Journal of Theoretical and Applied Information Technology
31st October 2015. Vol.80. No.3

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

APPLICATION OF MANGROVE FOREST COVERAGE DETECTION IN NGURAH RAI GRAND FOREST PARK USING NDVI TRANSFORMATION METHOD

[1]I PUTU WAWAN SANJAYA PUTRA, [2]I KETUT GEDE DARMA PUTRA, [3]I PUTU AGUNG BAYUPATI, [4]A.A.K. OKA SUDANA, [5]I DEWA NYOMAN NURWEDA PUTRA, [6]NI KADEK DWI RUSJAYANTHI

[1,2,3,4,5,6] Department of Information Technology, Engineering Faculty in Udayana University
Bukit Jimbaran, Bali, Indonesia, Telp. +62 85102853533
E-mail: [1]wawansingaa@gmail.com, [2]ikgdarmaputra@gmail.com, [3]bayuhelix@yahoo.com,
[4]agungokas@unud.ac.id, [5]nurweda14@gmail.com, [6]dwi.rusjayanthi@gmail.com

ABSTRACT

This study aims to detect the area and the changes of Mangrove forest coverage in Ngurah Rai Grand Forest Park in Bali. This detection was managed automatically by using a particular application constructed by employing Matlab programming language. It is more rapid and effective rather than manual computation and direct field measurement. NDVI is the frequently used method in indentifying vegetation. The value of pixel of NDVI is obtained from a formula constituting two images of Landsat satellite. The pixel value of NDVI ranges between -1 to +1 in which the positive value indicates the vegetations and the negative value indicates non-vegetation objects. NDVI Threshold is a process of classifying objects based on the NDVI pixel value. NDVI Threshold is conducted by providing range of value towards NDVI pixel. Mangrove forest is included in the category of briny forest, the NDVI pixel value for this kind of forest ranges from 0.4 to 0.8. The result of NDVI Threshold is used to calculate the total pixel of NDVI which includes within that range. Then, the result will be multiplied to the spatial resolution of Landsat satellite to obtain the area of Mangrove forest coverage.

Keywords: *NDVI, Landsat, NDVI Threshold, Mangrove Forest*, *Mangrove Coverage*

1. INTRODUCTION

Manual computation is still frequently used to calculate the area of vegetation. Generally, any researches related to the field of Remote Sensing are conducted by utilizing an application of image processing provided by the third party application. This application is provided in the Internet, it can either be free-of-charge or charged.

The area of Mangrove forest in Indonesia is around 4.25 million hectares or 3.98% of the total area of Indonesian forest, however, it is only 2.5 million hectares of Mangrove forest which are considered well-managed [1]. Ngurah Rai Grand Forest Park is briny forest area. This kind of forest is highly affected by the ebb and flow of sea water. The main vegetation in this Grand Forest Park is Mangrove. Ngurah Rai Grand Forest Park is legalized based on the Decree of the Minister of Forestry in 1993 stated that the area of this Grand Forest Park is 1373.50 hectares. Administratively, Ngurah Rai Grand Forest Park is located in two regencies, which are Badung Regency and Denpasar City. Area functional shift, littering, and polluted water are the major problems affecting the growth of Mangrove forest in Ngurah Rai Grand Forest Park. The condition of that Mangrove forest can be identified by using various approaches, one of them is Remote Sensing managed by identifying index value of vegetation [2].

The index value of vegetation provides information regarding the percentage of the coverage of vegetation, Leaf Area Index, plants, biomass, FAPAR (Fraction of Absorbed Photosynthetically Active Radiation), photosynthesis capacity, and the estimation on the rate of carbon dioxide absorption [3] [4]. There are many methods that can be utilized to calculate Vegetation Index. Normalized Difference Vegetation Index (NDVI) is frequently utilized [5].

