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Investigation of Land Cover Classification in Oil Palm Area Based on ALOS PALSAR 2 Image

Endyana Amin* and Soni Darmawan
Department of Geodesy Engineering, Institut Teknologi Nasional (Itenas), Bandung - INDONESIA
* Corresponding author e-mail: endyanaamin94@gmail.com

Abstract

Oil Palm is one of the most productive oil seeds in Indonesia. At present, Indonesia is the largest producer and exporter of oil palm worldwide. In general, oil palm production will be related to the age of the plant. The development of plant age will undergo physical changes in biomass and canopy density, so to identify the growth of planting age of oil palm can be used satellite image analysis from remote sensing. The objective on this study are examining techniques of image classification ALOS PALSAR 2 for land cover mapping of oil palm area. Study areas in oil palm plantations areas of Simpang Empat sub-district, Asahan Regency, North Sumatera. Methodology consisted of data collection of image ALOS PALSAR 2 and data of age of oil palm planting, the processing includes geometric correction, filtering, image cropping, making training sample using region of interest (ROI) tools, band combination, image classification for several methods like minimum distance, mahalanobis distance, maximum likelihood, and support vector machine, and then using confusion matrix for accuracy assessment. The results from this study are ALOS PALSAR 2 image classified with overall accuracy of 85.21% and coefficient kappa 0.6763 with RGB band combinations for support vector machine method as the most effective method for this research.

Keywords: remote sensing, radar image, classification, L-band, spatial distributin of age of oil palm.

1. Introduction

Oil palm is one of the most productive oil seeds and a very important commodity in agriculture in Indonesia. The production of oil palm is dominated by Indonesia and Malaysia which can produce about 85 to 90% of the world's total oil palm production. Recently, Indonesia is the largest producer and exporter of oil palm worldwide (Indonesia Investment, 2016).

Since the 1990s, oil palm plantations in expansion in the humid tropics and land under oil palm increased to 12.6 million hectares in 2010 with annual oil palm production exceeding 32 million tonnes indicating global demand for oil palm will be around 62 to 63 million tonnes by 2015 (Darmawan et al., 2016). In a long time, the world demand for oil palm shows an increasing trend with the rapidly expanding world population. Therefore, it will increase consumption of products with raw materials of oil palm (Indonesia Investment, 2016). In addition, this oil palm has many benefits for human life processed into cooking oil raw materials, butter raw materials, toothpaste raw materials, raw materials for paint, etc. (Kelapa sawit, http: //kelapasawit.ptnasa. Net / benefits-palm-palm/).

In general, oil palm production will be related to the age of the plant. Oil palm have a regular cropping pattern, because it is planted in blocks according to the year of planting. The development of plant life will undergo physical changes of biomass and canopy density, so for the provision of growth of planting age with oil palm can be done by using satellite image analysis from remote sensing data (Aswandi, 2012). Remote sensing data has been shown to play an important role in monitoring and mapping that can be used on land usage, land cover, and plantation areas (Darmawan et al., 2016).

The use of the satellite ALOS PALSAR 2 in this study because the radar image data has energy derived from the satellite itself, without the need for energy from the sun and is suitable for tropical regions such as in Indonesia. Study areas in oil palm plantations areas of of Simpang Empat sub-district, Asahan Regency, North Sumatera.

2. Methodology

The methodology consisted of data collection of ALOS PALSAR 2 and age data of oil palm, data processing including geometric correction, filtering, cropping image, making training sample using region of interest (ROI) tools, band combination, image classification by using the minimum distance method, mahalanobis distance, maximum lilkelihood, and support vector machine, to accuracy assessment using confusion matrix. In general, the methodology in this study can be seen in Figure 1.

