



UNIVERSITI PUTRA MALAYSIA

The Use of Remote Sensing and Geographic Information System to Determine the Spatial Distribution of *Melaleuca cajuputi* as a Major Bee Plant in Marang, Terengganu

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Distribution of *Melaleuca cajuputi* as a Major Bee Plant in Marang, Terengganu**

By

MOHAMMADMEHDI SABERIOON

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in
Fulfilment of the requirement for the Degree of Master of Science**

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Dedication

This thesis is dedicated to my wonderful parents, Ashraf and Abbas, who have raised me to be the person I am today. You have been with me every step of the way, through good times and bad. Thank you for all the unconditional love, guidance, and support that you have always given me, helping me to succeed and instilling in me the confidence that I am capable of doing anything I put my mind to. Thank you for everything.

Mohammad Mehdi Saberioon



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

The Use of Remote Sensing and Geographic Information System to Determine the Spatial Distribution of *Melaleuca cajuputi* as a Major Bee Plant in Marang, Terengganu

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11th SEPTEMBER 2009

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In Malaysia, honey is chiefly obtained from species of honeybees known as *Apis dorsata* and to a lesser extent *Apis cerana*. Honey from *Apis dorsata* is a supplementary source of income to many rural poor in the district of Marang, Terengganu. The colonies of *A. dorsata* are found to nest in aggregates on tall bee trees (tree emergent) in the open, as well as, nesting singly in concealed locations when nesting low, especially in the submerged forest of *Melaleuca cajuputi* as in the vast hectare (> 200,000 hectares) of *Melaluca* forest along the coastal areas of Terengganu. So, Melaleuca forest mapping and flower mapping can be reliable methods for determining this species distribution as the main source of nectar and pollen for these aforementioned honey bees. In ecology, biomass can be defined as accumulation of living matter which is useful as a biophysical index for mapping of flower in forest. In this study, we used SPOT-5 and RADARSAT-1 for inventory of Melaleuca forest in Marang and developed Above Ground Biomass (AGB)



estimation model as indirect index for obtaining and producing distribution of *Melaleuca cajuputi* flowers. Also, *Apis dorsata* colonies distribution and motorbike parking points of honey hunters were collected using GPS in field survey to determine distribution of colonies and improve searching ability in *Apis dorsata* colonies harvesting by honey hunters in the study area.

The Melaleuca forest, located in Marang, Terengganu, Malaysia which is lying in upper left latitude 5°17'15.473"N, and longitude 103°05'25.021"E and lower right latitude 4°37'55.236" N, longitude 103°45'47.568"E was chosen for this research. SPOT-5 was enhanced, classified and vectorized using image processing software for the purpose of Melaleuca forest mapping. Based on the image analysis of the SPOT-5 image the Melaleuca forest were classified as five classes *Melaleuca Cajuputi*, *Acacia auriculiformis*, non-vegetation, water bodies and Cloud/haze/Shadow. The analysis showed that *Melaleuca cajuputi* covered 76,061.73ha (61.72%), *Acacia auriculiformis* 24,484.32ha (19.88%), non-vegetation 9,991.76ha (8.11%), water bodies 2,203.47ha (1.79%) and Cloud/Haze/Shadow 10,491.86ha (8.51%) with an overall classification accuracy of 91.79% while the statistics value obtained from kappa coefficient was more than 0.86 which is relatively quite good results for image processing.

Based on Melaleuca forest inventory, 10 plots of 10m × 10m were established to measure the AGB along with two stand parameters namely the DBH and height. The measurements were analyzed to determine the descriptive statistics of each plot using SPSS software. AGB was later regressed against the radar backscattering coefficient, derived earlier from

the RADARSAT-1 images, to establish the regression fit. Once the regression fit model was obtained, the radar backscattering coefficient data were converted to the AGB mapping. The accuracy of AGB was evaluated using the accuracy assessment in ERDAS IMAGINE v 9.1.