The data of Remote Sensing is the data obtained from the result of reflection of various wave lengths captured by a sensors, this sensors alter the wave lengths into numerical data to make it perceptible in the form of graph or image [6]. The Remote Sensing data processing is managed by utilizing image processing application, it is expected that this application can provide any information rapidly and effectively so that the data can be used in the process of analysis and

Journal of Theoretical and Applied Information Technology
31st October 2015. Vol.80. No.3

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

manipulation. To recognize the emergence of those problems, supervision over Mangrove coverage needs implementing immediately by utilizing any technologies, i.e. Remote Sensing and Digital Image Processing. The purpose of this study is to obtain the result of Mangrove area coverage, area of Mangrove coverage classification, and alteration of the area in particular years. This study was conducted by construction satellite image processing application using Matlab programming language.

2. METHODS

The common method for Application of Mangrove Forest Coverage Detection started from the image selection process obtained from Band Landsat imagery. To get the input of the bands images, user must first download it on earthexplorer.usgs.gov site. Figure 1 is a Flowchart of processing method using the implementation of Remote Sensing.

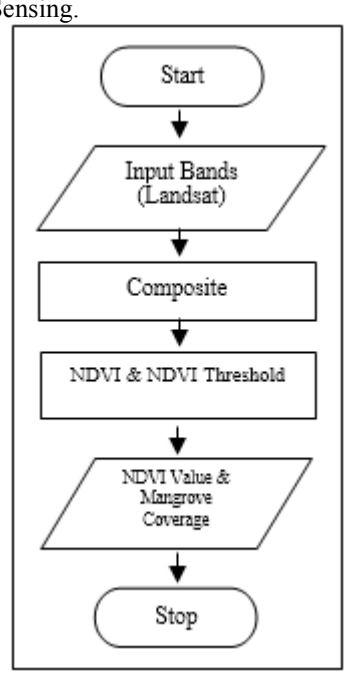


Figure 1: Flowchart of Image Processing Method

Image processing is started with the input of the Band Landsat imagery. There are two processes before achieving the final outcome of Mangrove vegetation area, which are Composite and NDVI processes using Reflectance correction [12].

The next stage is to build an application. This application has two menus with different processing purposes. The first is the NDVI Tools menu. This menu has the ability to process Band Landsat inputs in the form of image with TIF file format into information in the form of Mangrove coverage area. The second menu is the Coverage Changes menu. The menu has a function to display the Mangrove coverage area similar with the processing on the NDVI Tools menu, but this menu has more capabilities which can display Mangrove coverage area based on different date input as a comparison. This menu can also display the Mangrove area changes occur during a certain period. The entire process in this application can be seen in the following activity diagram.

2.1 Activity Diagram

Activity diagram in NDVI Tools and Coverage Changes are displayed in Figure 2 and Figure 3. Figure 2 describes the course of activity of NDVI Tools menu displaying the course of the Band inputs to displaying the final result in the form of Mangrove coverage area. Figure 3 represents the course of activity of Coverage Changes menu displaying the courses of Band inputs to displaying final result in the form of the area comparison and the shift of value of Mangrove coverage.