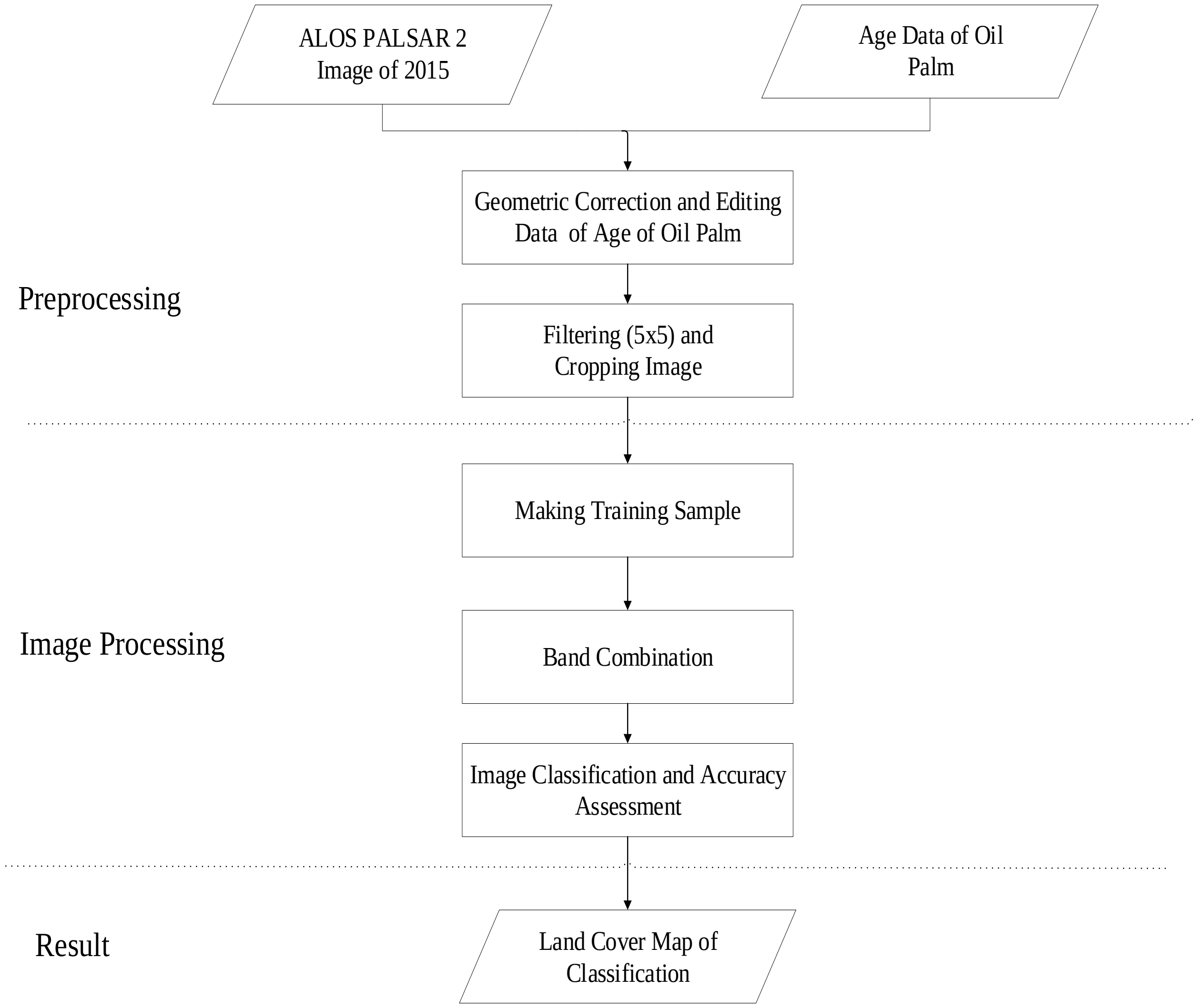

Fig. 1: Methodology on this study

2.1. Data Collection

The data collected is include the image of ALOS PALSAR 2 Level 1.5 with 6.25 m resolution as the primary data consisting of two polarization of HH and HV. Image data acquisition on June 1 2015 obtained from Lembaga Penerbangan dan Antariksa Nasional (LAPAN) for Asahan District, North Sumatera Province. Meanwhile, data on the age of oil palm plantation in Simpang Empat sub-district, Asahan regency, North Sumatera province as secondary data calculated until 2016 also obtained from LAPAN.

