6): 714-726. https://doi.org/10.1016/j.oneear.2020.11.007.

[34] Michaels, T. E. (2015): Grain Legumes and Their Dietary Impact. – The World of Food Grains 1-4: 265-273.

[35] Moeljono, S., Murdjoko, A., Mardoyono, M. S., Silitonga, B. L., Lasamahu, L., Kiwo, T. (2020): Lowland rain forest stands formation of Samares in Sepsi Village, East Biak Sub-district, District of Biak Numfor. – Jurnal Kehutanan Papuasia 6(2): 113-121.

[36] Msimbira, L. A., Smith, D. L. (2020): The roles of plant growth promoting microbes in enhancing plant tolerance to acidity and alkalinity stresses. – Frontiers in Sustainable Food Systems 4: 106. https://doi.org/10.3389/fsufs.2020.00106.

[37] Neina, D. (2019): The role of soil pH in plant nutrition and soil remediation. – Applied and Environmental Soil Science 2019: 5794869. https://doi.org/10.1155/2019/5794869.

[38] Newsome, D., Perera, P. (2023): Nature-Based Tourism: Before, During, and After COVID-19. The Routledge Handbook of Nature Based Tourism Development. – Routledge, London.

[39] Nugraha, B. H., Kusmana, C. (2022): Species composition and vegetation structure of lowland forest in Rambut Island Wildlife Reserve, Kepulauan Seribu, DKI Jakarta. – IOP

Conf. Series: Earth and Environmental Science 950: 012021. https://doi.org/10.1088/1755-1315/950/1/012021.

[40] Nugroho, H. Y. S. H., Nurfatriani, F., Indrajaya, Y., Yuwati, T. W., Ekawati, S., Salminah, M., Gunawan, H., Subarudi, S., Sallata, M. K., Allo, M. K., Muin, N., Isnan, W., Putri, I. A. S. L. P., Prayudyaningsih, R., Ansari, F., Siarudin, M., Setiawan, O., Baral., H. (2022): Mainstreaming ecosystem services from Indonesia's remaining forests. – Sustainability 14: 12124. https://doi.org/10.3390/su141912124.

[41] Odum, E. P., Barrett, G. W. (2009): Fundamentals of Ecology. 5th Ed. – Cengage Learning, Melbourne.

[42] Oktavia, D., Pratiwi, S. D., Munawaroh, S., Hikmat, A., Hilwan, I. (2022): The potential of medicinal plants from heath forest: local knowledge from Kelubi Village, Belitung Island, Indonesia. – Biodiversitas 23(7): 3553-3560. https://doi.org/10.13057/biodiv/d230731.

[43] Oladeji, O. S., Adelowo, F. E., Oluyori, A. P., Bankole, D. T. (2020): Ethnobotanical description and biological activities of *Senna alata.* – Evidence-Based Complementary and Alternative Medicine 2020: 2580259. https://doi.org/10.1155/2020/2580259.

[44] Onwuka, B. M. (2018): Effects of soil temperature on some soil properties and plant growth. – Advances in Plants & Agriculture Research 8(1): 34-37. https://doi.org/10.15406/apar.2018.08.00288.

[45] Oraon, S., Mondal, S. (2022): Allelopathic impacts of an agroforestry tree species (*Streblus asper* Lour.) on seed germination and seedling growth of chickpea. – Legume Research 45(10): 1295-1300. https://doi.org/10.18805/LR-4679.

[46] Prasansuklab, A., Theerasri, A., Payne, M., Ung, A. T., Tencomnao, T. (2018): Acid-base fractions separated from Streblus asper leaf ethanolic extract exhibited antibacterial, antioxidant, antiacetylcholinesterase, and neuroprotective activities. – BMC Complementary and Alternative Medicine 18: 223. https://doi.org/10.1186/s12906-018-2288-4.

[47] Rahmah, A., Rahmawati, D. L. (2021): Effect of the abiotic factor on *Schleichera oleosa* chlorophyll level. – El-Hayah 8*(*2): 55-61. https://doi.org/10.18860/elha.v8i2.12313.

