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TREE SPECIES AND ABOVEGROUND BIOMASS ESTIMATION USING MACHINE LEARNING, HYPERSPECTRAL AND LIDAR DATA

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ABSTRACT

Above-ground biomass (AGB) and tree species classification using a combination of airborne hyperspectral and Light Detection and Ranging (LiDAR) can provide valuable and effective methods for forest management, such as planning and monitoring purposes. However, the identification process of tree species and AGB estimation in tropical forest is quite challenging either by traditional or remote sensing methods due to the structure of forest type. Besides, only a few studies have applied using both combinations in the tropical forest. Therefore, the aim of this study is to classify and determine tree species and Above-ground biomass (AGB) and Carbon Stock using airborne hyperspectral and LiDAR at tropical forests. The objectives of this study to establish the AGB, Carbon Stock and species recognition using biophysical field data collection, to determine the individual tree species using different classifiers on hyperspectral data, and to estimate AGB using Random Forest (RF) and Artificial Neural Network (ANN). In this research, Object-Based Image Analysis (OBIA) method was applied on hyperspectral data to extract the crown of individual tree species for classification and estimation purposes. The result shows that Support Vector Machine (SVM) and Random Forest (RF) achieved the highest overall accuracy above 50% compared to other classifiers in the tropical forest. Besides, Artificial Neural Network (ANN) and Random Forest (RF) algorithm was used to predicted the AGB using different combination of variables. The best predicted selection using ANN is model 2 with produced RMSE = 24.117kg/tree and R^2 = 0.999 which is two hidden layer. While the best predicted selection using RF is model 4 with mtry = p produced R^2= 0.997 and RMSE=30.653kg/tree. Therefore, by using combination of field observation and remote sensing data with machine learning technique is reliable in forest management to estimate AGB in tropical forest.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

A total of 60065 tree species are recorded worldwide, and Malaysia is one of the countries with height diversity of species in the tropical forest (Beech et al., 2017; FAO 2020). A variety of trees in the big forest can make it the best place to store carbon for maintaining the stability of the earth's ecosystem from the occurrence of disasters. Unfortunately, nowadays, forests are under threat from anthropogenic factors because of increasing population growth, which leads to the occurrence of uncontrolled forest exploration. According to Omar et al. (2016) forest lands have decreased from roughly 19.3 Mil.ha in year 2005 to 18.2 Mil.ha in 2020. Besides, three tree species from the family of *Dipterocarpaceae viz, Dipterocarpus semivestitus, Vatica flavida*, and *S.macrantha* had been reported to have restricted distribution due to the development of forest into an urban area (Suratman 2017). The forest had been facing a significant threat due to overexploitation and lead to numerous pollution problems such as an increase in greenhouse gasses (GHG). Therefore, to curb this problem than getting more serious, it is necessary important to develop effective methods for reporting, monitoring, and verifying to reduce emissions from deforestation and forest degradation. For example, by estimating Above-Ground Biomass (AGB) and Carbon stock, and identifying the endangered tree species in the large area.

Remote sensing has advantages in mapping for tree species identification, AGB and Carbon stock estimation as it capable to observe wide and inaccessible area (Jha et al., 2019; Modzelewska et al., 2020; Mustafa et al., 2015). Besides, it has the benefit of capturing the spectral reflection of the earth's objects of each different feature including tree species. Several airborne and remote sensing methods have been developed by previous researchers for AGB and Carbon stock estimation and tree species identification. Such as by using airborne Light Detection and Ranging (LiDAR), satellite multispectral images, and airborne hyperspectral (Dalponte et al., 2012; Latif et al., 2012; Mohd Zaki and Abd Latif, 2017)Multispectral imagery has widely used for forest management. However, it is not suitable for individual plant species detection because of less accuracy due to limited resolution and spectral bands in low and medium