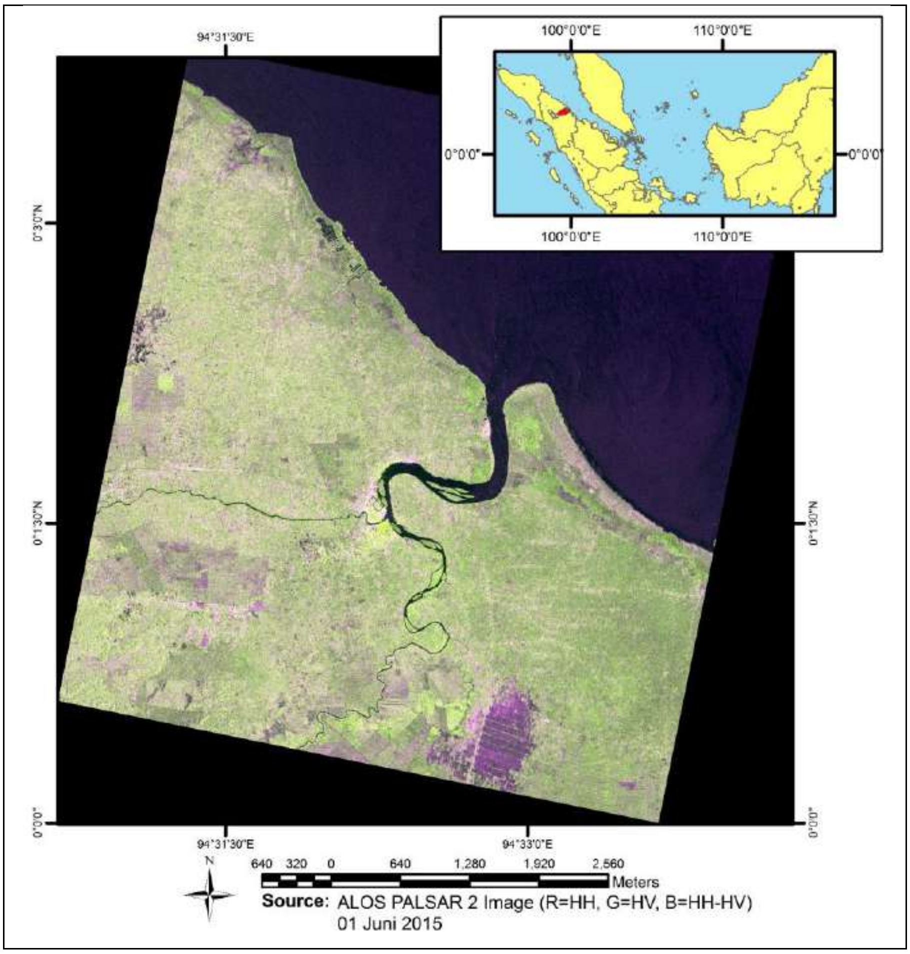

Fig. 2: Data used on study areas

2.2. Preprocessing

The image data of ALOS PALSAR 2 obtained by preprocessing for geometric correction of image, editing data of age of oil palm plant, filtering image, and cropping. After that, the process of digital image processing for making training sample to make a classification of land cover area of oil palm plantation and then accuracy assessment to determine the most effective image classification method.

- Geometric Corrections

ALOS PALSAR image 2 Level 1.5 has georeferenced that has a multi-look view and regardless of noise. In this study, checking and controlling the quality of objects in the image by making the points of Independent Control Point (ICP) as much as 15 points spread in the study area with reference used to Google Earth. The parameters used are the root mean square error (RMSE) value, if the RMSE value from the distribution of ICP points below from 1 pixel is then the result of the geometric correction of the image with the image to map method is assumed to have geometric correction systematically (Purwadhi, 2001 in Kartikasari and Sukojo, 2015).

- Editing Data of Age of Oil Palm

Editing data of age of oil palm because the data that gives information on the age of oil palm plant has a position not in accordance with the actual position, then the editing process needs to be done so that the age data of the palm oil plant is in the actual location. By improving the data position of the age of oil palm plantation, it can assist the process of image interpretation for the oil palm area.

- Filtering

The filtering process is to improve the quality of the image display and is designed to 'filter' the spectral information so as to produce a new image that has a different spectral value variation than the original image (Danoedoro, 2012). Filtering image which used in this study is the adaptive filters process, which uses filter weights that refer to the level of spots present in the image display, where the image smoothing is obtained based on local statistical value in the filtering process (Tso and Mather 2001 in Ozdarici , 2010). Meanwhile, the type of adaptive filters used is a lee filter with size 5x5. Image filtering by lee filter type is chosen because it can be useful to smoothing the spots on the image data while maintaining the image sharpness while reducing the existing noise in the image display (Tso and Mather, 2009 in Wijaya, 2014).

- Cropping Image

Cropping is intended to make image processing for classification more effective, so the image is focused on study area which has block of age of oil palm plantation. Therefore, the study area studied is dominated by the distribution of oil palm crops.

2.3 Digital Image Processing

Digital image processing focuses on making training sample using region of interest (ROI) tools and selection of classification methods to determine an effective classification method for mapping land cover of oil palm plantation area. Meanwhile, for the band combinations, using two different combinations of HH + HV bands for the first combination and RGB band combinations consist of (R = HH, G = HV, B = HH-HV).

Region of Interest (ROI)

On this study, training sample is making by using ROI tools. This ROI tool using to create land cover classes consisting of oil palm, non-oil palm vegetation (rice fields, fields, plantations, etc.), settlements, and waters that will be used for image classification. Based on the interpretation of the image, this study area is dominated by the objects of oil palm plantation. Therefore, making training of sample are focused on samples of oil palm objects. The number of training samples can be seen in Table 1.