The relationship between AGB and radar backscattering is described with the linear regression equation of $AGB=238.73+ (15.4) \times \sigma^{\circ}$ ($R^2 = 0.89$) for flowering season and $AGB=170.843+ (13.82) \times \sigma^{\circ}$ ($R^2 = 0.81$) for non-flowering season. The range of measured AGB was similar to the overall range in AGB from radar backscattering. Through the model of AGB value estimation, AGB mapping on Melaleuca forest can be done with each pixel holding its own AGB value. This study found that remote sensing can be used to estimate AGB in forest stands and also to produce AGB map in Melaleuca forest. Then, flowering map was derived from AGB classified map in two different seasons of flowering and non-flowering. Finally, all maps and information were transferred and overlaid in Arc/GIS v 9.1 to find probability and searching ability of *Apis dorsata* colonies by honey hunters.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah sarjana sains

Penentuan Kawasan Sabalan *Melaleuca cajuputi* Sebagai Pokok Lebah Utama Menggunakan Penderiaan Jauh dan Sistem Maklumat Geografi di Marang, Terengganu

Oleh

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Di Malaysia, sebahagian besar madu asli dihasilkan oleh spesis lebah yang dikenali sebagai *Apis dorsata* dan selebihnya daripada spesis lebah *Apis cerana*. Madu lebah *Apis dorsata* menyumbang pendapatan tambahan kepada ramai golongan miskin di daerah Marang, Terengganu. Koloni-koloni lebah *Apis dorsata* umumnya membuat sarang secara berkelompok pada dahan pohon-pohon tinggi di kawasan yang lapang. Namun, spesis lebah ini juga boleh ditemui bersarang rendah di kawasan-kawasan terlindung terutamanya hutan pohon gelam (*Melaleuca cajuputi*) seperti yang terdapat di sepanjang pinggir pantai Terengganu. Oleh itu, pemetaan hutan Gelam (*Melaleuca*) dan pemetaan bunga merupakan satu kaedah yang boleh diguna pakai bagi menentukan taburan spesies ini sebagai sumber utama nektar (nectar) and tiub debunga (pollen) bagi madu lebah yang telah dinyatakan sebelum ini. Dari sudut ekologi, jisim biologi boleh didefinisikan sebagai pengumpulan benda hidup atau berkemungkinan benda hidup dimana ia berguna sebagai indeks biofizikal bagi pemetaan bunga dalam hutan. Dalam kajian ini, SPOT-5 dan RADARSAT-1 digunakan bagi pemetaan taburan hutan gelam (*Mellaleuca cajuputi*) di



Marang dan penghasilan model penganggaran jisim biologi atas tanah (AGB) sebagai index tidak langsung yang digunakan untuk memperoleh dan menghasilkan taburan bungaan *Mellaleuca cajuputi* di hutan berkenaan. Selain daripada itu, peninjauan tapak kerja dengan penggunaan GPS bagi pengumpulan data mengenai taburan koloni *Apis dorsata* dan titik-titik tempat letak motosikal pemburu madu, dengan ini penentuan taburan koloni dan perbaikian keupayaan pencarian koloni *Apis dorsata* untuk dituai oleh pemburu madu di kawasan kajian dapat dilakukan.

Hutan gelam yang terletak di Marang, Terengganu dari garis lintang $4^{\circ}37'55.236''\text{U}$ ke $5^{\circ}17'15.473''\text{U}$ dan garis bujur $103^{\circ}05'25.021''\text{T}$ ke $103^{\circ}45'47.568''\text{T}$ telah dipilih sebagai tapak kajian ini. SPOT-5 yang digunakan bagi tujuan pemetaan hutan ini dipertingkatkan, diklasifikasikan, dan divektorkan dengan bantuan perisian pemprosesan imej. Imej yang terhasil pada skrin radar SPOT-5 memaparkan lima kawasan berbeza di hutan gelam tersebut. Lima kawasan tersebut adalah kawasan tumbuhan *Melaleuca cajuputi*, tumbuhan *Acacia auriculiformis*, kawasan tidak bertumbuhan, kawasan berair, dan awan/jerubu. Analisis menunjukkan bahawa Tumbuhan *Melaleuca cajuputi* meliputi kawasan seluas 76,061.73 hektar (61.72%) daripada keseluruhan keluasan hutan berkenaan, diikuti oleh tumbuhan *Acacia auriculiformis* dengan keluasan 24,484.32 hektar (19.88%). Keluasan-keluasan kawasan tidak bertumbuhan dan kawasan berair adalah 9,991.76 hektar (8.11%) dan 2,203.47 hektar (1.79%) masing-masing, manakala 10,491.86 hektar (8.51%) merupakan tompok-tompok awan. Ketepatan pengelasan yang dilakukan adalah sebanyak 91.79% manakala nilai statistik kappa adalah 0.86, menandakan bahawa pemprosesan imej tersebut adalah agak baik.

