UNIVERSITI TEKNOLOGI MARA

ECOLOGICAL CHARACTERISTICS OF FRESHWATER SWAMP FOREST, PERAK TENGAH, MALAYSIA

LILIWIRIANIS BINTI NAWI

Thesis submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Science)

Faculty of Applied Sciences

November 2021

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student	:	Liliwirianis binti Nawi
Student I.D. No.	:	2011802254
Programme	:	Doctor of Philosophy in Science – AS990
Faculty	:	Applied Sciences
Thesis	:	Ecological Characteristics of Freshwater Swamp Forest Perak Tengah, Malaysia
Signature of Student	:	…… ……..
Date	:	17 November 2021

ABSTRACT

Freshwater swamp forest has a distinctive floristic structure, covering a very limited area. The freshwater swamp forests are forests that are found in low lying areas inundated by rainwater and composed of species that occur in confined areas due fragmentation of their habitats, and this make the populations more vulnerable to extinction in the short term. This study aims to determine the ecological characteristics of a freshwater swamp forest at Perak Tengah. which are forest community structure, species diversity, soil properties, tree soil relationship, tree biomass and carbon stock. A total of 150 plots with quadrats of 20 m x 20 m each (totalling 6 ha) were established at selected freshwater swamp forest areas. All trees with diameter at breast height (DBH) of 10 cm and above were measured, collected and identified. Topsoil samples (0-30 cm) in each plot were collected and analysed for texture, pH, base cations and available nutrients that include Mg, P, K. A total of 3364 tree stands belonging to 624 species in 184 genera and 56 families were enumerated in all study plots. Euphorbiaceae was the largest family recorded from the study plot. Density-wise, Euphorbiaceae also recorded as the highest tree density (≥10 cm DBH). Total tree basal area (BA) for all plots was 25.29 m^2/ha. *Macaranga triloba* (Euphorbiaceae) was the most important species with the highest value for Species Importance Value Index (SIvi) of 11.52%. Euphorbiaceae, Dipterocarpaceae and Moraceae were the most important families. The Margalef's Diversity Index index shows that the study area displayed high value of species richness. Shannon Diversity indicated high value of H'= 5.242 (H_{max}=6.436). The Chave equation was applied to identify the total above-ground biomass (AGB) and Niiyama regression for the below-ground biomass (BGB). The total tree biomass was 472.743 t/ha, which was composed of AGB of 421.668 t/ha and BGB of 51.140 t/ha. The total amount of carbon stock was 222.189 t/ha. The freshwater swamp forest at Perak Tengah exhibited the presence of endemic and threatened species that are listed under the IUCN Red List, that include *Dipterocarpus semivestitus*, *Shorea hemsleyana* ssp. *hemsleyana*, *S. macrantha*, *Vatica flavida* and *Hopea apiculata*. Soil analyses showed that soil texture is varied, of which the soil texture was dominated by sandy clay loam. In general, ordinations using *Canonical Correspondence Analysis* (CCA) indicated that soil factors have no relationship with species distribution (eigenvalues for the three ordination axes p-value = 0.5860 at $p<0.05$). The results gathered from this study are anticipated to contribute a new knowledge for the stakeholders on the importance of conservation of freshwater swamp forests and the species.

ACKNOWLEDGEMENTS

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ In the name of Allah S.W.T. the Most Gracious and the Most Merciful and His messenger Prophet Muhammad (PBUH), Alhamdullilah I am thankful for Allah's blessing, mercy and compassion that made me possible to finish this incredible journey.

I would like to express my gratitude and appreciation to my supervisor Dr. Shaikh Abdul Karim Yamani bin Zakaria, my co-supervisor Professor Dr. Farida Zuraina Mohd. Yusof, Prof. Emeritus Dato' Dr. Abdul Latiff Mohamad and Prof. Madya Dr. Noraini binti Talip whose guidance, support and encouragement have been invaluable throughout this study. Special thanks to my colleagues and friends, my assistants during the ground data collection also to all my SUG members.

Next, I would like to thank to the Ministry of Education (MoE), Malaysia for providing research grants through the Fundamental Research Grant Scheme (FRGS) 600-RMI/FRGS 5/3 (41/2014) and Universiti Teknologi MARA (UiTM) for providing support and logistic related services.

Finally, this thesis is dedicated to my husband, Muhammad Zamani bin Zakaria, for his enduring love, for believing in me, and for sharing my wish to reach the goal of completing this task but caring enough to love me even if I do not achieve it. My children, who have inspired me with their love and compassion, even as they bore the brunt of my moods and absences. Thank you, Nurhasya Hana, Muhammad Harith, Nur Aisya Husna, Nur Fadia Nuha and Muhammad Umar for your concern and late-night vigils. May Allah bless us all with success, health, happiness, patience, and strength. May all your dreams come true, and may you live the life that you have always dreamt of. May Allah bless you with the victory in this life and hereafter too. Ameen!

TABLE OF CONTENTS