

UNIVERSITI TEKNOLOGI MARA

**MODELLING AND MONITORING
OF STAND VOLUME, ABOVE
GROUND BIOMASS AND CARBON
STOCKS OF OIL PALM (*Elaeis
guineensis*) PLANTATIONS USING
LANDSAT THEMATIC MAPPER IN
MALAYSIA**

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ABSTRACT

Oil palm (*Elaeis guineensis*) plantations play important roles in the economics and sources of income to Malaysia. Accurate and reliable information on forecasts of resource availability and contribution of oil palm plantations on global carbon cycle are needed for its management efforts and planning. The need for effective inventories and monitoring methods has prompted this research into supplementing the ground field survey with the information from satellite remote sensing for developing methods for oil palm plantation inventory. For monitoring purposes, the effective procedures were developed using three dates of Landsat Thematic Mapper (TM) imagery. Field-measured above ground biomass (AGB), stand volume and carbon stocks values from 230.8 ha of oil palm plantations were compared with individual Landsat TM bands and nine vegetation indices. The potential models selected were obtained using stepwise and backward elimination method where R^2 , adjusted R^2 , Standard Error of Estimate (SE_E), Root Mean Squared Error (RMSE) and C_p were examined in model development and validation. For stand volume, AGB and carbon stocks estimation, it was found that the most promising model provides moderately good prediction of about 62% of the variability of the stand volume, AGB and carbon stocks with RMSE values of 14.31 m³/ha, 3.68 tonnes/ha and 1.66 tonnes/ha, respectively. In conclusion, Landsat TM offers the low cost of stand volume, AGB and carbon stock estimates and mapping of oil palm plantations with moderate accuracy in Malaysia. The combination use of a time series of Landsat TM data, post classification change detection and Geographic Information System (GIS) have provided useful tools and techniques to produce land cover/use change matrices and oil palm area change statistics which necessary in providing in-depth understanding on the general processes of changes, the factor that drives the changes in land cover/use types, and thus contributes to the good management and sustainable oil palm resources. In addition, the information from this thesis may provide useful tool for resource planners and oil palm related agencies in making resource forecasts, and assist in the development of management plan for the tree crop. The information is also useful in helping to assess the important indicators of sustainability and the way in which the resource availability vary over time.

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CHAPTER ONE

INTRODUCTION

1.1 RESEARCH BACKGROUND

Forests and trees are crucial parts of life on Earth in terms of maintaining biodiversity, balancing the ecosystem, culture and recreation. Forests also provide crucial sources of food, medicine, raw materials, clothing and shelter as basic human needs. It is estimated that over more than 1.6 billion people worldwide are depending directly on forests and forest products. These sectors have become the essential economic important of many developing countries. However, the increasingly demand for forest products such as for food, fodder, energy, wood and non-wood forest products have led to conversion of considerable areas of forestland into plantations, agriculture, pasture and other form of land uses. This phenomenon is leading to deforestation and a range of ecological and social impacts. At the global scale, it was reported that 96% of deforestation is caused by agricultural expansion as compared to infrastructure expansion which contributes to 72% (Geist and Lambin, 2002). As a result, agriculture is often perceived to be one of the main causes for land cover changes.

Agriculture is one of the important components of land use in Malaysia and since 1980s the development policy has been changed from agricultural sector to focus on the manufacturing sector. Even though the policy has shifted, the agricultural production remains the most crucial part to sustain the economic development in Malaysia. Malaysia has a tremendous inherent strength in agriculture, particularly in tree crop such as oil palm, rubber and other selected crops. In 2012, for example Malaysia has total of 6.24 million ha of agricultural tree crops which are mainly oil palm, rubber, coconut and cocoa (Malaysia Palm Oil Board [MPOB], 2012a; Department of Agriculture [DOA], 2013; Malaysia Rubber Board [MRB], 2014; Malaysia Cocoa Board [MCB], 2014) which constituted an increase of approximately 2.8% from 2009.

Elaeis guineensis or known as oil palm, originated from the tropical rain forests of West Africa. The oil palms have become a major source of fats and oils for human food and traditionally, the oil palm is used for manufacturing of compound fat and soap. In Asia, Malaysia is known as the second world largest palm oil producer and exporter