Berdasarkan kepada taburan hutan gelam, sebanyak 10 plot berdimensi 10m x 10m setiap satu dibuat untuk mengukur AGB dan dua parameter iaitu DBH dan tinggi. Ukuran-ukuran yang diperolehi dianalisis dengan menggunakan perisian SPSS untuk mendapatkan gambaran terperinci setiap plot tersebut. Nilai-nilai AGB kemudiannya diregresi terhadap nilai-nilai penyebaran balik radar yang diperolehi melalui imej RADARSAT-1 untuk mendapatkan regresi yang sesuai (regression fit). Apabila model regresi yang sesuai antara koefisien penyebaran balik radar diperolehi, data koefisien penyebaran balik radar ditukarkan kepada pemetaan AGB. Ketepatan AGB dinilai dengan menggunakan taksiran ketepatan yang terdapat pada ERDAS IMAGINE v 9.1.

Hubungan lurus antara AGB dan penyebaran balik radar dapat diuraikan dengan menggunakan persamaan regresi $AGB = 238.73 + (15.4) \times \sigma^{\circ}$ dengan R^2 yang tinggi (0.89) pada musim bunga dan $AGB = 170.843 + (13.82) \times \sigma^{\circ}$ dengan $R^2 = 0.81$ pada bukan musim bunga. Julat pengiraan AGB adalah sama dengan julat keseluruhan AGB dari penyebaran balik radar. Melalui model penganggaran nilai AGB, pemetaan AGB pada hutan gelam boleh dilaksanakan dengan setiap piksel diwakili nilai AGB nya sendiri. Kajian ini menyatakan bahawa sistem penderiaan jauh (remote sensing) boleh digunakan untuk menganggarkan AGB di kawasan hutan dan juga dapat menghasilkan peta AGB hutan gelam. Seterusnya, peta pembungaan (flowering map) telah dihasilkan daripada peta pengelasan AGB pada dua musim iaitu musim bunga dan bukan musim bunga. Akhir sekali, semua peta-peta dan maklumat telah dipindahkan dan dilapis-lapis di Arc/GIS v

9.1 bagi memperoleh kebarangkalian dan keupayaan pencarian koloni *Apis dorsata* oleh pemburu madu.



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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

MOHAMMAD MEHDI SABERIOON

DATE:



TABLE OF CONTENTS

ABSTRACT	Page
	iii
ABSTRAK	vi
ACKNOWLEDGEMENTS	x
APPROVAL	xii
DECLARATION	xiv
LIST OF TABLES	xvii
LIST OF FIGURES	xix
LIST OF ABBREVIATIONS	xxi

CHAPTER

1	INTRODUCTION	
1.1	Introduction	1
1.2	Statement of Problem	6
1.3	Research Objectives	7
1.4	Significance of Study	8
2	LITERATURE REVIEW	
2.1	General Introduction	9
2.2	Global Position System (GPS)	12
2.3	Remote Sensing (RS)	15
2.3.1	SPOT	18
2.3.2	RADARSAT-1	20
2.4	Geographic Information System (GIS)	24
2.5	Melaleuca Forest	26
2.5.1	<i>Melaleuca cajuputi</i> (Gelam)	27
2.6	Giant Honey bees (<i>Apis dorsata</i>)	29
2.7	Biomass	31
2.8	Application Remote Sensing in Forestry	34
2.8.1	Applications of Remote sensing in Forest Mapping	37
2.8.2	Applications of Remote sensing in Quantifying Forest Biophysical Parameters	38
3	METHODOLOGY	
3.1	Description of Study Area	44
3.2	Data Acquisition	46
3.2.1	Field Measurement	46
3.2.1.1	Diameter at Breast Height (DBH)	48
3.2.1.2	Height	50
3.2.2	Image Data	51
3.2.3	Biomass Calculation	53
3.3	Forest Mapping	54
3.3.1	Digital Image Processing and Visual Interpretation	54



