

COMPARISON OF VEGETATION INDICES - SOIL-LINE
BASED INDICES FOR MARINE VEGETATION
MAPPING AT KELANTAN DELTA

NORSALIZA USAM

FAKULTI SAINS DAN TEKNOLOGI
UNIVERSITI MALAYSIA TERENGGANU
2007

COMPARISON OF VEGETATION INDICES (SOIL-LINE BASED INDICES)
FOR MANGROVE VEGETATION MAPPING AT KELANTAN DELTA

By

Norsaliza Usali

Research Report Submitted in partial fulfillment of
the requirement for the degree of
Bachelor of Applied Science (Biodiversity Conservation and Management)

Department of Biological Sciences
Faculty of Sciences and Technology
UNIVERSITI MALAYSIA TERENGGANU
2007

1100051219

This project should be cited as:

Norsaliza, U. 2007. Comparison of Vegetation Indices (Soil-line Based Indices) for Mangrove Vegetation Mapping at Kelantan Delta. Undergraduate thesis, Bachelor of Applied Science in Biodiversity Conservation and Management, Faculty of Science and Technology, Universiti Malaysia Terengganu, Terengganu. 94p.

No part of this project report may be produced by any mechanical, photographic, or electronic process, or in the form of phonographic recording, nor may it be stored in a retrieval system, transmitted, or otherwise copied for public or private use, without written permission from the author and the supervisor(s) of the project.



**JABATAN SAINS BIOLOGI
FAKULTI SAINS DAN TEKNOLOGI
UNIVERSITI MALAYSIA TERENGGANU**

**PENGAKUAN DAN PENGESAHAN LAPORAN
PROJEK PENYELIDIKAN I DAN II
RESEARCH REPORT VERIFICATION**

Adalah ini diakui dan disahkan bahawa laporan penyelidikan bertajuk: COMPARISON OF VEGETATION INDICES (SOIL-LINE BASED INDICES) FOR MANGROVE VEGETATION MAPPING AT KELANTAN DELTA oleh Norsaliza Usali, no. matrik: UK 9952 telah diperiksa dan semua pembetulan yang disarankan telah dilakukan. Laporan ini dikemukakan kepada Jabatan Sains Biologi sebagai memenuhi sebahagian daripada keperluan memperolehi Ijazah Sarjana Muda Sains Gunaan (Pemuliharaan & Pengurusan Biodiversiti), Fakulti Sains dan Teknologi, Universiti Malaysia Terengganu.

Disahkan oleh: / Verified by:

Penyelia Utama / Main Supervisor

Nama: **KASAWANI IBRAHIM**

Cop Rasmi: Pensyarah
Jabatan Sains Biologi
Fakulti Sains dan Teknologi
Universiti Malaysia Terengganu
21030 Kuala Terengganu, Terengganu.

Tarikh: 29 April 2007

Penyelia Kedua (jika ada) / Co-Supervisor (if applicable)

Nama: **MOHD SUFFIAN IDRIS**

Cop Rasmi: Pensyarah
Institut Oseanografi
Universiti Malaysia Terengganu (UMT)
21030 Kuala Terengganu, Terengganu.

Tarikh: 29 April 2007

Ketua Jabatan Sains Biologi / Head, Department of Biological Sciences

Nama: **DR. AZIZ BIN AHMAD**

Cop Rasmi: Ketua
Jabatan Sains Biologi
Fakulti Sains dan Teknologi
Universiti Malaysia Terengganu
21030 Kuala Terengganu

Tarikh: 30 April 2007

ACKNOWLEDGMENTS

In the name of ALLAH, the Most Gracious, the Most Merciful

Praise to Allah Almighty for his blessing allowed me to complete this thesis. I would like to express my sincere gratitude and deepest appreciation to my Supervisor, Mr. Kasawani Ibrahim for his guideline, advice and encouragement throughout this study.

A special thanks also to my co-supervisor, Mr. Suffian Idris for his comments, guidance, and suggestion of the thesis.

I wish to express my thanks to Institute of Oceanography (INOS) Universiti Malaysia Terengganu, Malaysian Center for Remote Sensing (MACRES) and State Forestry of Kelantan for their cooperation in providing the facilities during data collection, field work and during data processing and analysis.

Acknowledgments also dedicated to Mr. Razali because help me in identifying the mangrove species. Thanks also to Mr. Karthik for his help in process and analyze the data. Also I would like to express the deep thanks to the INOS staff, Mr. Nasir and Mr. Azri who have assisted me in technical during the studies.

I would like also to thank my friends Che Ku Akmar Che Ku Othman, Roziatul Zaila Bukari and Najiha Sudin for their helping and moral support.