Table 1: Number of Training Sample

Land Cover Classes	Number of Training Sample
Oil Palm	102
Non-oil palm Vegetation	30
Settlements	30
Waters	10

- Image Classification and Accuracy Assessment

Image classification in this study using four methods, which is minimum distance, mahalanobis distance, maximum likelihood, and support vector machine. This image classification making by two band combinations, the first is HH+ HV polarization, while the second is (R = HH, G = HV, B = HH-HV). After image classification, then accuracy assessment with using confusion matrix based on the result of image classification with sample data taken by using ROI tool.

3. Conclusion

The result of image classification from image processing that has been done is the result of classification of guided image consisting of four methods, including: minimum distance, mahalanobis distance, maximum likelihood, and support vector machine. Each method involves two band combinations of HH+ HV polarization and RGB consisting of (R = HH, G = HV, B = HH-HV). From the results of classification of guided imagery and then tested the accuracy to determine the most appropriate and effective classification method for mapping the oil palm area.

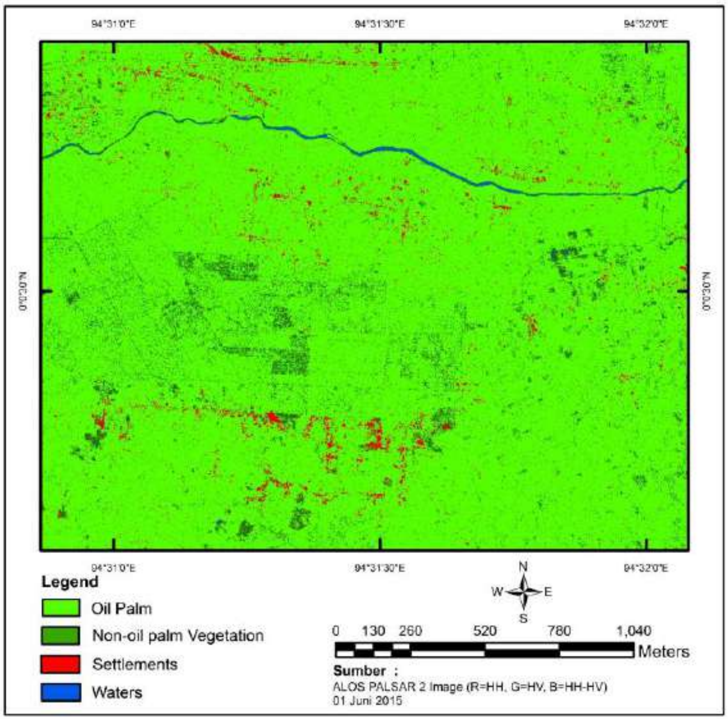

Fig. 3: Image classified using support vector machine methods (R = HH, G = HV, B = HH-HV)

After the image classification process is done for all the methods, it can be determined the most appropriate and effective classification method for mapping the oil palm plantation area based on the image of ALOS PALSAR 2 of Simpang Empat sub-district, Asahan Regency, North Sumatera Province. The parameters taken to determine the most appropriate and effective method are seen based on two main components of overall accuracy and kappa coefficient. The results of the accuracy assessment of each classification method can be seen in Table 2.

Table 2: Accuracy Assessment

Image Classification Method	Band Combinations			
	Band HH + Band HV		(R= HH, G= HV, B= HH-HV)	
	Overall Accuracy (%)	Kappa Coefficient	Overall Accuracy (%)	Kappa Coefficient
Minimum Distance	68.7686	0.4164	66.1085	0.3846
Mahalanobis Distance	73.1401	0.5004	74.6206	0.5249
Maximum Likelihood	74.5752	0.5308	77.0043	0.5682
Support Vector Machine	84.6867	0.6645	85.2112	0.6763

From that Table 2, it can be assessed that the support vector machine method is the most appropriate and effective method for mapping the oil palm plantation area based on ALOS PALSAR image 2. In addition, it can be analyzed that combination with RGB also shows that by adding band combinations, then also adds on the value of accuracy obtained. This result shows that three classification methods which is mahalanobis distance, maximum likelihood, and support vector machine produces a relatively higher accuracy when compared with band combinations that only use two polarization (HH and HV). The accuracy assessment on this study also shows that the image processing in this study is directly proportional to the research conducted by Nooni et al. (2014), which states that the support vector machine classification method is the right method for palm oil mapping and has more accuracy than the maximum likelihood method.

Based on the results of the research that has been done, it can be argued that the supervised classification for mapping of oil palm plantation land cover based on ALOS PALSAR 2 image with the Support Vector Machine (SVM) method is the most effective method among other supervised classification methods such as minimum distance, mahalanobis distance, and maximum likelihood. Using the combination of bands (R = HH, G = HV, B = HH-HV), the SVM method shsows an accuracy assesment of 85.21% and a kappa coefficient of 0.6763.

4. Acknowledgements

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