3.3.1.1	Preprocessing	54
3.3.1.1.1	Radiometric Correction	55
3.3.1.1.2	Geometric Correction	57
3.3.1.1.3	Band Combination	59
3.3.1.1.4	Masking	60
3.3.1.2	Classification	61
3.3.2	Radar Backscattering Coefficient Calculation	63
3.3.3	Accuracy Assessment	64
3.3.3.1	Overall Accuracy	64
3.3.3.2	Kappa Coefficient	65
3.4	Statistical Analysis	66
3.5	Flower Mapping	67
3.6	Spatial Map	67
4	RESULTS AND DISCUSSION	
4.1	Field Data	69
4.2	Band Combination and Image Enhancement	73
4.3	Supervised Classification	75
4.4	Accuracy Assessment in Forest Mapping	78
4.5	Raster to Vector Conversion	79
4.6	Above Ground Biomass Modeling	81
4.6.1	Above Ground Biomass Measurement	81
4.6.2	Radar Backscattering Calibration	83
4.6.3	Regression Analysis	84
4.6.4	AGB Regression Model and Mapping	86
4.6.5	Unsupervised Classification	88
4.6.6	Accuracy Assessment	93
4.7	Flowering Map	95
4.8	<i>Apis dorsata</i> Nesting Sites Distribution	97
4.9	Potential Honey Hunting Maps	101
5	CONCLUSION AND RECOMMENDATION	
5.1	Conclusion	105
5.2	Recommendation	109
	REFERENCES	112
	APPENDICES	128
	BIODATA OF STUDENT	151



LIST OF TABLES

Table		Page
2.1	Indicates the Elevation Angles and Incidence Angles of the seven Standard Beams, specified for near and far ranges(Luscombe, 1993)	22
2.2	Taxonomy of <i>Apis dorsata</i>	30
3.1	SPOT-5 image details	52
3.2	RADARSAT-1 images details	52
4.1	Classes in Maximum likelihood Classification (MLC) of SPOT-5 image	75
4.2	Statistical result of Maximum Likelihood Classification (MLC) of SPOT-5 image	77
4.3	Accuracy Total from Maximum Likelihood Classification (MLC) for SPOT-5 image	79
4.4	Above Ground Biomass (AGB) in flowering and non-flowering periods for <i>Melaleuca cajuputi</i>	82
4.5	Radar backscatter calibrate (Sigma Nought) from RADARSAT-1 images	83
4.6	Regression models in Flowering and non-flowering season of <i>Melaleuca Cajuputi</i>	84
4.7	Above Ground Biomass (AGB) estimates from ground and linear regression equation from radar backscattering in flowering season	87
4.8	Above Ground Biomass estimates (AGB) from ground and linear regression equation from radar backscattering in non-flowering season	88
4.9	Statistical results unsupervised classification (ISODATA) of Above Ground Biomass(AGB) in flowering season	91
4.10	Statistical results unsupervised classification (ISODATA) of Above Ground Biomass (AGB) in non-flowering season	93
4.11	Overall accuracy assessment for unsupervised classification (ISODATA) of Above Ground Biomass in flowering season	94



4.12	Overall accuracy assessment for unsupervised classification (ISODATA) of Above Ground Biomass (AGB) in non-flowering season	95
4.13	<i>Apis dorsata</i> nesting sites distribution data in Marang district	98



LIST OF FIGURES

Figure		Page
1.1	Land Cover Map of Peninsular Malaysia (Miettinen <i>et al.</i> , 2008)	2
1.2	Simplified Information System (Chandra & Ghosh, 2006)	6
2.1	How GPS works (McNamara, 2004)	15
2.2	SPOT-5 Satellite (Anon ^f , 2009)	20
2.3	Beam Modes of Ground Coverage in RADARSAT-1 (Anon ^b , 2009)	23
2.4	RADARSAT-1 as Right Looking Satellite (Anon ^b , 2009)	23
2.5	Flower and Leaf of <i>Melaleuca cajuputi</i> (Gelang)	28
2.6	<i>Melaleuca cajuputi</i> Trees	29
2.7	<i>Apis dorsata</i> Colony (a) Aggregation (b) Single	31
2.8	Interaction Mechanisms for Forest Canopies (Boyd and Danson, 2005)	36
2.9	Flow of Remotely Sensing Information to Biomass Estimation (Rosillo-Calle, 2007)	39
3.1	A Map of Study Area	45
3.2	Juno™ ST Handheld(a) Garmin 60 CX (b)	48
3.3	Diameter Tape for Calculate DBH	49
3.4	Haga Hypsometer Measuring Tree Height	51
3.5	Flowchart of Research Process	68
4.1	Training Site Locations in Marang district, Terengganu	70
4.2	Sampling Plots for Measurement of AGB from Field Locations in Marang District, Terengganu	71
4.3	Zooming Sampling Plots for Measurement of AGB from Field Locations in Marang District, Terengganu	72