Finally, my sincere gratitude and appreciation to my beloved mother, father, brothers, and sisters for their moral and money support.

TABLE OF CONTENTS

	Page
ACKNOWLEDDgements	ii
LIST OF TABLES	vi
LIST OF FIGURES	vii
LIST OF ABBREVIATIONS	ix
LIST OF APPENDICES	x
ABSTRACT	xi
ABSTRAK	xii
CHAPTER 1 INTRODUCTION	
1.1 Study Background	1
1.2 Objectives of the Study	2
CHAPTER 2 LITERATURE REVIEW	
2.1 Mangrove Forest	
2.1.1 Definition of Mangrove	3
2.1.2 Mangrove in the World	4
2.1.3 Mangrove in Asia	6
2.1.4 Mangrove in Malaysia	6
2.1.5 Importance of Mangrove	12
2.2 Landsat Thematic Mapper (TM)	13
2.3 Remote Sensing of Vegetation	15
2.4 Vegetation Index	
2.4.1 Definition of VIs	16
2.4.2 Application of VIs	17
2.4.3 Types of VI	19
2.4.4 Soil-line Based VIs	20
2.4.5 Application of VIs in Mangrove Forest	28

CHAPTER 3 METHODOLOGY

3.1	Description of Study Area	29
3.2	General Methodology	30
3.3	Satellite Images	31
3.4	Geometric Correction	31
3.5	Ground Truthing	32
3.6	Unsupervised Classification of Raw Image	32
3.7	VI Approach	33
3.7.1	PVI	34
3.7.2	SAVI	34
3.7.3	OSAVI	34
3.7.4	TSAVI	34
3.7.5	MSAVI	35
3.8	VI Analysis	35
3.8.1	Unsupervised Classification of VI	35
3.9	Accuracy Assessment	36

CHAPTER 4 RESULTS

4.1	General Distribution of Land Cover Types in Kelantan Delta	37
4.1.1	<i>Avicennia-Sonneratia</i> Forest	38
4.1.2	<i>Acanthus-Sonneratia</i> Forest	39
4.1.3	<i>Avicennia</i> Forest	40
4.1.4	Mixed <i>Acrostichum</i> Forest	41
4.1.5	Mixed <i>Sonneratia</i> Forest	42
4.2	Geometric Correction	43
4.3	Ground Truthing	44
4.4	Unsupervised Classification of Raw Image	44
4.5	Determination of Soil Line Slope and Intercept	47
4.6	VI Approach	48
4.7	Statistical Analysis of VI	48
4.8	Unsupervised Classification of VI	55
4.9	Accuracy Assessment	61

CHAPTER 5 DISCUSSION

5.1	Mangrove Forest Distribution	68
5.2	The Soil Reflectance	71
5.3	Soil-line Based VIs	73
5.4	Differences of Soil-line Based VIs Value for Mangrove Classes	75
5.5	The Classification and Accuracy of Soil-line Based VI	80

CHAPTER 6 CONCLUSION AND RECOMMENDATION	82
--	-----------

REFERENCES	84
-------------------	-----------

APPENDICES	92
-------------------	-----------

CURICULUM VITAE	94
------------------------	-----------

LIST OF TABLES

Table		Page
2.1	Estimates of mangrove areas	5
2.2	Mangrove area in top eight countries	5
2.3	Current extent (ha) of mangrove forest reserves and state land mangroves	11
2.4	The spectral bands of Thematic Mapper and its application	14
4.1	The Exclusive species of mangrove in Kelantan Delta	37
4.2	The Mean and Ranges value of the PVI, SAVI, OSAVI, TSAVI and MSAVI for mangrove class at Kelantan Delta	54
4.3a	Unsupervised error matrix classification for PVI	62
4.3b	Unsupervised error matrix classification for SAVI	63
4.3c	Unsupervised error matrix classification for OSAVI	64
4.3d	Unsupervised error matrix classification for TSAVI	65
4.3e	Unsupervised error matrix classification for MSAVI	66
4.4	The overall accuracy (%) and Kappa (k) statistic values generated from unsupervised classification of mangrove in Kelantan Delta	67