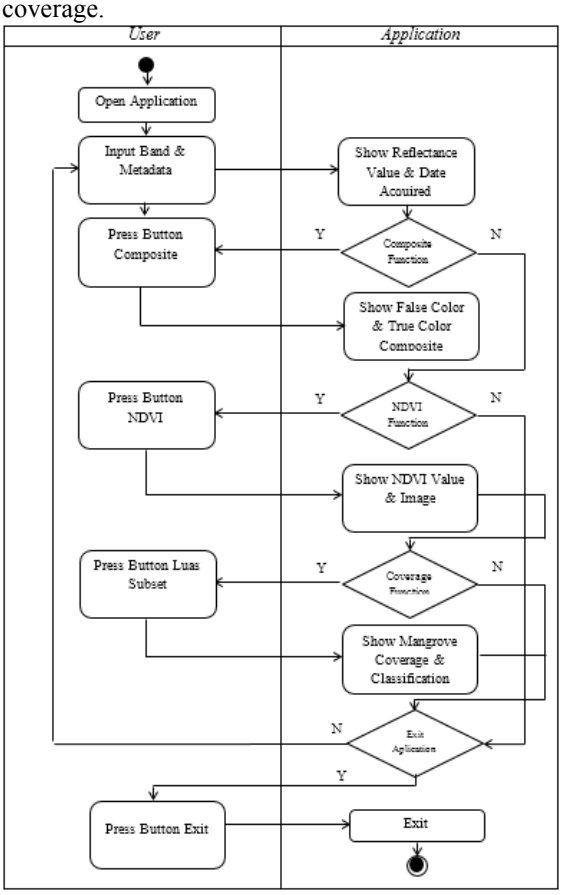


Figure 2: Activity Diagram of NDVI Tools

Journal of Theoretical and Applied Information Technology
31st October 2015. Vol.80. No.3

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

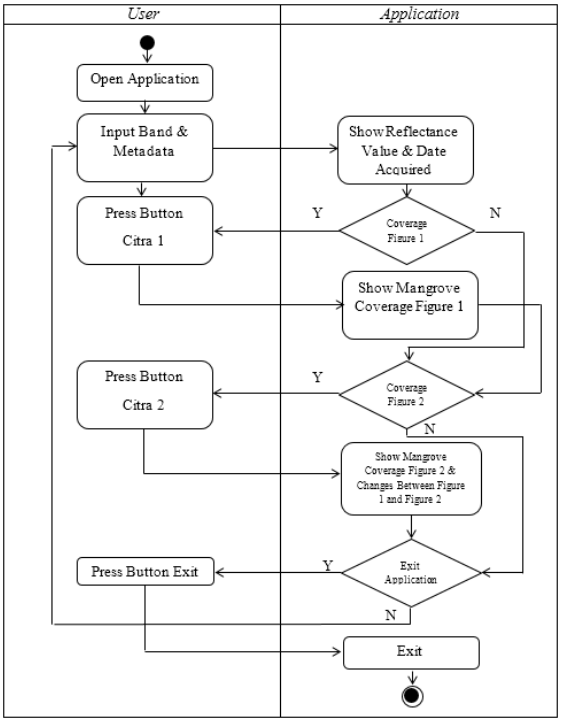


Figure 3: Activity Diagram of Coverage Changes

2.2 Bands Input

The images of Remote Sensing are attained from a particular satellite, aircraft, or other vehicle. Those images are originated from the sensors recordings which have distinct characteristics within each level of height, it determines the differences of the resulted data of Remote Sensing [7]. Landsat is one of distant sensing vehicle launched in 1972 [8]. The satellite images used in this study are originated from different Landsat satellites, they are Landsat 7 and Landsat 8. This Landsat image can be downloaded for free in http://earthexplorer.usgs.gov.

Landsat satellite has several electromagnetic wave sensors with different recording specifications. The sensor of Landsat satellite is widely known as Band. In this study, the input of image is obtained from four types of Bands, which are Near Infrared Band, Visible Red Band, Visible Green Band, and Visible Blue Band. As seen in Table 1, Landsat satellite specifications have different Band numbers based on the types of captured electromagnetic waves.

Table 1: Landsat Band Requirements (Source: NASA).

Wave Spectrum	Landsat 8 OLI/TIRS	Landsat 7 ETM+	Spatial Resolution (one pixel)
Near Infrared	Band 5	Band 4	30m x 30m
Visible Red	Band 4	Band 3	30m x 30m
Visible Green	Band 3	Band 2	30m x 30m
Visible Blue	Band 2	Band 1	30m x 30m

Figure 4 is the images obtained from the wave reflection. Each image is going to be utilized as an input during processing process to determine NDVI value and the area of Mangrove forest coverage. In determining NDVI value, there is a composite feature requiring the combination of those four Bands, while the process of NDVI requires only two input Bands, which are Near Infrared and Visible Red.