4.4	False Color SPOT-5 in band 3,2 and 1	74
4.5	Maximum Likelihood Classification SPOT-5 Image , Marang, Terengganu	76
4.6	Percentages of Classes in Maximum Likelihood Classification MLC of SPOT-5 Image in Marang, Terengganu	77
4.7	Vector Map of Distribution of <i>Melaleuca cajuputi</i> and <i>Acacia auriculiformis</i> in Marang district	78
4.8	Regression between AGB and Radar Backscattering in Flowering Season	85
4.9	Regression between AGB and Radar Backscattering in Non-flowering Season	85
4.10	Unsupervised Classification on <i>Melaleuca cajuputi</i> Above Ground Biomass (AGB) in Flowering Season (November) on Marang District	90
4.11	Unsupervised Classification on Above Ground Biomass (AGB)'s <i>Melaleuca cajuputi</i> During Non-Flowering Season (August) on Marang District	92
4.12	The Flowering Distribution of <i>Melaleuca cajuputi</i> in Marang District	96
4.13	<i>Apis dorsata</i> Nesting Sites Distribution Map in Marang District	97
4.14	Forage Radius <i>Apis dorsata</i> in Marang District	100
4.15	The Foraging Radius of <i>Apis dorsata</i> and the Locations of Motorbike Parking Sites in the Honey Hunter's Area of the Marang District	102
4.16	Honey Hunting Map Which Indicated Road Network, Nesting sites, Motorbikes Parking and Flowering Map	103
4.17	Honey Hunting Map Which Indicated River Network, Nesting sites, Motorbikes parking and Flowering Map	104

LIST OF ABBREVIATIONS

AGB	: Above Ground Biomass
AOI	Area of Interest
β_1	: Intercept of Regression
B_0	Slope of Regression
CCRS	Canada Center for Remote sensing
CNES	Centre National d'études Spatiales
Cv	Coefficient of Variation
DBH	: Diameter at Breast Height
df	Degree freedem
DN	Digital Number
ENVI	Environmental for Visualizing Images
ESRI	Environmental Systems Research Institute
EMR	Electric Magnetic Radiation
etc	et cetera
FAO	: Food and Agriculture Organization



FCC	False Color Composition
FW	Fresh Weight
GPS	: Geographic Positioning System
GIS	Geographic Information System
GCPs	Ground Control Points
H	: Height
ha	Hectare
HRG	High Resolution Geometrical
I_j	Incidence Angle
j^{th}	Range Pixel
JUPEM	Jabatan Ukur dan Pemetaan Malaysia
k	Kappa Coefficient
log	Logarithm
MLC	Maximum Likelihood Classification
MIR	Mid Infrared
NIR	Near Infrared



NDVI	Normalized Difference Vegetation Index
P	Total Number of Pixels in All the Ground Truth Class
Pixel	Picture Elements
RS	Remote Sensing
r	Regression
R^2	Regression Square
R-G-B	Red-Green-Blue
RSO	Rectified Skew Orthomorphic Projection
ROI	Region of Interest
SAR	: Synthetic Aperture Radar
SPOT	Satellite Pour l'Observation de la Terre
SNSB	the Swedish National Space Board
SSTC	the Belgian Scientific, Technical and Cultural Services
TM	Thematic Mapper
σ^0	Sigma Nought



X_{kk}

Confusion Matrix Diagonal



CHAPTER 1

INTRODUCTION

1.1 Introduction

Forest is an important natural resource that plays a major role in supporting the livelihood of human like in providing material goods, such as fuel wood, commercial timber, non-wood products, and water for irrigation and drinking, preventing landslides or debris flows, providing protection from strong winds and purifying the atmosphere. It is a trove of biodiversity and genetic resource, as well as provider of other environmental services and a key player in poverty alleviation (F.A.O., 2005; Myers, 1992; Sellers, 1985).

Rainforest gets rainfall more than 150 cm/yr and it gives rise to twenty five different types, including evergreen lowland forest, evergreen mountain forest, tropical evergreen alluvial forest, and semi-deciduous forest. All rainforests, however, can be broadly classified as either tropical or temperate rainforests. The global distribution of equatorial rainforest is closely tied to the warm, moist climates that occur near to the Equator (Figure 1.1) (Adams & Ridge, 1994).