LIST OF FIGURES

Figure	Page	
2.1	Mangrove distribution in Peninsular Malaysia	8
2.2	Mangrove distribution in Sabah	9
2.3	Mangrove distribution in Sarawak	10
2.4	Tasselled cap plot by Kauth and Thomas (1976)	22
2.5	Linear relationship red (R) and near-infrared (NIR) reflectance of bare soil	24
3.1	The location of study area	29
3.2	Flow chart of methodology	30
3.3	Schematic diagram of the basic model (A) and complex (B) forms constructed in Model Maker module in ERDAS software	33
4.1	<i>Avicennia-Sonneratia</i> forest	38
4.2	<i>Acanthus-Sonneratia</i> forest	39
4.3	<i>Avicennia</i> forest	40
4.4	Mixed <i>Acrostichum</i>	41
4.5	Mixed <i>Sonneratia</i>	42
4.6	The geocoded images of Kelantan Delta	43
4.7	Distribution of mangrove class at Kelantan Delta determined by unsupervised classification	45
4.8	Unsupervised classification of Kelantan Delta	46
4.9	The soil line scatter plot extracted from landsat images in Kelantan Delta	47
4.10a	The gray scale image of PVI	49
4.10b	The gray scale image of SAVI	50
4.10c	The gray scale image of OSAVI	51
4.10d	The gray scale image of TSAVI	52
4.10e	The gray scale image of MSAVI	53
4.11a	The unsupervised classification map by PVI	56
4.11b	The unsupervised classification map by SAVI	57
4.11c	The unsupervised classification map by OSAVI	58
4.11d	The unsupervised classification map by TSAVI	59
4.11e	The unsupervised classification map by MSAVI	60

5.1	Spectral reflectance signature of Band 4 (NIR) and band 3 (Red) for mangrove classes in Kelantan Delta	77
5.2	Comparison of the mean value and standard deviation of PVI	77
5.3	Comparison of the mean value and standard deviation of SAVI	78
5.4	Comparison of the mean value and standard deviation of OSAVI	78
5.5	Comparison of the mean value and standard deviation of TSAVI	79
5.6	Comparison of the mean value and standard deviation of MSAVI	79

LIST OF ABBREVIATIONS

AOI	-	Area of Interest
ARVI	-	Atmospherically Resistant Vegetation Index
DN	-	Digital number
DVI	-	Different Vegetation Index
GEMI	-	Global Environment Vegetation Index
GIS	-	Geographic Information System
GPS	-	Global Positioning System
ha	-	hectare
IPVI	-	Infrared Percentage Vegetation Index
LAI	-	leaf area index
MACRES	-	Malaysian Center for Remote Sensing
MSAVI	-	Modified Soil-adjusted Vegetation Index
MSAVI2	-	Modified Soil-adjusted Vegetation Index 2
NDVI	-	Normalized Different Vegetation Index
NIR	-	Near Infrared
OSAVI	-	Optimized Soil-adjusted Vegetation Index
PVI	-	Perpendicular Vegetation Index
R	-	Red
RMS	-	Root Mean Square
RVI	-	Ratio Vegetation Index
SAVI	-	Soil-adjusted Vegetation Index
SPOT	-	Systeme Pour l' Observation de la Terre
TM	-	Thematic Mapper
TSAVI	-	Transformed Soil-adjusted Vegetation Index
VI	-	Vegetation Index
VIs	-	Vegetation Indices
WDVI	-	Weighted Differences Vegetation Index

LIST OF APPENDICES

Appendix		Page
A	General scene of Kelantan Delta	92
B	Table of accuracy for unsupervised classification at Kelantan	93

ABSTRACT

The study of comparison five soil-line based vegetation indices for mangrove mapping was carried out at Kelantan Delta. The aim of this research is to identify mangrove forest type based on soil-related vegetation indices which were Perpendicular Vegetation Index (PVI), Soil-adjusted Vegetation Index (SAVI), Optimized Soil-adjusted Vegetation Index (OSAVI), Transformed Soil-adjusted Vegetation Index (TSAVI) and Modified Soil-adjusted Vegetation Index (MSAVI) approach derives from Landsat Thematic Mapper (TM) 2000. Soil-line based VI which include soil slope, intercept and parameter were introduced in mangrove mapping in order to remove the soil background such as humus, root and rock which can alter the vegetation readings. From field survey, *Avicennia-Sonneratia* forest type was found as dominant mangrove class at Kelantan Delta. Total of five mangrove classes consist of *Avicennia-Sonneratia*, *Avicennia*, *Acanthus-Sonneratia*, Mixed *Acrostichum* and Mixed *Sonneratia* with accuracy 72.67% were determined from conventional unsupervised classification. Accuracy of indices were ranged from 70.00% to 79.14% and was improved the conventional unsupervised classification. SAVI was found the best performance of mangrove mapping if compare to other indices with accuracy 79.14% and can determine four mangrove classes. There were *Acanthus-Sonneratia*, *Avicennia*, *Avicennia-Sonneratia* and Mixed *Acrostichum* and Mixed *Sonneratia*. It might be due to capability of SAVI to constant their sensitivity in the full range of vegetation covers.