[48] Rashid, M. H., Islam, S., Kashem, S. B. (2018): Floristic diversity (Magnoliids and Eudicots) of Baraiyadhala National Park, Chittagong, Bangladesh. – Bangladesh Journal of Plant Taxonomy 25(2): 273-288. https://doi.org/10.3329/bjpt.v25i2.39532.

[49] Rodrigues, A. R., Botequim, B., Tavares, C., Pecurto, P., Borges, J. G. (2020): Addressing soil protection concerns in forest ecosystem management under climate change. – Forest Ecosystems 7: 34. https://doi.org/10.1186/s40663-020-00247-y.

[50] Saha, D., Ramani, R., Baboo, B. (2010): Kusum, multipurpose tree, not yet popular. – Science Reporter (February 2010): 20-22.

[51] Sanjaya, F. A., Safeí, R., Winarno, G. D., Setiawan, A. (2022): Health assessment of conservation forest-based on biodiversity indicator tree types (case study at Elephant Respont Unit Margahayu Way Kambas National Park). – IOP Conf. Series: Earth and Environmental Science 950: 012042. https://doi.org/10.1088/1755-1315/950/1/012042.

[52] Setyawati, T., Narulita, S., Bahri, I. P., Raharjo, G. T. (2015): A Guide Book to Invasive Alien Plant Species in Indonesia. – Research, Development and Innovation Agency, Ministry of Environment and Forestry of Indonesia, Bogor.

[53] Shimamoto, C. Y., Padial, A. A., Rosa, C. M., Marques, M. C. (2018): Restoration of ecosystem services in tropical forests: a global meta-analysis. – PLOS ONE 13(12): 0208523. https://doi.org/10.1371/journal.pone.0208523.

[54] Sivamaruthi, B. S., Prasanth, M. I., Kesika, P., Tencomnao, T., Chaiyasut, C. (2022): Functional properties of *Streblus asper* Lour.: a review. – Food Science and Technology 42: e113421. https://doi.org/10.1590/fst.113421.

[55] Sujarwo, W., Keim, A. P. (2017): Ethnobotanical study of traditional building materials from the island of Bali, Indonesia. – Economic Botany 71(3): 224-240. https://doi.org/10.1007/s12231-017-9385-z.

[56] Sutomo, van Etten, E. J. B. (2023): Fire impacts and dynamics of seasonally dry tropical forest of East Java, Indonesia. – Forests 14: 106. https://doi.org/10.3390/f14010106.

[57] Tian, F., Liu, L. Z., Yang, J. H., Wu, J. J. (2021): Vegetation greening in more than 94% of the Yellow River Basin (YRB) region in China during the 21st century caused jointly by warming and anthropogenic activities. – Ecological Indicators 125: 107479. https://doi.org/10.1016/j.ecolind.2021.1074.

[58] Turner, I. M. (2001): The Ecology of Trees in The Tropical Rainforest. – Cambridge University Press, Cambridge.

[59] Van Steenis, C. G. G. J. (2008): Flora for Schools. – Penebar Swadaya, Jakarta.

[60] Wiratmaja, I. W. (2017): Temperature, Solar Energy, and Water in Relation to Plants. – Udayana University, Denpasar.

[61] Yadav, A. K., Khan, M. E., Pal, A., Dubey, A. M. (2016): Experimental investigations of performance and emissions characteristics of Kusum (*Schleichera oleosa*) biodiesel in a multi-cylinder transportation diesel engine. – Waste and Biomass Valorization 8(4): 1331-1341. https://doi.org/10.1007/s12649-016-9658-2.

[62] Yadav, V. S., Yadav, S. S., Gupta, S. R., Meena, R. S., Lal, R., Sheoran, N. S., Jhariya, M. K. (2022): Carbon sequestration potential and CO_2 fluxes in a tropical forest ecosystem. – Ecological Engineering 176: 106541. https://doi.org/10.1016/j.ecoleng.2022.106541.

[63] Zhang, Y. Y., Wu, W., Liu, H. (2019): Factors affecting variations of soil pH in different horizons in hilly regions. – PloS ONE 14(6): e0218563. https://doi.org/10.1371/journal.pone.0218563.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2203_24392453