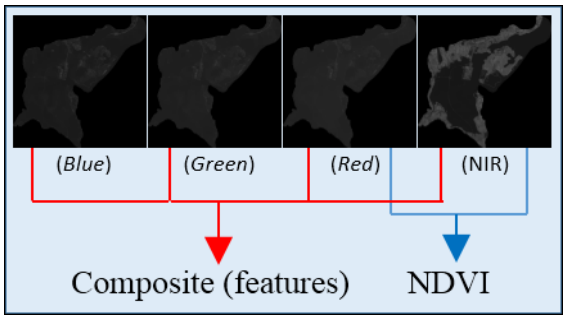


Figure 4: Input Image

Figure 5 represents how subset process is conducted by using Region of Interest (ROI). Subset is the process of cutting the satellite images into the desired size. ROI data are in the form of vector standing as the administrative boundary of a region. This vector is available and it can be freely downloaded from several governmental sites.

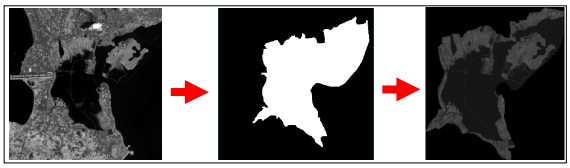


Figure 5: Subset by Region of Interest

2.3 Normalized Difference Vegetation Index

Digital image analysis using Vegetation Index transformation method is more effective for the research objects with wide and homogenous distribution area [9], i.e. Mangrove forest. NDVI (Normalized Difference Vegetation Index) is a calculation process involving satellite images to attain Vegetation Index value. Generally, NDVI is

Journal of Theoretical and Applied Information Technology
31st October 2015. Vol.80. No.3

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

employed to identify the rate of greenery, this is advantageous for the classification of vegetation area. NDVI value is acquired from mathematical formula between Near Infrared Band and Visible Red Band [10]. Those two Bands are selected due to light reflection by objects (reflectance), light absorption by objects (absorption), and light transmission by objects (transmittance). Maximum reflection on vegetation occurs within the wave plength of Near Infrared. This maximum reflection is caused by the structure of the leaves (mesophyll) that can increase Near Infrared wave reflection. Maximum absorption occurs within the wave length of Visible Red. This absorption is caused by Chlorophyll [10].

NDVI equation is the result of the subtraction of Near Infrared Band pixel value to Visible Red Band pixel value which is divided by the sum of Near Infrared Band pixel value to Visible Red Band pixel value. Band input which is formerly used must be corrected radio-metrically [12]. This process produces image with new pixel value as illustrated in Figure 6. Following is the formula of NDVI [11].

$$NDVI = \frac{(\text{Band NIR} - \text{Band Visible Red})}{(\text{Band NIR} + \text{Band Visible Red})} \quad (1)$$

NDVI process produces new image with the value of pixel ranges from -1 to +1. The positive value of pixel indicates the existence of vegetation, while the negative value of pixel indicates non-vegetation object. The classification of object constructed based on the value of NDVI is represented in Table 2 [13].

Table 2: NDVI Value.

Classifications	NDVI Value
Cloud, Water, Snow	< 0
Rocks and Bare Land	0 – 0,1
Grassland and Shrubs	0,2 – 0,3
Tropical Forests, Mangrove Forest	0,4 – 0,8

2.3 NDVI Threshold

NDVI Threshold is the process of setting up range limitation to NDVI pixel value. In this research, Mangrove obtains NDVI Threshold with the range of NDVI pixel value of 0.4 to 0.8 referred to Table 2. The calculation of Mangrove coverage area is administered by sum up NDVI pixels that gets into the range of NDVI Threshold. The total of pixel is multiplied by spatial resolution value of Landsat image, which is 30 x 30 (m^2).

The illustration in Figure 7 shows the image of NDVI Threshold with the size of matrix of 5 x 5 obtaining new values; 14 pixel points which worth is 1 and 11 pixel points which worth is 0. The pixel point which worth is 1 is NDVI Threshold under the consideration that NDVI value of Mangrove ranges from > 0.4 and ≤ 0.8, hence, it can be ascertained that NDVI Threshold which worth is 1 is Mangrove vegetation.

-0.3	0.4	0.5	0.6	0.1		NDVI
0.4	0.3	0.5	0.6	0.8		
0.8	-0.4	0.7	0.3	-0.2		
0.1	0.5	0.6	0.6	0.3		
0.6	0.5	-0.4	0.8	0.6		

Figure 6: NDVI Transformation

				30 m			
0	0	1	1	0	30 m		Mangrove
0	0	1	1	1			
1	0	1	0	0			
0	1	1	1	0			
1	1	0	1	1			

Figure 7: NDVI Threshold

The process of identifying the area based on the classification of Mangrove coverage can be managed by classifying the value of NDVI Threshold into several segments. The value of NDVI Threshold can be classified into several ranges only if it does not go beyond the minimum and maximum boundaries of NDVI value of Mangrove forest itself. Classification process of Mangrove coverage divided into 4 parts. The classification of Mangrove coverage is showed in Table 3.

Journal of Theoretical and Applied Information Technology
31st October 2015. Vol.80. No.3

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Table 3: Coverage Classification.

Classifications	NDVI Threshold
Very Rare	0,4 < NDVI ≤ 0,45
Rare	0,45 < NDVI ≤ 0.5
Medium	0,5 < NDVI ≤ 0.55
Full	0,55 < NDVI ≤ 0.8

3. RESULT AND DISSCUSION

The implementation of the method was managed by constructing a particular application. This application consists of two menus. The main menu are labeled as NDVI Tools. These menu can process NDVI equations and provide the information related to Mangrove forest coverage area in a certain date. Figure 8 shows the image of NDVI Tools.

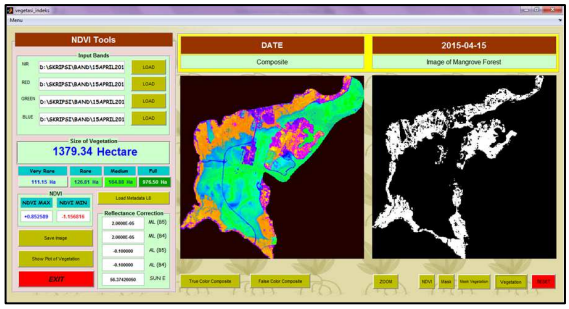


Figure 8: NDVI Tools

The subsequent menu is Vegetation Changes menu. This menu processes NDVI equations from two inputs of images with different dates. Those inputs are processed to form a new image and displayed, the areas are compared afterwards. The menu of Vegetation Changes is represented in Figure 9.

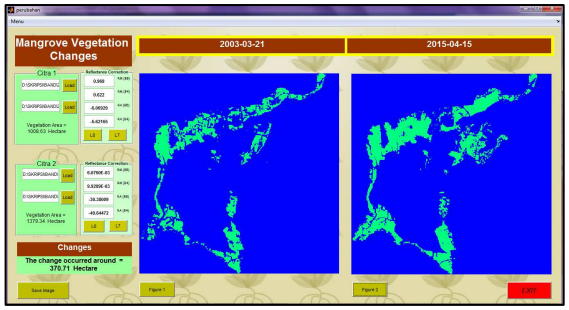
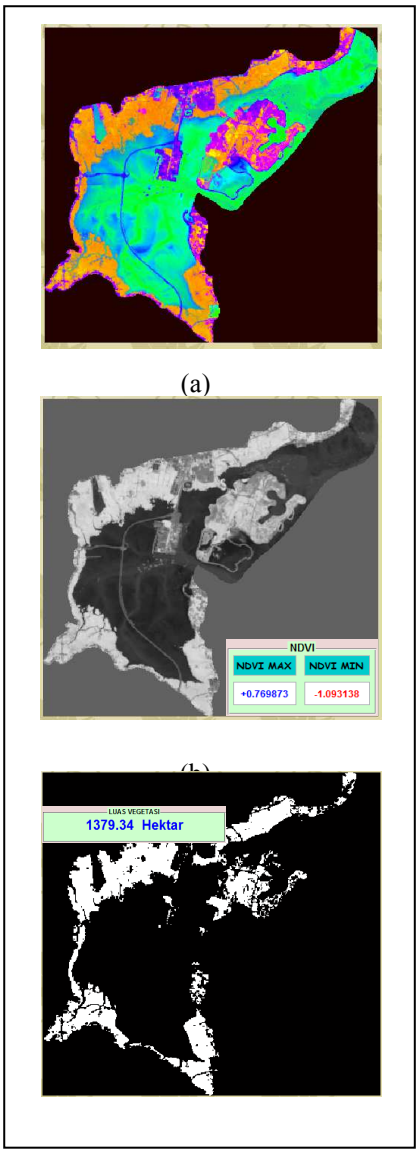


Figure 9:Vegetation Changes

Experiment was carried out by examining some functions in NDVI Tools menu and Vegetation Changes menu. Band Composite was conducted by combining three Band inputs and putting color intensity over those Bands. Those three Band inputs are Near Infrared Band, Red Band, and Blue Band. The colors displayed are dominant rather than the other objects, it makes Mangrove objects easily recognized. The process of Band Composite is depicted in Figure 10a.



(a)

(c)

Figure 10: Composite (a) NDVI (b) NDVI Threshold (c)

Figure 10b shows images obtained from the result of NDVI. The inputs used are the images of Near Infrared and Visible Red Band. NDVI images are processed to create NDVI Threshold image displayed in Figure 10c. The completing process of NDVI must be conducted to display the maximum and minimum NDVI pixel values. The coverage of Mangrove vegetation is showed after the user executed NDVI Threshold.

Journal of Theoretical and Applied Information Technology
31st October 2015. Vol.80. No.3

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

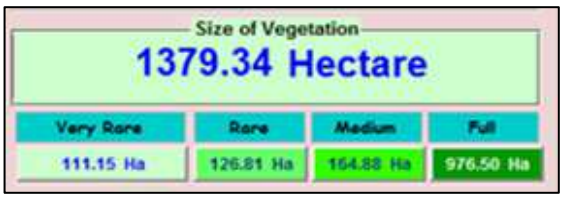


Figure 11: Mangrove Coverage Area

Mangrove coverage area is displayed by using the unit of hectare. Figure 11 shows Mangrove coverage area in Ngurah Rai Grand Forest Park in 15th of April 2015. The showed Mangrove coverage area is classified into several classes of coverage and the results can be seen in Table 4.

Table 4: Coverage Results (15 April 2015).

Classifications	Result
Very Rare	111.15 Hectare
Rare	126.81 Hectare
Medium	164.88 Hectare
Full	976.50 Hectare

The Changes of area is displayed by using the unit of hectare similar to the calculation of Mangrove forest coverage area. Figure 12 represents the changes of Mangrove coverage area occurring in 21st of March 2003 and 15th of April 2015.

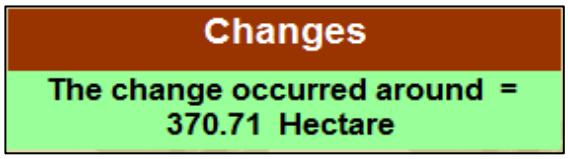


Figure 12: Mangrove Coverage Changes

The area calculation conducted in 21st of March 2003 required inputs of images obtained from Landsat 7 satellite, while The area calculation conducted in 15th of April 2015 required inputs of images obtained from Landsat 8 satellite. By referring to Table 1, the wave of Near Infrared in Landsat 7 was captured by sensor Band 4 and the wave of Visible Red was captured by sensors Band 3. Further explanations are presented in Table 5, it includes the inputs and the results of area calculation.

Table 5: Mangrove Coverage Changes

Date	Band Inputs	Mangrove Coverage
15 April 2015	Band 5 & Band 4 (Landsat 8 OLI)	1379,34 Ha
21 March 2003	Band 4 & Band 3 (Landsat 7 ETM+)	1008,63 Ha

Based on the explanations given in Table 5, it can be stated that Mangrove forest in Ngurah Rai Grand Forest Park undergoes a coverage of area which is 1008.63 hectares into 1379.34 hectares.

4. CONCLUSIONS

The area calculation and the shift of Mangrove forest coverage area administered by using NDVI transformation method are effective since Mangrove vegetation in Ngurah Rai Grand Forest Park spreads widely and homogenously. To facilitate the area calculation and shift, Matlab language programming-based application was constructed. This application requires image input which is originated from Landsat satellite. This image input was used in this research administered in 21st of March 2003 and 15th of April 2015. The Mangrove coverage area in 2015 is 1379.34, while it is only 1008.63 in 2003, it can be stated that there is area alteration as much as 370.71 hectares. Therefore, it can be concluded that Mangrove coverage in Ngurah Rai Grand Forest Park increases as much as 370.71 hectares within 12 years.

5. FURTHER RESEARCH DIRECTION

Vegetation analysis using Vegetation Index transformation is not limited to the use of NDVI method, it is expected that the development of this application does not focus on NDVI method and Mangrove forest only. The selection of Vegetation Index method should be conformed to the kinds of vegetation, whether the vegetation is heterogeneous or homogeneous.

ACKNOWLEDGEMENT

The authors would like to thank Department of Information Technology, Engineering Faculty in Udayana University for providing support and

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

assistance this research.

REFRENCES:

[1] Nontji, Anugrah. *Laut Nusantara*. Djambatan, Jakarta, 2005.

[2] Yunhao, C., S. Peijun, L. Xiaobing, C. Jin, and L. Jing. *A Combined Approach for Estimating Vegetation Cover in Urban/Suburban Environments From Remotely Sensed Data*. Computers & Geosciences, 2006. 32. pp. 1299 – 1309.

[3] Horning, N. *Global Land Vegetation; An Electronic Textbook.* NASA Goddard Space Flight Center Earth Sciences Directorate Scientific and Educational Endeavors (SEE). 2004.

[4] Ji, L., A.J. Peters. *Performance Evaluation of Spectral Vegetation Indices Using a Statistical Sensitivity Function.* Remote Sensing of Environmental. 2007. 106, 59 – 65.

[5] Danoedoro. P. *Pengolahan Citra Digital, Teori dan Aplikasinya dalam Penginderaan Jauh.* Fakultas Geografi Universitas Gadjah Mada, Yogyakarta. 1996. pp. 253.

[6] Purwadhi. S.H. *Interpretasi Citra Digital.* Gramedia Widiarsana Indonesia. Jakarta, 2001.

[7] Richards, John.A. Jia, Xiuping. *Remote Sensing Digital Image Analysis; An Introduction.* Springer, 2006.

[8] Sutanto. *Penginderaan Jauh Jilid 2.* Gajah Mada University Press, Jogjakarta. 1994.

[9] Arnanto, Ardi. *Pemanfaatan Transformasi Normalized Difference Vegetation Index (NDVI) Citra Landsat TM Untuk Zonasi Vegetasi di Lereng Merapi Bagian Selatan.* Geomedia, 2013. Vol. 11, No. 2. pp. 166 – 168.

[10] As-syakur, A.R., I W.S. Adnyana. *Analisis Indeks Vegetasi Menggunakan Citra Alos/Avnir-2 nan Sistem Informasi Geografi (SIG) Untuk Evaluasi Tata Ruang Kota Denpasar*. Jurnal Bumi Lestari, 2009. Vol. 9, No. 1. pp. 1 – 11.

[11] Jensen, J.R. *Remote Sensing of The Environmental Earth Resource Perspective.* Prentice Hall. New Jersey-USA. 2000.

[12] Kustiyo. Dewanti, Ratih. Lolitasari, Inggit. *Pengembangan Metoda Koreksi Radiometrik Citra SPOT 4 Multi-Spektral dan Multi-Temporal Untuk Mosaik Citra.* Prosiding. SINASINDERAJA. Bogor, 2014 p. 82 – 83.

[13] Benny. *NDVI.* Bennys Idea. https://benichi.wordpress.com/2008/11/28/ndvi .November 28, 2008. Accessed July 14, 2015